THAI FIBER OPTICS CO., LTD.

SPECIFICATION

OF

SINGLE MODE OPTICAL FIBER (G.652 D)

FOR

TOT CORPORATION PUBLIC COMPANY LIMITED

Specification No. TFS-1010-02

Issued Date : March 10, 2007

(PORNSAWAN BOONTARAWA)

DEPUTY FACTORY MANAGER

(YUICHI SEKII)

FACTORY MANAGER

Certificate: No. 157... Certificate: No. 196777

DIRECTOR & GM : _____ DOC. No. _____

MARKETING DEPARTMENT DISTRIBUTED DATE _____

SINGLE MODE OPTICAL FIBER CABLE
(OFC for Core Network)

1. GENERAL

1.1. This specification covers the requirements of the standard single mode optical fiber cable to be supplied to TOT Public Company Limited (TOT) intended primarily for use in outside plant network.

1.2. The single mode optical fiber cable herein after referred to as the “CABLE” shall comply with the requirements of this specification and generally meet any latest relevant ITU-T Recommendation or better.

1.3. This specification shall be mainly designed to apply for core network/backbone network which is the optical network link from the exchange or access node to other exchanges or access node. Furthermore this specification shall also be able to apply for passive optical network (PON) such as G-PON, GE-PON, etc. by specifying attenuation at all three PON transmission wavelength : 1310 nm , 1490 nm and 1550 nm.

1.4. The fiber of the cable shall be the dispersion un-shifted fiber having low water peak attenuation fiber for full spectrum transmission range from 1285 nm to 1625 nm (including the extended band 1360 nm -1460 nm).

1.5. The primary design consideration of the cable shall protect the optical fibers from environmental and mechanical stresses.

1.6. The cable shall be applied for aerial, duct and direct buried installation.

1.7. The cable proposed shall be new and its lifetime shall be at least 25 years without any significant deterioration.

1.8. Full details of this following information shall be provided in bidding document by bidder. Failure in this section, the proposal shall be **Disqualified**.

1.8.1. Fiber information: manufacture name, factory location, manufacturing method (i.e. MCVD, OVD, VAD, etc.) and the refractive index.

1.8.2. Product specification issued by manufacturer including cable weight (kg/km), overall diameter of cable and cable drum specification.

1.8.3. Lifetime calculation of the proposed cable as required in section 1.7.

1.8.4. Test method and test data result of all requirement of section 2.1, 2.2, 2.3.2.2, 2.3.3 and 5 according to this specification.

1.8.5. Fully details of sags and tensions as required in section 4.1.9 c) and 4.4.11.

1.8.6. Fully filled down in test instrument list which is attached to this specification including the pictures of all test instruments involved.

1.9. The other test method standards which are equivalent to as specified in this specification shall be allowable.

2. FIBER CHARACTERISTICS

All characteristics of the cabled fiber (fiber of finished cable) shall be, at least, in accordance with the ITU-T Recommendation G.652.D and shall be as follows.

Unless otherwise specified, the test method of section 2.1 and 2.2 shall be accordance with the ITU-T Recommendation G.650.

2.1. Geometrical Characteristics

2.1.1. Cladding Diameter

The nominal value of the cladding diameter shall be 125 μm. The cladding deviation from nominal shall not exceed the limits of ±1μm.

2.1.2. Core-Clad Concentricity Error

The Core-Clad concentricity error shall not exceed the limit of 0.5 μm.

2.1.3. Cladding Non-Circularity

The maximum value of the cladding non-circularity shall not be more than 1.0%.

2.2. Transmission Characteristics

2.2.1. Mode field Diameter

The nominal value of the mode filed diameter at 1310 nm. shall be 9.2 μm. The mode field diameter deviation shall not exceed the limits of ± 0.4 μm

2.2.2. Cable Cut-Off Wavelength (λcc)

The cable cutoff wavelength in deployment condition shall not exceed 1260 nm according to EIA/TIA-455-170

2.2.3. The attenuation coefficient shall be as follows :

Wavelength (nm)	Maximum Attenuation (dB/km)
1310	0.35
1383*	0.35
1490	0.24
1550	0.21
1625	0.23

* Maximum attenuation at this wavelength represents post-hydrogen aging performance according to IEC 60793-2-50 regarding the B1.3 fiber category.

2.2.4. The attenuation coefficient for the wavelengths range from 1285 nm to 1330 nm shall not exceed the attenuation coefficient at 1310 nm by more than 0.03 dB/km.

2.2.5. The attenuation coefficient for the wavelengths range from 1525 nm to 1575 nm shall not exceed the attenuation coefficient at 1550 nm by more than 0.02 dB/km.

2.2.6. The maximum value of chromatic dispersion coefficient shall not be greater than 3.5 ps/(nm.km),18.0 ps/(nm.km) and 22.0 ps/(nm.km) at the 1310 nm, 1550 nm and 1625 nm wavelength respectively.

2.2.7. The zero dispersion wavelength, λ_0, shall be between 1300 nm and 1324 nm, and the maximum value of the dispersion slope at λ_0 , shall not be greater than 0.093 ps/(nm^2 .km)

2.2.8. The polarization mode dispersion coefficient

The PMD coefficient of individual fiber and the PMD link design value, PMD_Q shall not be greater than 0.1 $ps/\sqrt{km}$

2.2.9. The maximum attenuation with macrobending shall not be exceed the specified value as follows :

100 turns 30 mm. radius $\leq$ 0.10 dB at 1550 nm.

2.3. Material Properties of the Fiber

2.3.1. Fiber Materials

The fiber shall be made of high grade silica, compound silica glasses or equivalent material.

2.3.2. Protective Material

2.3.2.1. The primary protective coating shall be made of UV curable acrylate, UV curable urethane, epoxy acrylate or equivalent material.

2.3.2.2. The primary coating diameter of fiber shall be 245 $\pm$ 5 μm. according to EIA/TIA-455-173.

2.3.2.3. Removal of the primary coating for jointing preferably shall be achieved without the use of chemicals.

2.3.3. Each fiber shall be proof-tested to at least 0.69 Gpa (100 kpsi) in accordance with EIA-455-31C or the optical fiber proof test by IEC 60793-1-30.

3. CABLE STURCTURE

3.1. The cable structures shall accommodate at least the following fiber capacities :

a) 12 fibers
b) 24 fibers
c) 36 fibers
d) 48 fibers
e) 60 fibers
f) 72 fibers
g) 84 fibers
h) 96 fibers
j) 108 fibers
k) 120 fibers
l) 144 fibers
m) 216 fibers
n) 240 fibers
o) 264 fibers
p) 288 fibers
q) 312 fibers

3.2. The required cable structure and color identification shall be specified in the table 1 and table 2 respectively.

Fiber Capacities	No. of elements by layers		buffer tubes x fibers in buffer tube
	1st	2nd	
12	5	-	2 x 6
24	5	-	4 x 6
36	5	-	3 x 12
48	5	-	4 x 12
60	5	-	5 x 12
72	6	-	6 x 12
84	7	-	7 x 12
96	8	-	8 x 12
108	9	-	9 x 12
120	10	-	10 x 12
144	12	-	12 x 12
216	6	12	18 x 12
240	7	13	20 x 12
264	8	14	22 x 12
288	9	15	24 x 12
312	10	16	26 x 12

Table 1 Cable Structure

Fibers/buffer tube	Fiber, Unit Identification
1	Blue
2	Orange
3	Green
4	Brown
5	Slate
6	White
7	Red
8	Black
9	Yellow
10	Violet
11	Rose
12	Aqua
13 – 16	Color 1-4 with a Black tracer (these items shall be applied to identify only the buffer tube.)

Table 2 Fiber and Unit Color Identification

3.2.1. The color identification specified in table 2 shall be in accordance with EIA/TIA-598-A (Optical Fiber Cable Color Coding).

3.2.2. The coloring shall be stable during the lifetime of the cable. The fiber color ink shall be durably cured surrounding all fiber surfaces with color specified. The colored fiber ,at least 2 hours after inking, shall be confirmed the quality of ink coating by using the industry-wide accepted “MEK Rub” test that herein after called the fiber rub test as described in item 5.10.

3.3. Minimum Bending Radius of Cable
The minimum allowable bending radius of the cable shall be 20 times the external diameter of the cable during handling or installation, and 15 times when fixed.

4) CABLE APPLICATIONS

The cable intended to use in aerial, direct buried and duct installation shall meet the requirements in section 4.1, 4.2, 4.3 and 4.4 respectively.

4.1. AERIAL CABLE

4.1.1. Cable core
The cable core shall, at least, consist of the strength member, fiber buffer tubes, fibers, fillers (if necessary) and swellable materials with tape or yarn or equivalent material for water blocking.

4.1.2. The strength member
The strength member located centrally, called the central strength member (CSM), shall be made of non-metallic material. The CSM shall provide both tensile and anti-buckling strength to the cable.

4.1.3. Fiber buffer tube

a) The fiber shall be surrounded by the buffer tube. The buffer tube shall be made of a single layer of polybutylene terephthalate (PBT) or a dual layer of polycarbonate and PBT or equivalent material.

b) The buffer tube shall be fully water-blocked with a thixotropic compound or equivalent material. The buffer tube compound shall be non-hygroscopic, non-nutritive to fungus, electrically non-conductive and shall be free from dirt and foreign matter and the compound shall be readily removable with conventional non-toxic solvents.

c) The buffer tube shall be resistant to kinking and stranded around the CSM using stranding method of Reverse Oscillating Lay (ROL) Technique (SZ direction).

4.1.4. The filler/fillers
The filler/fillers shall be placed on position that they shall not interrupt the consecutive positioning of the buffer tube.

4.1.5. The swellable materials for waterblocking

a) The cable core shall use the dry core technology and shall be fully water-blocked with the dry swellable materials such as tape or yarn or equivalents.

b) The swellable material shall contain super absorbent polymer (SAP) which rapidly swell upon contact with water.

4.1.6. Core covering

a) The core shall be completely covered with one or more layers of dry swellable materials or non-hygroscopic dielectric materials.

b) The core binder shall be helically applied around the core of stranded cables to secure the buffer tubes in their position and shall be made of polyester or equivalent materials.

c) For additional strength member, in case of non figure eight self-supporting cable such as direct buried and duct cable, one or more layers of stranded aramid yarns shall be wrapped around the core covering to be assured that the tensile strength of the cable is sufficient.

4.1.7. Ripcords

a) The ripcord shall be non-hygroscopic, non-wicking, dielectric and shall be continuous throughout the whole cable length. The ripcord material shall be aramid yarn or equivalents.

b) Two ripcords shall be provided under the sheath to be diametrically opposite of each other and provide a means for quick sheath removal.

c) Each ripcord shall have sufficient strength to be capable of slitting the sheath for a continuous length of 1(one) meter.

4.1.8. Cable sheath

a) The cable sheath shall be made of black high density polyethylene (HDPE) and containing a suitable antioxidant to offer maximum protection in hostile environment. The cable sheath shall contain carbon black for UV light protection and shall not promote the growth of fungus and free from holes, splits, blisters or other imperfections.

b) The minimum thickness of the cable core sheath shall be 2 mm. The minimum thickness of the support strand sheath shall be 1.0 mm. The minimum dimension of the integral web shall be 2 mm x 2 mm. The qualification of cable sheath shall be according to the table below. The procedure for testing the cable sheath specification shall conform to paragraph 5.9.

Parameter	Specification
1. Carbon Black	2.6 ± 0.25 %
2. Minimum Tensile Strength	168 kg/cm^2
3. Minimum Elongation	300 %
4. Environment Stress Cracking : Max. Failure From 10 Specimens	2
5. Max. Shrinkback	5%

Table 3 Cable sheath specification

4.1.9. Support strand

a) The support strand shall be the seven wires extra high strength grade, class A galvanized steel strand meeting all the requirement of the ASTM-A-475 “Standard for zinc-coated steel wire strand” , latest issue. The qualification of support strand shall be according to the Table 4

Fibers Capacities	Nominal Diameter of Strand, inch (mm.)	Nominal Diameter of Coated Wire in Strand, inch (mm.)
12 –60	5/32 (3.97)	0.052 (1.32)
72 – 216	3/16 (4.76)	0.062 (1.57)
240 – 312	1/4 (6.35)	0.080 (2.03)

Table 4 Support strand specification

b) The applied support strand shall be according to table 4.

c) The bidder shall provide full details of span lengths, sags, and tensions of aerial cables that limit the elongation and sensitivity to static fatigue of cable under a specified design load concerning size and weight of cable, distance between the utility poles, and storm loading region for Thailand. The installation conditions specified in table 5 shall be used for guideline to propose such detailed calculation.

Parameters		Value
1. Maximum pole span length		40 m
2. Temperature	Installation	32 ºC
	Operation	Tropical, -10 to 70 ºC
3. Worst case loading condition (short-term)	Wind Velocity	Max. 144 km/hr
	Temperature	25 ºC
4. Initial Sag		0.5% of span length
5. Relative humidity		Up to 90%, no frost

Table 5 Installation Conditions

4.1.10. Cable marking

a) Length marking

The outside cable sheath shall have sequentially numbered length marking at intervals of approximately 1 meter along the whole cable length. The starting number of ordering length for any reel shall begin with 0000 M (zero meter). The accuracy of the measurement of length marking shall be held within the limits of ±1%

b) Identification marking

Each marking length interval, the identification marking shall be permanently identified as to TOT, manufacturer, contract number, year (E.C.) of manufacture and type and size of cable .

Example : TOT ABC 200/3270000698/2547 DEF 2004 OFC/SM/A – XXX F

Where as

TOT	= TOT
ABC	= Manufacturer
200/3270000698/2547	= Contract number
DEF	= Project name (see remark)
2004	= Year (E.C.) of manufacturer
OFC	= Optical fiber cable
SM	= Single mode
A	= Arial cable
XXX	= Number of fibers
F	= Fibers

Remark: If supplied for turnkey project, the project name shall be marked

c) Additional identification marking

The outside of cable sheath shall be permanently identified by extruding the red stripe while forming cable sheath throughout the cable length. The red stripe shall

contain the UV resistance additive for UV protection (UV proof). The red stripe dimension and position shall be as specified in figure 1.

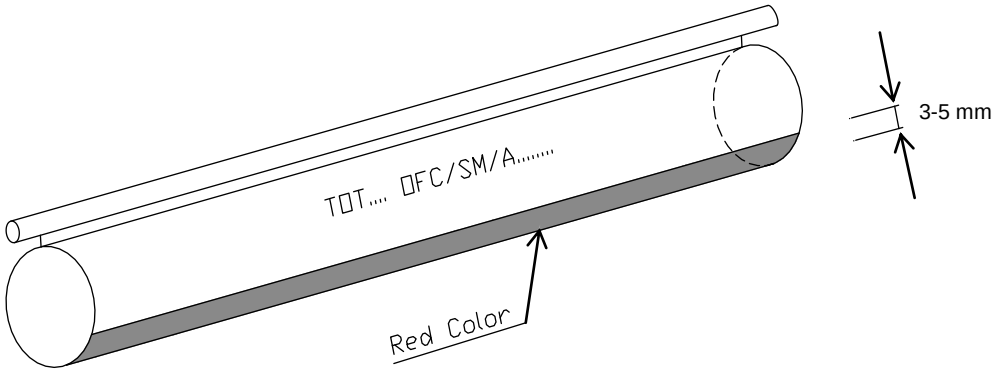


Figure 1

The Color of marking for section 4.1.10 a) and 4.1.10 b) shall preferably be white color and the color of marking for section 4.1.10 c) shall be red color according to EIA/TIA-598-A.

The cable marking process shall not reduce or increase the sheath dimensions. The paint used shall be clearly visible, adhesive with the sheath and resistive to environmental conditions during the lifetime of the cable.

4.2. DIRECT BURIED CABLE

4.2.1. Cable core
This is given in paragraph 4.1.1.

4.2.2. The strength member
This is given in paragraph 4.1.2.

4.2.3. Fiber buffer tube
This is given in paragraph 4.1.3.

4.2.4. The filler/fillers
This is given in paragraph 4.1.4.

4.2.5. The swellable materials for waterblocking
This is given in paragraph 4.1.5.

4.2.6. Core covering
This is given in paragraph 4.1.6.

4.2.7. Moisture barrier sheath

a) The moisture barrier of plastic coated aluminium foil or equivalent material shall be applied longitudinally over the core covering with an overlap to ensure that the core is completely covered at the minimum bending radius of the cable. The overlap shall be 3.0 mm minimum.

b) The minimum thickness of the aluminium foil or equivalent shall not be less than 0.2 mm.

c) The aluminium foil or equivalent material shall be coated on both sides with a protective plastic coating. The thickness of the protective coating on each side of the aluminium foil or equivalent material shall be a minimum of 0.05 mm.

4.2.8. Ripcords

a) The ripcord shall be non-hygroscopic, non-wicking, dielectric and shall be continuous throughout the whole cable length. The ripcord material shall be aramid yarn or equivalents.

b) The cable shall contain inner and outer ripcord. Two inner ripcords (approximately 180° apart) shall be placed under the moisture barrier and two outer ripcords (approximately 180° apart) shall be placed under the armour.

c) The inner ripcord and the outer ripcord shall be capable of slitting the moisture barrier/inner sheath and the armour/outer sheath respectively for a continuous length of 1 (one) meter.

4.2.9. Inner sheath

The inner sheath shall be made of polyethylene (PE) and shall be applied over moisture barrier to form a complete seal over the entire surface. The inner sheath shall contain carbon black for UV light protection and shall not promote the growth of fungus and free from holes, splits, blisters or other imperfections. The minimum thickness of sheath shall be 1 mm.

The qualification of inner sheath shall be according to the table below. The procedure for testing the inner sheath specification shall conform to paragraph 5.9.

Parameter	Specification
1. Carbon Black	2.6 ± 0.25 %
2. Minimum Tensile Strength	119 kg/cm^2
3. Minimum Elongation	400 %
4. Environment Stress Cracking : Max. Failure From 10 Specimens	2
5. Max. Shrinkback	5%

Table 6 Inner sheath specification

4.2.10. Armour

The protective armouring shall be applied under the outer sheath. The armouring shall typically be a corrugated tape of electrolytic chrome coated steel (ECCS) or equivalent. The thickness of the armour shall be within limit of 0.15 mm ± 10%. The overlap of the armour shall be 3.0 mm minimum. The plastic coating, in case of plastic coated corrugated steel tape, shall be 0.05 mm minimum on each side of the armour.

4.2.11. Outer sheath

The outer sheath of black high density polyethylene (HDPE) with a minimum thickness of 2 mm shall be applied over the armouring. The outer sheath shall contain carbon black for UV light protection and shall not promote the growth of fungus and free from holes, splits, blisters or other imperfections. The qualification of outer sheath shall be according to the table below. The procedure for testing the outer sheath specification shall conform to paragraph 5.9.

Parameter	Specification
1. Carbon Black	2.6 ± 0.25 %
2. Minimum Tensile Strength	168 kg/cm^2
3. Minimum Elongation	300 %
4. Environment Stress Cracking : Max. Failure From 10 Specimens	2
5. Max. Shrinkback	5%

Table 7 Outer sheath specification

4.2.12. Cable marking

a) Length marking

The outside cable sheath shall have sequentially numbered length marking at intervals of approximately 1 meter along the whole cable length. The starting number of ordering length for any reel shall begin with 0000 M (zero meter). The accuracy of the measurement of length marking shall be held within the limits of ±1%

b) Identification marking

Each marking length interval, the identification marking shall be permanently identified as to TOT, manufacturer, contract number, year (E.C.) of manufacture and type and size of cable .

Example : TOT ABC 200/3270000698/2547 DEF 2004 OFC/SM/DB – XXX F

Where as

TOT	= TOT
ABC	= Manufacturer
200/3270000698/2547	= Contract number
DEF	= Project name (see remark)
2004	= Year (E.C.) of manufacturer
OFC	= Optical fiber cable
SM	= Single mode
DB	= Direct buried cable
XXX	= Number of fibers
F	= Fibers

Remark: If supplied for turnkey project, the project name shall be marked

c) Additional identification marking

The outside of cable sheath shall be permanently identified by extruding the red stripe while forming cable sheath throughout the cable length. Two red stripes diagonally opposite each other shall be provided. The red stripe shall contain the UV resistance additive for UV resistance additive for UV protection (UV proof).The red stripe dimension and position shall be as specified in figure 2.

