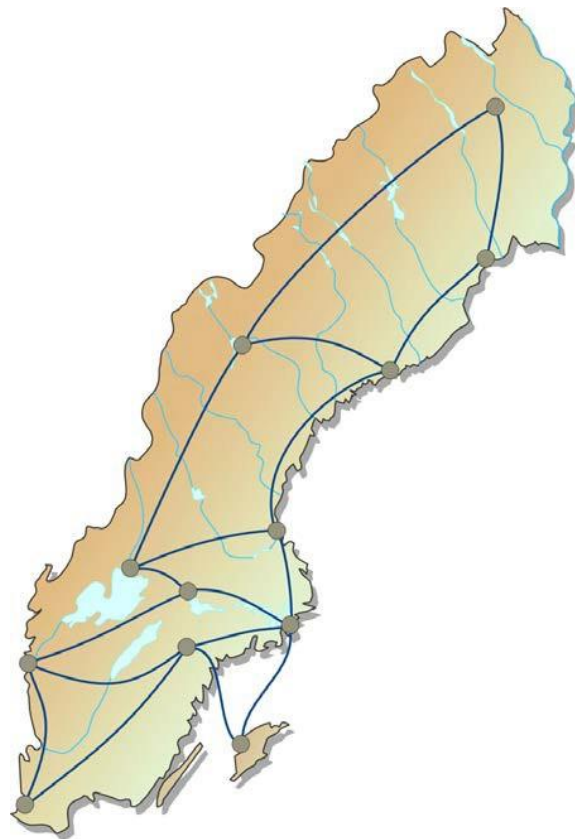




## Instructions for Robust Fiber

Instructions for installation of robust fibre-optic broadband networks

Ver 1.3.2.1





# CONTENTS

<b>1.</b>	<b>Introduction .....</b>	<b>4</b>
1.1	Background.....	4
1.2	Purpose .....	4
1.3	Target group .....	5
1.4	About the instructions .....	5
1.5	Application.....	6
1.6	Network topologies and limits .....	6
1.6.1	National networks .....	7
1.6.2	Regional networks .....	7
1.6.3	Connection networks .....	8
1.6.4	Access networks.....	8
1.6.5	Limits .....	8
1.7	Administration and Revision .....	9
<b>2.</b>	<b>Responsibility for a fibre installation .....</b>	<b>10</b>
2.1	Operational reliability .....	10
2.2	Environment .....	10
2.3	General information about roles and responsibilities from a work environment perspective .....	11
2.4	Work environment plan.....	11
2.5	Environmental plan.....	12
<b>3.</b>	<b>References .....</b>	<b>13</b>
3.1	General.....	13
3.2	Networks .....	13
3.3	Sites and nodes.....	14
3.4	Documentation.....	14
3.5	Inspection .....	14
<b>4.</b>	<b>Contributory organisations.....</b>	<b>15</b>
<b>5.</b>	<b>Reference dokument .....</b>	<b>16</b>

## 1. INTRODUCTION

### 1.1 Background

The need for broadband as part of the overall infrastructure is constantly increasing throughout society. Society will be dependent for a long time on the fibre infrastructure that is being built today. As a result, broadband investment has to be robust and operationally reliable in a cost-effective manner.

Several players in the sector, with the support of the Swedish Post and Telecom Authority (PTS), have taken the initiative regarding these instructions, which describe how a robust fibre installation should be established and operated.

The instructions are a further development of previous documents produced by the Swedish Local Fibre Alliance (SSNf) as well as Swedish IT and Telecom Industries.

