

**REPUBLIC OF YEMEN**

***Ministry of Telecommunication & Information Technology***

***Public Telecommunication Corporation***

**Technical Specifications for**

**(DUCT OR DIRECT BURIED OPTICAL FIBER CABLES)**

**With Schedule of Quantities**

**Issued 2012**

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## 1. GENERAL:

- 1.1 This specification covers the general requirements for Optical fibers telecommunications cables used for duct or direct buried installation.
- 1.2 The optical fiber should be single mode and high silica material (based on ITU-T recommendation G652.D).
- 1.3 The type of optical fiber cable as described in this specification is as follow:-
- 1310/1550 nm SM optical fiber armored for duct or buried applications with capacity (up to 216 fibers) and suitable for used DWDM systems.
  - The tenderers should submit offer for the underground cable of capacities (up to 216 fibers).

## 2. OPTICAL FIBER CONSTRUCTION & TECHNICAL PARAMETERS:

- 2.1 Operation wavelengths should be 1310nm and 1550nm wavelength bands.
- 2.2 The geometric structures and optical characteristics should be as per ITU-T Rec. G652.D, as briefly indicated below. The tenderer should give the corresponding figures for each these items for their offered cables:

Items	Specified values
Mode field diameter at 1310nm	9.5 $\mu$ m $\pm$ 0.6 $\mu$ m
Mode field diameter at 1550nm	10 $\mu$ m $\pm$ 1 $\mu$ m
Mode field concentricity error	Less than 0.6 $\mu$ m
Cladding diameter	125 $\pm$ 1 $\mu$ m
Cladding non circularity	Less than 1%
cladding concentricity error	Less than 0.6 $\mu$ m
Coating diameter	245 $\pm$ 5 $\mu$ m
coating non circularity	Less than 5%
Fiber cut-off wavelength	1150-1280 nm
Cable cut-off wavelength	Less than 1260 nm
Chromatic dispersion coefficient:	
- At 1300-1324nm	Less than 3 ps/nm.Km
- At 1550 nm	Less than 17.5 ps/nm.Km
Zero dispersion wavelength	1300-1324nm
Zero dispersion slope	Less than 0.092ps/nm <sup>2</sup> .Km
Attenuation coefficient:	
- 1310 nm	Less than 0.35dB/Km
- 1550 nm	Less than 0.21dB/Km
PMD	Less than 0.1 ps/ $\sqrt$ Km

### 2.3 Optical fiber materials:

Optical fibers are composed of a solid inner cylinder (typically made of Germanium doped silica glass) called the core, surrounded by an outer layer (typically silica) called the cladding. The refractive index of the core is larger than that of the cladding.

### 2.4 Coating:

A protective dual an ultraviolet (UV) light- cured acrylate coating should be applied directly to the cladding surface.

The coating should be applied over the entire length without bare spots of the variation in thickness. The coating should be color-coded and if possible have additional ring marking. The refractive index if the coating should be higher than that of the cladding, which means that undesirable light lunched into the cladding is absorbed within a few meters. The coating must be removable mechanically or chemically for jointing fibers. The values of coating stripping must be in range 1.3N to 8.9N

## 2.5 Technical properties:

### 2.5.1 Tensile load:

All optical fibers with primary coating shall pass the proof test before cabling. The tensile load carried for duration of approximately 1 second shall not be less than 5N (about 0.4Gpa, 58Kpsi) and the proof strain of optical fiber shall not be less than 1%.

### 2.5.2 Bending radius:

The minimum bending radius of the coated fiber should be less than 30mm.

### 2.5.3 Color-coding:

All fibers used in the cable are color-coded with undeniable color to facilitate individual fiber identification. The color-coding should be according to IEC 304 as follow:

No. of fibers	Color of fiber	No. of fibers	Color of fiber
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Grey	11	Pink
6	white	12	aqua

### 2.5.4 Temperature ranges:

Transportation and storage temperature	-20°C to +50°C
Installation temperature	-10°C to +50°C
Operating temperature	-10°C to +50°C

## 3. OPTICAL CABLE DESIGN:

The basic building block of the optical cable required is a multi fiber loose tubes (buffers) each tube have up to as the following table:-

