Tender No.	:	Spec. No.	: LSSS-OC0064-05
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Tender Title	:		
Bidder	: LS Cable & System Ltd.		
Document Title	:		

Specification

For

MICRO AIR BLOWN CABLE

(SZ Stranded Loose Tube Type)

Rev. No.	Date	Descriptions	Prepared By	Reviewed By	Approved By
05	OCT. 15 2015	Table 9. The Mechanical and Environmental Performance of the Cable is modified according to IEC 60794-5-10	Eunkyung Min	Tae Gyoung Kim	Yu-Hyoung Lee
04	SEP. 10. 2012	Added -144F (12Fiber per tube) -288F	Kim, JungMok	Jun, YoungHo	Yu-Hyoung Lee
03	MAR. 30. 2012	Cable diameter clarified depending on NYLON or PE jacket	Mansu Lee	Young-Ho Jun	Yu-Hyoung Lee
02	MAY. 6. 2011	Marking for Fiber No. 20 in Table 5 removed (Natural color)	T.G. Kim	Yu-Hyoung Lee	Min Son
01	DEC. 13. 2010	G.655 & 657 added and Max. 216 Fiber added	Ho Lee	Yu-Hyoung Lee	Min Son
00	NOV. 17. 2007	First Issue	T.G. Kim	Jae Tae Seo	Min Son

1. SCOPE

1.1 Application

This specification covers the general requirements of compact loose tube fiber optic telecommunication cables for outside plant applications installed in air blown method.

The cable designs described herein are capable of transmitting telephone, data and video signals in micro-duct installations.

1.2 Cable Description

Color coded fibers, jelly filled color coded loose tubes, PE filler (if necessary), water swellable yarn, SZ-stranded around the dielectric central strength member, ripcords and outer PE or Nylon jacket

2. OPTICAL FIBER

The optical, geometrical, mechanical and environmental performance of the optical fiber shall be in accordance with Table 1 ~ 4 below.

Table 1. Performance of the Single Mode Fiber (ITU-T G. 652 D)

ITEMS	UNITS	SPECIFICATION
Attenuation	dB/km	≤ 0.36 at 1310nm ≤ 0.36 at 1383nm[1)] ≤ 0.25 at 1550nm ≤ 0.28 at 1625nm
Chromatic Dispersion	ps/nm.km	≤ 3.5 at 1285nm ~ 1330nm ≤ 18 at 1550nm ≤ 22 at 1625nm
Zero Dispersion Wavelength	nm	1300 ~ 1322
Zero Dispersion Slope	$ps/nm^2.km$	≤ 0.092
Polarization Mode Dispersion(PMD_Q)	$ps/(km)^{1/2}$	≤ 0.2 (20 section link)
Cut-off Wavelength (λcc, Cabled fiber)	nm	≤ 1260
Attenuation vs. Bending (30mm radius x 100turns)	dB	≤ 0.1 at 1625nm
Mode Field Diameter	μm	9.2 ± 0.4 at 1310nm
Core-Clad Concentricity Error	μm	≤ 0.6
Cladding Diameter	μm	125 ± 1
Cladding Non-circularity	%	≤ 1
Coating Diameter	μm	250 ± 15
Proof Test Level	kPsi	≥ 100 (1%, 1 second)

Note [1)] The sampled attenuation average at this wavelength shall be less than or equal to the value specified at 1310 nm after hydrogen ageing according to IEC 60793-2-50 regarding the B1.3 fiber category

Table 2. Performance of the Single Mode Fiber (ITU-T G. 655)

ITEMS	UNITS	SPECIFICATION
Attenuation	dB/km	≤ 0.35 at 1550nm ≤ 0.40 at 1625nm
Chromatic Dispersion	ps/nm.km	2.0 ~ 7.0 at 1530nm ~ 1565nm 4.5 ~ 11.2 at 1565nm ~ 1625nm
Polarization Mode Dispersion(PMD_Q)	$ps/(km)^{1/2}$	≤ 0.2 (20 section link)
Cut-off Wavelength (λcc, Cabled fiber)	nm	≤ 1450
Attenuation vs. Bending (30mm radius x 100turns)	dB	≤ 0.5 at 1625nm
Mode Field Diameter	μm	8.2 ~ 11.0 ± 0.7 at 1550nm
Core Concentricity Error	μm	≤ 0.8
Cladding Diameter	μm	125 ± 1.0
Cladding Non-circularity	%	≤ 2.0
Coating Diameter	μm	250 ± 15
Proof Test Level	kPsi	≥ 100 (1%, 1 second)