- 09/10/2011 Network documentation
- 09/10/2011 Robust nodes
- 09/10/2011 Robust networks
- 01/01/2015 Clarification of the Swedish Local Fibre Alliance's recommendation for Robust Networks Version 2
- Classification and documentation, fibre-based infrastructure
- Concepts and definitions, fibre-based infrastructure
- Minimum requirements, documentation for access networks

### 1.2 Purpose

The purpose of the instructions is:

- To increase knowledge about fibre installations and how they should be built,
- To describe and stipulate requirements for an acceptable minimum level for a robust fibre installation,
- To work to ensure that the players in the sector use the results,
- To define sector-wide terms and expressions,
- To provide supporting data for a certification process where expertise will be ensured at contracting companies and among their personnel.

The instructions will help to raise the level of robustness in fibre installations by means of the players in the sector complying with the requirements contained in the instructions. It is therefore important for network owners and clients in fibre installation projects to have these instructions as the basis for their own instructions.

### 1.3 Target group

The instructions are aimed at stakeholders in the sector, e.g. network owners, fibre alliances, equipment suppliers, contracting companies that install broadband infrastructure, manufacturers of installation machinery, players involved in the administration of training and certification for companies and individuals, as well as contractors for infrastructure projects. Officials at authorities, municipalities and county councils also constitute a target group.

### 1.4 About the instructions

The instructions are based on standards and regulations within the various sub-areas covered in the instructions, e.g. EBR, Svensk Standard, SSF, SEK and AMA.

The instructions highlight selected elements from various standards and describe requirements and recommendations for creating a robust fibre installation. The requirements regarding a fibre installation may deviate from standards and regulations for other types of cable installations.

The instructions comprise a main document along with appendices. The purpose of the main document is to provide an overview as well as references to relevant standards. The appendices include in-depth information, with minimum requirements and recommendations.

At the start of each appendix there is a list of the areas in which there are minimum requirements. All documentation is available at [www.robustfibre.eu](http://www.robustfibre.eu).

The appendices cover the following:

- **Appendix 1: Terms and definitions**  
A list of the terms and definitions mentioned in the main document and the appendices.
- **Appendix 2: Robust networks**  
A review of minimum requirements regarding how ducts and fibre optic cables should be selected and routed, as well as how they should be handled, labelled and measured.
- **Sub-appendix 2.1 Robust networks, Attenuation calculation**  
A tool for calculating attenuation values in fibre optic cables.
- **Appendix 3: Robust routing methods**  
A description of various routing methods.
- **Appendix 4: Robust sites and nodes**  
A review of the minimum requirements imposed on a robust site or node
- **Bilaga 4.1: Robust sites for digital critical infrastructure protection**  
The sub-appendix is a guide with minimum requirements for how a robust Site should be supplemented with regard to protection and functions for extended operating time in order to be able to handle electronic communication in the event of Extraordinary events. The sub-appendix also consists of an RSA template with a guide called:
  - **Sub-appendix 4.1.1: Robust Site RSA-mal**
  - **Sub-appendix 4.1.2: Robust Site tutorial RSA**

- **Appendix 5: Documentation**  
A description of the documents that should exist and the minimum requirements for these.
- **Appendix 6: Inspection**  
A review of the various steps in the inspection process and the minimum requirements that are stipulated regarding e.g. final inspection.
- **Sub-appendix, Appendix 6.1: Checklist for final inspection**  
Provides support for the inspector during the final inspection of a contract.
- **Appendix 7: Fibre installation projects**  
This appendix is a brief description of the elements included in a fibre installation project.
- **Appendix 8: Ledningskollen (Only as a Swedish version)**  
The appendix is a brief description of the elements that are part of a cable indication query.

## 1.5 Application

The instructions' appendices contain minimum requirements regarding how networks and nodes should be routed and documented. Individual network owners apply the instructions according to in-house instructions, processes and building descriptions, and may have requirements that are more stringent or requirements that are not included here.

It is therefore important to note that ***the purpose of these instructions is to describe and stipulate requirements for a minimum level regarding how a robust network should be installed.***

The instructions should e.g. be used as:

- Supporting documentation for training.
- Technical support during procurement.
- Information material for permit issuers.
- Description of approaches for inspection.
- Description of the stages in a fibre installation project.
- Basis for specification of requirements when applying for grants.

