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Specification for submarine optical fiber cables

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Specification for submarine optical fiber cables

1 Scope

This Specification specifies the product classification, materials, manufacturing length, technical requirements, inspection methods, inspection rules, requirements for sealing, marking, transportation, storage of submarine optical fiber cables.

This specification applies to the manufacture and use of submarine optical fiber cables. For underwater optical fiber cables across rivers and lakes, it may also refer to this Specification.

2 Normative references

The provisions in following documents become the provisions of this Standard through reference in this Standard. The versions indicated at the time of publication of this standard are valid. All standards are subjected to revision, AND parties who reach an agreement based on this Standard are encouraged to study if the latest versions of these documents are applicable.

GB/T 2828-1987 Sampling procedures and tables for lot-by-lot inspection by attributes (Apply to inspection of successive lots or batches)

GB/T 2829-1987 Sampling procedures and tables for periodic inspection by attributes (Apply to inspection of stability for productive process)

GB/T 2952.1-1989 Protective coverings for electric cables - Part 1: General

GB/T 3048.4-1994 Test methods for determining electrical properties of electric cables and wires - Measurement of D.C. resistance of conductors (neq IEC 885-2)

GB/T 3048.6-1994 Test methods for determining electrical properties of electric cables and wires - Determining insulation resistance - Voltmeter-ammeter method (neq IEC 885-2)

GB/T 3048.14-1992 Electric cables and wires - Method for D.C. voltage test (neq IEC 60.1 ~ 60.4:1973)

GB/T 3206-1982 Carbon constructional quality steel wires

GB/T 4239-1991 Cold rolled stainless steel and heat resisting steel strips

wire.

3.1.5 Double armored optical fiber cables

Optical fiber cable, which is protected by double-layer armored steel wire.

3.2 Symbols and abbreviations

This specification uses the following symbols and abbreviations.

DK - Single armored;

SK - Double armored.

4 Requirements

4.1 Detailed specifications

The requirements of submarine optical fiber cables shall comply with the provisions of this Specification and the corresponding detailed specification. When the requirements of this Specification conflict with the requirements of the detailed specification, the detailed specification shall prevail.

4.2 Classification

Submarine optical fiber cables, that contain optical fiber cables AND may contain electrical conductors, include the following types:

a) According to its applicable water depth and marine environment, it can be divided into two categories: deep water optical fiber cables AND shallow water optical fiber cables;

b) According to its different protection levels, it can be divided into single-layer armored, double-layer armored, non-armored optical fiber cables;

c) According to the different structural characteristics of its products, it can be divided into skeleton type, central tube type, loose tube stranded optical fiber cable;

d) According to the relay mode, it can be divided into: submarine optical fiber cable with relay AND submarine optical fiber cable without relay.

4.3 Materials

Submarine optical fiber cables shall use materials, which are specified in this Specification. For materials not specifically specified in this Specification, the manufacturer shall use materials, that meet the performance requirements of

It shall use the low-density polyethylene materials or equivalent materials, that meet the requirements of PE-M-13D022 in GB 11115.

4.3.8 Outer sheath

It shall use the high-density polyethylene materials or equivalent materials, that meet the GH requirements in GB 15065.

4.3.9 Electrical conductor (when required)

The quality of the electrical conductor shall be uniform and free of defects. Its electrical performance shall meet the requirements of the relevant product specifications.

4.4 Structure

4.4.1 Overview

The submarine optical fiber cable shall be composed of a cable core, an inner sheath, an outer sheath. The submarine optical fiber cable shall have a circular cross-section and a concentric geometric structure. The design of the submarine optical fiber cable shall meet the requirements of 4.1.

See Appendix C (informative) for several typical cross-sectional schematic diagrams of submarine optical fiber cable structures.

4.4.2 Cable core

The cable core usually includes optical fibers, loose tubes, reinforcements, metal sealing tubes, water blocking tapes, inner sheaths, as well as possibly auxiliary components such as yarn ties.

4.4.2.1 Number of optical fibers

The number of optical fibers, in the loose tube, shall be 4 ~ 12 cores; the maximum is 48 cores.