Type of cable	Number of fibers per tube	Number of loose tube and location	
		First Layer	Second Layer
10F	2 fibers	5	-----
16F	4 fibers	4	-----
24F	4 fibers	6	-----
36F	6 fibers	6	-----
48F	8 fibers	6	-----
64F	12 fibers	6 (once tube for 4 fibers)	-----
72F	12 fibers	6	-----
96F	12 fibers	8	-----
144F	12 fibers	12	-----
180F	12 fibers	6	9 + 3 filler
192F	12 fibers	6	10 + 2 filler
196F	12 fibers	6	11 (once tube for 4 fibers)+1 filler
216F	12 fibers	6	12

For others these tubes are jelly filled and stranded (SZ stranded) around a nonmetallic central strength member in one layer or two isolated layer (according cable capacity as the table above). The cable core is covered with inner sheath, corrugated steel tape and outer sheath. The cable construction preferred is as indicated in the following paragraphs.

### 3.1 Cable core:

The cable core consists of a central strength member, loose tubes, filling compound, and core covering tape(s). In additional, a polyester tape (water blocking tape) should be applied over the cable core.

### 3.2 Central strength member:

The central strength member shall be PE-coated Reinforced Glass Fiber; the outer diameter of the central strength member shall not be less than 1.8mm (according to the size of the cable).

### 3.3 Loose tube color-coded:

The tube (buffer) which made of Polybutylene Terephthalate must hold its shape, be tough, not to be susceptible to aging and be very flexible. The tube should be smooth inside, causing the lowest possible resistance to movement of the fibers. It should be filled with thixotropic jelly compound. The dimension of the loose tube should be within the following typical values:

Outside diameters: 2-3.5mm (according to number of fibers)

Wall thickness: approx 20% of outer diameter

Every loose tubes used in the cable core should be color coded to facilitate individual loose tube identification as follow:

First layer		Second layer	
No. of tube	Color of tube	No. of tube	Color of tube
1	Blue	1	Blue
2	Orange	2	Orange
3	Green	3	Green
4	Brown	4	Brown
5	Grey	5	Grey
6	white	6	white
7	Red	7	Red
8	Black	8	Black
9	Yellow	9	Yellow
10	Violet	10	Violet
11	Pink	11	Pink
12	aqua	12	aqua

### 3.4 Stranding:

The loose tube should be stranded around the central strength member using the reverse lay (SZ) stranding method. A suitable binder must be wound around the stranded elements.

### 3.5 Cable core filing:

The empty interstices in the cable core should be filled with a suitable compound at very high pressure (about 15 bars). This compound must have a composition such that it is not detrimental to the properties of the other cable elements. The compound must have a negligible swelling tape on the PE sheath and a low thermal expansion coefficient. A barrier layer of petroleum resistant and relaxing thermoplastic adhesive extruded around the cable core serves as an additional barrier for the filling compound.

### 3.6 Core wrap:

The stranded core should be covered with a layer of a polyester material with thickness at least 0.2mm.

### 3.7 Identification:

An identification tape, durably marked with R.Y – P.T.C the manufacturer's name and the year of manufacture of the cable, shall be placed longitudinally, straight or in spiral, under or over the water blocking material.

This information shall be repeated at intervals of maximum 300mm.

### 3.8 Rip cords:

At least two yarn rip cords should be provided with cable as (one under inner sheath and one under outer sheath).

### 3.9 Inner PE cable sheath:

The kind of cable core PE sheath should have the following features: low densities, high viscosity, break elongation, and easy workability. The inner sheath thickness should be 1.0 mm (nominal) with a suitable dielectric barrier layer.

### 3.10 A armor:

A corrugated steel tape shall be Electrolytic Chrome Steel (ECCS) tape with a polymer coating applied to both sides for rodent, termite and corrosion protection.

### 3.11 Outer PE cable sheath:

The outer sheath covers the cable core with inner sheath and armor. The outer sheath consists of an extruded layer of black weather resistant polyethylene (MDPE). The average thickness should be 1.8 to 2.0mm.

### 3.12 Cable outer diameter:

The cable outer diameter should not be more than 22mm (according to the number of fibers).

3.13 The tender shall give a cross sectional diagrams of cables offered with the details of the structure and content of the cable

3.14 Catalog must be attached and similar to the data sheath.

## 4. Length marking:

4. 1 The length number shall be marked at regular intervals of one meter along the outer sheath of the entire cable length.