Table 3. Performance of the Single Mode Fiber (ITU-T G. 657.A1& A2)

ITEMS	UNITS	SPECIFICATION	
		G.657.A1	G.657.A2
Attenuation	dB/km	≤ 0.36 at 1310nm ≤ 0.36 at 1383nm[1)] ≤ 0.25 at 1550nm ≤ 0.28 at 1625nm	
Chromatic Dispersion	ps/nm.km	≤ 3.5 at 1285nm ~ 1330nm ≤ 18 at 1550nm ≤ 22 at 1625nm	
Zero Dispersion Wavelength	nm	1300 ~ 1324	
Zero Dispersion Slope	$ps/nm^2.km$	≤ 0.092	
Polarization Mode Dispersion (PMD_Q)	$ps/(km)^{1/2}$	≤ 0.2 (20 section link)	
Cut-off Wavelength (λcc, Cabled fiber)	nm	≤ 1260	

Note [1)] The sampled attenuation average at this wavelength shall be less than or equal to the value specified at 1310 nm after hydrogen ageing according to IEC 60793-2-50 regarding the B1.3 fiber category

Table 3. Performance of the Single Mode Fiber (ITU-T G. 657.A1& A2) - Continued

ITEMS	UNITS	SPECIFICATION	
		G.657.A1	G.657.A2
Attenuation vs. Bending (15mm radius x 10turns)	dB	≤ 0.25 at 1550nm ≤ 1.0 at 1625nm	≤ 0.03 at 1550nm ≤ 0.1 at 1625nm
Attenuation vs. Bending (10mm radius x 1turn)	dB	≤ 0.75 at 1550nm ≤ 1.5 at 1625nm	≤ 0.1 at 1550nm ≤ 0.2 at 1625nm
Attenuation vs. Bending (7.5mm radius x 1turn)	dB		≤ 0.5 at 1550nm ≤ 1.0 at 1625nm
Mode Field Diameter	㎛	8.6 ± 0.5 at 1310nm	
Core-Clad Concentricity Error	㎛	≤ 0.6	
Cladding Diameter	㎛	125 ± 1	
Cladding Non-circularity	%	≤ 1	
Coating Diameter	㎛	250 ± 15	
Proof Test Level	kPsi	≥ 100 (1%, 1 second)	

Table 4. Performance of the Multi Mode Fiber

ITEMS	UNITS	SPECIFICATION	
		50 Multi Mode	62.5 Multi Mode
Attenuation	dB/km	≤ 3.0 at 850nm ≤ 1.0 at 1300nm	≤ 3.5 at 850nm ≤ 1.0 at 1300nm
Bandwidth	MHz.km	≥ 500 at 850nm ≥ 500 at 1300nm	≥ 200 at 850nm ≥ 500 at 1300nm
Numerical Aperture	-	0.20 ± 0.015	0.275 ± 0.015
Core Diameter	μm	50 ± 3.0	62.5 ± 3.0
Core Non-circularity	%	≤ 6.0	≤ 6.0
Cladding Diameter	μm	125 ± 2.0	125 ± 2.0
Cladding Non-circularity	%	≤ 2.0	≤ 2.0
Core/Cladding Concentricity Error	μm	≤ 3.0	≤ 3.0
Coating Diameter	μm	245 ± 15	245 ± 15
Proof Test	kPsi	≥ 100 (1%, 1 second)	