## 1.6 Network topologies and limits

The country's fixed electronic communication networks are divided into four levels

- National networks (level 1)
- Regional networks (level 2)
- Connection networks (level 3)
- Access networks (level 4)

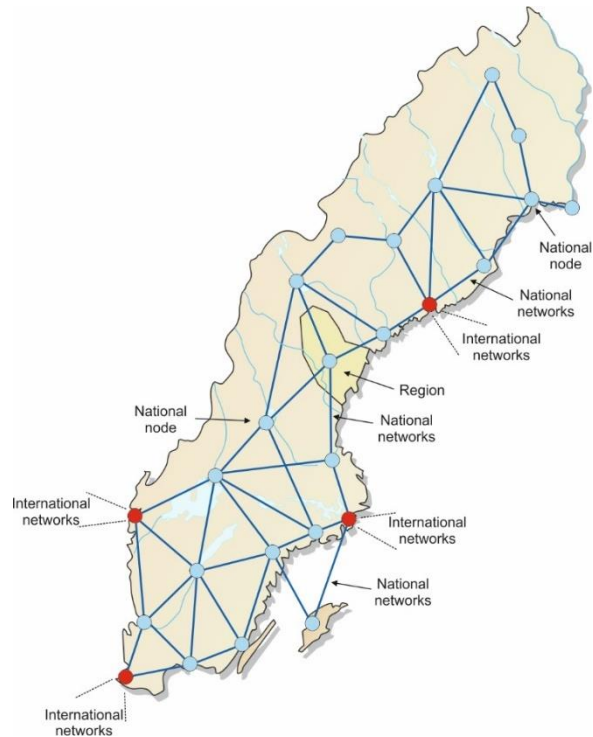
Below is an overview of the networks at the various levels.

### 1.6.1 National networks

The national networks:

- Link together the various regions in the country.
- Are also connected to international networks.
- Are owned by the country's major operators.
- Have very high capacity.
- Are also known as wide area networks, core networks and backbone networks.

A national node is a connection point in a national network or between regional networks. The security and functional requirements are extremely high.



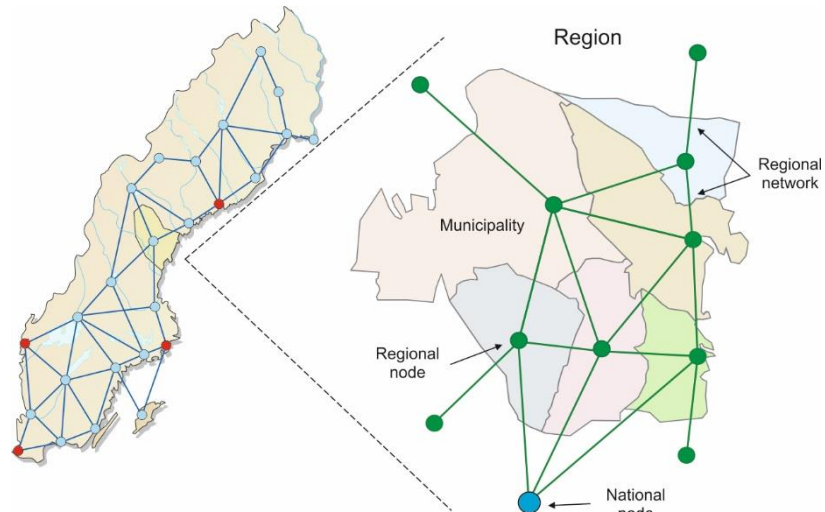
Image, National networks

### 1.6.2 Regional networks

The regional networks:

- Link together networks within a region.
- Owned by national or regional operators, e.g. urban network clusters and medium-sized operators.

A regional node is connected to national networks, other regional networks and connection networks in the region.