4. 2 The accuracy of the marking shall be held within a limit of  $\pm 1\%$ .

4. 3 Each cable shall have the following information clearly marked between the numbers marked:

- Name of manufacturer.
- Year of manufacturer.
- Code of cable.

4. 4 The color of these marking shall be undeniable and preferably to be white color.

## 5. MECHANICAL CHARACTERISTICS:

### 5.1 Tensile strength

The allowable maximum tensile strength in Newton shall be indicated in the offer for the cable when tested as per ICE 794 – 1 – E1 tensile performances with the following consideration:

- Maximum tensile strength shall be at least 2000N by the method ICE 794 – 1 – E1 at least 5meter length.
- Mandrel diameter: 30 times the cable outer diameter.
- Duration of load: 5 minutes.

During the tensile test the cable elongation, the fiber elongation and the change in attenuation should be registered as a function of the tensile force and indicated in the offer technical sheet.

The tests must not affect the functioning of the optical fiber.

### 5.2 Crush performance:

The offered cable shall meet the impact test as per ICE 794 – 1 – E4 impact with following consideration:-

- A point of cable in factory length shall be subjected to 10 times impacts of hammer head of 25mm in diameter, 1Kg in weight and 1meter in high of dropping.
- The distance of impacts 19cm along the cable.

On the completion of test, no fiber break shall occur and the outer PE sheath of cable shall not be cracked. Maximum added loss shall not exceed 0.1dB.

### 5.3 Repeated bending:

The offered cable shall meet the repeated bending test as per IEC 790 – 1 – E6 repeated bending with the following consideration:-

Bending diameter	20 X the cable outer diameter
Applied load	25Kg
Bending angle	90 degree
Bending cycle	25 times
Bending speed	1 cycle per 2 second

On the completion of test, no fiber break shall occur and the outer PE sheath of cable shall not be cracked. Maximum added loss shall not exceed 0.1dB.

#### 5.4 Torsion:

The offered cable shall meet the torsion test as per IEC 794 – 1 – E7 torsion with the following consideration:-

Test length	2m
Applied load	25Kg
Twist angle	+180 degree
Twist cycle	not less than 10 times

On the completion of test, no fiber break shall occur and the outer PE sheath of cable shall not be cracked. Maximum added loss shall not exceed 0.1dB.

#### 5.5 Water penetration test:

One-meter specimen of the finished cable shall be supported horizontally and one-meter head of water shall be applied at one end of cable core at  $23\pm 5^{\circ}\text{C}$  for a period of 24 hours.  
At the end of the test period, no water shall have leaked from the opposite end of the cable.

#### 5.6 Temperature performance:

At least 1.000 meter of the cable should be subjected to in temperature cycle test with great variation in environmental temperature. The attenuation should not vary more than 0.1dB/Km at 1310nm and 1550nm for any fiber in the test.

#### 5.7 Sheath:

- (a) The maximum melt flow index should not be exceeding 0.28 g/10 minute.
- (b) The tensile strength should not be less than  $12.5\text{N/mm}^2$  and the ultimate elongation not less than 400%.
- (c) Resistance to environment stress cracking should not be allowed more than 2 failures from 10 tested specimens.
- (d) The carbon black content should be  $2.5\pm 0.5$  percent (weight).

### 6. Cable life:

The fiber and cable shall be designed for a live expectancy for at least 30years without serious degradation of the performance or reliability when maintained in accordance with the manufacturer's recommendations and when operated in the environmental condition.

### 7. COMPLIANCE

The tenderer should be state their compliance with specification in figures and detailed statements any deviation suggested by manufacture should be fully documented and may be presented the word (comply) is not sufficient for this purpose.

### 8. SUPPLY EXPERIENCE

The tenderer should be submitting document of supply experience.

### 9. SAMPLES

- 9. 1 The tender should offer 4 four samples of the offered cable with length not less 1m, clearly showing all the cable layer and to clarity the difference between the samples and the offered cable.
- 9. 2 The sample must be stamp by Manufacture Company.

## **10. Test for geometrical, Optical & transmission characteristics:**

Tests on the finished cables shall be made to prove compliance with all requirements of this specification. The Bidder shall submit full details of quality assurance procedures, which shall ensure that the cable fully comply with the requirements of the specification.