4.4.2.2 Optical fiber's color code

For easy identification, the surface of each optical fiber's coating layer shall be colored OR use colored ring. The color code shall be marked, according to the color, which is specified in GB 6995.2, as shown in Table 1. For optical fibers, which have more than 12 cores in a single tube, it shall use a color ring or equivalent method, for distinction.

cause the sheath to penetrate; the optical fiber shall have no residual additional attenuation.

4.5.3.6 Repeated bending

After the submarine optical fiber cable is tested according to 5.4.2, the sheath shall be free of cracks or fractures; the optical fiber shall have no residual additional attenuation.

4.5.4 Environmental performance

The environmental performance of submarine optical fiber cables shall include temperature cycling, watertightness, sheath integrity.

4.5.4.1 Temperature cycle

The submarine optical fiber cable adopts stainless steel loose tube, for temperature cycling test. After keeping the temperature for 4 h AND 2 cycles, the additional attenuation of the optical fiber, after the test, shall not be greater than 0.05 dB/km.

4.5.4.2 Watertightness

The watertightness performance of the deep water optical fiber cable shall meet the requirements of 4.1;

After the shallow water optical fiber cable is placed at 2 MPa water pressure, for 336 h, the longitudinal water seepage length of the cable core shall not be greater than 200 m.

4.5.4.3 Sheath integrity

The polyethylene sheath shall be continuous and complete. When there is a metal moisture barrier or armor layer under it, it shall adopt the electrical method, to carry out the integrity test of the polyethylene sheath.

The integrity of the submarine optical fiber cable is checked by a water immersion test. The electrical properties of the polyethylene sheath of the submarine optical fiber cable, after being immersed for 24 hours, shall meet the following requirements:

- Water insulation at DC 500 V shall not be less than 2000 MΩ • km;

- Withstand voltage strength at DC 15 kV for 2 min, without breakdown.

is used, for inspection.

5.2.2 Attenuation uniformity

The inspection shall be carried out, according to GB/T 15972.4-C1C backscattering method.

5.2.3 Dispersion

The dispersion of submarine optical fiber cables shall be tested, according to GB/T 15972.4-C5A phase shift method.

5.3 Electrical performance

The submarine optical fiber cable shall be immersed in water, for electrical performance test; the immersion time shall not be less than 168 h.

5.3.1 DC resistance

The inspection shall be carried out, according to the test method, which is specified in GB/T 3048.4.

5.3.2 Insulation resistance

The inspection shall be carried out, according to the test method, which is specified in GB/T 3048.6.

5.3.3 DC voltage

The inspection shall be carried out, according to the test method, which is specified in GB/T 3048.14.

5.4 Mechanical properties

5.4.1 Tensile load

The test shall be carried out, according to the test method, which is specified in Appendix B (Normative) of this Specification. The test conditions are as follows:

5.4.1.1 Tensile load at break

a) The tensile load at break shall be tested, in accordance with Table 3;

b) The length of the specimen shall not be less than 50 m.

5.4.1.2 Short-term tensile load

a) The short-term tensile load shall be tested, in accordance with Table 3;

The test shall be carried out, according to the test method, which is specified in GB/T 7424.1-E4. The mass of the falling weight and the height of the falling weight shall meet the requirements of Table 3. The test conditions are as follows:

a) The length of the specimen shall not be less than 10 m;

b) The radius of curvature of the spherical surface of the impact block is not less than 100 mm;

c) Impact three points on the surface of the specimen. The three points shall not be on the same plane; each point shall be impacted once;

d) Measure the attenuation change after the test.

5.5 Environmental performance

5.5.1 Temperature cycle

The test shall be carried out, according to the test method, which is specified in GB/T 7424.1-F1. The test conditions are as follows:

a) The specimen is a loose tube. The length of the specimen is the manufacturing length;

b) The highest temperature is 50 °C ± 2 °C; the lowest temperature is -20 °C ± 2 °C; the holding time is 4 h; the number of temperature cycles is 2;

c) Measure the attenuation changes during and after the test.