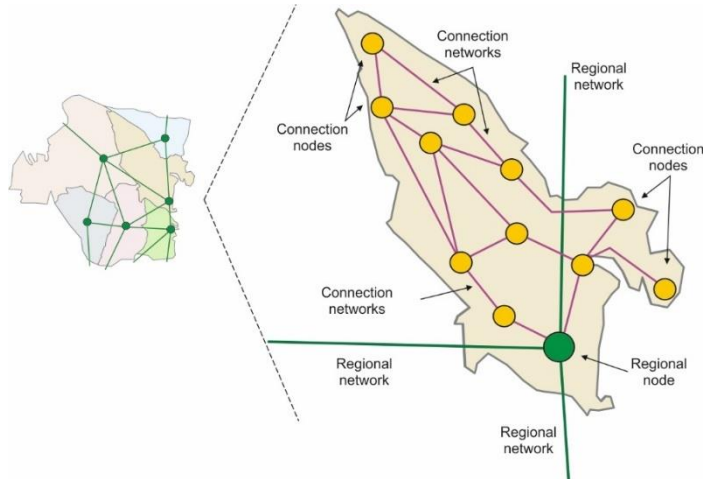
Image, Regional networks

### 1.6.3 Connection networks

The connection networks:

- Link together regional networks with access networks.
- Are owned e.g. by national operators and local urban networks.
- Are often a network within an urban area or municipality.

The connection node has connections to regional networks, other connection networks and access nodes.



Image, Connection network

### 1.6.4 Access networks

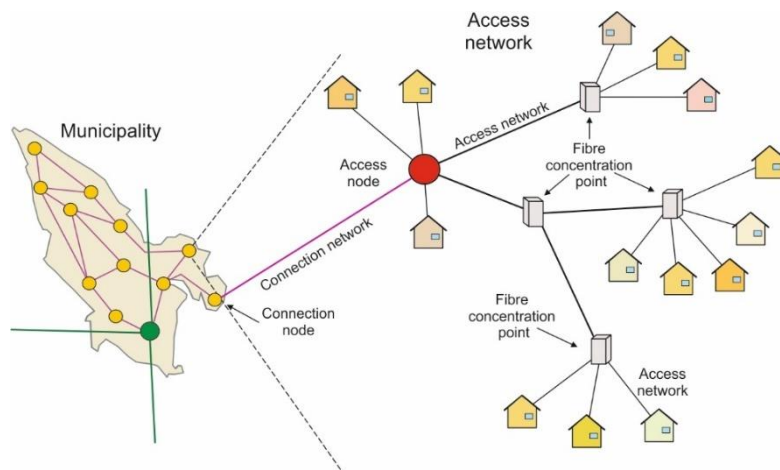
Access networks:

- Are networks between access nodes and end customers.
- Are owned e.g. by national operators, urban networks and fibre alliances.

Fibre connections from end customers are terminated in access nodes. Access nodes are connected via connection networks to connection nodes or other access nodes.

#### MINIMUM REQUIREMENTS

In the event the access node constitutes a connection point between various network owners, the linking of the fibre connections must take place through a cross-connection.



Image, Access network

### 1.6.5 Limits

The instructions are limited to describing ducting for fibre-optic connection and access networks.



## 1.7 Administration and Revision

The document is managed by an administration council, which goes through the document at least once a year to ensure that updates with new information, changes and additions are introduced and documented in an Amendment.

All documentation is available at [www.robustfibre.se](http://www.robustfibre.se).

Proposed changes to these instructions are submitted by e-mail to [info@robustfibre.se](mailto:info@robustfibre.se).

## 2. RESPONSIBILITY FOR A FIBRE INSTALLATION

Being responsible for a fibre installation places considerable demands on the network owner and the organisation that has to plan, build and manage the installation. There are a number of laws and regulations that have to be followed. In addition, requirements are stipulated by customers that place ever higher demands on the accessibility of the services in the network.

The instructions are always subordinate to applicable laws and official regulations.