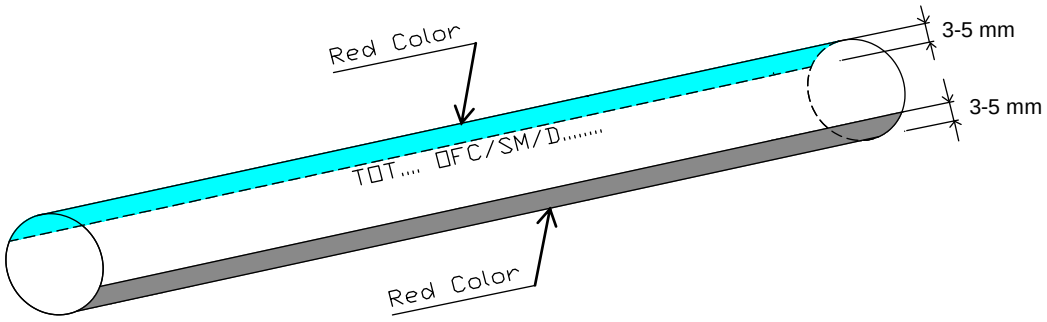


Figure 2

The Color of marking for section 4.2.12 a) and 4.2.12 b) shall preferably be white color and the color of marking for section 4.2.12 c) shall be red color according to EIA/TIA-598-A.

The cable marking process shall not reduce or increase the sheath dimensions. The paint used shall be clearly visible, adhesive with the sheath and resistive to environmental conditions during the lifetime of the cable.

4.3. DUCT CABLE

4.3.1. Cable core
This is given in paragraph 4.1.1.

4.3.2. The strength member
This is given in paragraph 4.1.2.

4.3.3. Fiber buffer tube
This is given in paragraph 4.1.3.

4.3.4. The filler/fillers
This is given in paragraph 4.1.4.

4.3.5. The swellable materials for waterblocking
This is given in paragraph 4.1.5.

4.3.6. Core covering
This is given in paragraph 4.1.6.

4.3.7. Moisture barrier sheath
This is given in paragraph 4.2.7.

4.3.8. Ripcords

a) The ripcord shall be non-hygroscopic, non-wicking, dielectric and shall be continuous throughout the whole cable length. The ripcord material shall be aramid yarn or equivalents.

b) Two ripcords shall be provided under the moisture barrier to be diametrically opposite of each other and to provide a means for quick sheath removal.

c) Each ripcord shall be capable of slitting the moisture barrier and sheath for a continuous length of 1 (one) meter.

4.3.9. Cable sheath

The cable sheath shall be made of black high density polyethylene (HDPE) and shall contain carbon black for UV light protection and shall not promote the growth of fungus and free from holes, splits, blisters or other imperfections and to facilitate easier pull in ducts. The minimum thickness of the sheath shall be 2 mm. The qualification of cable sheath shall be according to the table below. The procedure for testing the cable sheath specification shall conform to paragraph 5.9.

Parameter	Specification
1. Carbon Black	2.6 ± 0.25 %
2. Minimum Tensile Strength	168 kg/cm^2
3. Minimum Elongation	300 %
4. Environment Stress Cracking : Max. Failure From 10 Specimens	2
5. Max. Shrinkback	5%

Table 8 Cable sheath specification

4.3.10. Cable marking

a) Length marking

The outside cable sheath shall have sequentially numbered length marking at intervals of approximately 1 meter along the whole cable length. The starting number of ordering length for any reel shall begin with 0000 M (zero meter). The accuracy of the measurement of length marking shall be held within the limits of ±1%

b) Identification marking

Each marking length interval, the identification marking shall be permanently identified as to TOT, manufacturer, contract number, project name, year (E.C.) of manufacture and type and size of cable .

Example : TOT ABC 200/3270000698/2547 DEF 2004 OFC/SM/D – XXX F

Where as

TOT	= TOT
ABC	= Manufacturer
200/3270000698/2547	= Contract number
DEF	= Project name (see re mark)
2004	= Year (E.C.) of manufacturer
OFC	= Optical Fiber Cable
SM	= Single Mode
D	= Duct Cable
XXX	= Number of fibers
F	= Fibers

Remark: If supplied for turnkey project, the project name shall be marked

c) Additional identification marking

The outside of cable sheath shall be permanently identified by extruding the red stripe while forming cable sheath throughout the cable length. Two red stripes diagonally opposite each other shall be provided. The red stripe shall contain the

UV resistance additive for UV protection (UV proof). The red stripe dimension and position shall be as specified in figure 3.

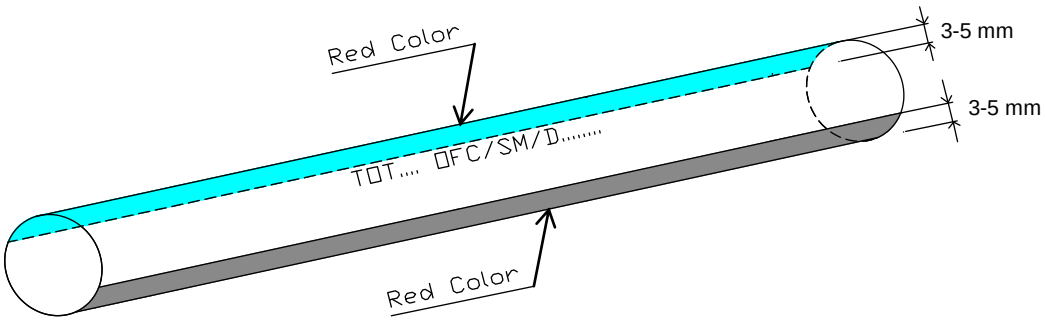


Figure 3

The Color of marking for section 4.3.10 a) and 4.3.10 b) shall preferably be white color and the color of marking for section 4.3.10 c) shall be red color according to EIA/TIA-598-A.

The cable marking process shall not reduce or increase the sheath dimensions. The paint used shall be clearly visible, adhesive with the sheath and resistive to environmental conditions during the lifetime of the cable.

4.4. ARMOURED AERIAL CABLE

This type of cable shall be used for the area where having severe environments and this special cable shall be applied to relief the cable deteriorations which result from wildfire, squirrel, rodent etc.

4.4.1. Cable core
This is given in paragraph 4.1.1.

4.4.2. The strength member
This is given in paragraph 4.1.2.

4.4.3. Fiber buffer tube
This is given in paragraph 4.1.3.

4.4.4. The filler/fillers
This is given in paragraph 4.1.4.

4.4.5. The swellable materials for waterblocking
This is given in paragraph 4.1.5.

4.4.6. Core covering
This is given in paragraph 4.1.6.

4.4.7. Ripcords

a) The ripcord shall be non-hygroscopic, non-wicking, dielectric and shall be continuous throughout the whole cable length. The ripcord material shall be aramid yarn or equivalents.

b) The cable shall contain inner and ripcord. Two inner ripcords (approximately 180° apart) shall be placed under the inner sheath and two outer ripcords (approximately 180° apart) shall be placed under the armour.

c) The inner and outer ripcord shall be capable of slitting the inner sheath and armour/outer sheath respectively for a continuous length of 1 (one) meter.

4.4.8. Inner sheath

The inner sheath shall be made of polyethylene (PE). The inner sheath shall contain carbon black for UV light protection and shall not promote the growth of fungus and free from holes, splits, blisters or other imperfections. The minimum thickness of sheath shall be 1 mm.

The qualification of inner sheath shall be according to the table below. The procedure for testing the inner sheath specification shall conform to section 5.9.

Parameter	Specification
1.Carbon Black	2.6 ± 0.25 %
2.Minimum Tensile Strength	119 kg/cm^2
3.Minimum Elongation	400 %
4.Environment Stress Cracking : Max. Failure From 10 Specimens	2
5.Max. Shrinkback	5%

Table 9 Inner sheath specification

4.4.9. Armour

This is given in paragraph 4.2.10.

4.4.10. Outer sheath

This is given in paragraph 4.2.11. and the minimum thickness of the support stand sheath shall be 1.0 mm. The minimum dimension of the integral web shall be 2 mm x 2mm.

4.4.11. Support strand

This is given in paragraph 4.1.9.

4.4.12. Cable marking

a) Length marking

The outside cable sheath shall have sequentially numbered length marking at intervals of approximately 1 meter along the whole cable length. The starting number of ordering length for any reel shall begin with 0000 M (zero meter). The accuracy of the measurement of length marking shall be held within the limits of ±1%

b) Identification marking

Each marking length interval, the identification marking shall be permanently identified as to TOT, manufacturer, contract number, project name, year (E.C.) of manufacture and type and size of cable.

Example : TOT ABC 200/3270000698/2547 DEF 2004 OFC/SM/AA – XXX F

Where as

TOT	= TOT
ABC	= Manufacturer
200/3270000698/2547	= Contract number
DEF	= Project name (see remark)
2004	= Year (E.C.) of manufacturer
OFC	= Optical fiber cable
SM	= Single mode
AA	= Armoured aerial cable
XXX	= Number of fibers
F	= Fibers

Remark: If supplied for turnkey project, the project name shall be marked

c) Additional identification marking

The outside of cable sheath shall be permanently identified by extruding the red stripe while forming cable sheath throughout the cable length. The red stripe shall contain the UV resistance additive for UV protection (UV proof). The red stripe dimension and position shall be as specified in figure 4

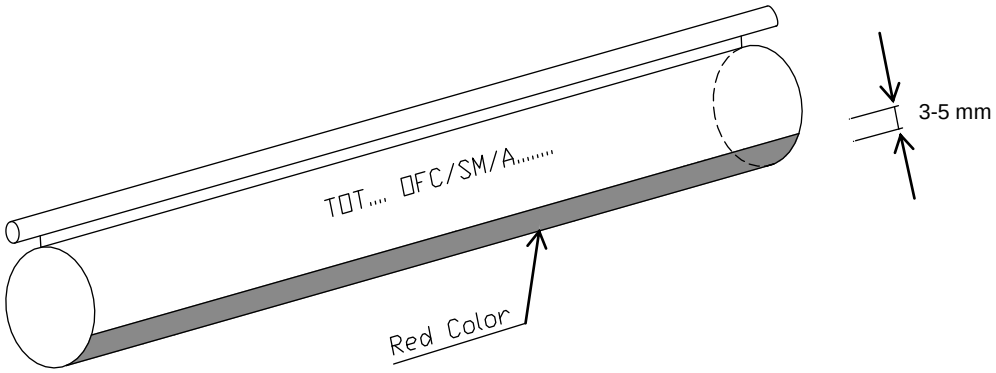


Figure 4

The Color of marking for section 4.4.12 a) and 4.4.12 b) shall preferably be white color and the color of marking for section 4.4.12 c) shall be red color according to EIA/TIA-598-A.

The cable marking process shall not reduce or increase the sheath dimensions. The paint used shall be clearly visible, adhesive with the sheath and resistive to environmental conditions during the lifetime of the cable.

5. MECHANICAL AND ENVIRONMENTAL CHARATERISTICS

This section covers the mechanical, environment, and endurance qualification requirements for completed cables. Test wavelengths shall be within limit of 1550 $\pm$ 10 nm. Test to establish the mechanical properties of the cables shall have no detrimental effect in transmission characteristics on the transmission properties of the cables.

5.1. Tensile Loading

To qualify the design, the cable must pass the Tensile Loading. Test specified by IEC 60794-1-2-E1 or EIA-455-33A. The conditions for testing shall be conformed to TOT's specification as follows :

Test standard : IEC 60794-1-2-E1 or EIA-455-33A

Pre-requirements :

Length of cable under load : sufficient to achieve the desired accuracy of measurement of attenuation change.

Diameter of mandrel : 30 x outside diameter of cable

Load :

- Aerial cable : ≥ 7,000 N (self supporting cable)
- Direct buried cable : ≥ 2,500 N
- Duct cable : ≥ 2,500 N
- Armoured aerial cable : ≥ 7,000 N (self-supporting cable)

Test result:

- The fiber strain is measured during the cable has been subjected to the installation load for 1 hour. It shall not be greater than 1/3 of the fiber proof test (since fiber proof test = 1%, so that fiber strain ≤ 33% of 1% that means fiber strain shall not be greater than 0.33%)
- Change of attenuation for each test stage (during loaded and after load removal) compared with attenuation before testing < 0.1 dB.
- No fiber break and no sheath damage.

5.2. Impact Resistance

To qualify the design, the cable must pass the impact Test specified by EIA/TIA-455-25C or IEC 60794-1-2-E4. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-25C or IEC 60794-1-2-E4

Pre-requirements :

In case of aerial cable and armoured aerial cable, specimen for testing, the support strand shall be remove prior testing.

Impact energy : according to Table 10

Number of impacts : 20 Cycles

Radius of hammer head : 12.5 ± 0.1 mm.

Impact rate : ≤ 2 sec/cycle

Test result : - change of attenuation measured between before and after test < 0.1 dB.

- No fiber break and no cable damage.

CABLE DIAMETER		IMPACT ENERGY	
mm.	**Inch**	**N.m**	**lb.ft**
0 < D < 3.8	0 < D ≤ 0.15	0.74	0.54
3.8 < D < 5.3	0.15 < D ≤ 0.21	1.47	1.08
5.3 < D < 7.5	0.21 < D ≤ 0.30	2.21	1.63
7.5 < D < 13.0	0.30 < D ≤ 0.51	2.94	2.17
13.0 < D < 15.0	0.51 < D ≤ 0.59	4.41	3.25
15.0 < D < 16.6	0.59 < D ≤ 0.65	5.15	3.80
16.6 < D < 18.9	0.65 < D ≤ 0.75	5.88	4.34
18.9 < D < 21.4	0.75 < D ≤ 0.84	6.62	4.88
21.4 < D	0.84 < D	7.53	5.42

Table 10 Impact resistance test

5.3. Compression/Crush Test

To qualify the design, the cable must pass the Compression Test specified by EIA/TIA-455-41A or Crush Test by IEC 60794-1-2-E3. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-41A or IEC 60794-1-2-E3

Pre-requirements :

Load : 1. Aerial cable and duct cable : ≥ 2,200 N

2. Direct buried cable and: ≥ 4,400 N

3. Armoured aerial cable : ≥ 4,400 N

(In case of aerial cable and armoured aerial cable, specimen for testing, the support strand shall be removed prior testing.)

Steel plate : according to EIA/TIA-455-41A or IEC 60794-1-2-E3

Loading time : ≥ 10 min. (one point and one time)

Test result : - Change of attenuation for each stage (during loaded and after load removal) compared with attenuation before testing : < 0.1 dB.

- No fiber break and no cable damage.

5.4. Flexing/Repeat Bending Test

To qualify the design, the cable must pass the Flexing Test specified by EIA/TIA-455-104A or Repeat Bending Test by IEC 60794-1-2-E6. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-104A or IEC 60794-1-2-E6

Pre-requirements :

Diameter of mandrel : 20 x diameter of cable

Load : according to Table 11

Number of cycles : ≥ 25 cycles

Flexing rate : ≤ 2 sec./cycle

Test result : - Change of attenuation for each stage (during loaded and after load removal) compared with attenuation before testing : < 0.1 dB.

- No fiber break and no cable damage.

Nominal Cable Diameter Range		Minimum Load	
mm.	**Inch**	**Kg Weight**	**N**
≤ 2.5	≤ 0.10	1.5	14.71
2.6 to 4.0	0.101 to 0.159	2.5	24.52
4.1 to 6.0	0.160 to 0.239	4.0	29.23
6.1 to 9.0	0.240 to 0.355	4.5	44.13
9.1 to 13.0	0.356 to 0.514	5.0	49.03
13.1 to 18.0	0.515 to 0.711	5.5	53.94
18.1 to 24.0	0.712 to 0.948	6.5	63.74
24.1 to 30.0	0.949 to 1.180	7.0	68.65
≥ 30.1	≥ 1.181	7.5	73.55

Table 11 Flexing/Repeat Bending Test

5.5. Water Penetration Test

To qualify the design, the cable must pass the Water Penetration Test specified by EIA/TIA-455-82B or IEC 60794-1-2-F5. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-82B or IEC 60794-1-2-F5

Pre-requirements :

Height of water column : 1 m.

Test time : 1 hour

Sample length : 3 m.

Test result : At the end of 1 hour period, no water shall have leaked from the opposite end of the cable.

5.6. Twist/Torsion Test

To qualify the design, the cable must pass the Twist Test specified by EIA-455-85A or Torsion Test by IEC 60794-1-2-E7. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-85A or IEC 60794-1-2-E7

Pre-requirements :

Twist rate : ≤ 1 min./cycle

Twist angle : ± 180 °

Number of cycles : 10 cycles

Load : according to Table 12

Test result : - Change of attenuation for each stage (during loaded and after load removal) compared with attenuation before testing : < 0.1 dB.

- No fiber break and no cable damage.

Nominal Cable Diameter Range		**Recommended Load**	
mm.	**Inch**	**Kg Weight**	**N**
≤ 2.5	≤ 0.10	1.5	14.71
2.6 to 4.0	0.101 to 0.159	2.5	24.52
4.1 to 6.0	0.160 to 0.239	4.0	29.23
6.1 to 9.0	0.240 to 0.355	4.5	44.13
9.1 to 13.0	0.356 to 0.514	5.0	49.03
13.1 to 18.0	0.515 to 0.711	5.5	53.94
18.1 to 24.0	0.712 to 0.948	6.5	63.74
24.1 to 30.0	0.949 to 1.180	7.0	68.65
≥ 30.1	≥ 1.181	7.5	73.55

Table 12 Twist/torsion test

5.7. Cable Bending Test

To qualify the design, the cable must pass the Cable Bend Test by IEC 60794-1-2-E11B. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : IEC 60794-1-2-E11B.

Pre-requirements :

Diameter of mandrel : 20 x diameter of cable

Number of cycles : 1

Test result : - Change of attenuation for each stage (during loaded and after load removal) compared with attenuation before testing : < 0.1 dB.

- No fiber break and no cable damage.

5.8. Temperature Cycling Test

To qualify the design, the cable must pass the Temperature Cycling Test specified by EIA/TIA-455-3A or IEC 60794-1-2-F1. The conditions for testing shall be conformed to TOT's specification as follow :

Test standard : EIA/TIA-455-3A or IEC 60794-1-2-F1

Pre-requirements :

Variation of temperature : - 10 to + 70 ° C

Number of Cycles : 2

Soak time : according to Table 13

Condition measurement - Low temperature condition (-10±2°C)

- High temperature condition (70±2°C)

Test result : - Change of attenuation for each condition measurement compared with attenuation before testing : < 0.1 dB/km.

- No fiber break and no cable damage.

Minimum Soak for a Given Sample Mass		
Sample Mass (kg.)	**Sample Mass (lb.)**	**Soak Time (Hours)**
$M \leq 0.35$	$M \leq 0.77$	0.5
$0.35 < M \leq 0.70$	$0.77 < M \leq 1.50$	1
$0.70 < M \leq 1.50$	$1.50 < M \leq 3.30$	2
$1.50 < M \leq 15.00$	$3.30 < M \leq 33.00$	4
$15.00 < M \leq 100$	$33.00 < M \leq 220$	8
$100 < M \leq 250$	$220 < M \leq 550$	12
$250 < M \leq 500$	$550 < M \leq 1100$	14
$M > 501$	$M > 1100$	16

Table 13 Temperature Cycling Test

5.9. Cable Sheath Test

The procedure for testing fiber cable sheath for compliance with paragraph 4.1.8, 4.2.9, 4.2.11, 4.3.9, 4.4.8 and 4.4.10 shall be as follows or by equivalent method:

Carbon Black : The procedure for carbon black testing shall conform to ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.

Tensile strength and elongation : Specimens of polyethylene material die cut from the sheaths shall be tested in accordance with ASTM D470-latest

except that the speed of jaw separation shall be 50 cm. (20 in) per minute for inner sheath and 5 cm (2 in.) per minute for outer sheath

Environmental stress cracking : Test specimens shall be die cut in the transverse direction from the cable sheath having an outside diameter of 2.8 cm.(1.1 in) and larger. These specimens shall be prepared and subjected to an environmental stress cracking test as described in ASTM D1693, except that the conditioning requirement is waived, the depth of the controlled imperfection shall be proportional to the sheath thickness, and the stress cracking reagent shall be a 10 percent solution (by volume) of “Igepal” CO-630.

Shrinkback : Slab specimens shall be cut from the cable sheaths 5 cm.(2 in.) long, 13 mm.(1/2 in.) wide, and the same thickness as the cable sheath. The slab specimens shall be placed in a convection type circulating air oven operating at a temperature of $100 \pm 1°$ C for a 4-hour period for inner sheath, and $115 \pm 1°$ C for 4-hour period for outer sheath

5.10. Fiber Rub Test

To qualify the fiber color coating, the fiber shall pass the fiber rub test. The conditions for testing shall conform to TOT specification as follow :

Pre-requirements :

Sample : 50 cm length of the single colored fiber.

Materials : 1. Absorbent materials in white color such as cleaning tissue or soft cotton cloth.

2. Pincers

3. MEK Solution, grade : MEK FOR ANALYSIS,

Code : 462703, Carlo Erba Reagents Co.,Ltd.

Local supplier : Vidhaya-som Co.,ltd. Etc.

