

<b>Technical Requirements for Electrical Equipment</b>  Rubrik / Title <b>Technical Requirements for Optical Cables</b>	Beteckning / Document TBE 122
	Utgåva / Issue 5
	Datum / Date 2020-04-20
	Ersätter / Supersedes 4 (E)

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# 1 General

These Technical Requirements states the requirements necessary for optical cables intended for use in nuclear power stations. Optical cables are used to transfer measurement and control data and for communications.

These technical requirements specify general requirements for the design, installation and documentation of optical cables.

General technical requirements and instructions for the Supplier/Manufacturer are specified in the Technical Specification (TS).

Peripheral equipment in addition to the cable, such as contacts or connections to the reactor containment, are not dealt with in these technical requirements, but shall be described and specified by the Supplier and approved by the Purchaser.

# 2 Definitions

## Fibre cladding

The layer which encloses the core and which the light beams are reflected against.**Fibre sheath**

The external layer of an optical cable

Definitions according to TBE 100 and KBE 100 do also apply.

# 3 Product Requirements

## 3.1 Standards and regulations

Optical cables shall meet design and testing standards in accordance with Swedish Standards, EN or IEC.

The following standards shall be adhered to or applied unless otherwise prescribed in the order:

SS 4010346	Fibre optics - Terminology
IEC 60793	Optical fibres
IEC 60794	Optical fibre cables

## 3.2 General product requirements

Upon request the connections and contacts necessary for connection for the specified function and purpose shall be included when optical cables are supplied.

The order shall specify whether the installation and connection of the optical cables is to be included.

Data specified shall be checked in accordance with applicable standards when the cables are installed. If there is no such standard, a test procedure shall be agreed upon and included in the final inspection plan.

### **3.3 Mechanical properties**

#### **3.3.1 Structure**

The fibre cladding shall be visible and easy to remove for splicing or attaching contacts.

The Manufacturer shall in the quotation state whether the cable contains any metallic parts such as wire or any other conducting material.

The structure of the cable in general depends on the application and is specified in the TS.

#### **3.3.2 Flexibility**

The permitted minimum bending radius of the cable shall be less than ten times the diameter of the cable unless otherwise specified in the TS. The optical cable shall be able to withstand being bent no fewer than 1 000 times without being damaged.

### **3.4 Environmental properties**

The material and design shall be selected so that the requirements for durability and function in the specified environment are met. All factors which affect the function of the optical cable shall be taken into consideration. Plastic fiber is not suitable in environment with radiation because of rapid degradation. Glas fiber is also aged by radiation, but at a slower rate.

Requirements related to the environment are laid down in the TS. Special environmental durability requirements for cables in accordance with the information below shall apply as a supplement to the general environmental durability requirements.

#### **3.4.1 Environmental capability requirements**

In addition to the general requirements for environmental conditions according to TBE 101 the cable shall be designed for installation in wet areas, and shall withstand sprinkling and high-pressure washing with water without affecting its function.

#### **3.4.2 Radiation**

The TS shall state radiation resistance requirements, the total integrated radiation dose and necessary service life. The Manufacturer shall propose a suitable optical cable to be laid in environment with ionizing radiation.

Requirements with respect to resistance to ultra-violet radiation are laid down in the TS if so required.

### **3.5 Long-term performance**

The Manufacturer shall in the Tender give a life analysis of the cable on the basis of the long-term properties of the polymeric materials essential to the function of the cable. This analysis shall include materials specifications, and the long-term thermal properties of the material shall be verified by testing in accordance with IEC 216 or an equivalent procedure.

### **3.6 Marking**

The entire length of the cable shall be labelled with the type, unit and time of manufacture, for example in the form of a marking thread or marking band beneath the cable sheath or a permanent mark on the cable sheath.

The distance between the markings on cables with one or two fibres shall not exceed 0,5 m, and shall not exceed 1,0 m on multifibre cables.

### **3.7 Flame spread**

The material of the cable shall be non-flammable and self-extinguishing.