### 2.1 Operational reliability

Continuous work on operational reliability must be carried out by the network owner. This includes performing a risk analysis of the fibre installation, e.g. sites, nodes and fibre optic cables.

The purpose of the risk analysis is to reduce the vulnerability of the fibre installation and increase awareness of the risks that exist and the consequences should an incident occur. An example of a management model for operational reliability, with templates showing how the network owner can handle the operational reliability work, can be found at the Swedish Local Fibre Alliance, [www.ssnf.org](http://www.ssnf.org).

For more information about requirements that apply to operational reliability for a fibre installation, please refer to the Swedish Post and Telecom Authority's regulations regarding requirements for operational reliability, PTSFS 2015:2 (subsequently referred to as the Operational reliability regulations).

### 2.2 Environment

This chapter provides a general description of environmental and work environment aspects that can occur in conjunction with a fibre installation project. All commercial operations' environmental and work environment aspects are covered to a large extent by various laws and regulations.

The legislation regarding both the environment and the work environment is continually being developed, which is why the organisation's work on these areas must be conducted on an ongoing basis in order to be successful.

Generally speaking, a specific person should be appointed within each organisation to monitor and spread information about developments within each area. With regard to the work environment, the Swedish Work Environment Authority is tasked with ensuring compliance with laws about the work environment, and the Authority supplies several different tools and checklists for the work in this area.

### 2.3 General information about roles and responsibilities from a work environment perspective

The Principal is the party that commissions the execution of building or installation work. In the case of a fibre installation project, the ordering network owner is the Principal. The Principal can reach agreement with a Contractor regarding taking over the role of Principal with some or all of the responsibility for the work environment that is associated with the role of Principal. In the case of a fibre installation project, the network owner may agree in writing with a contractor regarding taking over the role of Principal.

The Principal is responsible for appointing a Construction work environment coordinator for planning and design (BAS-P) and a Construction work environment coordinator for execution (BAS-U). The Principal is also responsible, together with the BAS-P, for drawing up a Work environment plan.

### 2.4 Work environment plan

During the start-up of a fibre installation project, a separate work environment plan must be drawn up for the specific project if any of the following three criteria are satisfied:

1. The work is estimated to continue for more than 30 days and where more than 20 are employed simultaneously at some point.
2. The total number of person-days is estimated to exceed 500 days.
3. If any of the 13 risks occurs (See AFS 1999:3 Section 12a C).

The work environment plan must be drawn up before the work at the location of the fibre installation project commences. BAS-U is responsible for the work environment plan being available at the workplace and for it being updated, if necessary, as the work on the fibre installation project progresses.

The work environment plan may contain the following:

- The regulations that are to be applied at the location of the installation work.
- A description of how the work environment work is to be organised.
- A description of the measures that are to be implemented to minimise the risks in the case of “work involving particular risk” and any other risks.

Examples of work involving particular risk during a fibre installation project:

- work with a risk of falling to a lower level where the difference in level is two metres or more,
  - work that entails a risk of being buried under soil or sinking into soft ground,
  - work in the vicinity of high voltage cables,
  - work that entails a risk of drowning,
  - work in manholes and tunnels as well as installation work below ground,
  - work that is carried out under water using diving equipment,
  - work that involves the use of explosives,
  - work in a location or area where there is passing vehicular traffic.
- If the installation work is to be conducted in a location where another operation will be ongoing at the same time, this must be taken into consideration in the work environment plan by taking account of any risks to people who belong to another operation.

The ordering network owner should impose requirements on the parties that are carrying out the work in the fibre installation project, whereby the parties should document and submit such information to the client that will facilitate future work environment work and safety rounds at the installation.

The ordering network owner should, for its own part and for the same reason, ensure that parties that are carrying out work in the fibre installation project have procedures and systems in place for documenting and reporting accidents and near-accidents.

## 2.5 Environmental plan

In parallel with the Work environment plan's efforts to create a good work environment and prevent accidents, the preparation of an environmental plan can contribute to minimising the fibre installation project's negative environmental impact.