4. Tool for fixing one end of the colored fiber

5. Rubber glove

6. Mask

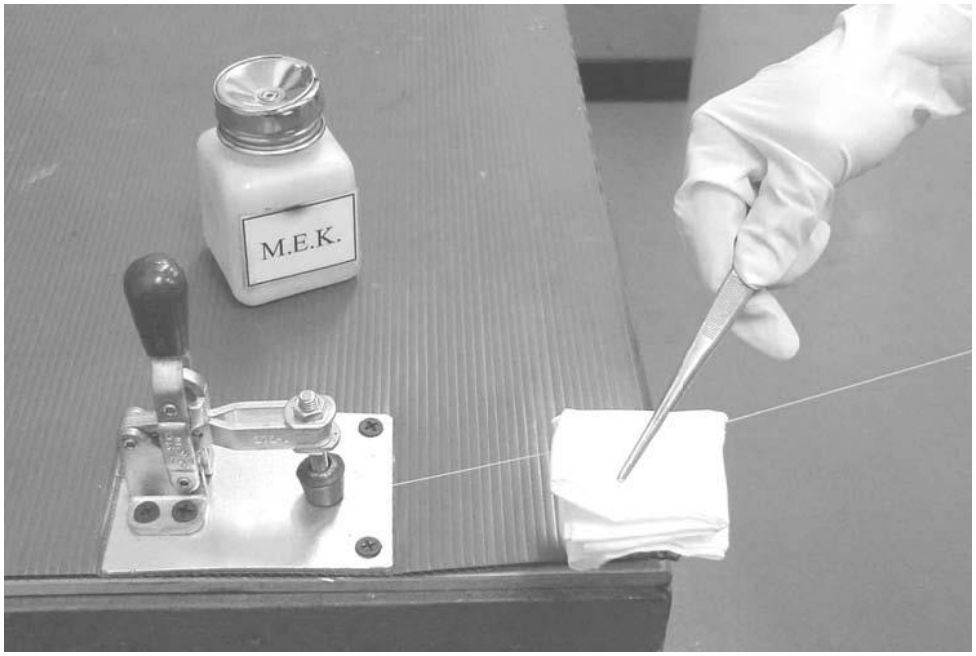


Figure 5 Fiber Rub test

Procedure ;

The test shall be prepared and performed according to figure 5. The 5 ml (5 milliliters) of MEK solution shall be dripped at the middle point of absorbent material. After the absorbent material is soaked by the MEK solution then the MEK soaked cloth or tissue shall be wiped on the single colored fiber core with uniform backward and forward motion (15 cm wiping span, one time of backward and forward motion = 1 cycle = 30 cm wiping length) requiring total 75 cycles. Observe the sample.

Test result :

- No color of fiber peel off until could see the surface of bare fiber by visual check.

6. QUALITY ASSURANCE AND FACTORY TESTING

6.1. Contractor shall submit full details of their Quality Assurance procedures which shall ensure that the cables fully comply with the requirements of specification

6.2. Contractor shall guarantee that the materials used for production of the fibers and coatings shall be of the same origin for all cables. Combination fibers and coatings from different suppliers is not acceptable. Factory splicing of optical fiber is not permitted.

6.3. Testing of equipment and material to be supplied under the contract shall be carried out by the contractor in accordance with agree QA procedure. Test results shall be provided to TOT by contractor.

6.3.1. Fiber Testing

Fibers shall be tested Geometrically, Optically, and for their Transmission Characteristics.

a) Geometric tests shall include the following :

- Mode field diameter
- Cladding diameter
- Core cladding concentricity
- Cladding non-circularity (measuring method : microscope)

b) Optical properties of the fiber shall include tests such as :

- The refractive index difference
- Cut-off wavelength

c) Transmission test shall include the following for each production length

- Attenuation; The attenuation coefficient and the attenuation graph by OTDR shall be provided.
- Chromatic dispersion

- Polarization mode dispersion (PMD)

6.3.2. Cable Testing

Ready-made optical cables shall be tested for their Transmission Characteristics according to test methods specified in ITU-T Rec. G650.

6.4. Cables containing any metallic members shall be subject to testing for increased loss due to hydrogen produced by corrosion. In addition an estimate of the hydrogen amount inside the cable during its life cycle shall be given

6.5. Independently certified test records of specified materials and components and assembled cable parameters shall be submitted to the TOT if so requested.

6.6. Contractor shall submit to the TOT, on or before the delivery of cables, detailed test reports for every delivered length and for each production batch of a given size and type of cable.

7. PACKING AND MARKING

7.1. Packing – Cable drum

7.1.1. Material

a) Wood : Hardwood (non-coniferous wood) or softwood (coniferous wood). The moisture content of wood shall be less than 30%.

b) Steel : The steel used in construction of the drum shall be the same quality as normal commercially available products.

7.1.2. Preservative Treatment

If softwood (coniferous wood) used, the softwood (coniferous wood) shall be pressure treated by full-cell process (Bethell process) or equivalent process with one of the preservatives (solution of Chromated Copper Arsenate, CCA) listed in Table 13.

Preservative (CCA)	**Minimum retention in kg.of dry salt or paste per cubic metre of timber**
Boliden K33	9.6
Celcure	12.0
Tanalith C	12.0

Table 13

Remark : The other preservatives than those listed in table 13 shall be allowable.

The sequence of procedures used in the full-cell process is summarized below :

a) Enclose dried wood in a pressurable cylinder.

b) Use a vacuum pump to remove the air from the cylinder and pressurized with a stabilized vacuum of 635 mm Hg for a period of 30 minutes.

c) Without releasing the vacuum, allow the cylinder to fill with a liquid preservative (CCA).

d) Apply pressurized with a stabilized pressure of 200 psi (14 bar) for a period of 120 minutes to the cylinder.

e) When the desired and measured amount of liquid preservative has been absorbed, release the applied pressure and drain the cylinder (initial drain).

f) Apply a final vacuum (635 mm Hg.) to expand the air remaining in the wood. This forces excess liquid to exude from the surface and run off.

g) Release final vacuum. As the remaining air in the call contracts, much of the surface wetness will be reabsorbed into the wood (This reduces dripping later).

h) Remove the treated wood products from the cylinder.

7.1.3. Construction

a) The construction of drum shall be strong enough to withstand any normal impact during transportation, installation and storage. Nails and staples used in the construction of the drum must not be placed in a position where they can damage the cables. The drums shall be non-returnable.

b) The cables shall be supplied on drum in lengths as specified at the time of contract. The standard reel shall be $\geq$ 4,000 m (with tolerance of -0%, +5%). Each length of cable shall be wound on separate drum unless otherwise specified or agreed to by TOT.

c) The diameter of the barrel shall not be less than 40 times the outside diameter of the cable. The thickness of barrel lagging shall not be less than 3.2 cm.

d) The diameter of flange shall be large enough to prevent damage to the cable during reeling or unreeling. The thickness of flange shall not be less than 2.5 cm.

e) The minimum thickness of batten shall be 4.0 cm. The interval between battens shall be small enough to prevent the rodent or squirrel from going inside the drum.

f) The spindle hole shall allow use of a 7.5 cm spindle without bending. The overall width of cable drum shall be small not be greater than 120 cm.

g) For testing purposed, the inner end of the cable shall be recessed into a slot in the drum flange and protected by a metal cover firmly secured to the flange. Alternatively, the inner end may protrude through the inside of a drum flange. A minimum length of 1 m of the inner end shall be accessible.

h) The cable ends shall be securely fastened so as not to protrude beyond any portion of the drum and to prevent the cable from becoming loose in transportation.

i) A protective wrap shall be applied over the outer convolution of the cable on each reel. The wrap shall be weather resistant and shall remain in place until the cable is installed.

j) If so required, the ends of cables shall be equipped with a pulling eye. The pulling eye shall be equipped so that ingress of moisture and escape of filling compound is prevented and such that no strain is transmitted to the fiber during shipping, handing, storage and installation.

k) The cable drum (including the battens for covering and protecting the cable drum) shall be treated by one of the following measures: Heat treatment or Fumigation by methyl bromide according to the International Standards for Phytosanitary Measures No.15 (ISPM #15): Guidelines for Regulating Wood Packaging Material in International Trade, latest issue. The ISPM #15 certified shall be declared on cable drum as specified in section 7.2.

7.2. Marking-Cable drum

7.2.1. Cable Drum

Details given below shall be distinctly marked on a weather proof material on both outer sides of the drum flange:

a) TOT , Thailand

b) Arrow showing the direction the drum shall be rolled.

c) Country of origin

d) The label of caution plate, ‘CAUTION – OPTICAL FIBER CABLE NOT TO BE LAID FLAT’ or equivalence instruction sign.

e) Manufacturer’s name or trademark

f) A mark indicating the location of the inner end of the cable if located internally

g) TOT code

h) Batch number.

i) ISPM 15 mark (This marking shall be accordance with the ISPM 15 Annex II and also as described in Figure 6).

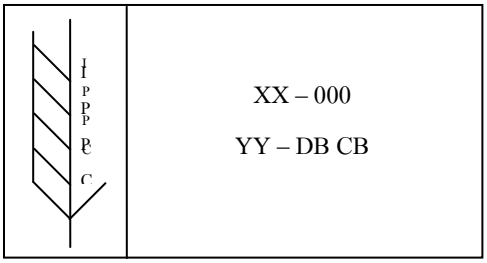


Figure 6

Remark :	XX	=	ISO country code
	000	=	Unique number assigned by the NPPO
			(National Plant Protection Organization)
	YY	=	Heat treatment (HT) or Methyl bromide (MB)
	DB	=	Didn't bark
	CB	=	Certification body
	IPPC	=	International Plant Protection Convention

7.2.2. Marking Plates

Marking plates containing the following information shall be securely attached to the both outer sides of each drum flange.

The numerals shall be punched:

a) Material specification (according to the out sheath type)

b) Type and size of cable

c) Cable length in meters

d) Net weight in kilograms

e) Gross weight in kilograms

f) Reel number

g) Manufacturer's name

h) Year of manufacture

i) Purchase Order number (P/O NO.)

j) Project number / TOT's Contract number

The plated shall be made of non – corrodible material. All marking shall be in accordance with figure 7 and 8.

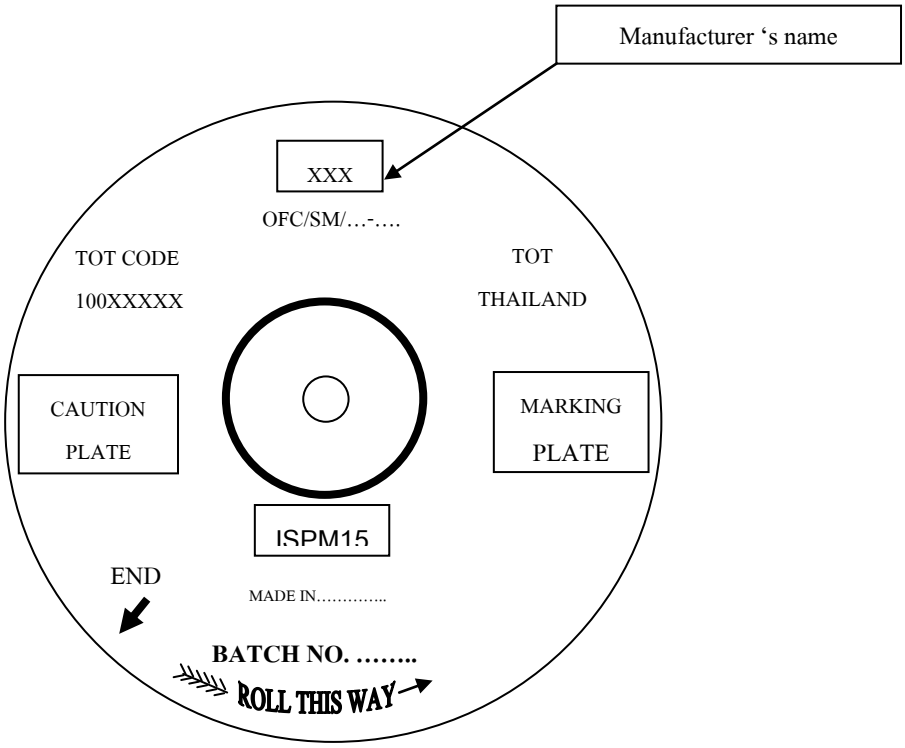


Figure 7 Cable drum marking

MATERIAL SPECIFICATION	:	SINGLE MODE OPTICAL FIBER CABLE
TYPE AND SIZE	:	SM XX C
CABLE LENGTH	:	X,XXX M
REEL NUMBER	:	XXX
NET WEIGHT	:	XXX KGS.
GROSS WEIGHT	:	XXX KGS.
MANUFACTURER'S NAME	:	XXX
PURCHASE ORDER NUMBER	:	32XXXXXXXXX
CONTRACT NUMBER	:	XXX/XXXXXXXXXX/25XX

Figure 8 Marking Plate

8. SPECIFIC CONDITIONS

The proposed cable shall be met the requirement in these specific conditions, otherwise those cables will be rejected.

8.1. SPECIFIC ENVIRONMENTAL CONDITIONS

All the cable shall meet or exceed to the following temperature ranges as below :

8.1.1. Temperature Cycling

Installation, Operation and Storage/Shipping temperature ranges are as follow :

Installation :	0	to	60	°C
Operation :	-10	to	70	°C
Storage/Shipping :	-20	to	70	°C

With their Technical Proposals, Bidder shall submit certification or other suitable evidence verifying that the products offered are qualified to the above environmental condition and ranges.

8.2. SPECIFIC ACCEPTANCE TEST

8.2.1. For the acceptance test, the cable will be tested against the requirements as specified in the contract document.

8.2.2. The tests shall be performed by laboratory of Technical Research and Develop Department of TOT or official representative. TOT reserve the right to test some vital item if so requires.

8.2.3. The contractor shall submit the detail of factory testing after delivered the cable to TOT. In the event that the cable so test fail to meet the specified requirements, TOT reserves the right to reject all the cable.

END OF SPECIFICATION

Appendix A
The construction and properties of SM optical fiber cable

1. General

1.1 Scope

This section describes the construction and properties of single-mode optical fiber cables for duct, direct buried and aerial application. This cable employs a non-metallic central strength member and the loose buffering principle. Optical fibers are in compliance with ITU-T Recommendation G.652.D

1.2 Quality Assurance

Thai Fiber Optics Co., Ltd. take pride in being an industry leader recognized for producing a quality product. To ensure a continuing level of quality in production cables, a quality system consistent with ISO 9001 “Quality Management System”, is provided for all optical fiber and fiber optic cables.

The adequacy of all materials is assured through incoming inspection, source inspection, or vendor certified data. Fiber is measured and classified before being placed into inventory, and then selected from inventory to satisfy customer order requirements. Inspection of cable construction characteristics is the responsibility of the employees producing the product. All cables are tested for compliance to customer specified transmission requirements in Final Test. Adequacy of this quality control system is assured through product and process audits conducted by the internal quality improvement organization.

TFOC supports industry standards such as
- Electronic Industries Association (EIA)
- Telecommunications Industry Association (TIA)
- International Telecommunications Union (ITU)
- International Electrotechnical Commission (IEC)
- American Society for Testing and Materials (ASTM)

1.3 General Fiber Optic Cable Characteristics

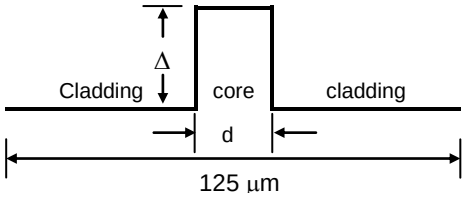
High quality optical fiber made with pure silica-based glass have very low loss for infrared wavelengths and can be used to carry large amounts of information for very long distances in optical communication systems. High fiber strength is obtained by protecting the surface of the glass fiber with thin coating layers of polymeric materials.

The coated fibers are then placed in cable structures having additional layers to protect the fiber during the rigors of outside plant installation and to provide long term reliable operation in the outside plant environment. The design philosophy in meeting these objectives is to provide high quality, rugged, well-tested fiber optic cables, which are compact and have a high strength-to-weight ratio. Compact fiber optic cables are easier to handle and install in the field and provide longer length for field installation.

2. Optical Fiber Requirements

TFOC Zero Water Peak (ZWP) Single Mode Fiber consists of a germanium doped core and a silica cladding. The fiber is fully compatible with other commercially available matched cladding fibers. TFOC ZWP Single Mode Optical Fiber is the industry's first fiber designed for use with transmission systems operating in entire wavelength region from 1285 to 1625 nm (including the extended band 1360 nm – 1460 nm).

TFOC fibers feature a dual UV curable acrylate coating system, which provides unparalleled performance in a wide range of environmental conditions. The advantages of this coating structure are excellent resistance to micro-bending induced losses, superior hydrolytic stability and long term preservations of color code integrity. The coating is easily strippable using mechanical methods.



(d = core diameter)

Fig.1 Refractive index profile, Dispersion Unshifted Single Mode Fiber

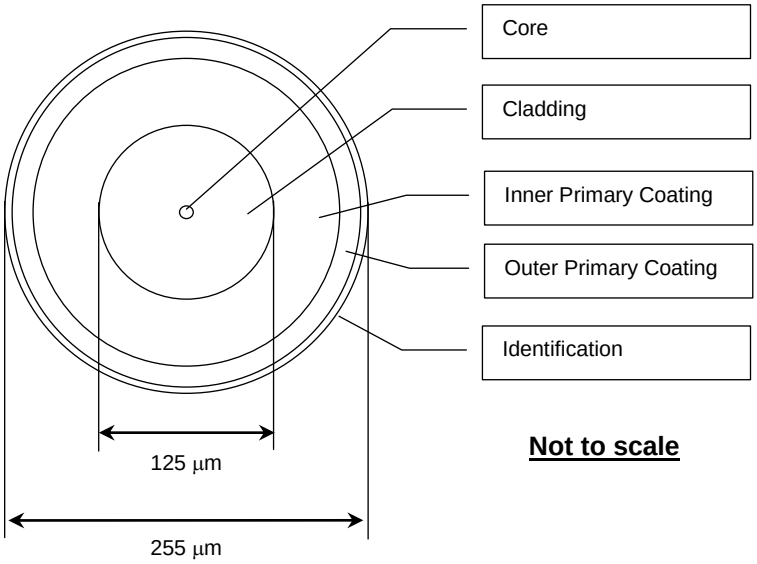


Fig. 2 Cross Section View of Dispersion Unshifted Single Mode Fiber

Table 1. Single Mode Fiber Requirements, Dispersion-Unshifted Fiber (ITU-T Rec. G.652.D)

Fiber attributes		
Item		**Description**
Manufacturing Method		VAD (vapor axial deposition method)
Refractive Index Profile		Step Index, Matched Cladding
Core		Germania (GeO_2) doped Silica (SiO_2)
Core Diameter		8.3 μm
Cladding		Silica (SiO_2)
Primary Coating		2 layers of UV curable resin
Refractive index for core		1.452 @ 1310 nm 1.450 @ 1550 nm
Refractive index for cladding		1.447 @ 1310 nm 1.445 @ 1550 nm
Index of refraction Difference		0.35%
Group refractive index *		1.469 @ 1310 nm and 1550 nm
Cladding Diameter		125 ± 1 μm
Cladding Non-Circularity		≤ 1 %
Core/Cladding Concentricity error		≤ 0.5 μm
Coating Diameter (uncolored)		245 ± 5 μm
Coating/Cladding Concentricity error		≤ 12 μm
Colored Fiber Diameter		255 ± 10 μm
Mode Field Diameter		9.2 ± 0.4 μm @ 1310 nm 10.4 ± 0.5 μm @ 1550 nm
Proof test stress		The entire length of fiber is subjected to tensile stress greater than 0.69 GN/ m^2 (100 kpsi) : 1% strain equivalent, 1s
Attenuation with Bending	100 turns, 30 mm radius	≤ 0.05 dB @ 1310 nm ≤ 0.10 dB @ 1550 nm
	1 turns, 16 mm radius	≤ 0.5 dB @ 1550 nm
Zero-Dispersion Wavelength (λ_0)		1300 ≤ λ_0 ≤1324 nm
Max. Zero-Dispersion Slope (S_{0max}) at λ_0		≤ 0.093 ps/(nm^2.km)
Chromatic dispersion coefficient, D(λ)		< 3.5 ps/(nm.km) @ 1288 ~ 1339 nm < 18 ps/(nm.km) @ 1550 nm < 22 ps/(nm.km) @ 1625 nm
Coating Strip Force (@ 0 °C to +45 °C)		1.3 N (0.3 lbf) ≤ F ≤ 8.9 N (2.0 lbf)
Cable attributes		
Item		**Description**
Attenuation coefficient		≤ 0.35 dB/km @ 1310 nm ≤ 0.35 dB/km @ 1383 nm ≤ 0.24 dB/km @ 1490 nm ≤ 0.21 dB/km @ 1550 nm ≤ 0.23 dB/km @ 1625 nm
Attenuation Coefficient @ 1285~1330 nm		≤ Measured attenuation at 1310 nm + 0.03 dB/km
Attenuation Coefficient @ 1525~1575 nm		≤ Measured attenuation at 1550 nm + 0.02 dB/km
Cabled Cut-off Wavelength (λ_{cc})		≤ 1260 nm
Polarization mode dispersion (PMD) (Link Design Value)		≤ 0.10 ps/√km

* Optical time domain reflectometers (OTDRs) require the setting of the fiber's group refractive index in order to calculate and display distance. The above is a group refractive index values for OTDR settings.