3. CABLE CONSTRUCTION

The construction of the cable shall be in accordance with Table 5 below

Table 5. Construction of the Cable

ITEMS		DESCRIPTION				
Number of Fibers		Max. 72	Max. 96	Max. 144		Max. 288
No. of Fibers per Tube		Max. 12	Max. 12	Max. 12	Max. 24	Max. 12
Loose Buffer Tube		PBT (Polybutylene Terephthalate)				
Filler		Polyethylene Rod or PBT tube (If necessary to make good core configuration)				
Filling Compound in Loose Buffer Tube		Thixotropic Jelly Compound				
Central Strength Member		FRP (with PE coating if necessary)				
Water Blocking Material		Water Swellable Yarn around the CSM (If necessary to prevent the ingress of water)				
Rip Cord		Two Ripcords				
Outer Jacket	Material	Nylon or HDPE				
	Thickness	Nylon : Nom. 0.4 mm, HDPE : Nom. 0.5 mm				

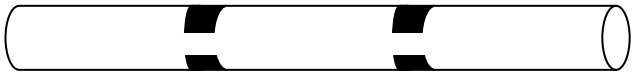
4. FIBER AND LOOSE BUFFER TUBE IDENTIFICATION

The color code of the loose buffer tubes and the individual fibers within each loose buffer tube shall be in accordance with Table 6 ~ 8 below.

Table 6. The Color Code of the Individual Fibers

No. of Fiber	Color	No. of Fiber	Color
1	Blue	13	Blue / Single Dot Marking*
2	Orange	14	Orange / Single Dot Marking*
3	Green	15	Green / Single Dot Marking*
4	Brown	16	Brown / Single Dot Marking*
5	Gray	17	Gray / Single Dot Marking*
6	White	18	White / Single Dot Marking*
7	Red	19	Red / Single Dot Marking*
8	Black	20	Natural
9	Yellow	21	Yellow / Single Dot Marking*
10	Violet	22	Violet / Single Dot Marking*
11	Rose	23	Rose / Single Dot Marking*
12	Aqua	24	Aqua / Single Dot Marking*

* Single Dot Marking



(Black Intermittent Ring)

Table 7. The Color Code of the Loose Buffer Tubes (max. 144F)

No. of Loose Buffer Tubes	Color	No. of Loose Buffer Tubes	Color
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Gray	11	Pink
6	White	12	Aqua

Table 8. The Color Code of the Loose Buffer Tubes (288F)

No. of Loose Buffer Tubes(1^{st} layer)	Color	No. of Loose Buffer Tubes(2^{nd} layer)	Color
1	Blue	1	Blue
2	Orange	2	Orange
3	Green	3	Green
4	Brown	4	Brown
5	Gray	5	Gray
6	White	6	White
7	Red	7	Red
8	Black	8	Black
9	Yellow	9	Yellow
		10	Violet
		11	Pink
		12	Aqua
		13	Natural
		14	Natural
		15	Natural

5. PHYSICAL / MECHANICAL / ENVIRONMENTAL PERFORMANCE AND TESTS

5.1 Mechanical and Environmental Performance of the Cable

The mechanical and environmental performance of the cable shall be in accordance with Table 9 below. Unless otherwise specified, all attenuation measurements required in this section shall be performed at 1550nm for SMFs and 1300nm for MMFs. The phrase 'No change in attenuation' is defined as 'Values in the range ±0.05dB or dB/km for SMF and ±0.2dB or dB/km for MMF are considered as no change' according to IEC 60794-1-20 (measurement uncertainty).

Table 9. The Mechanical and Environmental Performance of the Cable

ITEMS	TEST METHOD AND ACCEPTANCE CRITERIA
Tensile Loading And Bending Test	▪ Test method : IEC 60794-1-21 Method E1 - Length under tension : Min. 50m - Mandrel diameter : Typically 1m or Min. 40D (D: cable diameter) - Installation tensile load : 1 X W (W: cable weight in kg/km) - duration Maximum tension : 10 minutes ▪ Acceptance criteria - Fiber strain : ≤ 0.60% during the test - No change in attenuation after removal of load
Crush Test	▪ Test method : IEC 60794-1-21 Method E3A - Load : 500N/10cm - Duration of load : 1 minute - Test number : 3 times at 3 different places (Min. 500mm apart and different from the lay length of the tubes) ▪ Acceptance criteria - No change in attenuation after removal of load
Impact Test	▪ Test method : IEC 60794-1-21 Method E4 - No. of impact : One in 3 different places (Min. 500mm apart) - Striking surface curvature radius : Flat or min. 300mm - Impact energy : 1J (e.g. 15cm X 0.7kg) ▪ Acceptance criteria - Residual increase in attenuation : ≤0.1dB(≤0.2dB) for SMF(MMF)
Repeated bending Test	▪ Test method : IEC 60794-1-21 Method E6 - Bending diameter : 40D - No. of cycles : 25 - Load : Adequate to assure uniform contact with the mandrel - Flexing speed : 30 cycles/minute ▪ Acceptance criteria - No damage to the sheath and to the cable elements

