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TECHNICAL SPECIFICATION

Doc No: DSF-SPC-INS-012

Rev. 1

Page 1 of 10

HIGH PRESSURE (HP) TRANSMISSION SYSTEMS

ALL DIELECTRICAL OPTICAL FIBER CABLES

JUNE 2021

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Doc No: DSF-SPC-INS-012

Rev. 1

Page 2 of 10

REVISION HISTORICAL SHEET

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Rev. 1

Page 3 of 10

Table Of Contents

REFERENCES DOCUMENT	4
1. SCOPE	5
2. OPTICAL FIBER MATERIAL AND PROTECTION.....	5
3. OPTICAL FIBER CHARACTERISTICS.....	7
4. FIBER OPTIC CABLE CHARACTERISTICS	7
5. FIBER OPTIC CABLE STRUCTURE	8
6. PACKING.....	9
7. TESTING	9
8. ATTACHED DOCUMENTS.....	10

	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr	TECHNICAL SPECIFICATION
Doc No: DSF-SPC-INS-012	Rev. 1	Page 4 of 10

REFERENCES DOCUMENT

EN 60793-1-1

[Optic Fibers – Part 1-1: Measurement Methods and Test Procedures – General and Guidance]


EN 60794-1-2

[Optic Fiber Cables – Part 1-2: Generic Specification – Basic Optical Cable Test Procedures]

ITU-T G.655 (11/2009)

[Characteristics of a non-zero dispersion-shifted single-mode optical fibre and cable]

All standards or codes mentioned in this specification are valid in their latest version or by the relative superseded edition.

	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr	TECHNICAL SPECIFICATION
Doc No: DSF-SPC-INS-012	Rev. 1	Page 5 of 10

1. SCOPE

This specification specifies the properties of non-armoured single mode fiber cable (FOC) required by Owner for outdoor installation. The number of fibers is specified in the relevant contractual document.

The fibers of the FOC must in accordance with the ITU-T Recommendation G.655 (11/2009), G655.C Attribute.

The fibers must be suitable for optical transmission of signals between optoelectronic devices with wavelength ranging from 1530 to 1565 nm.

2. OPTICAL FIBER MATERIAL AND PROTECTION

The optical fibers must be made of glass with high density silicon content or other suitable material to have the optical, mechanical and other properties of optical fibers as required by the applicable standards. The materials must be described in detail by the manufacturer.

The manufacturer must also state the method of connection by fusing the fibers together. The temperature for fusing the glass shall be the same and shall be constant for fibers of the same geometrical and optical characteristics and this temperature shall be given by the manufacturer in his data sheets.

The optical fibers must be placed loosely in tubes (loose tube structure) formed around a core.

The fibers must have distinct primary coating color for identification. The connection of the optical fibers shall be made applying the method 'local light injection and detection lid' and the light to be used should penetrate the color of the primary coating of the fibers.

The fibers in each tube must have the following primary coating color:



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TECHNICAL SPECIFICATION

Doc No: DSF-SPC-INS-012

Rev. 1

Page 6 of 10

FIBER No	COLOUR	FIBER No	COLOUR
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Grey	11	Pink
6	White	12	Turquoise

The tubes shall be colored applying the color code as follows:

TUBE No	COLOUR	TUBE No	COLOUR
1	Blue	7	Red
2	Orange	8	Black
3	Green	9	Yellow
4	Brown	10	Violet
5	Grey	11	Pink
6	White	12	Turquoise


In a rare instance of more than 12 fibers per tube or more than 12 tubes in the FOC, same colors as above shall be applied with black rings of 1mm width at spanning of 3cm.

The above colors shall be oriented clockwise as viewed by an observer holding the beginning of the FOC or viewing the FOC from beginning towards the end. The beginning of the FOC shall be marked on the drum.

The fibers shall be surrounded with a filling compound for waterproof. The filling compound must be antiallergenic, non-toxic and compatible with the other cable materials. The compound must withstand 70°C temperature without degradation of color marking.

The manufacturer shall provide all the characteristics of the fibers as specified in this specification, and in the applicable standards referred here in and shall apply the most effective method of stripping the fibers for connection by fusing or with connectors.

No splicing of fibers is permitted in the cable's factory length.

	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr	TECHNICAL SPECIFICATION
Doc No: DSF-SPC-INS-012	Rev. 1	Page 7 of 10

3. OPTICAL FIBER CHARACTERISTICS

The fiber optic characteristics shall be in accordance with the ITU-T Recommendation G.655 (11/2009), G655.C Attribute, the requirements of which are described here below.

The nominal mode field diameter of the fiber at 1550 nm wavelength shall range from 8 to 11 μm and the deviation for a given nominal mode field diameter must not exceed $\pm 0.7\mu\text{m}$.

The nominal cladding diameter of the fiber must be 125 μm with tolerance $\pm 1\mu\text{m}$.

The core concentricity error of the fiber must not exceed 0.8 μm and the cladding non-circularity of the fiber must not exceed 2.0%.