The environmental plan is also a way of ensuring, in a structured manner, that the fibre installation project is not taking place in contravention of applicable environmental legislation, local regulations or the individual environmental policies of the parties involved.

An environmental plan may cover the following aspects:

- Involved vehicles and work machines and their environmental impact. Machinery must be environmentally classified, CE marked and properly maintained. Emissions levels must be within the framework of applicable regulations. Local regulations for environmental classification may occur where the areas can be classified as sensitive. Object-specific environmental requirements may occur in certain cases.
- Analysis of the risk of leakage of oil, fuel, coolants or other environmentally hazardous chemicals into the land and watercourses or other sensitive natural environments. The risks should be associated with an action plan in the event of an accident. A decontamination company must be available in an emergency if necessary.
- Environmental impact associated with excavation. Select a method with little environmental impact in respect of emissions from work machinery, vehicles and for the transport of backfill material.
- Plan for handling contaminated material. Ensure that relevant contractors possess the required knowledge and have the necessary permits to handle the material.
- Identification of risks of disruptive noise and vibrations of the environment.
- Planning of working hours from the perspective of disruptions to the surrounding environment and the general public. Local rules and regulations govern when noisy work may be carried out.
- Risk of large amounts of dust. Some routing methods can create a large amount of dust and require measures to reduce the spread of the dust, in the form of covering or interrupting the work in windy conditions.
- Work in the vicinity of particular sensitive nature, trees, bushes, alleys and watercourses.

### 3. REFERENCES

Below is a list of standards, rules, regulations, legal requirements, etc., that may be relevant in order to find out more about a subject.

#### 3.1 General

Laws, ordinances, statutes and regulations:

- The Alarm Systems Act (1983:1097).
- The Electronic Communications Act (2003:389) (LEK).
- The Protection of Essential Facilities Act (2010:305)
- The Work Environment Act (1977:1160)
- The Swedish Work Environment Authority's provisions (AFS)
- PTSFS 2015:2 Swedish Post and Telecom Authority's regulations on operational responsibility requirements

#### 3.2 Networks

For nodes, property networks or fibre outlets in apartment buildings, see "Robust property networks".

An overview of cable routing according to the instructions EBR KJ 41:15, popularly known as the "Excavation bible"

AMA (General material and workmanship specifications) Site works is a reference work that is used in the preparation of descriptions and the execution of construction work.

Information about splicing units and fibre optic cables can be obtained from ITU-T and Svensk Standard.

Information about ducts:

- European Standard EN 60794-5:2007 Optical fibre cables – Part 5: Sectional specification – Microduct cabling for installation by blowing.
- SP's standard PS 144.
- EN ISO 3126:2005.

Cables:

- Product regulation for cables indoors, CPR (Construction Product Regulation) SS-EN 50 575.
- Fibre-optic cables – Type designations SS 424 18 86 developed by SEK).

#### Enclosure classification

The relevant standard is called SS-EN 60 529.

#### Impact resistance

The relevant standard is called SS-EN 50 102.

### 3.3 Sites and nodes

For the handling of methods and equipment for surveillance and burglar protection, please refer to the Swedish Theft Prevention Association's standards and instructions.

For rules and regulations relating to electrical safety, please refer to the National Electrical Safety Board and SEK Svensk Elstandard. Local power suppliers may have their own provisions.

Lightning protection, earthing and equipotential bonding are described in Svensk Standard.

For fire protection, regulations exist for which the Swedish Fire Protection Association is responsible.

For requirements regarding buildings, please refer to Boverket.

For physical safety in nodes, there are a number of standards that can be obtained from Svensk Standard

### 3.4 Documentation

The standard for the documentation of teletechnical installations can be obtained from Svensk Standard

### 3.5 Inspection

For more information, please refer to the Construction Contracts Committee and the General Conditions of Contract (AB and ABT).