### **10. 1 Geometric tests shall include the following:**

- Mode field diameter.
- Cladding diameter.
- Mode field concentricity.
- Cladding non-circularity.
- Primary coating diameter. (measuring method: microscope)

### **10. 2 Optical properties test of the fiber shall include the following:**

- Refractive index profile.
- Maximum theoretical numerical aperture.
- Cut off wavelength.

### **10. 3 For each production length, to be delivered in Yemen the following measurements shall be performed:**

- Attenuation at 1310nm and 1550nm.
- Chromatic dispersion at 1310nm and 1550nm.
- Polarization mode dispersion.

### **10. 4 The bidder shall indicate and explain the test method at the time of submission of the bid.**

### **10. 5 Independently certified test records of the specified materials, components of assembled cable parameters shall be submitted.**

### **10. 6 The detailed test reports for each drum of cabled shall be submitted on or before delivery cable.**

### **10. 7 The approval to attend two PTC engineers to test the cables during the manufacture on the cost of the tenderer.**

## **11. SHIPPING:**

### **10. 1 Drum length:**

The nominal drum length should be 4,000 meters (+100 meters without any additional cost)

### **10. 2 Length of cable shall be shipped on wooden reels. The diameter of drum must not exceed 1.7 meters.**

### **10. 3 After completion of factory test, the outside end of the cable shall be sealed heat shrinkable cap.**

### **10. 4 Drum axle diameter shall be 110mm.**

### **10. 5 A distinguishing number and the following information shall be plainly marked on the outside of each drum:**

- Manufacture's name and country of origin.
- Consignee's name & address
- Purchase order No. & date.
- Number of fibers.
- Length and type of cable.
- Drum number.
- Net and gross weights.

### **10. 6 An arrow shall be painted on the drum to show direction of rolling (i.e in the opposite direction to that in which the outer end of the cable points) and the words 'ROLL THIS WAY' shall be lettered on the drums. Drums shall be lettered 'HANDLE WITH CARE' and 'SLING THROUGH CENTER HOLE ONLY' in English language and also in Arabic.**

### **10. 7 All cables shall be protected against damage by insects, vermin's, termites and other similar creatures.**



## 12. TECHNICAL DATA SHEETS (ENCLOSED):


Includes data sheet should be filled in and stamped by the concerned tenderer.

Any changes in the stamped data sheet submitted to PTC which might affect the technical figures in your offer will be neglected and will lead to the total rejection of your offer.

*Technical data sheet  
Table 1  
Cable construction*

Characteristics	Offered by the tenderer
1- No. of tubes	
2- No. of fibers per tube	
3- Central strength member	
- material	
- Diameter	
4- Loose tube	
- Material	
- Outer diameter	
- Thickness	
- Type of filling compound	
5- Tube assembly	
- Tube layout	
- Stranding type	
6- Flooding compound material	
7- Core wrap	
- Material	
- Thickness	
8- Internal identification tape	
9- Rip cords	
10- Inner sheath	
- material	
- Thickness	
11- Armouring	
- material	
- Thickness	
- Coating material & Thickness	
12- Outer sheath	
- material	
- Thickness	
13- Cable outer diameter	
14- Carbon black content (%)	
15- Length marking	

16-External identification mark	
17-Drum length	
18-Drum flange diameter	
19-Drum core diameter	
20-Outside width	
21-Central hole diameter	
22-Cable weight (Kg/Km)	
23-Test results of mechanical characteristics:	
- Tensile strength	
- Impact	
- Repeated bending	
- Water penetration	
- Operating Temperature / Humidity Range	
24-Cable life	



*Technical data sheet*

*Table 2  
Fiber data*

Characteristics	Offered by the tenderer
<b>1- Fiber material:</b>	
- Core	
- Cladding	
- Coating	
<b>2- Geometrical Specification:</b>	
- Mode field diameter (1310 nm)	
- Mode field diameter (1550 nm)	
- Cladding diameter	
- Primary coating diameter	
- Mode field concentricity error	
- Cladding non-circularity	
- cladding concentricity error	
- Coating non-circularity	
<b>3- Optical and performance specification:</b>	
- Attenuation at 1310 nm (db/Km)	
- Attenuation at 1550 nm (db/Km)	
- Fiber cut-off wavelength	
- Cable cut-off wavelength	
- Chromatic dispersion (ps/nm.Km)	
- At 1300-1324nm	
- At 1550 nm	
- Zero dispersion wavelength	
- Zero dispersion slope (Ps/nm <sup>2</sup> .Km)	
- Refractive index difference	
- Effective group index of refraction:	
- At 1310 nm	
- At 1550 nm	
- PMD (Ps/√Km)	
<b>4- Mechanical specification:</b>	
- Proof test	
- Coating stripping (mechanical stripping)	
- Minimum bending radius in splice enclosure	