<table>
<tr><th>ITEMS</th><th>TEST METHOD AND ACCEPTANCE CRITERIA</th></tr>
<tr><td>Torsion Test</td><td>▪ Test method: IEC 60794-1-21 Method E7
- Length under test : 2m
- Load : Adequate to assure minimum sag(bend) between clamps
- No. of cycles: 10 cycles
- Test speed : Max. 1min/cycle
- Rotating angle : ±180°

▪ Acceptance criteria
- No damage to the sheath and to the cable elements
- No change in attenuation after test</td></tr>
<tr><td>Kink</td><td>▪ Test method: IEC 60794-1-21 Method E10
- Minimum diameter : 40D

▪ Acceptance criteria
- No damage to the sheath and to the cable elements</td></tr>
<tr><td>Bend</td><td>▪ Test method : IEC 60794-1-21 Method E11A
- Bending diameter : 40D
- Method : Single helix
- No. of turns : 4
- No. of cycles : 3

▪ Acceptance criteria
- No change in attenuation after test</td></tr>
<tr><td>Temperature Cycling</td><td>▪ Test method: IEC 60794-1-22 Method F1
- Temperature condition
<table>
<tr><td></td><td>Operation(1)</td><td>Storage(2)</td></tr>
<tr><td>Low (A)</td><td>T_{A1} : -15℃</td><td>T_{A2} : -30℃</td></tr>
<tr><td>High (B)</td><td>T_{B1} : 60℃</td><td>T_{B2} : 70℃</td></tr>
</table>
- Temperature cycle sequence (2 cycles)
.1st cycle : T_{A2} → T_{B2}
.2nd cycle : T_{A1} → T_{A2} → T_{B1} → T_{B2} → 23℃
- Soak time at each temperature : ≥16 hours
- Attenuation shall be measured at 23℃ (reference attenuation) before the sequence and at the end of the soak time at each step (T_{A1}, T_{A2}, T_{B1}, T_{B2}) in the 2nd cycle

▪ Acceptance criteria
- No change in attenuation for T_{A1} and T_{B1}
- Max. 0.15dB/km(0.3dB/km) for SMF(MMF) for T_{A2}, T_{B2}</td></tr>
<tr><td>Water Penetration Test</td><td>▪ Test method: IEC 60794-1-22 Method F5B
- Length of specimen: 3m
- Height of pressure head: 1m
- Test time: 24 hours

▪ Acceptance criteria
- No water shall be detected at the unsealed end of the sample</td></tr>
</table>

6. PACKING AND MARKING

6.1 Cable Marking

The jacket shall be marked with white characters at intervals of one meter with following information. Other marking is also available if requested by customer.

1) Cable type and fiber number
2) Name of the manufacturer
3) Year of manufacture
4) Length marking

Ex.1) For 144-fiber cable

0001m	ABC SM144C LS Cable & System 2015	0002m

6.2 Cable Re-marking

The re-marking shall be marked, preferably with yellow characters, on a different position of the outer cable jacket, and shall have a numbering scheme differing by a minimum of 5000 from the original number. Any cable that contains two sets of cable markings shall be marked to indicate the color of the marking to be used.

6.3 Cable Packing

6.3.1 Standard length of cable shall be 2,000 or 4,000 meters. Other cable length is also available if required by customer.

6.3.2 Each length of the cable shall be wound on a separate wooden reel.

6.3.3 Both ends of the cable shall be sealed with a suitable plastic cap to prevent the entry of moisture during shipping, handling and storage.