The maximum macro bend loss of the fiber must be 0.5dB at 1625 nm wavelength, 100 turns and 30 mm bend radius.

The minimum specified proof stress of the fiber shall be 0.69 GPa.

The chromatic dispersion coefficient of the fiber for wavelength range from 1530 to 1565 nm shall be minimum $D_{\min} = 1.0\text{ ps/nm}\cdot\text{km}$ and maximum $D_{\max} = 10.0\text{ ps/nm}\cdot\text{km}$ with $D_{\max} - D_{\min} \leq 5.0\text{ ps/nm}\cdot\text{km}$ for any wavelength. The chromatic dispersion coefficient may be either positive or negative but must not cross zero for the specified wavelength range.


The maximum cable cut-off wavelength must be 1450 nm.

The life of the fiber shall be greater than 40 years and the bending radius does not exceed 50mm.

4. FIBER OPTIC CABLE CHARACTERISTICS

The maximum attenuation coefficient of the FOC at wavelength 1550 nm must be 0.35 dB/km and at wavelength 1625 nm must be 0.4 dB/km. The attenuation should be practically unchanged for temperature range from -20°C to +60°C.

The polarization mode dispersion coefficient of the non-cabled fiber must not exceed a value such that the cabled fiber polarization mode dispersion coefficient, which is statistically

	Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr	TECHNICAL SPECIFICATION
Doc No: DSF-SPC-INS-012	Rev. 1	Page 8 of 10

specified and not on an individual basis, may exceed $0.20 \text{ ps/km}^{1/2}$ only within a defined possible link of 20 cable sections at the small probability level 0.01%.

The FOC shall be suitable for installation in High Density Polyethylene Pipe (HDPE).


The FOC shall resist a permanent pulling force of 250 Kp during installation and a force equal to the weight of one kilometer of the cable. During the application of these forces, neither elongation of the fibers nor change of attenuation may occur.

The FOC must withstand a permanent bending of 30cm radius without deterioration of its characteristics.

5. FIBER OPTIC CABLE STRUCTURE

The FOC shall consist of the following successive layers from the inside out:

- i. Central strength member made of fiber reinforced plastic having a modulus of elasticity at least 5000 kp/mm^2 and proper mechanical and thermal properties. The diameter of the central strength member shall be at least 2 mm.
- ii. Number of tubes made of polyamide (PA) or polyethylene (PE). In tubes there shall be placed up to 12 fibers with certain excess (loose structure), depending on the total number of fibers. The tubes shall be stranded around the central strength member in order to form the cable core. The tubes shall be filled with a gel compound which shall prevent moisture seeping through the hollow tube.
- iii. Protective material flooding the core among the tubes to prevent water ingress. If the composition of the optical fibers is such that there is danger of hydroxyl (OH-) formation due to hydrogen within the cable, the filling compound should be chemically active to absorb hydrogen.
- iv. Non-metallic strength member, for example aramid yarn, encircling the core and loose tubes to provide mechanical and thermal protection.
- v. Sheath made of PE in black color with minimum thickness of 1.0 mm. The PE sheath provides protection against moisture, heat and ultraviolet radiation.

 <p>Hellenic Gas Transmission System Operator S.A. 357-359 Messogion Av., GR 152 31 Halandri Tel.: 213 088 4000 Fax: 210 674 9504 Email: desfa@desfa.gr</p>	TECHNICAL SPECIFICATION
Doc No: DSF-SPC-INS-012	Rev. 1 Page 9 of 10

vi. Outer sheath made of PA in black color for rodent protection and protection against tensile stresses.

On the outer sheath and at a spanning of 1 m the following identification information must be written with prominent figures:

OWNER /k Warning: Invisible Laser Light MTI l-m-n /manufacturer/date of production/length,

where k : number of optic fibers
l : wavelength of optical transmission
m : attenuation
n : dispersion
MTI : code for single mode optical fibers

The units of the transmission characteristics shall not be written.

6. PACKING

The length of coiled FOC per drum shall be specified in the contract documents, and it is dependent on the specific construction works. However, in case of lack of such information in the contract documents, a FOC length of 2100 m (-40, +100) per drum should be provided.


The diameter of the barrel of the reels shall be at least 40 times the outside diameter of the FOC and should in no case be less than double the minimum acceptable bending radius.

The ends of each shipped FOC must be water tight to prevent water or moisture penetration in the cable.

The beginning and end of the FOC shall be marked with red and green tape respectively. The beginning of the FOC must be at the outer side of the reel.

7. TESTING

The FOCs shall be tested in accordance with **EN 60793-1-1** and **EN 60794-1-2** as applicable.

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<p>Doc No: DSF-SPC-INS-012</p>	<p>Rev. 1</p>	<p>Page 10 of 10</p>

EN 60793-1-1 gives guidance on the use of documents giving the uniform requirements for measuring and testing optical fibers.

8. ATTACHED DOCUMENTS

None.