

Technical Requirements for Electrical Equipment <small>Title</small> Technical Requirements for Cable	Document TBE 111
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1 Introduction

These Technical Requirements state the requirements for electrical and optical cables intended for use in nuclear power stations. Included in the definition cable are insulated conductors for internal connection within enclosures and also for connection of certain process components.

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, is not dealt with in these technical requirements, but shall be described and specified by the Supplier and approved by the Purchaser.

2 Definitions

In general the definitions as stated in TBE 100:1 and KBE 100-X shall apply.

Fibre cladding

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

Fibre jacket

The external layer of an optical cable

3 General product requirements

3.1 General requirements

The requirements in this chapter apply to all types of cables.

Cable must conform to Swedish legislation and to Swedish safety regulations for electrical cables.

The cable must be designed and manufactured in a manner that does not jeopardise its functions as a result of manufacturing tolerances and input materials, or due to strain during installation or normal variations in operational and environmental conditions after installation.

Cable manufactured and delivered according to these Technical Requirements must, for traceability reasons, be marked in such a way that a specific cable can be identified from other cables of the same type even after being cut in appropriate installation lengths.

Cable must have a circular cross section unless otherwise stated in TS.

No splicing of conductors in delivered cable lengths is allowed.

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

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

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

3.2 Standardization

All cables must conform to the design and testing rules as stated by Swedish Standard, EN or IEC.

Cable for installation in process location outside the reactor containment must conform to the standards stated in the TS. Depending of the cable type, TS applicable standards are stated in KBE IP 111.1, KBE IP 111.2, or KBE IP 111.3.

Cable for installation in the reactor containment, must conform to the standards stated in the TS. Depending of the cable type, TS applicable standards are stated in KBE IP 111.1, KBE IP 111.2, or KBE IP 111.3, as well as the standards that are specific for the environment of the reactor containment stated in KBE IP 111.4.

Optical cable for installation in process location must conform to the standards stated in the TS. TS applicable standards are stated in KBE IP 111.5.

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

3.3 Flame spread

The material of the cable must 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)

3.4 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.

3.5 Materials

The cable shall not emit corrosive gases when in normal or extreme operation according to TBE 101. The amount of corrosive gases emitted in case of fire shall be reported by the Manufacturer in the Tender.

Documentation on fire-load shall also be included in the Tender.

3.6 Marking

The entire length of the cable shall be labelled with the type, manufacturer and time of manufacturing with a minimum of marking every meter, in form of a readable and permanent marking on the cable jacket and for optical cables in the form of a marking thread or marking band beneath the cable jacket or a permanent mark on the cable jacket.

Cable parts shall be individual identified in the whole length of the cable with marking or by color. If they are marked, the marking shall be readable every 30 centimeters in normal indoor lighting.

For optical cables 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 Other requirements

When cable is delivered on cable-drums, both ends of the cable shall be sealed water-tight. Cable-drums with protruding sealed ends shall be supplied with a sturdy protection for the cable ends. The cable shall also be protected from sunlight.

It shall be feasible to strip cable jacket and conductor insulation using generally available stripping tools approved/recommended by the Manufacturer.

The Manufacturer shall in the Tender specify any limitations during cable pulling.

3.8 Mechanical properties for optical cables

3.8.1 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.

3.8.2 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 less than 1 000 times without being damaged.

3.9 Environmental properties for optical cables

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.

Requirements related to the environment are stated 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.

3.9.1 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 installed in environment with ionizing radiation.

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

3.10 Life and long term performance for optical cables

The Manufacturer shall in the Tender present an analysis of the cable life based on the long-term characteristics of the polymeric materials that are essential for its functions and environmental protection. The analysis shall include material specifications.

4 Nuclear Specific Requirements

4.1 Life and long term performance

The Manufacturer shall in the Tender present an analysis of the cable life based on the long-term characteristics of the polymeric materials that are essential for its functions and environmental protection. The analysis shall include material specifications.

4.2 Requirements on cable for installation in process locations, outside the reactor containment

The cable shall be manufactured for the environment in the process locations outside the reactor containment (TBE 101, Severity B). Specific requirements (e.g. high temperature, steam or ionizing radiation) shall be specified in the TS and verified in the Inspection Plan.

4.3 Requirements on cable for installation inside the reactor containment

The cable shall be manufactured for the environment in the reactor containment (TBE 101, Severity C). Specific requirements (e.g. high temperature, steam or ionizing radiation) shall be specified in the TS and verified in the control plan. Further, the cable shall also conform to the requirements for 1E-qualification according to nuclear regulations (Regulatory Guide 1.89, IEEE 383 or IEC/IEEE 60780-323).

Cable for installation in the reactor containment shall be halogen free.

5 Other Requirements for optical cables

5.1 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.

5.2 Installation

5.2.1 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 installed.

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 installed vertically.

Seismic installation of the cable can be required.

5.2.2 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 kilometer 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.

5.2.3 Connections

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

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

6 Documentation

In the Tender the Manufacturer shall present the following documentation in addition to what is required in TBE 100:1 and KBE 100-X:

- specifications of materials of conductor insulation and cable jacket
- data on materials, materials testing and life analysis according to section 3.4
- instructions for cable pulling and installation
- amount of corrosive products at combustion according to IEC 60754 “Test on gases evolved during combustion of materials from cables”
- fire-load data (amount of combustible material per unit length)
- Suitable connectors and their attenuation
- Specification of materials in the fibre, fibre cladding and fibre jacket
- Instructions for cable pulling, applying contacts etc. according to 5.2

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

If the installation is a part of the delivery of optical cables 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

7 Agreement between Manufacturer/Supplier 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)	
	Avoid halogen content	
	Labeling readability (labeling, type, manufacturer and date)	
	Environmental properties	
	Specification of content, Material specification	
	Life analysis (Elongation at break, activation energy)	
	Requirements on cable pulling and installation	
	Bending radius	
	Mechanical properties of outer jacket	
	Absence of splice in wires	
	Batch identity marking	
	Suitable connectors and their attenuation	
	Connectors in metal not plastic	
	Presence of conducting materials in the optical cable	
	Extent of delivery with respect to connections, tools, material required for the installation etc.	
	Procedures for attenuation testing including type of measuring equipment	