Fire performance requirements shall be stated in the TS and shall be verified according to one of the following alternative methods:

- Class Cca according to EN 13501-6
- Class Dca according to EN 13501-6 and additional flame spread requirements in class Cca according to EN 13501-6
- Class Dca according to EN 13501-6 and additional flame spread requirements according to IEC 60332-3 (F4A, F4B, F4C or F4D)

### **3.8 Materials**

Cables may not give off corrosive gases during normal or extreme operations.

The amount of corrosive products at combustion according to IEC 60754 "Test on gases evolved during combustion of materials from cables" shall be stated by the manufacturer in the Tender.

Cables intended for use in the reactor containment shall be free of halogen.

## **4 Other Requirements**

### **4.1 Delivery**

When supplied, optical cables shall have watertight box terminals, and cable reels with protruding, sealed cable ends shall be fitted with a robust protective sleeve over the ends of the cable. The cable shall be protected against sunlight.

### **4.2 Installation**

#### **4.2.1 Cable pulling**

It shall be possible to pull the cable on a cable tray or through fire-classed cable penetrations. The Manufacturer shall specify any limitations, including minimum installation temperature, to the ways in which the type of cable can be laid.

The Manufacturer shall specify the type of clips or cable ties to be used, and how tightly these may be applied without the pressure causing damage to the fibres. The Manufacturer shall also

specify the distance between these clips so that the maximum permissible tensile load is not exceeded when the cable is laid vertically.

Seismic installation of the cable can be required.

#### **4.2.2 Splicing**

The cables shall be spliced using a method which results in a permanent connection. Attenuation in a finished splice shall not exceed the value specified by the Manufacturer.

Splices shall meet the same environmental durability requirements as the cables.

The Manufacturer shall document the regulations regarding procedures to be followed when splicing and the requirements as to the maximum number of splices for each kilometre of cabling with respect to attenuation.

The Manufacturer shall specify approved tools for cutting and splicing.

The Manufacturer shall on request recommend suitable fluids for cleaning the cable. The Manufacturer should also be able to state the resistance of the materials used to common chemicals.

#### **4.2.3 Connections**

The Manufacturer shall document the regulations regarding procedures to be followed when applying contacts. Attenuation in a finished contact shall not exceed the value specified by the Manufacturer.

Connections shall meet the same environmental durability requirements as the cables.

## **5 Documentation**

In the Tender shall the Manufacturer/Supplier present the following documentation for optical cables in addition to what is required in TBE 100 and KBE 100:

- Suitable connectors and their attenuation
- Presence of conducting materials in the cable
- Specification of materials in the fibre, fibre cladding and fibre sheath
- Data on materials, materials testing and life analysis according to 3.5
- Amount of corrosive products at combustion
- Fire load data (amount of combustible material per unit length)
- Instructions for cable pulling, applying contacts etc. according to 4.2

Documentation that cannot be submitted until the delivery are to be specified in the Tender.

In that case the installation is a part of the delivery a report containing the following information shall be included in the documentation:

- Cable lengths, cable route and cable pulling method
- Splice attenuation values
- Reflectometer curves
- Attenuation over entire range

## 6 Requirements on Agreement between Manufacturer and Purchaser

The list below should serve as a basis for screening between Manufacturer / Supplier and Purchaser in connection with the quotation or order.

	Review and complete the Technical Specification	
	Review of current Inspection Plan and Examination Procedures	
	Flame spread class	
	Fire load (amount of combustible material per unit length)	
	Halogen content	
	Marking readability (meter marking, type, manufacturer, date)	
	Environmental properties	
	Material specification	
	Lifetime analysis	
	Requirements on installation (cable pulling and termination)	
	Bending radius	
	Mechanical properties of outer sheath	
	Suitable connectors and their attenuation	
	Presence of conducting materials in the opto cable	
	Extent of delivery with respect to connections, tools, material required for the installation etc.	
	Procedures for attenuation testing including type of measuring equipment	
	Bending radius	
	Batch identity marking	