6.3.4 The cable ends shall be securely fastened to the reel to prevent the cable form becoming loose in transit or during placing operations.

6.3.5 The inner end of the cable is housed into a slot on the side of the reel without extra cable length for testing.

6.3.6 Circumference battens or Wood-fiber board shall be secured with steel bands to protect the cable during normal handling and shipping.

6.4 Cable Reel

6.4.1 Details given below shall be distinctly marked with a weather proof material on the both outer sides of the reel flange. Other shipping mark is also available if requested by customer.

1) Purchaser's name
2) Length of cable in meter
3) Number of fibers and size
4) Gross weight in kilogram
5) Reel number
6) Name of the manufacturer
7) Year of manufacture
8) Arrow showing the direction the drum shall be rolled

6.4.2 The cable shall be shipped on reels designed to prevent damage to the cable during shipment and installation.

7. SAFETY

7.1 ROHS DIRECTIVE

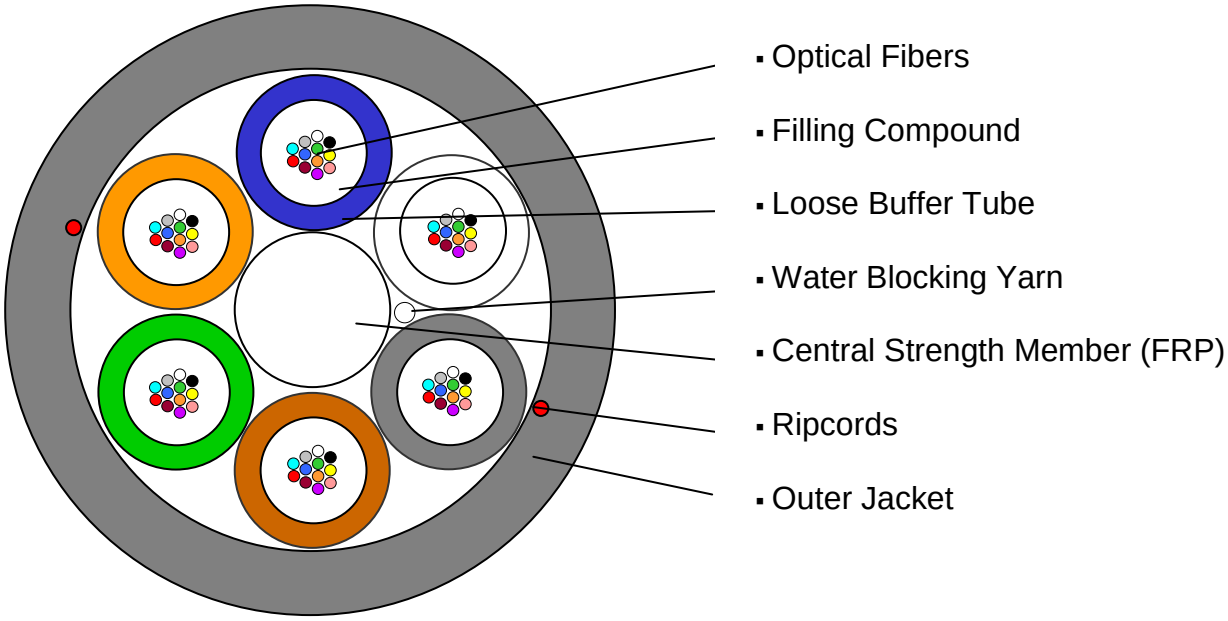
All cables and any associated packing and labeling materials shall meet RoHS (Restriction of the Use of certain Hazardous Substances) regulations as appropriate.