3. Cable Core / Cable Sheaths Characteristics and Construction
These core/sheath combinations are described in detail below.

Table 2. Construction of single jacket, self-supporting
Dry core aerial loose tube fiber optic cable.

Item		Description		
		2-30 fibers	36-60 fibers	72 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 6	Max. 12	
	Number	1-5	3-5	6
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	4-0	2-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Ripcord	Material	Aramid threads		
	Number	2		
Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.32		Nominal 7/1.57
Cable Diameter (Approx.) mm.		10.5	12.0	13.0
Overall Diameter (Approx.) mm.		19.5	21.0	22.5
Cable Weight (Approx.) kg/km		185	210	255
Structure		Fig. 3.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 2. (Con't) Construction of single jacket, self-supporting
Dry core aerial loose tube fiber optic cable.

Item		Description		
		84-96 fibers	108-120 fibers	144 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	7-8	9-10	12
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	1-0	1-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Ripcord	Material	Aramid threads		
	Number	2		
Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.57		
Cable Diameter (Approx.) mm.		14.5	16.5	18.0
Overall Diameter (Approx.) mm.		24.0	25.5	27.5
Cable Weight (Approx.) kg/km		290	325	370
Structure		Fig. 3.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 2. (Con't) Construction of single jacket, self-supporting
Dry core aerial loose tube fiber optic cable.

Item		Description		
		216 fibers	240-264 fibers	288-312 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	18	20-22	24-26
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	0	2-0	2-0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Ripcord	Material	Aramid threads		
	Number	2		
Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.57	Nominal 7/2.03	
Cable Diameter (Approx.) mm.		18.0	20.0	21.0
Overall Diameter (Approx.) mm.		27.0	30.5	32.0
Cable Weight (Approx.) kg/km		360	485	530
Structure		Fig. 3.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 3. Constructions of double jacket, single armor, laminated aluminum tape, dry core loose tube fiber optic cable.

Item		Description		
		2-30 fibers	36-60 fibers	72 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 6	Max. 12	
	Number	1-5	3-5	6
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	4-0	2-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
1st Ripcord	Material	Plastic threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm		
Cable Diameter (Approx.) mm.		18.0	19.0	20.0
Cable Weight (Approx.) kg/km		290	330	365
Structure		Fig. 4.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 3. (Con't) Constructions of double jacket, single armor, laminated aluminum tape, Dry core loose tube fiber optic cable.

Item		Description		
		84-96 fibers	108-120 fibers	144 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	7-8	9-10	12
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	1-0	1-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
1st Ripcord	Material	Plastic threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm		
Cable Diameter (Approx.) mm.		22.0	23.5	26.0
Cable Weight (Approx.) kg/km		435	500	585
Structure		Fig. 4.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 3. (Con't) Constructions of double jacket, single armor, laminated aluminum tape, Dry core loose tube fiber optic cable.

Item		Description		
		216 fibers	240-264 fibers	288-312 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	18	20-22	24-26
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	0	2-0	2-0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
1st Ripcord	Material	Plastic threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm		
Cable Diameter (Approx.) mm.		26.0	28.0	30.0
Cable Weight (Approx.) kg/km		585	680	775
Structure		Fig. 4.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 4. Constructions of single jacket, laminated aluminum tape, dry core loose tube fiber optic cable.

Item		Description		
		2-30 fibers	36-60 fibers	72 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 6	Max. 12	
	Number	1-5	3-5	6
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	4-0	2-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking Tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
Ripcord	Material	Aramid threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm.		
Cable Diameter (Approx.) mm.		13.5	14.5	16.0
Cable Weight (Approx.) kg/km		135	160	185
Structure		Fig. 5.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 4. (Con't) Constructions of single jacket, laminated aluminum tape,
Dry core loose tube fiber optic cable.

Item		Description		
		84-96 fibers	108-120 fibers	144 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	7-8	9-10	12
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	1-0	1-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking Tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
Ripcord	Material	Aramid threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm.		
Cable Diameter (Approx.) mm.		18.0	19.5	21.5
Cable Weight (Approx.) kg/km		230	285	345
Structure		Fig. 5.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 4. (Con't) Constructions of single jacket, laminated aluminum tape,
Dry core loose tube fiber optic cable.

Item		Description		
		216 fibers	240-264 fibers	288-312 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	18	20-22	24-26
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	0	2-0	2-0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking Tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
Additional Strength Member	Material	Aramid yarns (When necessary)		
	Number	The quantity of additional strength member shall be selected to minimize cable cost while meeting the performance requirement of the cable applications		
Ripcord	Material	Aramid threads		
	Number	2		
Moisture Barrier	Material	Aluminum tape with a polymer coating on both sides		
	Thickness	Aluminum : 0.2 ± 0.02 mm Aluminum & Polymer coating : 0.3 ± 0.02 mm		
Sheath	Material	Black High Density Polyethylene with two red stripes run longitudinally on the cable sheath		
	Thickness	Minimum 2.0 mm.		
Cable Diameter (Approx.) mm.		22.0	24.0	26.0
Cable Weight (Approx.) kg/km		350	415	490
Structure		Fig. 5.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 5. Construction of double jacket, single armor, self-supporting,
Dry core aerial loose tube fiber optic cable.

Item		Description		
		2-30 fibers	36-60 fibers	72 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 6	Max. 12	
	Number	1-5	3-5	6
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	4-0	2-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
1st Ripcord	Material	Plastic threads		
	Number	2		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.32		Nominal 7/1.57
Cable Diameter (Approx.) mm.		15.5	16.5	17.5
Overall Diameter (Approx.) mm.		24.0	25.5	27.0
Cable Weight (Approx.) kg/km		310	350	410
Structure		Fig. 6.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 5. (Con't) Construction of double jacket, single armor, self-supporting, Dry core aerial loose tube fiber optic cable.

Item		Description		
		84-96 fibers	108-120 fibers	144 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	7-8	9-10	12
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	1-0	1-0	0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
1st Ripcord	Material	Plastic threads		
	Number	2		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.57		
Cable Diameter (Approx.) mm.		19.0	20.5	22.5
Overall Diameter (Approx.) mm.		28.5	30.0	32.0
Cable Weight (Approx.) kg/km		455	505	575
Structure		Fig. 6.		

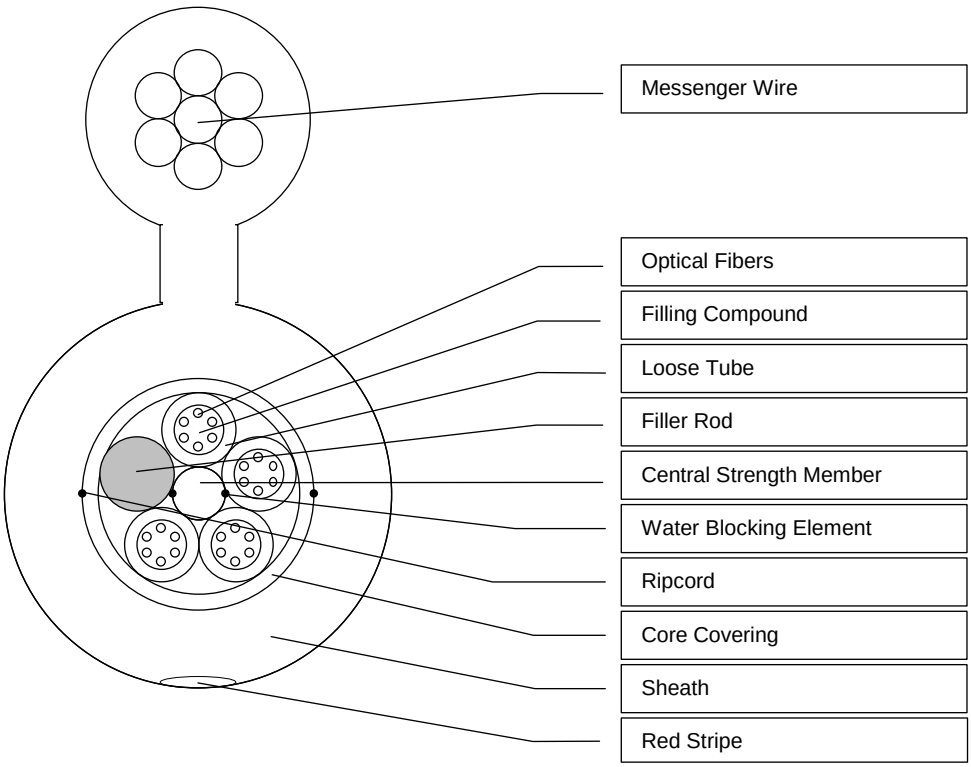
*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

Table 5. (Con't) Construction of double jacket, single armor, self-supporting, Dry core aerial loose tube fiber optic cable.

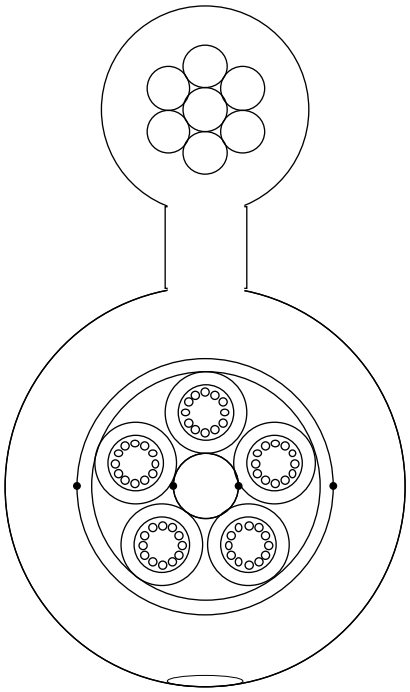
Item		Description		
		216 fibers	240-264 fibers	288-312 fibers
Optical Fiber	Construction	Table 1		
Filling Compound	Material	Thixotropic Jelly Compound		
Loose Tube	Material	(PBT) Polybutylene Terephthalate with color coding		
	Fiber per Tube	Max. 12		
	Number	18	20-22	24-26
	Assembly	Fibers are brought together with the filling compound and placed in the extruded tube		
Filler Rod	Material	Polyethylene, natural color		
	Number	0	2-0	2-0
Stranding	Method	Reverse oscillating lay (ROL) technique (SZ Direction)		
Central Strength Member	Material	FRP (Fiberglass Reinforce with Plastic) If necessary, jacketed with polyethylene		
Water Blocking Element	Material	Suitable Water Swellable Materials (Dry-Core Technology)		
Core Covering	Material	Water Blocking tape		
	Assembly	The tape shall be wrapped longitudinally over the cable core		
1st Ripcord	Material	Plastic threads		
	Number	2		
Inner Sheath	Material	Black polyethylene		
	Thickness	Minimum 1.0 mm		
2nd Ripcord	Material	Aramid threads		
	Number	2		
Armoring	Material	Corrugated steel tape coated with polymer		
	Thickness	Steel: 0.15 ± 0.020 mm. Steel tape & Plastic coat: 0.27 ± 0.027 mm.		
Outer Sheath	Material	Black High Density Polyethylene with red stripe run longitudinally on the cable sheath		
	Thickness (Cable)	Minimum 2.0 mm		
	Thickness(Messenger Wire)	Minimum 1.0 mm		
	Web	Minimum 2.0 mm x 2.0 mm		
Messenger Wire		Nominal 7/1.57	Nominal 7/2.03	
Cable Diameter (Approx.) mm.		22.0	24.0	25.5
Overall Diameter (Approx.) mm.		31.5	35.0	36.5
Cable Weight (Approx.) kg/km		560	700	770
Structure		Fig. 6.		

*The nominal value of a parameter refers to a design target. The thickness of the thinnest point shall not be measured at the groove of the ripcord or the lapping point of steel corrugated tape.
** Manufacturer may use additional suitable tape(s), thread(s) or dielectric elements into suitable place in the cable for manufacturer's reason.

24 Fibers



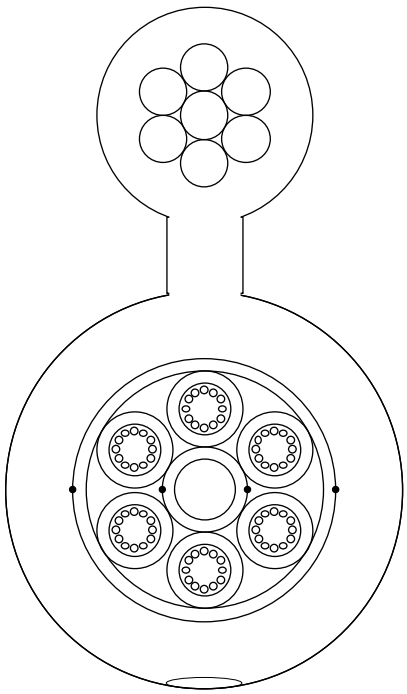
60 Fibers



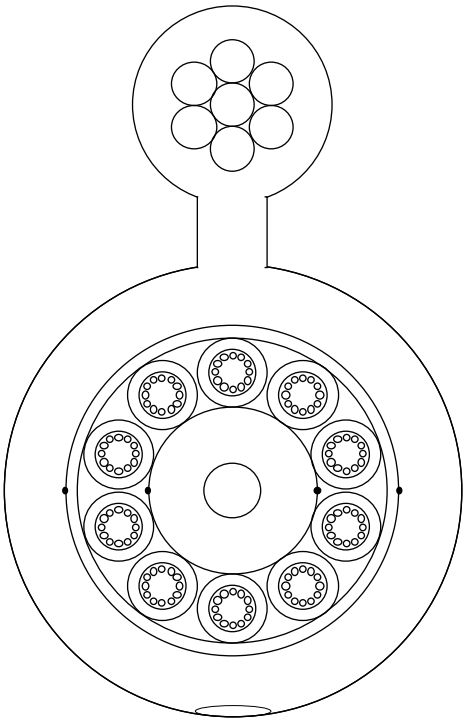
Not to scale

Fig. 3-1 Cross-section view of single jacket, self-supporting,
Dry core aerial loose tube fiber optic cable.

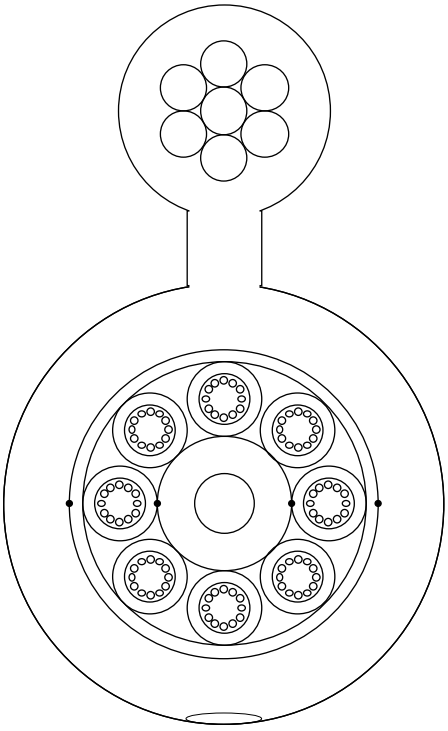
72 Fibers



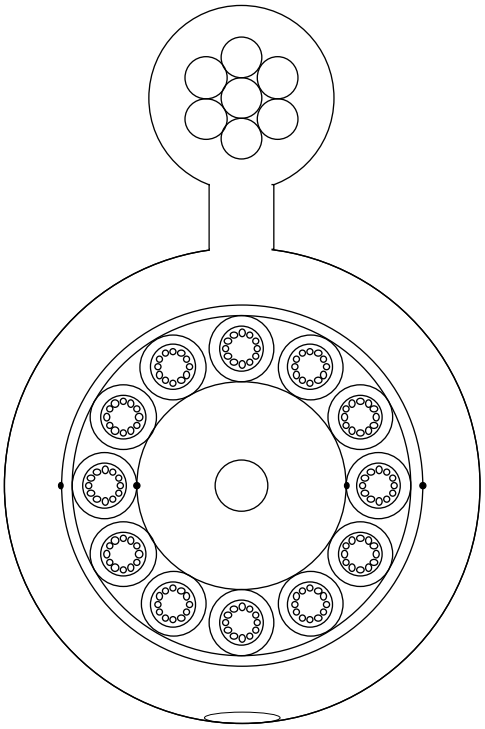
120 Fibers



96 Fibers



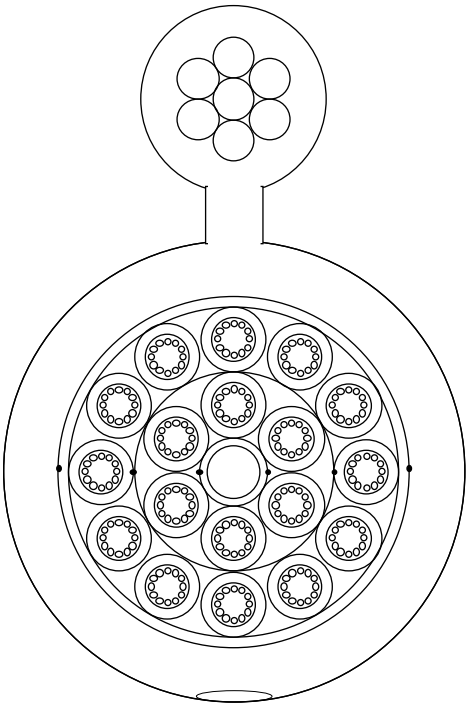
144 Fibers



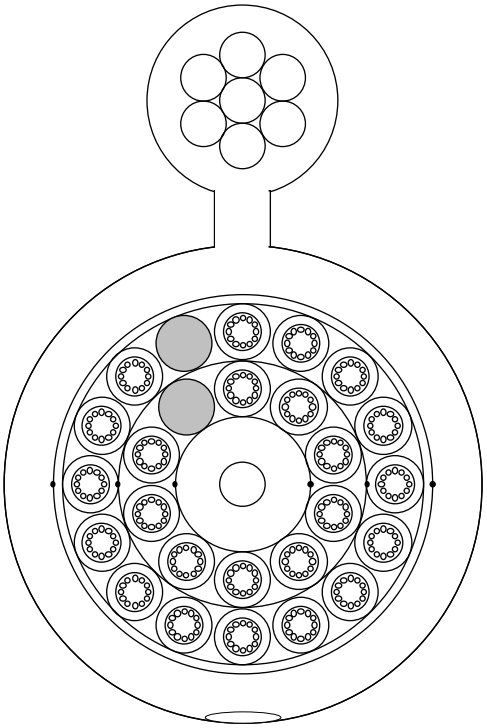
Not to scale

Fig. 3-2 Cross-section view of single jacket, self-supporting,
Dry core aerial loose tube fiber optic cable.