*Technical data sheet*  
*Table 3*  
*Sample*

Characteristics	Offered by the tendere
1- Manufacture's code for offered cable	
2- Manufacture's code for sample submitted with tender.	
3- List of deviation: - Between PTC specification and offered cable - Between offered cable and sample submitted	

*Technical data sheet*  
*Table 4*  
*Attenuation Vs Wavelength*

<i>Attenuation Vs Wavelength</i>		
<b>Range (nm)</b>	<b>Ref (nm)</b>	<b>Max. increased (dB/Km)</b>
<b>1285 to 1310</b>	<b>1310</b>	
<b>1525 to 1575</b>	<b>1550</b>	

**NOTES:**

The tenderes must be reply to the following points:-

1. Statement of complete form manufacturing company regarding the compliance with PTC specifications.
2. Respond to and comply with PTC Technical schedules.
3. Attach the Catalogs and documents containing instructions on how to install cables.
4. Manufacturer must submit company profile and experience.
5. Manufacturer's brand name must be printed on sample(s), which must be bringing with offer.
6. The approval to attend two PTC engineers to test the cables during the manufacturing process.

ملاحظات:

على مقدم العرض الالتزام بالآتي:

- 1- الإجابة المعملية من الشركة المصنعة على كل مواصفات المؤسسة ( عروض الاستجابة).
- 2- الإجابة على المواصفات الفنية الموضحة في الجداول الفنية.
- 3- إرفاق الكتالوجات والوثائق التي توضح تركيب الكابلات المطلوبة.
- 4- إرفاق الخبرة التزويدية للمصنع.
- 5- إحضار عينة (عينات) مع العرض على أن يكون مطبوعاً عليها اسم الشركة المصنعة بشكل واضح.
- 6- الموافقة على استضافة عدد (2) مهندسين لحضور عملية الفحص المصنعي للكابلات عند التصنيع.

**The essential standards for duct or direct buried optical fiber cables**

No	1- Optical Cable construction	Specifications
1	No. of tubes	According PTC specification
2	No. of fibers per tube	According PTC specification
3	Central strength member	PE coating FRP
4	Flooding compound	JELLY
5	Inner sheath	LDPE
6	Outer sheath	MDPE

No.	2- OPTICAL FIBER CONSTRUCTION & TECHNICAL PARAMETERS	Specifications
1	Fiber material: - Core - Cladding - coating	GERMANIUM DOPED SILICA GLASS PURE SILICA DUAL UV LIGHT- CURED ACRYLATE
2	Geometrical Specification: - Mode field diameter (1310 nm) - Mode field diameter (1550 nm) - Cladding diameter - Primary coating diameter - Mode field concentricity error - Cladding non-circularity	9.5 $\mu$ m $\pm$ 0.6 $\mu$ m 10 $\mu$ m $\pm$ 1 $\mu$ m 125 $\pm$ 1 $\mu$ m 245 $\pm$ 5 $\mu$ m LESS THAN 0.6 $\mu$ m LESS THAN 1%
3	Optical and performance specification - Attenuation at 1310 nm (db/Km) - Attenuation at 1550 nm (db/Km) - Fiber cut-off wavelength - Cable cut-off wavelength - Chromatic dispersion - At 1300-1324nm - At 1550 nm - PMD (Ps/ $\sqrt$ Km)	LESS THAN 0.35db/Km LESS THAN 0.21db/Km 1150 – 1280 nm LESS THAN 1260nm  LESS THAN 3ps/nm.Km LESS THAN 17.5ps/nm.Km LESS THAN 0.1ps/ $\sqrt$ Km

No.	3- Mechanical specification	Specifications
1	Coating stripping (mechanical stripping)	1.3 – 8.9N
2	Minimum bending radius in splice enclosure	30mm