7.2 ISPM 15 DIRECTIVEF

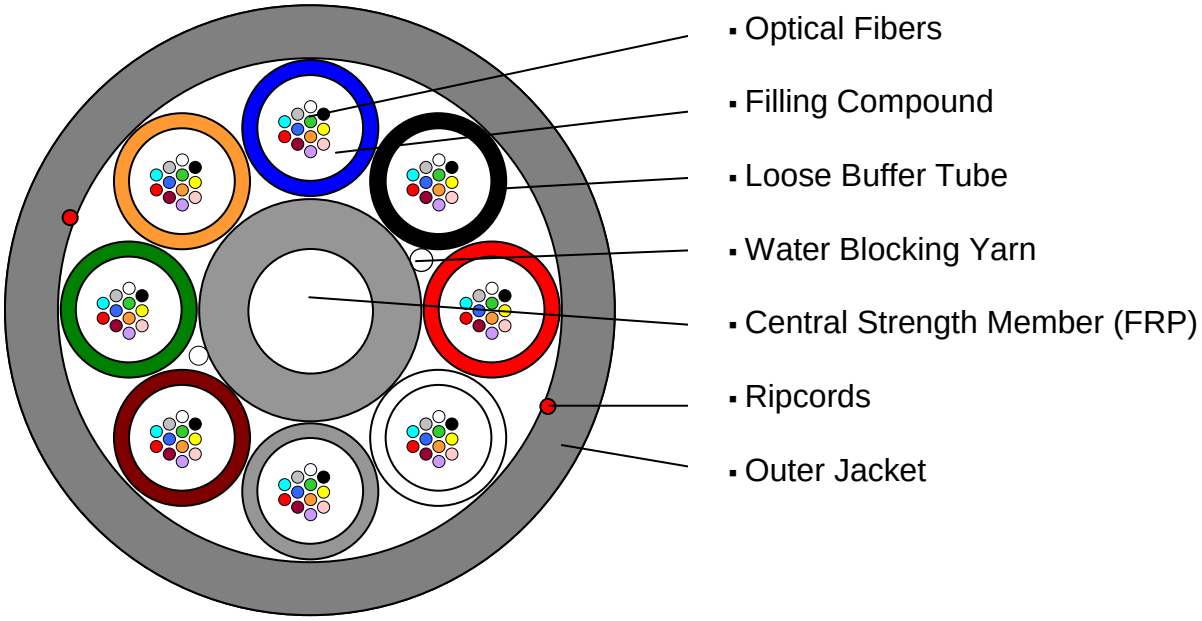
All wooden packing materials shall meet ISPM (International Standards for Phytosanitary