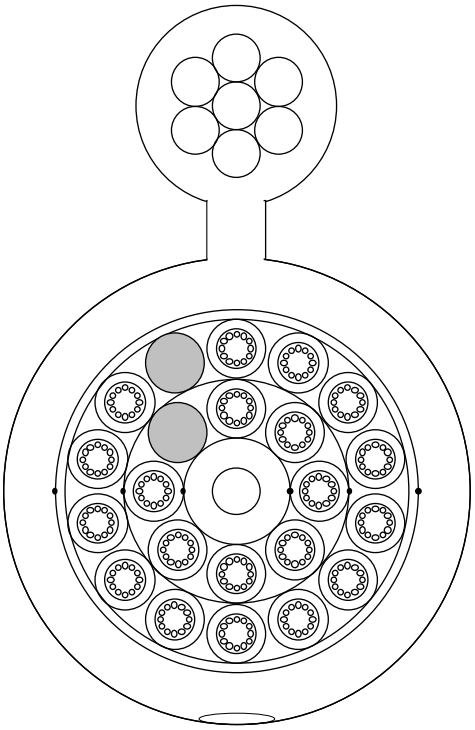
216 Fibers



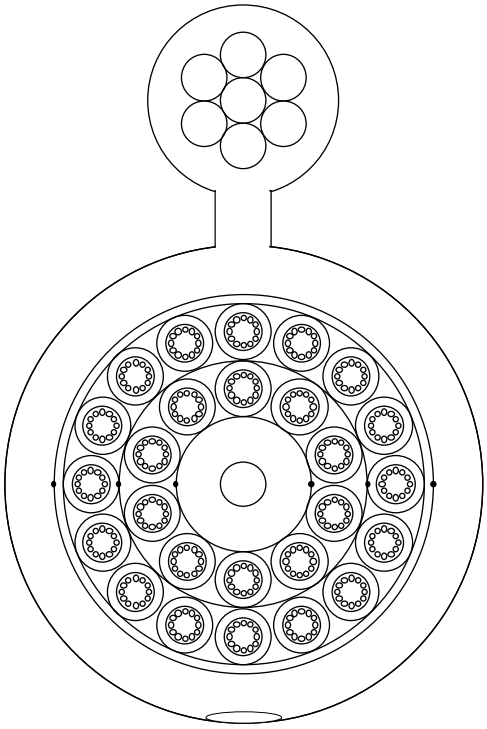
288 Fibers



240 Fibers



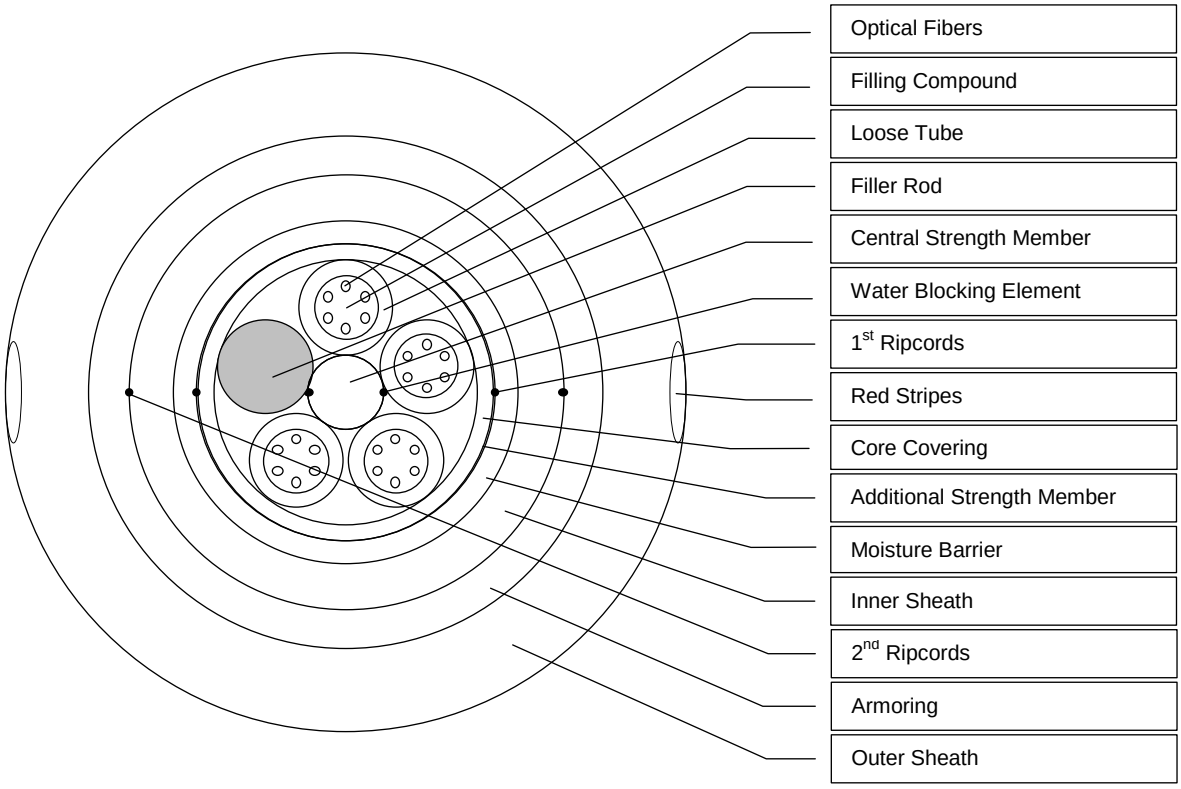
312 Fibers



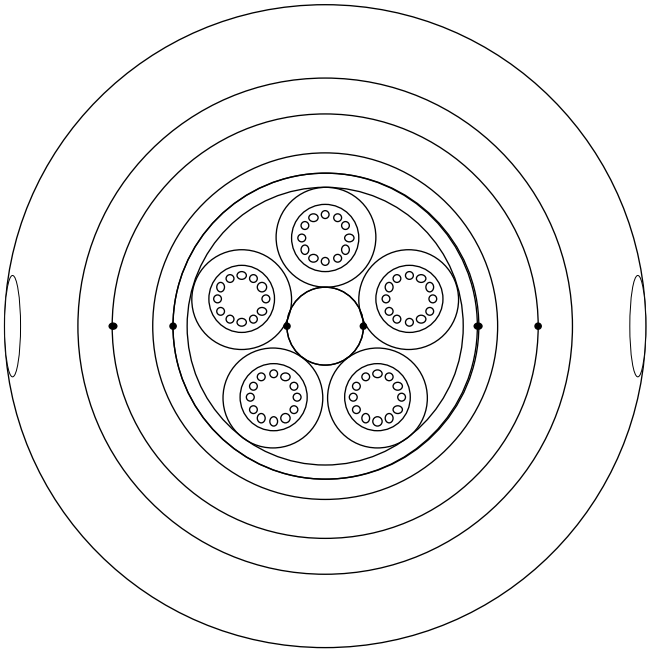
Not to scale

Fig. 3-3 Cross-section view of single jacket, self-supporting,
Dry core aerial loose tube fiber optic cable.

24 Fibers



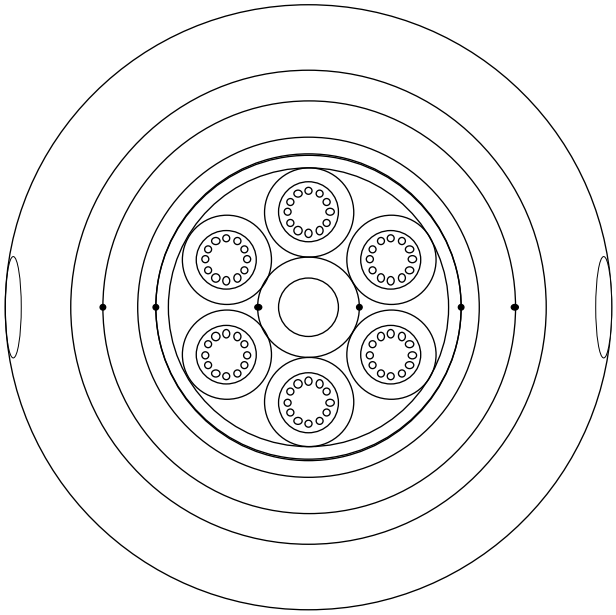
60 Fibers



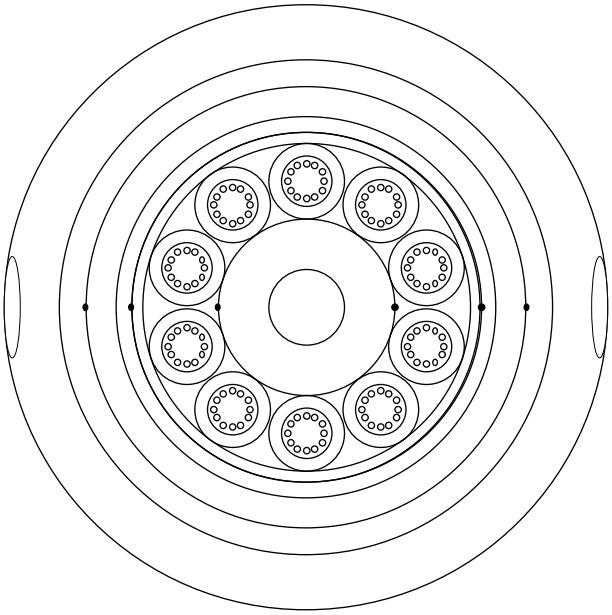
Not to scale

Fig. 4-1 Cross-section view of double jacket, single armor, laminated aluminum tape, Dry core loose tube fiber optic cable.

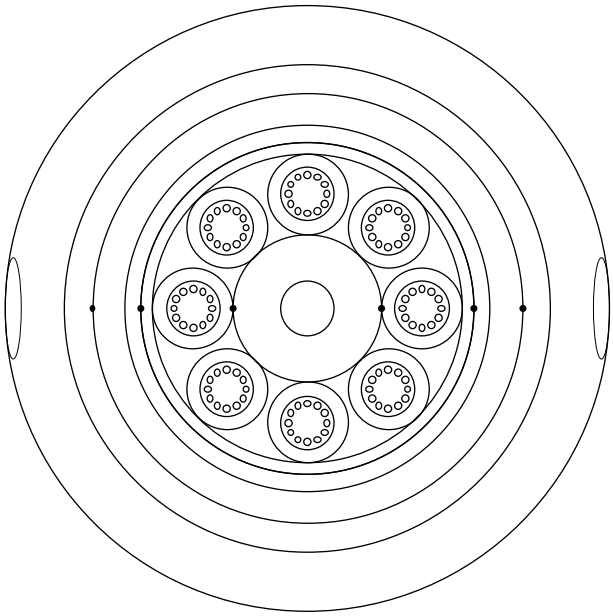
72 Fibers



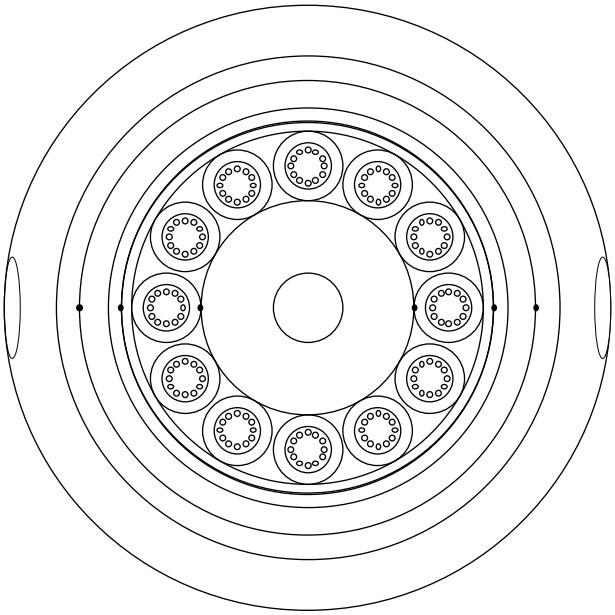
120 Fibers



96 Fibers



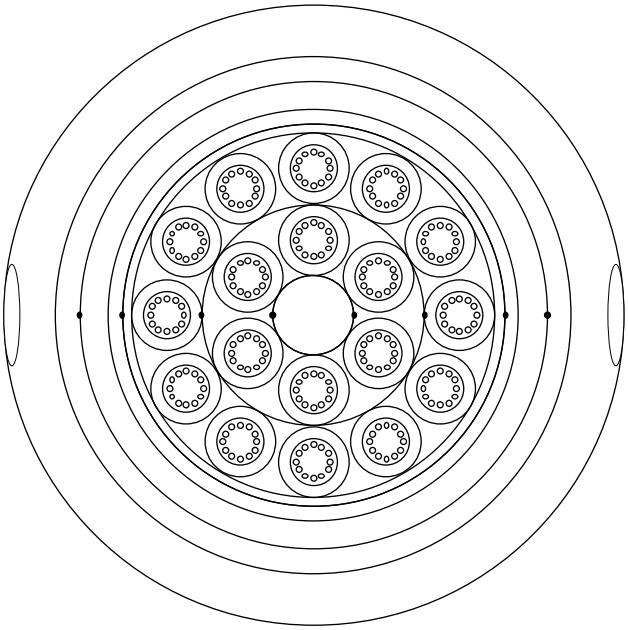
144 Fibers



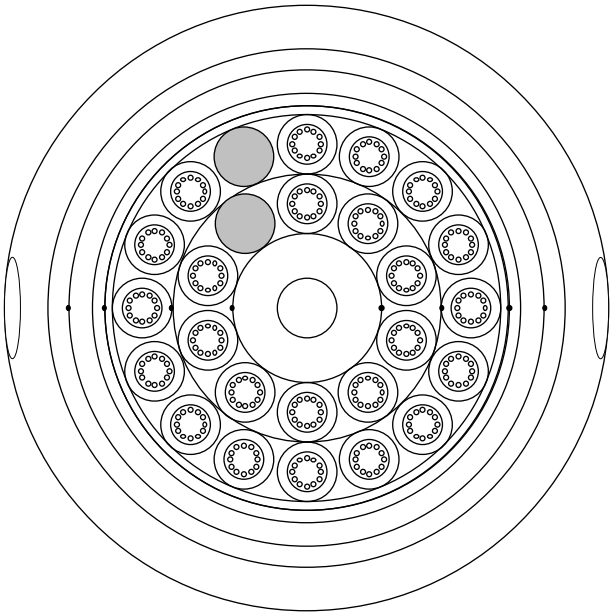
Not to scale

Fig. 4-2 Cross-section view of double jacket, single armor, laminated aluminum tape, Dry core loose tube fiber optic cable.

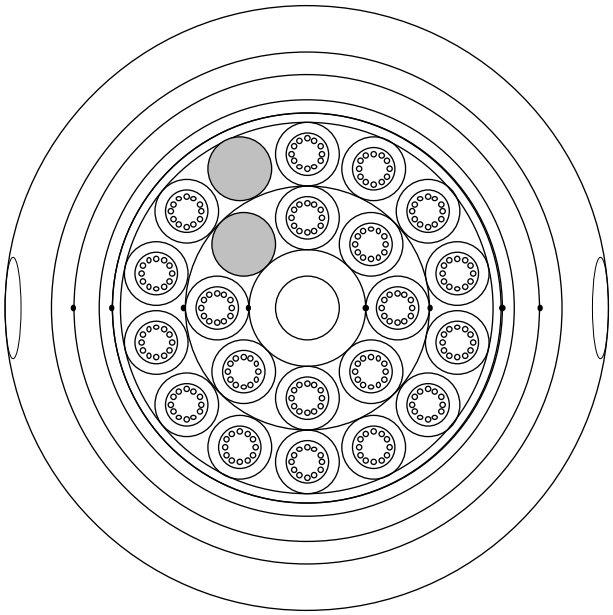
216 Fibers



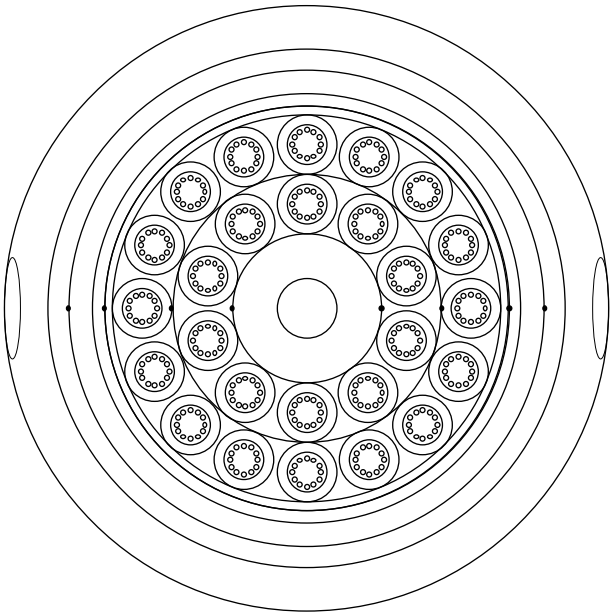
288 Fibers



240 Fibers



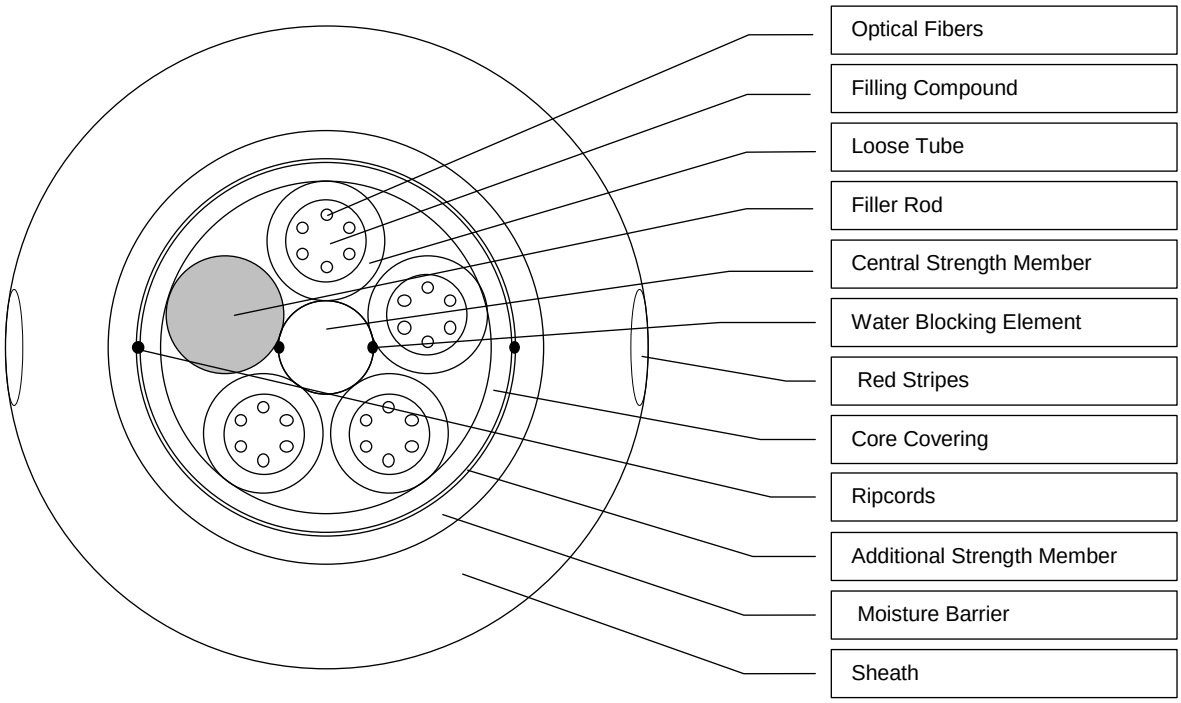
312 Fibers



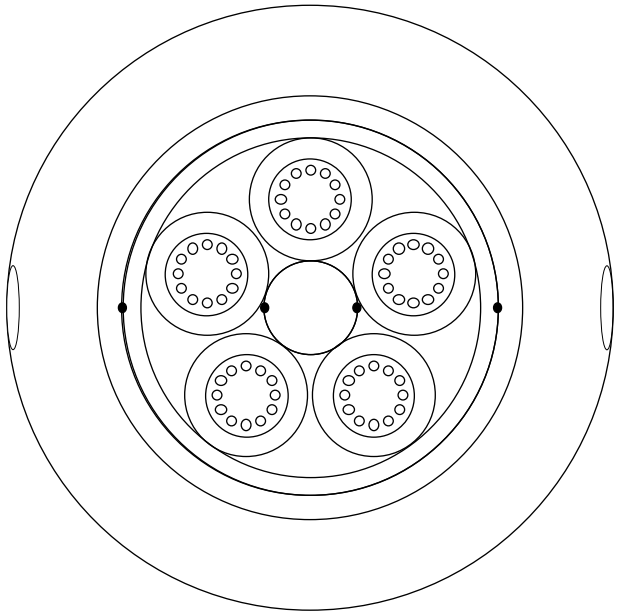
Not to scale

Fig. 4-3 Cross-section view of double jacket, single armor, laminated aluminum tape, Dry core loose tube fiber optic cable.