## 4. CONTRIBUTORY ORGANISATIONS

The following organisations, in collaboration with PTS, have been responsible for the drawing up of the instructions.

AB Stokab  
The Swedish Broadband Forum  
Bynet AB  
Dellcron AB  
Eltel Networks Infranet AB  
Empower AB  
GothNet AB  
ICT Consulting AB  
Iftac AB  
Incert AB  
IP-Only AB  
Swedish IT and Telecom Industries  
Johan Lundberg AB  
JLM Scandinavia AB  
Maskinentreprenörerna AB  
Netel AB  
Nexans Sweden AB  
Nordlund Entreprenad AB  
Swedish Post and Telecom Authority  
Rala Infratech AB  
Relacom AB  
Roland Gustavsson Grävmaskiner AB  
SG Optics AB  
Skanova AB  
STF Ingenjörutbildning AB  
Styrud AB  
Svensk Infrastruktur AB  
Swedish Local Fibre Alliance  
Swedish Association of Local Authorities and Regions (SALAR)  
Tele2 AB  
Telenor AB  
Thunman Konsult  
Utsikt Bredband AB  
We-Consulting AB  
Higher Vocational Education, Heta utbildningar Härnösand

## 5. REFERENCE DOKUMENT

CENELEC TS 50429 (30,31)	Opto fibre cables for installation in storm and sanitary sewers, high pressure gas pipes, drinking water pipes
CENELEC TS 50433	Guidelines for paving the way for "Broadband, 25 Mbit/s and more for all"
SS-EN 424 14 37- 6	Kabelförläggning i mark
SS-EN 424 1438	Kabelförläggning i byggnader
SS-EN 50377-xx	Anslutningsdon för fibreoptik
prEN 50377-xx	Connector sets and interconnect components
SS-EN 50411-xx	Fiberorganiserare, kapslingar, skarvboxar
SS-EN 60874-xx	Optofibertechnik – Anslutningsdon för optofibrer och optokablar, fiberoptik, art- och grupp-specifikationer
SS-EN 60875-xx	Optofibertechnik – Avgreningsdon
SS-EN 61073-1	Fiberoptik – Mekaniska skarvar och skydd för svetsskarvar
SS-EN 61274-xx	Optofibertechnik – Övergångsdon
SS-EN 61753-xx	Fiberoptik – Funktionsfordringar på anslutningsdon, Fibre interconnecting devices and passive components
SS-EN 61754-xx	Fiberoptik – Gränssnitt för kontaktdon, Fiberoptiskt kontaktdonsgränssnitt
SS-EN 61755-xx	Fiberoptik – Optiska gränssnitt för kontaktdon, Fibre optic connector optical interface
SS-EN 61756-1	Fiberoptik – Anslutningsdon och passiva komponenter- Gränssnitt för fiberhanteringssystem
SS-EN 61758-1	Fiberoptik – Anslutningsdon och passiva komponenter- Gränssnitt hos skarvboxar
SS- EN 60793-xx	Optofibrer: produktspecifikationer, mätning och provning – Bandbredd
SS-EN 60794- x	Optokablar/generella kabelnät: art- och familje-grupp-specifikationer, grundläggande provningsmetoder.
SS-EN 61280 xx	Delsystem för fiberoptisk kommunikation - Grundläggande provningsmetoder (multimodfiber/singelmodfiber)
SS-EN 61300.- xx	Fiberoptik – Anslutningsdon och passiva komponenter Provning och mätning
SS 455 12 01 (utg. 1)	Dokumentation av teleanläggningar
SEK Handbok 434	Fiberoptisk anslutning av slutanvändare – FTTX-nät
SEK Handbok 455	Dokumentation av teleanläggningar (baseras på SS 455 12 01)
EBR KJ 41:09	Kabelförläggning max 14,5 KV (baseras på SS 424 14 37- 6)
EBR B 14:00	Opto