Appendix 1. Cross-sectional Drawing of the Cable

1. 72-Fiber Air Blown Cable Design

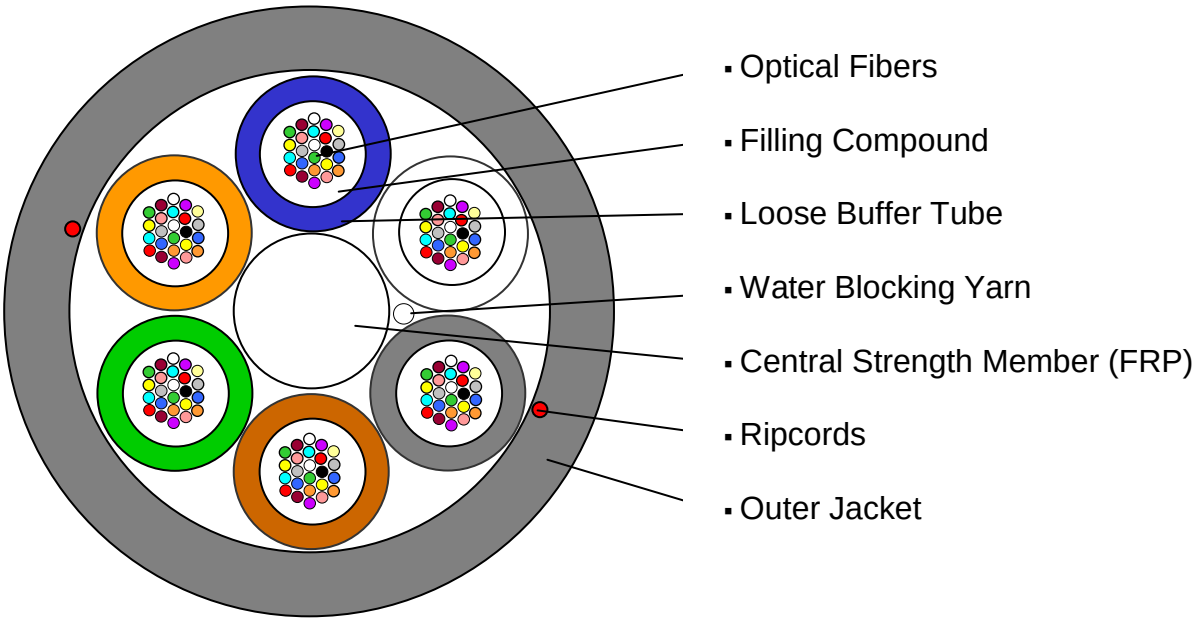


2. 96-Fiber Air Blown Cable Design

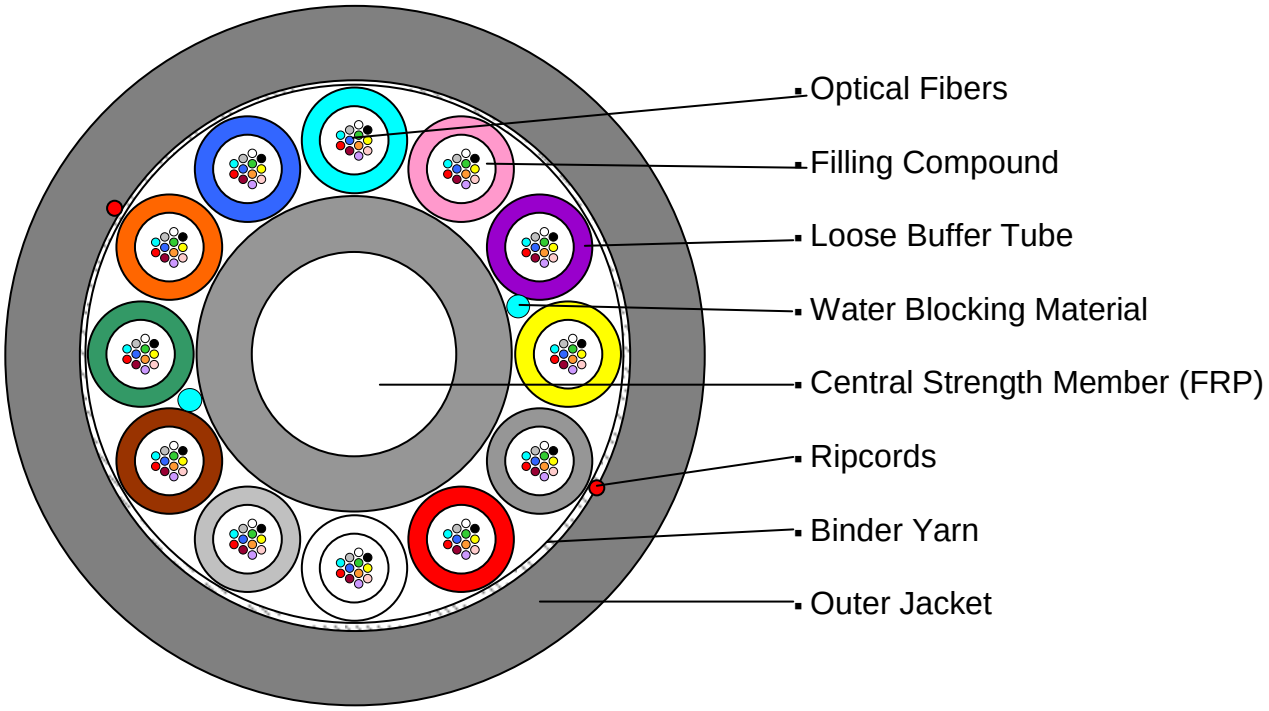


"The drawing appearing on this page may be subject to change or modification without any prior notice"

3. 144-Fiber Air Blown Cable Design (24 fiber/ tube)



4. 144-Fiber Air Blown Cable Design(12 fiber/ tube)