24 Fibers



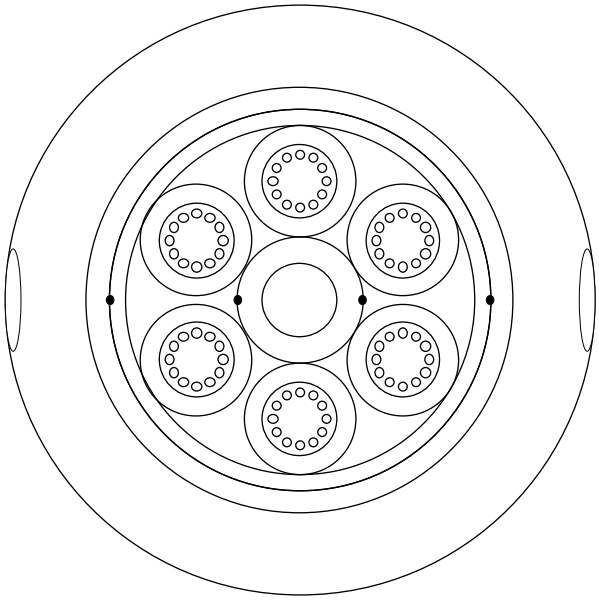
60 Fibers



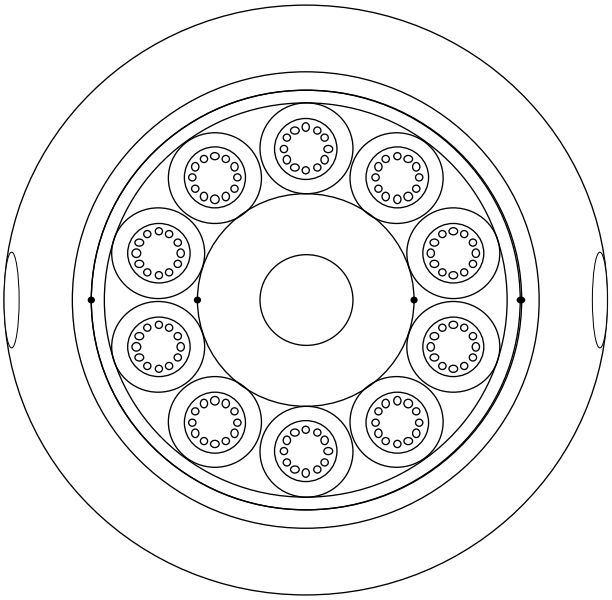
Not to scale

Fig. 5-1 Cross-section view of single jacket, laminated aluminum tape,
Dry core loose tube fiber optic cable.

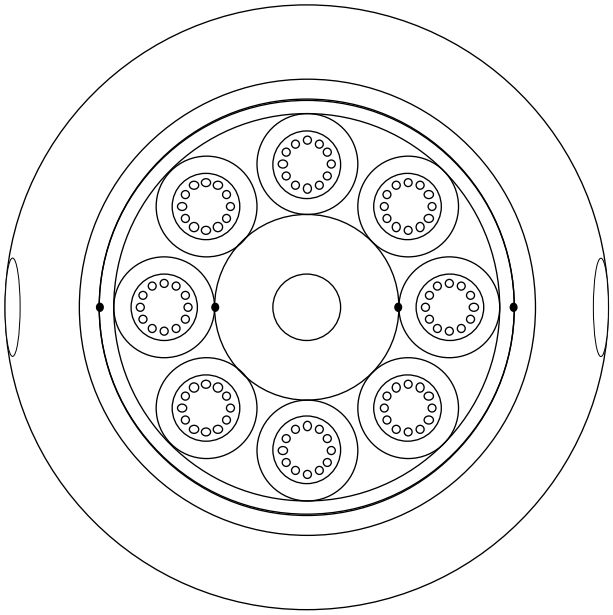
72 Fibers



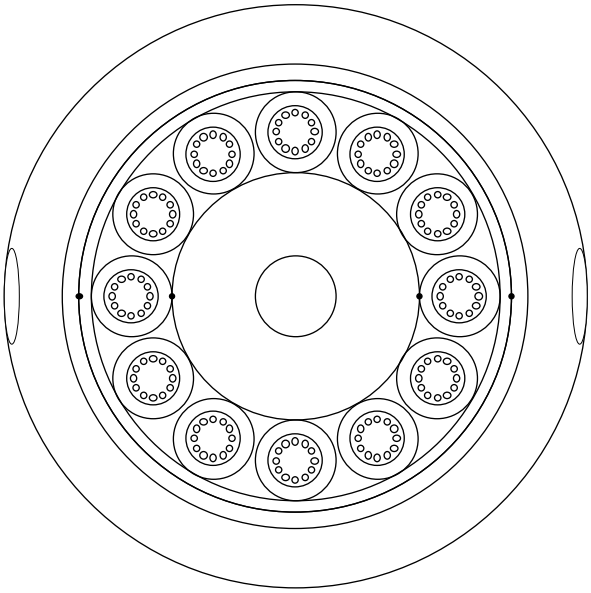
120 Fibers



96 Fibers



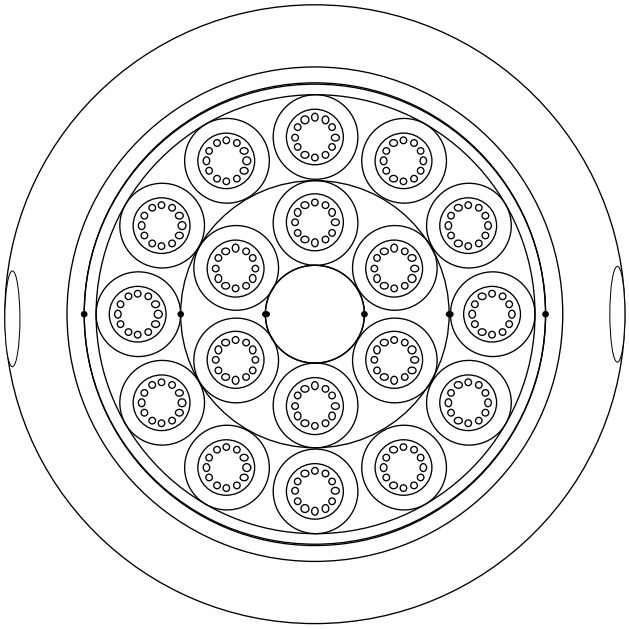
144 Fibers



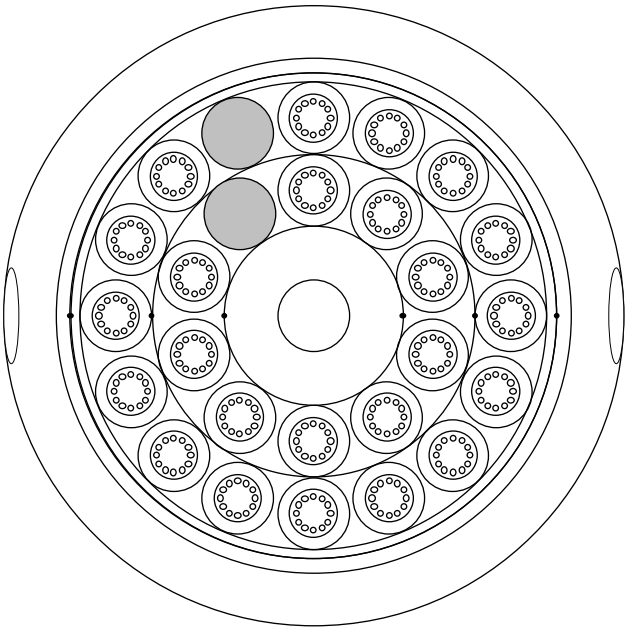
Not to scale

Fig. 5-2 Cross-section view of single jacket, laminated aluminum tape,
Dry core loose tube fiber optic cable.

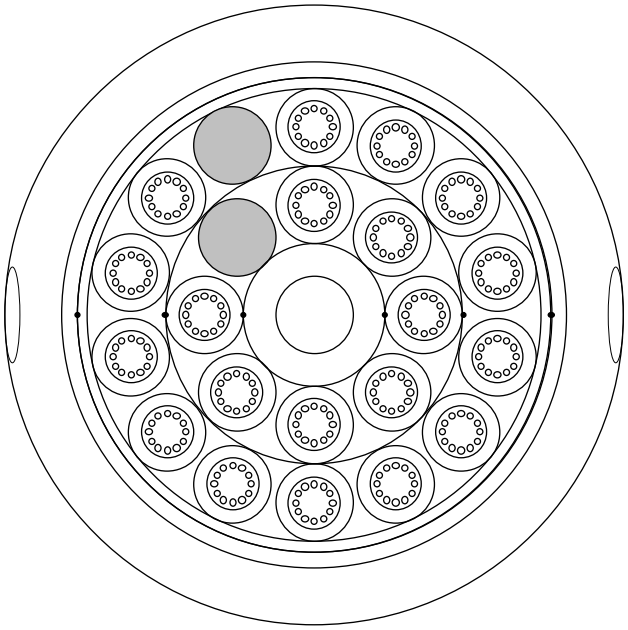
216 Fibers



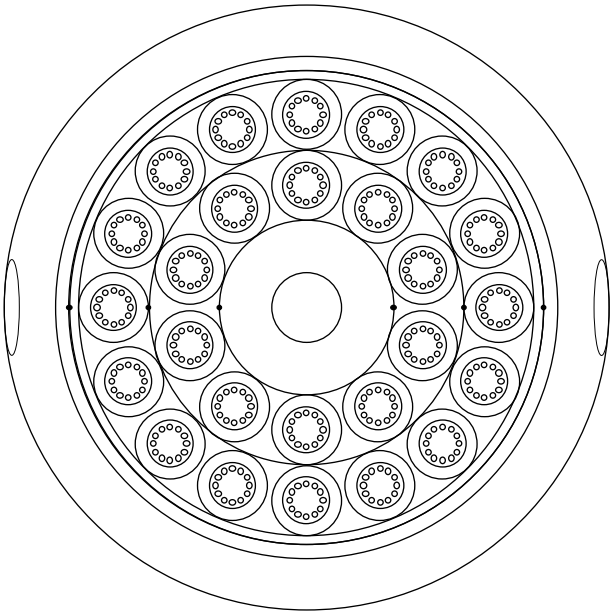
288 Fibers



240 Fibers



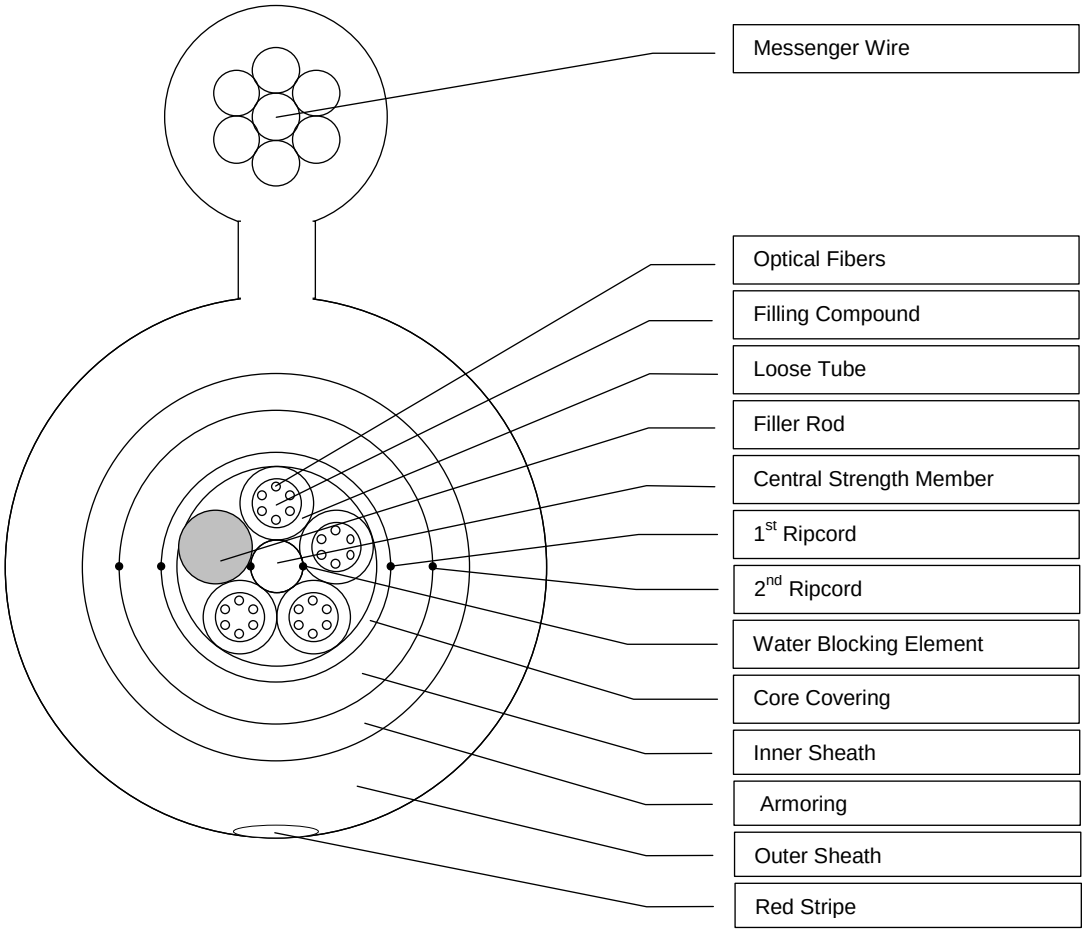
312 Fibers



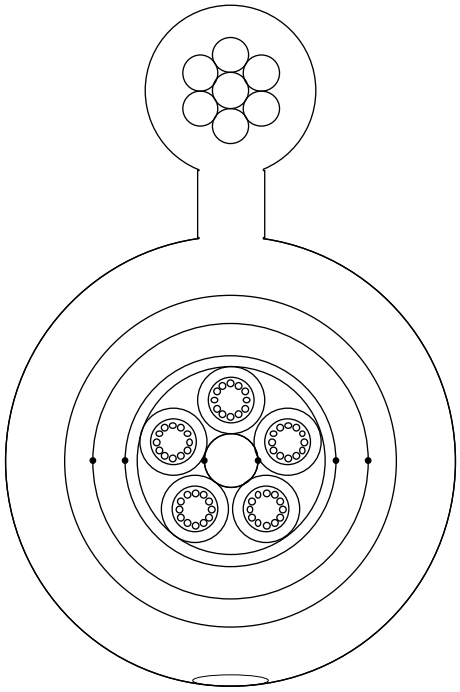
Not to scale

Fig. 5-3 Cross-section view of single jacket, laminated aluminum tape,
Dry core loose tube fiber optic cable.

24 Fibers



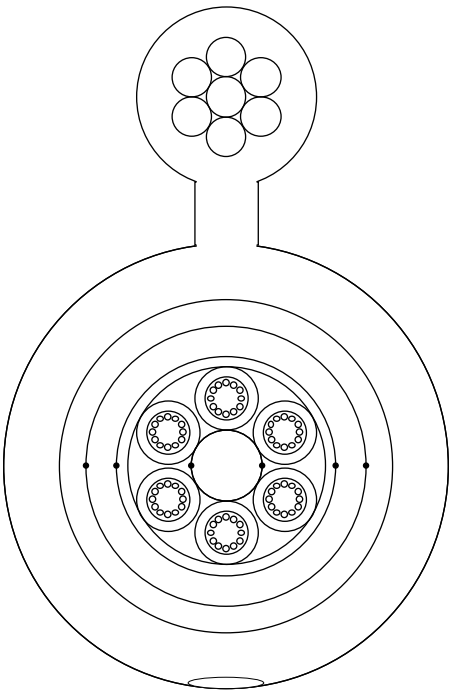
60 Fibers



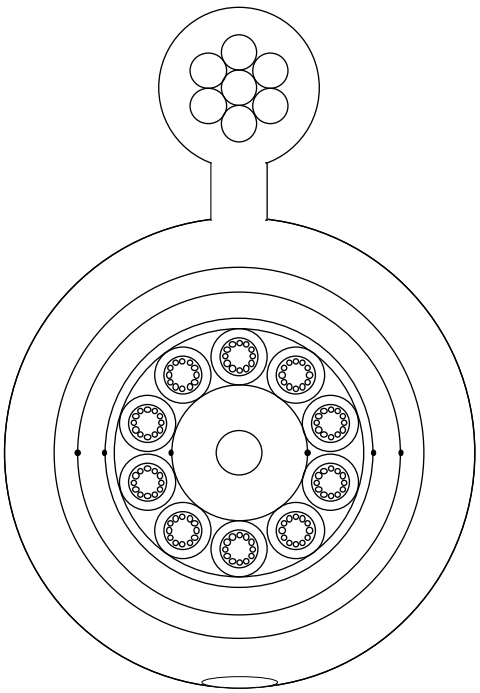
Not to scale

Fig. 6-1 Cross-section view of double jacket, single armor, self-supporting,
Dry core aerial loose tube fiber optic cable.

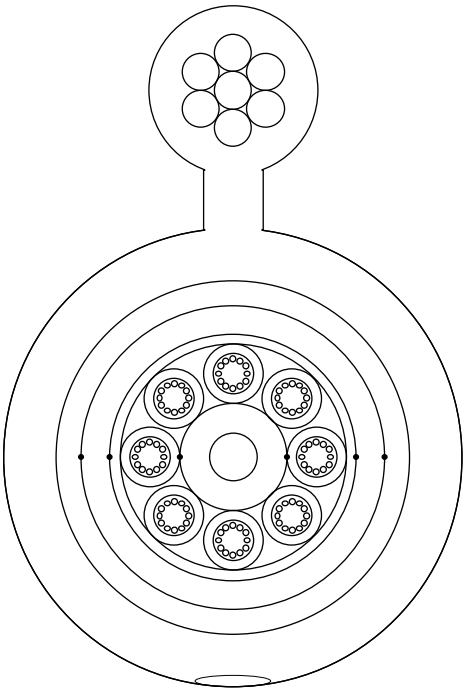
72 Fibers



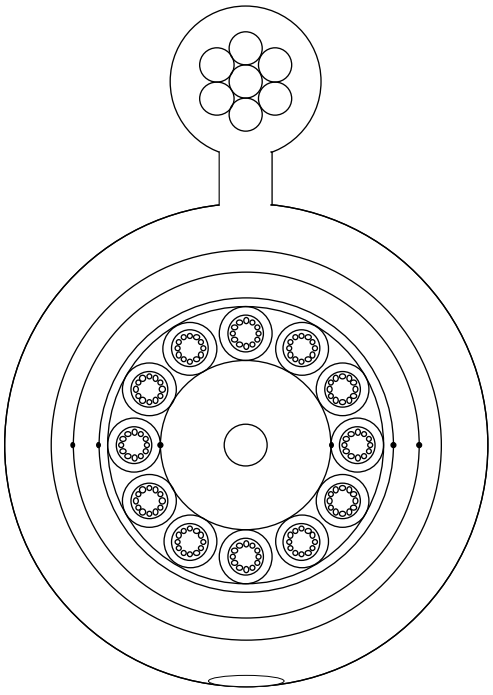
120 Fibers



96 Fibers



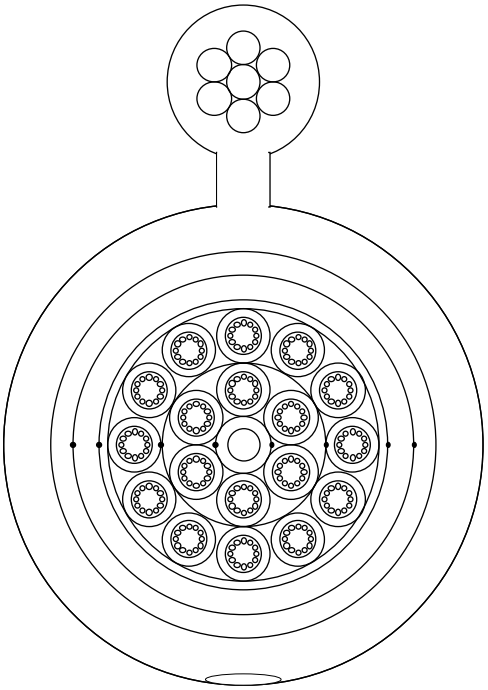
144 Fibers



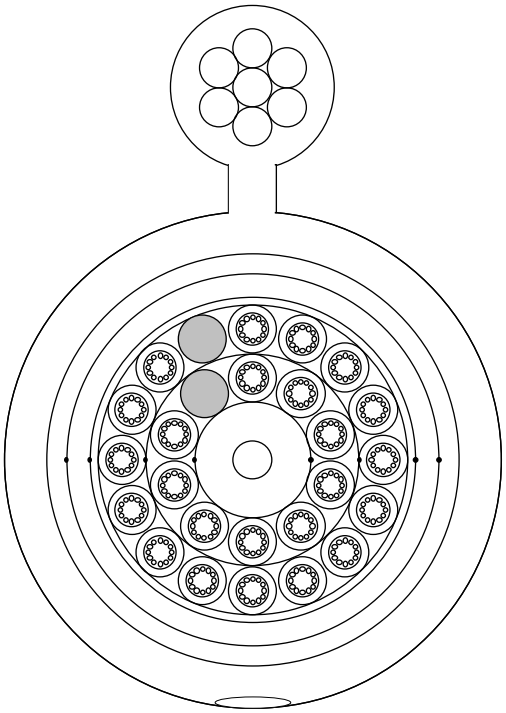
Not to scale

Fig. 6-2 Cross-section view of double jacket, single armor, self-supporting,
Dry core aerial loose tube fiber optic cable.