5.5.2 Watertightness

The watertightness test method of submarine optical fiber cable shall be tested, in accordance with the test method, which is specified in Appendix C (Normative) of this Specification.

5.5.3 Sheath integrity

The submarine optical fiber cable is immersed in the pool; the two ends are upwardly exposed to the water surface for about 2 m, whilst the remaining part is completely immersed in the water. After being soaked for 24 h, test the insulation resistance of the polyethylene sheath, under DC 500 V, according to the provisions of GB/T 3048.6; test the DC voltage resistance of the polyethylene sheath, according to the provisions of GB/T 3048.14. During the test, the negative pole is connected to water, whilst the positive pole is connected to the metals, which are connected to each other, in the submarine optical fiber cable.

this time, it shall stop the product delivery acceptance AND take corrective measures. The delivery acceptance cannot be resumed, until the periodic inspection is qualified.

6.3.2.2 Treatment of specimens

The specimens, which had been subject to the group C inspection, shall not be delivered as finished products.

7 Sealing, marking, transportation, storage

7.1 Sealing

The finished submarine optical fiber cable shall be sealed, by appropriate measures, AND stored in a special pool. The bending radius of the submarine optical fiber cable shall not be less than 40 times the outer diameter of the submarine optical fiber cable.

7.2 Marking

The deep water optical fiber cable shall be marked in white, along the length direction on the surface of the outer sheath. The marking shall not affect any performance of the optical fiber cable. The distance between the starting points of adjacent markings shall be 1 m. The content of the marking shall include: product model, meter length, manufacturer's name or trademark, manufacturing year or production batch number.

Shallow water optical fiber cables shall have a length sign plate, at the interval of 500 m. In addition, the submarine optical fiber cables shall be attached with an exit-factory nameplate, when they leave the factory. The product model, length, manufacturer's name or trademark shall be indicated on the nameplate. The sign plate shall be tied firmly. It shall not fall off, during the process of loading, unloading, transportation, laying.

7.3 Transportation and storage

Avoid direct sunlight exposure to the submarine optical fiber cable. Pay attention to fire prevention, during transportation and storage.

A3.3.1 The submarine optical fiber cable's clamping device shall be able to ensure that, the components of the specimen are uniformly stressed, on the same cross-section, without damaging its own mechanical properties.

A3.3.2 The traction device shall be able to provide a tensile load, which is twice the specified load.

A3.3.3 The applied tensile load shall be measured by a tensile load cell, which has the most accurate measurement of at least ±3%.

A3.3.4 Use mechanical methods or equivalent test methods, to measure the elongation of the specimen.

A4 Program

A4.1 The specimen shall be pretreated, under standard atmospheric conditions, for 24 h.

A4.2 As shown in Figure A1, install the specimen on the tensile device. During installation, pay attention that the two ends of the specimen, which are subjected to the tensile load, are tightly fixed on the clamping device, to ensure that the specimen will not be pull off, when the tensile load is applied; AND that the optical fiber at the ends of the specimen does not move longitudinally. It shall leave appropriate length at both ends of the specimen, to facilitate injecting the optical power for measuring attenuation changes.

A4.3 Measure the output optical power of the specimen, before applying the tensile load.

A4.4 For the deep water and shallow water optical fiber cables, it shall apply load of 10 kN and 20 kN, respectively, onto the specimen. OR use appropriate pre-loading force, to make the specimen in a straightened state.

A4.5 Measure the length L_1, between the two marks on the specimen, which is fixed between the two clamping devices of the tensile device.

A4.6 Apply the specified tensile load to the specimen, at a tensile rate of (5 ~ 10) mm/min. Maintain the specified load for the specified time. Measure the output optical power and fiber strain of the specimen, during the test.

A4.7 At the end of the test, measure the distance L_2, between the two marks, under tension. Calculate the specimen elongation $(L_2 - L_1) / L_1 \times 100\%$.

A4.8 After the above steps are completed, reduce the load to zero. Measure the output optical power and fiber strain of the specimen, after 5 minutes. Calculate the additional attenuation and fiber strain, as relative to before loading.

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