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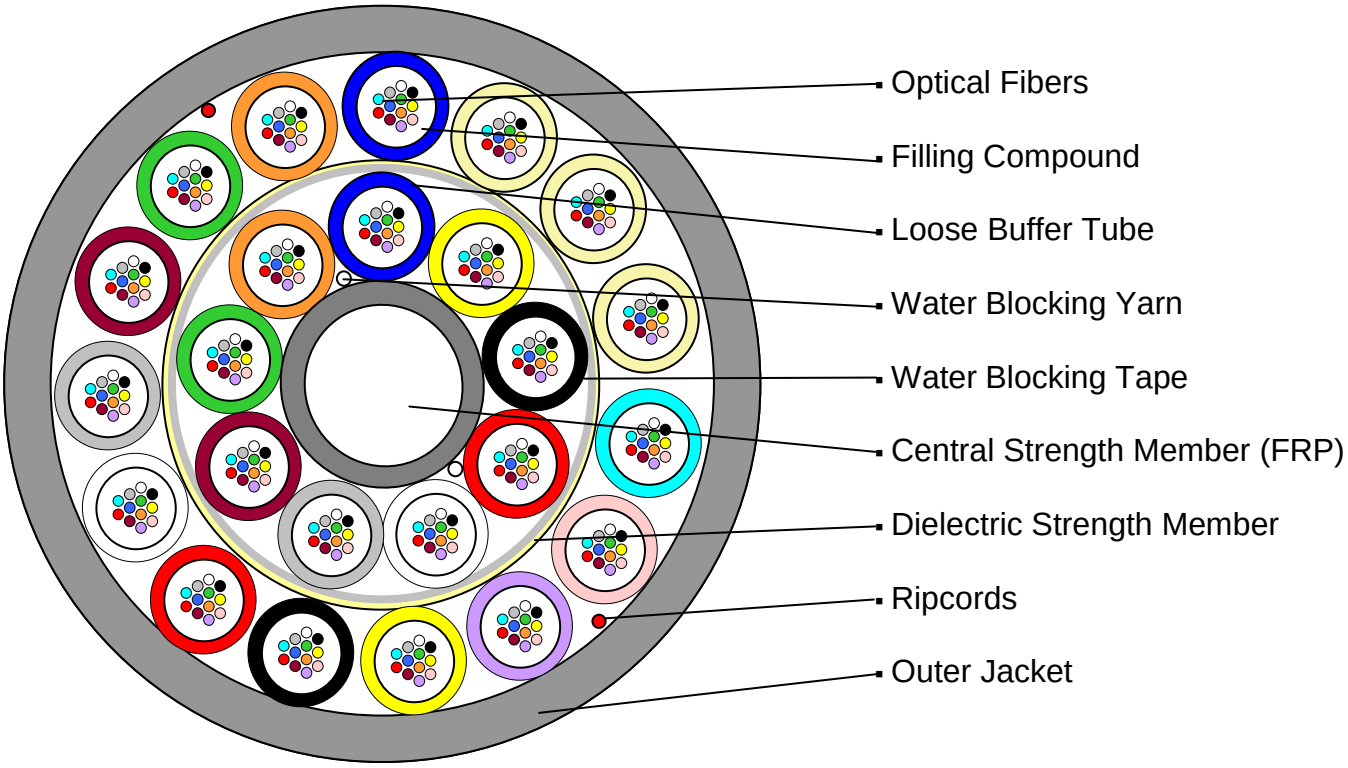
5. 288-Fiber Air Blown Cable Design



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Appendix 2. Diameter, Weight and Minimum Bending Radius

No. of Fibers	No. of fibers per tube	Jacket Material	Cable Diameter (mm)	Approx. Cable Weight(kg/km)	Min. Bending Radius(mm)	
					No Load	Under Load
Up to 72	12	Nylon	Max. 6.0	30	60	120
		HDPE	Max. 6.2			
Up to 96	12	Nylon	Max. 6.8	40	70	140
		HDPE	Max. 7.0			
Up to 144	12	Nylon	Max. 9.2	70	95	190
		HDPE	Max. 9.4			
Up to 144	24	Nylon	Max. 7.9	50	80	160
		HDPE	Max. 8.1			
Up to 288	12	Nylon	Max. 10.9	90	200	260
		HDPE	Max. 10.9			

* Actual values for cable weight and diameter may deviate from the calculated values given in the table above.

== End of Specification ==