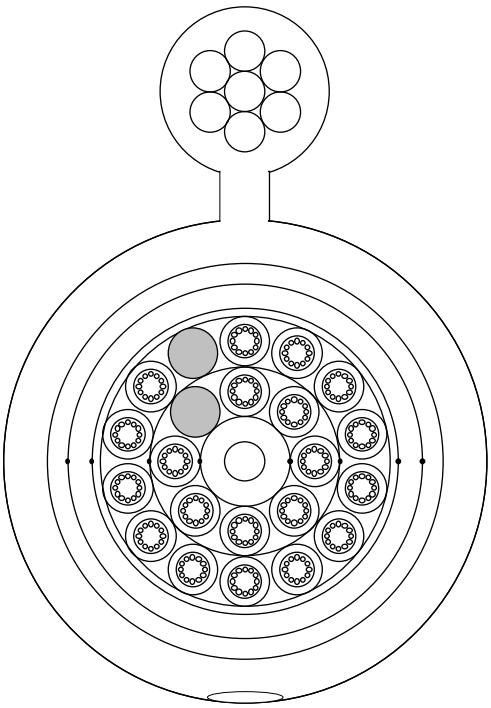
216 Fibers



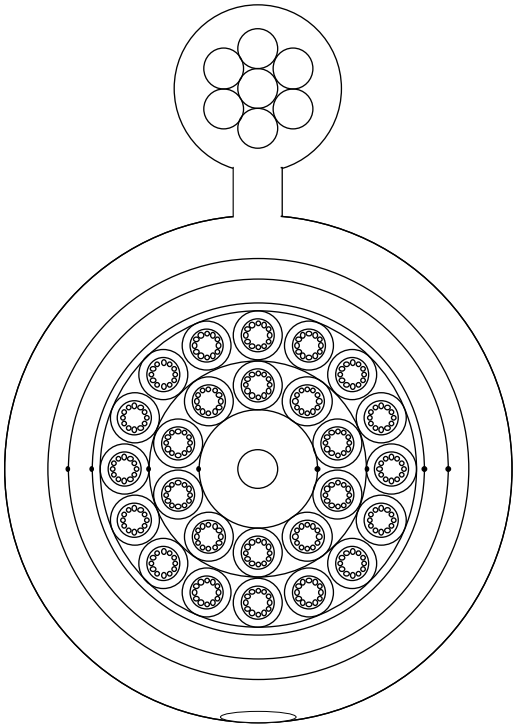
288 Fibers



240 Fibers



312 Fibers



Not to scale

Fig. 6-3 Cross-section view of double jacket, single armor, self-supporting,
Dry core aerial loose tube fiber optic cable.

Table 6. EIA/TIA-598A Color Code for Fiber and Loose tube Identification

No.	Fibers Identification	Fiber Units	
		1st Layer	2nd Layer
1	Blue	Blue	Blue
2	Orange	Orange	Orange
3	Green	Green	Green
4	Brown	Brown	Brown
5	Slate	Slate	Slate
6	White	White	White
7	Red	Red	Red
8	Black	Black	Black
9	Yellow	Yellow	Yellow
10	Violet	Violet	Violet
11	Rose	Rose	Rose
12	Aqua	Aqua	Aqua
13	-	-	Blue with Black tracer
14	-	-	Orange with Black tracer
15	-	-	Green with Black tracer
16	-	-	Brown with Black tracer

Note: - All fibers and tube used in our cables are color coded to facilitate individual identification. Unless otherwise specified, all cables employ the standard industry color code system in accordance with the Munsell color shades as specified in EIA/TIA-359. And EIA/TIA-598A, Color Coding of Fiber Optic Cables. Anyway the color code can be changed by customer's request.
- Unless otherwise requested by the customer, all cable jackets are black.
- To qualify the fiber color coating, the fiber shall pass the fiber rub test. The conditions for testing shall conform to TOT specification shall conform to OES-004-030-04.

Table 7. Technical Information of the cable

Item		Specification
Maximum allowable pulling tension*	Duct	≥ 2,500 N
	Direct Buried	≥ 2,500 N
	Figure eight self-supporting	≥ 7,000 N
	Figure eight armored self-supporting	≥ 7,000 N
Minimum bending Radius	During Installation Or handling	20 x External Diameter of Cable
	During Service Or fixed	15 x External Diameter of Cable

Note: The maximum allowable pulling tension is the greatest pulling force that can be applied to a cable during installation without cable damaging.

4. Cable Marking and Shipping Requirements

4.1 Sheath marking

The sheath marking is available upon customer's request. The Sheath marking shall be printed (Hot Stamp) on the outer sheath of the cable with white color in one-meter intervals.

For figure-8 and figure-8 armored aerial cable: there is red color identification stripe run longitudinally along the outer sheath.

For duct and direct buried cable: there are two red color identification stripes run longitudinally along the outer sheath diametrically opposite each other.

4.2 Reels

4.2.1 The cable will be delivered at the required length on a wooden reel. The reels are designed to prevent damage to the cable during shipment and installation.

4.2.2 The cable shall be delivered on wooden reel in standard manufacturing length of 4,000 m (Special length is available upon request)

4.2.3 The diameter of the barrel shall be not less than 40 times of the outer diameter of the cable

4.2.4 Circumference shall be completely enclosed with wooden battens, these battens shall be secured by nails to each flange. There are steel bands are strapped about the wooden batten to help secure the battens to the reel

4.2.5 To provide access for testing, the inner end of the cable protrudes through the inside of the reel. The end is securely kept on the side of the flange to protect it during transport and storage. The length of the inner end is typically 1 meter. The cable ends are securely fastened so as not to protrude beyond any portion of the reel in an unprotected manner and to prevent the cable from becoming loose in transport.

4.3 Sealing and Cable Termination

The both end of cable shall be sealed with a suitable rubber cap or heat shrinkable cap to prevent ingress of moisture.

4.4 Information Accompanying the Reel

The following information is securely attached to the reel.

- Manufacturer's Name
- Customer's Name
- Customer Order Number
- Customer Part Number (if Applicable)
- Kind & Size (Cable Description)
- Order Length
- Outside sequential
- Inside sequential
- Inspected by
- Drum No.
- Reel ID.
- Ship Length
- Gross Weight
- Net Weight
- Date

Appendix B
The Calculation of Single Mode Optical Fiber Life-time

The calculated life time , according to the failure frequency technique , is as follows

Formula ;

$$F = 1 - \exp\left(-N_p L \times \left(\left[1+(t_s/t_p) \times (k \times \delta_s/\delta_p)^n \right]^{m/(n-2)} - 1 \right) \right)$$

Where

F	=	Failure probability (%)	
N_p	=	Failure probability at the proof test (times/km)	: 0.02
L	=	Fiber length (km)	: 100
t_s	=	Life time (Sec.)	: 1.26144×10^9 (40 Years)
t_p	=	Duration of proof test (Sec.)	: 1
δ_s	=	Strain in life time (%)	: 0.2
δ_p	=	Strain of Proof test (%)	: 1
n	=	Stress corrosion factor	: 21
m	=	Weibull slope in low strength region	: 2
k	=	Safety factor at minimum proof strain	: 1

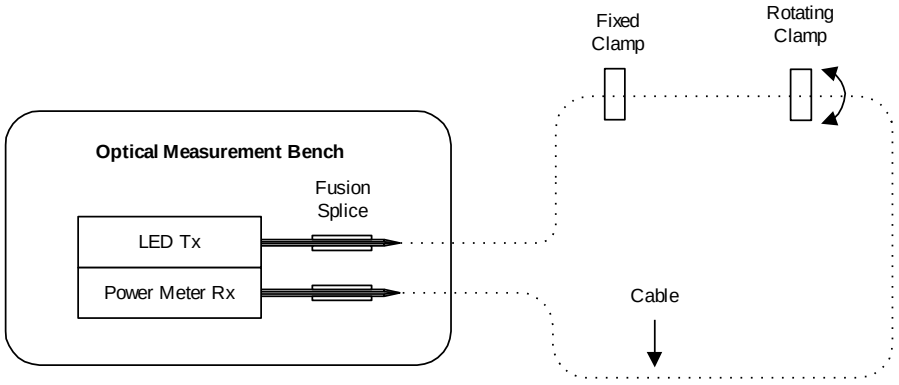
Failure probability (F) for fiber with length 100 km for 40 years is 0.000056 %

Appendix C
Properties of UV-Cured Acrylate

TYPICAL PROPERTIES OF UV CURED ACRYLATE

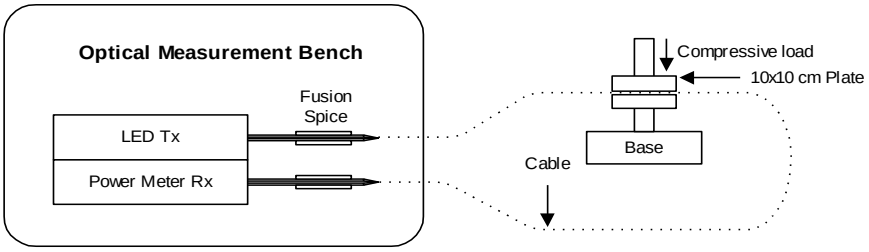
ITEM	Primary Coating (Inner)	Primary Coating (Outer)	Testing method
Density	0.9-1.1	1.0-1.3	JIS K 7112
Young modulus (kgf/mm^2)	Less than 0.5	More than 30	JIS K 7113
Tensile strength (kgf/mm^2)	-	More than 2	JIS K7113
Elongation (%)	-	More than 30	JIS K 7113
Refractive index	More than 1.47	-	Abbe's refractive Index tester

Appendix D
Mechanical Test



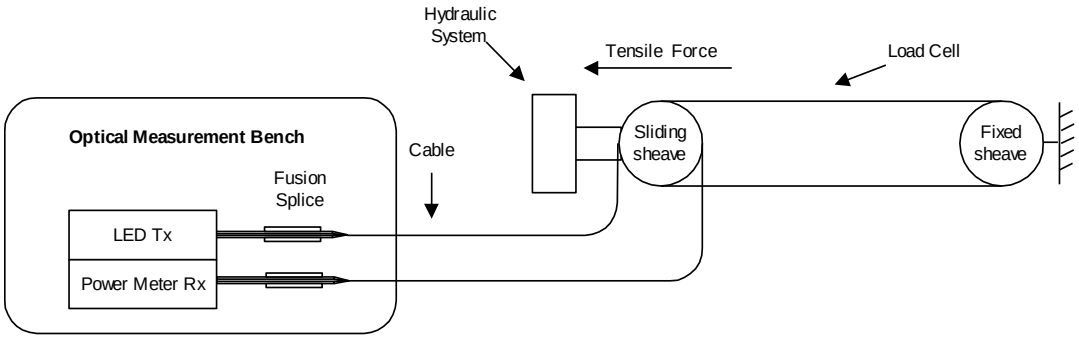
Method EIA-455-85A or IEC 60794-1-2-E7 Twist Test

Length Under Test:	1 m
Load	Per Table2, TIA/EIA-455-85A
Rotation:	±180° , 10 cycles
Requirements:	- Maximum attenuation change < 0.1 dB at 1550 ± 10 nm. No cable jacket cracking or splitting. - No fiber break and no cable damage.



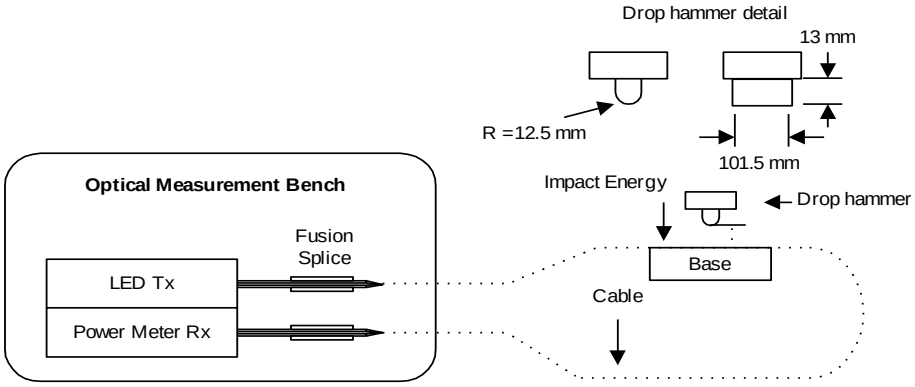
Method EIA-455-41A or IEC 60794-1-2-E3 Compression Test

Load:	≥ 2,200 N (220N/cm) non-armored ≥ 4,400 N (440N/cm) armored
Duration:	≥ 10 minutes (one point and one time)
Length of Sample:	Approximately 20 m
Requirements:	- Maximum attenuation change < 0.1 dB at 1550 ± 10 nm. No cable jacket cracking or splitting. - No fiber break and no cable damage.



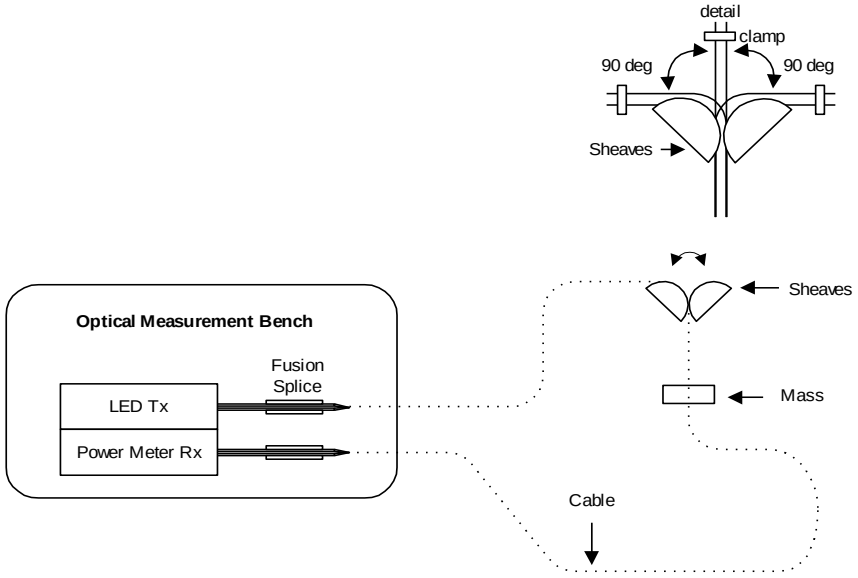
Method IEC-60794-1-2-E1 or EIA-455-33A Tensile Performance Test

Length of Cable Under Load:	Min. 25 m
Sheave Diameter:	30 x out side diameter of the cable
Load:	Maximum rated tensile load of cable
Requirements:	- Maximum attenuation change < 0.1 dB at 1550 ± 10 nm. No cable jacket cracking or splitting. and the fiber strain shall not be greater than 33% or the 1/3 of the fiber proof test. - No fiber break and no cable damage.



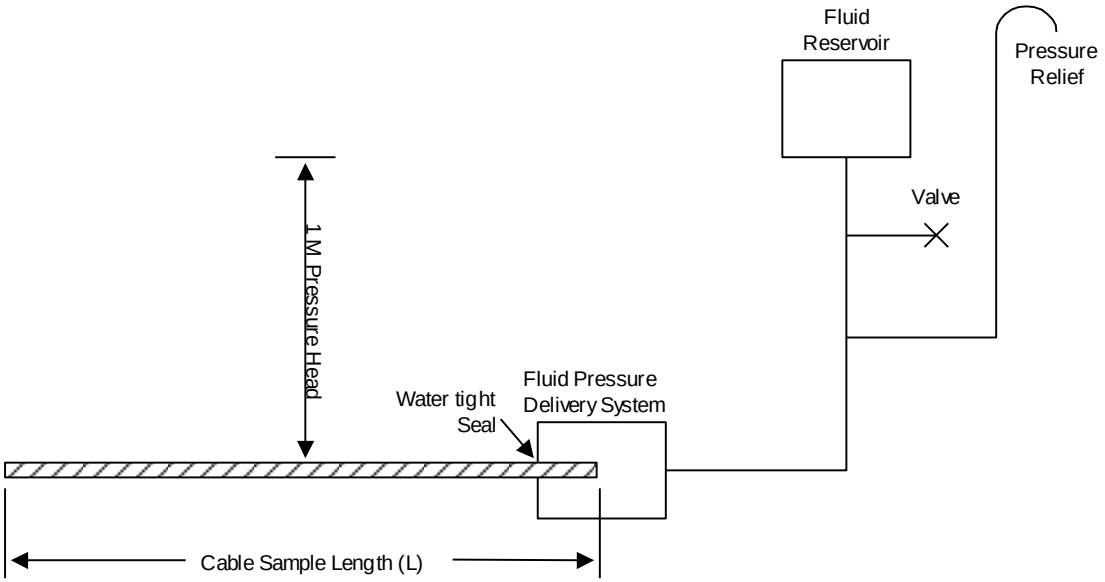
Method EIA/TIA-455-25C or IEC 60794-1-2-E4 Impact Test

Starting Energy:	Dependent on Cable Diameter, per Table 1, EIA/TIA-455-25C
Number Impact:	20
Length of Sample:	Approximately 20 m
Impact rate:	≤ 2 sec/cycle
Requirements:	- Maximum attenuation change < 0.1 dB at 1550 ± 10 nm. No cable jacket cracking or splitting. - No fiber break and no cable damage.



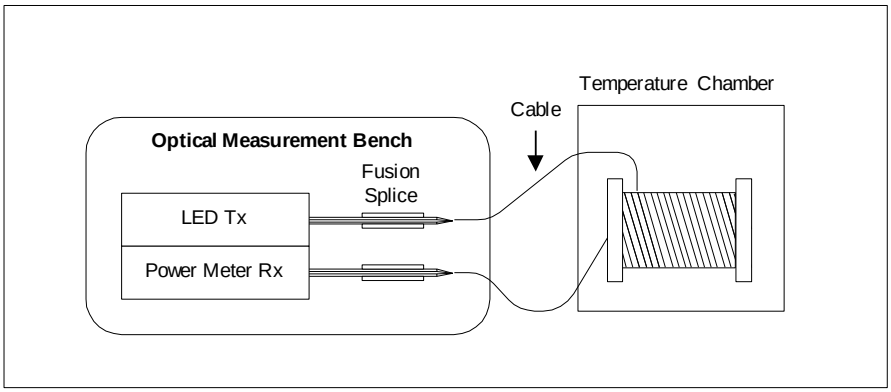
Method EIA/TIA-455-104A or IEC 60794-1-2-E6 Repeated Bending Test

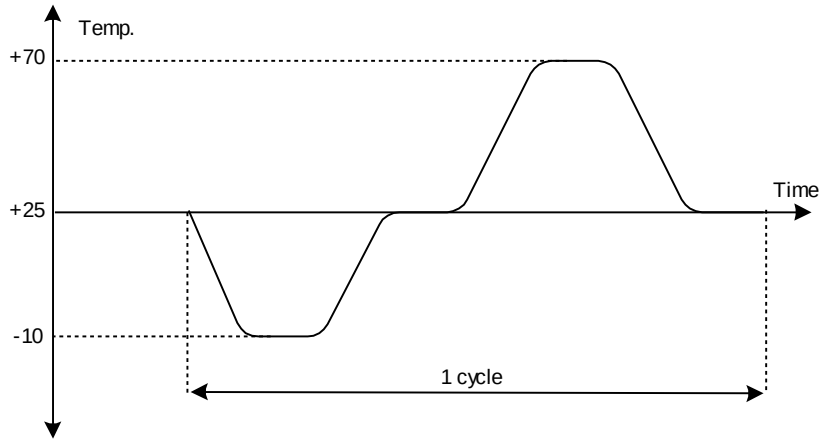
Sheave Diameter:	20 x cable diameter
Number Cycles:	≥ 25
Load:	per Table II, EIATIA-455-104A
Flexing rate:	≤ 2 sec./cycle
Length of sample:	Approximately 20 m
Requirements:	- Maximum attenuation change < 0.1 dB at 1550 ± 10 nm. No cable jacket cracking or splitting. - No fiber break and no cable damage.



Method EIA-455-82B or IEC 60794-1-2-F5 Water Penetration Test

Fluid Pressure:	1 m static head or equivalent pressure
Sample Length:	3 m
Duration:	1 hour
Requirements:	No fluid leakage through the open cable end after 1 hour.





Method EIA/TIA-455-3A IEC 60794-1-2-F1 Temperature Cycling Test

Time at Temperature:	At least 16 hr. each Temp.
Temperature Range:	-10°C (± 2°C) Minimum +70°C (± 2°C) Maximum
Number of Cycles:	2 cycle
Soak time:	per Table A, Minimum Soak Times for a Given Sample Mass of EIA/TIA-455-3A
Requirements:	- Maximum attenuation change < 0.1 dB/km at 1550 ± 10 nm. No cable jacket cracking or splitting. - No fiber break and no cable damage.

Cable Bending Test

Test standard:	IEC 60794-1-2-E11B
Diameter of mandrel:	20 x diameter of cable
Number of cycles:	1
Wave length:	1550 ± 10 nm
Test result:	Attenuation changes < 0.1 dB and no fiber break and no cable damage

Cable Sheath Test

Carbon Black:	The procedure for carbon black testing shall conform to ASTM D1603 Standard Test Method for Carbon Black in Olefin Plastics.
Tensile strength and elongation:	Specimens of polyethylene material die cut from the sheaths shall be tested in accordance with ASTM D470-latest issue, except that the speed of jaw separation shall be 50 cm. (20 in.) per minute for inner sheath and 5 cm. (2 in.) per minute for outer sheath.
Environmental stress cracking:	Test specimens shall be die cut in the transverse direction from the cable sheath having an outside diameter of 2.8 cm. (1.1 in.) and larger. These specimens shall be prepared and subjected to an environmental stress cracking test as described in ASTM D1693 latest issue, except that the conditioning requirements is waived, the depth of the controlled imperfection shall be proportional to the sheath thickness, and the stress cracking reagent shall be a 10 percent solution (By volume) of "Igepal" CO-630.
Shrinkback:	Slab specimens shall be cut from the cable sheaths 5 cm. (2 in.) long, 13 mm. (1/2 in.) wide, and the same thickness as the cable sheath. The slab specimens shall be placed in a convection type circulating air oven operating at a temperature of 100 ± 1°C for a 4-hour period for inner sheath and 115 ± 1°C for outer sheath.

Fiber Rub Test

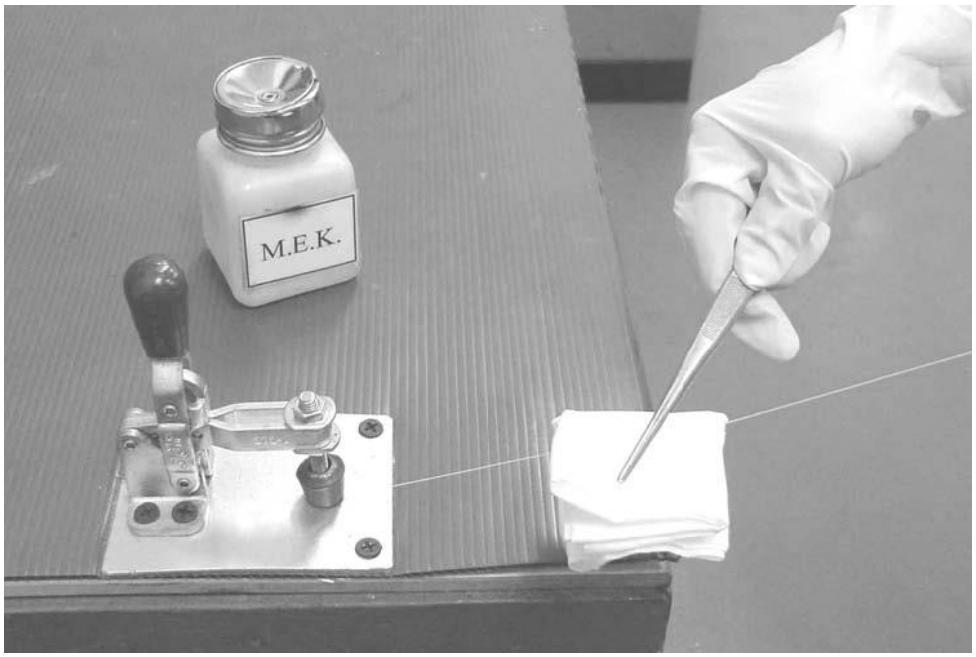
Sample : 50 cm length of the single colored fiber .

Materials :

1. Absorbent materials in white color such as cleaning tissue or soft cotton cloth.
2. Pincers
3. MEK Solution, grade: MEK FOR ANALYSIS, Code : 462703, Carlo Erba Reagents Co.,Ltd , Local supplier : Vidhaya-som Co.,ltd. etc.
4. Tool for fixing one end of the colored fiber
5. Rubber gloves
6. Mask

Procedure : The test shall be prepared and performed according to below figure. The 5 ml (5 milliliters) of MEK solution shall be dripped at the middle point of absorbent material. After the absorbent material is soaked by the MEK solution then the MEK soaked cloth or tissue shall be wiped on the single colored fiber core with uniform backward and forward motion (15 cm wiping span , one time of backward and forward motion = 1 cycle = 30 cm wiping length) requiring total 75 cycles. Observe the sample.

Test result : - no color of fiber peel off until could see the surface of bare fiber by visual check.



Appendix E
Sag Calculation

Figure-8 Self-Supporting Aerial Cable

General

These calculations are based on a maximum wind velocity of 144 km/hr
Initial Temperature (°C): 32
Operation temperature: from -10 ° C to 70 ° C

Mechanical and Environmental characteristics

Messenger wire: Metallic wire 7/1.32 mm. For 12 Fibers to 60 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 7,500 N

Messenger wire: Metallic wire 7/1.57 mm. For 72 Fibers to 216 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 10,000 N

Messenger wire: Metallic wire 7/2.03 mm. For 240 Fibers to 312 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 14,000 N

Cable construction

Figure-8, 24 core construction

Cable outer diameter: Approx. 19.5 x 10.5 mm , Messenger wire: Metallic wire 7/1.32 mm
Cable Weight: Approx. 185 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	1832
		A	-10	144	0.80	4800
		B	70	144	1.05	3650
	1%	Installation	32	0	0.40	915
		A	-10	144	0.93	4150
		B	70	144	1.18	3240
50	0.5%	Installation	32	0	0.25	2290
		A	-10	144	1.08	5555
		B	70	144	1.37	4380
	1%	Installation	32	0	0.50	1145
		A	-10	144	1.25	4795
		B	70	144	1.55	3860
60	0.5%	Installation	32	0	0.30	2745
		A	-10	144	1.38	6280
		B	70	144	1.70	5080
	1%	Installation	32	0	0.60	1375
		A	-10	144	1.60	5400
		B	70	144	1.93	4450

Figure-8, 60 core construction

Cable outer diameter: Approx. 21.0 x 12.0 mm , Messenger wire: Metallic wire 7/1.32 mm
Cable Weight: Approx. 210 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	2060
		A	-10	144	0.80	5220
		B	70	144	1.06	3940
	1%	Installation	32	0	0.40	1030
		A	-10	144	0.93	4490
		B	70	144	1.20	3480
50	0.5%	Installation	32	0	0.25	2575
		A	-10	144	1.08	6045
		B	70	144	1.37	4730
	1%	Installation	32	0	0.50	1290
		A	-10	144	1.25	5185
		B	70	144	1.57	4150
60	0.5%	Installation	32	0	0.30	3085
		A	-10	144	1.37	6835
		B	70	144	1.71	5490
	1%	Installation	32	0	0.60	1545
		A	-10	144	1.60	5840
		B	70	144	1.96	4785

Figure-8, 72 core construction

Cable outer diameter: Approx. 22.5 x 13.0 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 255 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	2535
		A	-10	144	0.72	6235
		B	70	144	0.98	4575
	1%	Installation	32	0	0.40	1265
		A	-10	144	0.85	5290
		B	70	144	1.12	4000
50	0.5%	Installation	32	0	0.25	3160
		A	-10	144	0.97	7215
		B	70	144	1.27	5505
	1%	Installation	32	0	0.50	1585
		A	-10	144	1.15	6105
		B	70	144	1.46	4785
60	0.5%	Installation	32	0	0.30	3800
		A	-10	144	1.23	8155
		B	70	144	1.57	6400
	1%	Installation	32	0	0.60	1900
		A	-10	144	1.46	6875
		B	70	144	1.82	5525

Figure-8, 96 core construction

Cable outer diameter: Approx. 24.0 x 14.5 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 290 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	2845
		A	-10	144	0.72	6725
		B	70	144	0.99	4870
	1%	Installation	32	0	0.40	1425
		A	-10	144	0.85	5660
		B	70	144	1.14	4235
50	0.5%	Installation	32	0	0.25	3570
		A	-10	144	0.97	7780
		B	70	144	1.28	5875
	1%	Installation	32	0	0.50	1785
		A	-10	144	1.15	6530
		B	70	144	1.48	5070
60	0.5%	Installation	32	0	0.30	4290
		A	-10	144	1.23	8800
		B	70	144	1.58	6850
	1%	Installation	32	0	0.60	2145
		A	-10	144	1.47	7350
		B	70	144	1.85	5860

Figure-8, 120 core construction

Cable outer diameter: Approx. 26.0 x 16.5 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 325 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	3190
		A	-10	144	0.71	7200
		B	70	144	0.99	5150
	1%	Installation	32	0	0.40	1590
		A	-10	144	0.85	6010
		B	70	144	1.15	4445
50	0.5%	Installation	32	0	0.25	3990
		A	-10	144	0.96	8335
		B	70	144	1.28	6225
	1%	Installation	32	0	0.50	1990
		A	-10	144	1.15	6925
		B	70	144	1.50	5320
60	0.5%	Installation	32	0	0.30	4787
		A	-10	144	1.22	9430
		B	70	144	1.58	7265
	1%	Installation	32	0	0.60	2392
		A	-10	144	1.48	7800
		B	70	144	1.87	6160

Figure-8, 144 core construction

Cable outer diameter: Approx. 27.5 x 18.0 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 370 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	3650
		A	-10	144	0.70	7835
		B	70	144	1.00	5525
	1%	Installation	32	0	0.40	1825
		A	-10	144	0.85	6470
		B	70	144	1.17	4720
50	0.5%	Installation	32	0	0.25	4560
		A	-10	144	0.95	9080
		B	70	144	1.29	6695
	1%	Installation	32	0	0.50	2280
		A	-10	144	1.16	7455
		B	70	144	1.52	5660
60	0.5%	Installation	32	0	0.30	5470
		A	-10	144	1.21	10285
		B	70	144	1.58	7835
	1%	Installation	32	0	0.60	2740
		A	-10	144	1.48	8390
		B	70	144	1.89	6560

Figure-8, 216 core construction

Cable outer diameter: Approx. 27.0 x 18.0 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 360 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	3560
		A	-10	144	0.70	7785
		B	70	144	1.01	5380
	1%	Installation	32	0	0.40	1780
		A	-10	144	0.84	6435
		B	70	144	1.18	4610
50	0.5%	Installation	32	0	0.25	4455
		A	-10	144	0.94	9005
		B	70	144	1.30	6530
	1%	Installation	32	0	0.50	2225
		A	-10	144	1.15	7400
		B	70	144	1.53	5535
60	0.5%	Installation	32	0	0.30	5345
		A	-10	144	1.20	10185
		B	70	144	1.60	7645
	1%	Installation	32	0	0.60	2675
		A	-10	144	1.47	8320
		B	70	144	1.91	6420

Figure-8, 264 core construction

Cable outer diameter: Approx. 30.5 x 20.0 mm , Messenger wire: Metallic wire 7/2.03 mm
Cable Weight: Approx. 485 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	4780
		A	-10	144	0.60	10360
		B	70	144	0.90	6815
	1%	Installation	32	0	0.40	2400
		A	-10	144	0.74	8300
		B	70	144	1.06	5755
50	0.5%	Installation	32	0	0.25	6000
		A	-10	144	0.80	11860
		B	70	144	1.15	8300
	1%	Installation	32	0	0.50	3000
		A	-10	144	1.00	9550
		B	70	144	1.38	6930
60	0.5%	Installation	32	0	0.30	7200
		A	-10	144	1.02	13405
		B	70	144	1.41	9745
	1%	Installation	32	0	0.60	3600
		A	-10	144	1.28	10740
		B	70	144	1.70	8060

Figure-8, 312 core construction

Cable outer diameter: Approx. 32.0 x 21.0 mm , Messenger wire: Metallic wire 7/2.03 mm
Cable Weight: Approx. 530 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	5255
		A	-10	144	0.59	10905
		B	70	144	0.90	7140
	1%	Installation	32	0	0.40	2630
		A	-10	144	0.73	8750
		B	70	144	1.07	5985
50	0.5%	Installation	32	0	0.25	6570
		A	-10	144	0.79	12615
		B	70	144	1.15	8715
	1%	Installation	32	0	0.50	3285
		A	-10	144	1.00	10065
		B	70	144	1.39	7215
60	0.5%	Installation	32	0	0.30	7890
		A	-10	144	1.01	14265
		B	70	144	1.41	10255
	1%	Installation	32	0	0.60	3945
		A	-10	144	1.28	11315
		B	70	144	1.72	8400

Figure-8 Armour Self-Supporting Aerial Cable

General

These calculations are based on a maximum wind velocity of 144 km/hr
Initial Temperature (°C): 32
Operation temperature: from -10 ° C to 70 ° C

Mechanical and Environmental characteristics

Messenger wire: Metallic wire 7/1.32 mm. For 12 Fibers to 60 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 7,500 N

Messenger wire: Metallic wire 7/1.57 mm. For 72 Fibers to 216 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 10,000 N

Messenger wire: Metallic wire 7/2.03 mm. For 240 Fibers to 312 Fibers
Maximum tensile strength of Messenger wire (Yield Point 0.4%): 14,000 N

Cable construction

Figure-8 Armour, 24 core construction

Cable outer diameter: Approx. 24.0 x 15.5 mm , Messenger wire: Metallic wire 7/1.32 mm
Cable Weight: Approx. 310 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	3105
		A	-10	144	0.77	6205
		B	70	144	1.02	4655
	1%	Installation	32	0	0.40	1550
		A	-10	144	0.93	5110
		B	70	144	1.20	3945
50	0.5%	Installation	32	0	0.25	3880
		A	-10	144	1.03	7235
		B	70	144	1.32	5635
	1%	Installation	32	0	0.50	1940
		A	-10	144	1.26	5915
		B	70	144	1.57	4720
60	0.5%	Installation	32	0	0.30	4655
		A	-10	144	1.30	8230
		B	70	144	1.62	6585
	1%	Installation	32	0	0.60	2330
		A	-10	144	1.60	6680
		B	70	144	1.96	5460

Figure-8 Armour, 60 core construction

Cable outer diameter: Approx. 25.5 x 16.5 mm , Messenger wire: Metallic wire 7/1.32 mm
Cable Weight: Approx. 350 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	3460
		A	-10	144	0.75	6725
		B	70	144	1.01	5000
	1%	Installation	32	0	0.40	1730
		A	-10	144	0.92	5495
		B	70	144	1.21	4205
50	0.5%	Installation	32	0	0.25	4325
		A	-10	144	1.01	7845
		B	70	144	1.31	6060
	1%	Installation	32	0	0.50	2160
		A	-10	144	1.25	6360
		B	70	144	1.57	5035
60	0.5%	Installation	32	0	0.30	5185
		A	-10	144	1.28	8930
		B	70	144	1.61	7095
	1%	Installation	32	0	0.60	2595
		A	-10	144	1.59	7185
		B	70	144	1.96	5830

Figure-8 Armour, 72 core construction

Cable outer diameter: Approx. 27.0 x 17.5 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 410 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	4030
		A	-10	144	0.69	7855
		B	70	144	0.94	5705
	1%	Installation	32	0	0.40	2015
		A	-10	144	0.85	6360
		B	70	144	1.13	4775
50	0.5%	Installation	32	0	0.25	5035
		A	-10	144	0.92	9150
		B	70	144	1.22	6930
	1%	Installation	32	0	0.50	2520
		A	-10	144	1.14	7360
		B	70	144	1.47	5725
60	0.5%	Installation	32	0	0.30	6040
		A	-10	144	1.16	10410
		B	70	144	1.49	8120
	1%	Installation	32	0	0.60	3020
		A	-10	144	1.46	8310
		B	70	144	1.83	6640

Figure-8 Armour, 96 core construction

Cable outer diameter: Approx. 28.5 x 19.0 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 455 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	4505
		A	-10	144	0.68	8470
		B	70	144	0.94	6070
	1%	Installation	32	0	0.40	2250
		A	-10	144	0.84	6785
		B	70	144	1.14	5025
50	0.5%	Installation	32	0	0.25	5630
		A	-10	144	0.91	9875
		B	70	144	1.21	7395
	1%	Installation	32	0	0.50	2815
		A	-10	144	1.14	7845
		B	70	144	1.48	6040
60	0.5%	Installation	32	0	0.30	6750
		A	-10	144	1.15	11245
		B	70	144	1.48	8685
	1%	Installation	32	0	0.60	3380
		A	-10	144	1.46	8860
		B	70	144	1.84	7010

Figure-8 Armour, 120 core construction

Cable outer diameter: Approx. 30.0 x 20.5 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 505 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	5000
		A	-10	144	0.67	9080
		B	70	144	0.94	6425
	1%	Installation	32	0	0.40	2500
		A	-10	144	0.84	7190
		B	70	144	1.15	5260
50	0.5%	Installation	32	0	0.25	6245
		A	-10	144	0.89	10605
		B	70	144	1.20	7850
	1%	Installation	32	0	0.50	3125
		A	-10	144	1.13	8315
		B	70	144	1.49	6325
60	0.5%	Installation	32	0	0.30	7495
		A	-10	144	1.12	12085
		B	70	144	1.47	9245
	1%	Installation	32	0	0.60	3750
		A	-10	144	1.45	9390
		B	70	144	1.85	7350

Figure-8 Armour, 144 core construction

Cable outer diameter: Approx. 32.0 x 22.5 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 575 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	5635
		A	-10	144	0.65	9895
		B	70	144	0.94	6895
	1%	Installation	32	0	0.40	2825
		A	-10	144	0.83	7725
		B	70	144	1.16	5570
50	0.5%	Installation	32	0	0.25	7065
		A	-10	144	0.87	11565
		B	70	144	1.19	8455
	1%	Installation	32	0	0.50	3530
		A	-10	144	1.13	8930
		B	70	144	1.50	6710
60	0.5%	Installation	32	0	0.30	8475
		A	-10	144	1.10	13200
		B	70	144	1.45	9995
	1%	Installation	32	0	0.60	4240
		A	-10	144	1.44	10090
		B	70	144	1.86	7810

Figure-8 Armour, 216 core construction

Cable outer diameter: Approx. 31.5 x 22.0 mm , Messenger wire: Metallic wire 7/1.57 mm
Cable Weight: Approx. 560 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	5535
		A	-10	144	0.65	9830
		B	70	144	0.95	6735
	1%	Installation	32	0	0.40	2770
		A	-10	144	0.83	7680
		B	70	144	1.17	5450
50	0.5%	Installation	32	0	0.25	6925
		A	-10	144	0.87	11475
		B	70	144	1.20	8260
	1%	Installation	32	0	0.50	3465
		A	-10	144	1.12	8870
		B	70	144	1.51	6570
60	0.5%	Installation	32	0	0.30	8310
		A	-10	144	1.10	13075
		B	70	144	1.47	9765
	1%	Installation	32	0	0.60	4155
		A	-10	144	1.43	10010
		B	70	144	1.87	7650

Figure-8 Armour, 264 core construction

Cable outer diameter: Approx. 35.0 x 24.0 mm , Messenger wire: Metallic wire 7/2.03 mm
Cable Weight: Approx. 670 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	6960
		A	-10	144	0.56	12535
		B	70	144	0.85	8295
	1%	Installation	32	0	0.40	3480
		A	-10	144	0.73	9685
		B	70	144	1.06	6675
50	0.5%	Installation	32	0	0.25	8705
		A	-10	144	0.76	14590
		B	70	144	1.08	10195
	1%	Installation	32	0	0.50	4355
		A	-10	144	0.99	11175
		B	70	144	1.37	8.070
60	0.5%	Installation	32	0	0.30	10445
		A	-10	144	0.96	16610
		B	70	144	1.31	12075
	1%	Installation	32	0	0.60	5225
		A	-10	144	1.26	12605
		B	70	144	1.69	9415

Figure-8 Armour, 312 core construction

Cable outer diameter: Approx. 36.5 x 25.5 mm , Messenger wire: Metallic wire 7/2.03 mm
Cable Weight: Approx. 770 kg/km

Span (m)	Initial Sag (%)	Condition	Temperature (°C)	Wind velocity (km/hr)	Sag at load (m)	Tension (N)
40	0.5%	Installation	32	0	0.20	7580
		A	-10	144	0.55	13330
		B	70	144	0.85	8700
	1%	Installation	32	0	0.40	3790
		A	-10	144	0.72	10200
		B	70	144	1.06	6930
50	0.5%	Installation	32	0	0.25	9475
		A	-10	144	0.74	15535
		B	70	144	1.07	10730
	1%	Installation	32	0	0.50	4740
		A	-10	144	0.98	11770
		B	70	144	1.37	8390
60	0.5%	Installation	32	0	0.30	11370
		A	-10	144	0.94	17700
		B	70	144	1.30	12740
	1%	Installation	32	0	0.60	5690
		A	-10	144	1.25	13270
		B	70	144	1.69	9800

- END OF SPECIFICATION -

For more information please contact
Factory: 233 Moo 6, Soi Watchangrueng, Naiklongbangplakot, Phrasamutchedi,
Samutprakarn, Thailand, Tel. 66 (0) 2817-5590, Fax. 66 (0) 2817-7187 Email: tfoc@btc-tfoc.com