

Code of Practice for

# Installation of fibre optic cabling

ICS 33.180.10

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# Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Electrotechnical Sector Board to Technical Committee EPL/86, Fibre optics, upon which the following bodies were represented:

- BECCAMA (BEAMA Electrical Cable Connector and Accessories Manufacturer's Association)
- BCMC (Telecommunications Cables Group)
- British Approvals Service for Cables
- British Cable Makers Confederation
- British Telecommunications
- Department of Trade and Industry (National Physical Laboratory)
- ERA Technology Ltd.
- FEI (Federation of the Electronics Industry)
- Fibre Optic Industry Association (FIA)
- Ministry of Defence
- National Supervising Inspectorate (BSI PC)
- Society of Cable Television Engineers

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## Foreword

This British Standard has been prepared by Technical Committee EPL/86 and supersedes BS 7718 : 1994 which is withdrawn. It was first circulated as a Draft for Public Comment in 1990 and was then considered by the CENELEC Committee CECC/WG 28, during which time the Standstill Agreement was applied and no national standard could be published.

However, the Fibre Optic Industry Association (FIA) was able to issue an interim document during 1991 which satisfied the urgent need to provide guidance and give recommended practices for the installation of fibre optic cabling.

After due consideration the CENELEC Committee CECC/WG 28 agreed that the Standstill Agreement should be waived and that each national standards organization should be free to issue its own publication on the subject.

BS 7718 : 1994 took into consideration the original British Standard draft and the interim FIA document as modified in the light of experience gained.

The revision incorporates a number of essential amendments which have been found necessary as a result of comments received from users of the Code of Practice since the original publication in 1994.

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

**Compliance with a British Standard does not of itself confer immunity from legal obligations.**

# Code of practice

## Introduction

Fibre optic cabling either separate from or combined with other media provides a high performance communications pathway. However, poor design and workmanship may incur severe penalties during both installation and operation. This code of practice is intended to allow the user and the installer to establish a specification for installation and defines recommended practices to ensure compliance with that specification.

This code of practice covers all applications of optical fibre as a communications medium and provides guidance to the user and installer with regard to the general aspects of fibre optic cabling design.

It also makes recommendations for the following:

- safe installation and operation of fibre optic cabling;
- design criteria of cabling components and accessories;
- the definition of a specification covering the installation of fibre optic cabling;
- working practices during installation;
- levels of quality assurance ensuring that the agreed specification is attained for the cabling components, accessories and the completed installation;
- levels of documentation;
- the performance verification of existing fibre optic cabling;
- repair and maintenance philosophies.

Installation practices are treated sequentially beginning with the installation specification and culminating with repair and maintenance.

Annex A details the recommended methods to be used to demonstrate that both cabling components and the installed cabling meet the requirements of the installation specification.

The need for guidance during the design phase, prior to the generation of an installation specification, is addressed in annex B.

A number of alternative communications media are available to the user, and the consideration of technical merit and cost, together with installation and operational aspects will promote the adoption of either copper, optical fibre or unguided transmission as the communications medium. Cabling systems may comprise a mixture of technologies, each being chosen as the most appropriate for the relevant application. The code of practice does not promote the sole or dominant use of optical fibre but supports its use within a communication system.

## 1 Scope

This British Standard provides recommendations for design, workmanship and quality assurance requirements for the installation of fibre optic cabling used to provide a communications path between two or more points.

This British Standard covers the use of glass and silica based optical fibres designed for transmission of electromagnetic radiation in the near-infra-red region between 750 nm and 1600 nm.

Optical fibre may be installed using either conventional cables or 'blown fibre' techniques. Unless otherwise stated the requirements for conventional cable designs are applicable to blown fibre ducts throughout the cabling design and installation process.

The information communicated covers the full range of communications services including voice, data, image and video. Applications are categorized as follows:

- *Equipment independent cabling:*  
cabling designed and installed in accordance with overall attenuation and/or bandwidth envelopes laid down by communications standards (e.g. FOIRL, IEEE 802.3 10baseF, FDDI);
- *Equipment based cabling:*  
cabling designed and installed to enable communication not covered by nationally and internationally agreed attenuation and bandwidth envelopes (e.g. video);
- *System based cabling:*  
cabling designed and installed as an integral component within a fixed proprietary communications system (e.g. command and control systems within a fighting vehicle).

A given installation can comprise cabling to service one or more of these applications.

Cabling installed in accordance with the recommendations of this code of practice is intended to have an operational lifetime consistent with or in excess of that exhibited by the terminal communications equipment.

This code of practice in no way supersedes the additional relevant standards and requirements applicable to certain hazardous environments, e.g. electricity supply and railway authorities.

## 2 References

### 2.1 Normative references

This British Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are made at the appropriate places in the text and the cited publications are listed on the inside back cover. For dated references, only the edition cited applies; any subsequent amendments to or revisions of the cited publication apply to this British Standard only when incorporated in the reference by amendment or revision. For undated references, the latest edition of the cited publication applies, together with any amendments.

### 2.2 Informative references

This British Standard refers to other publications that provide information or guidance. Editions of these publications current at the time of issue of this standard are listed on the inside back cover, but reference should be made to the latest editions.

## 3 Definitions and symbols

### 3.1 Definitions

For the purposes of this British Standard, the following definitions apply.

#### 3.1.1 adaptor (adapter)

A female-type part of an optical fibre connector in which one or two connector plugs are inserted and aligned.

#### 3.1.2 attenuation

A decrease of electromagnetic power between two points and the quantitative expression of power decrease which may be expressed by the ratio of the values at two points of a quantity related to power in a well defined manner.

NOTE 1. The loss of optical power through a fibre optic component is measured in dB units.

NOTE 2. Attenuation is generally expressed in logarithmic units, such as the decibel (dB).

#### 3.1.3 attenuation coefficient

The limit of the quotient of attenuation between two points on the axis of a transmission line or waveguide by the distance between the points when this distance tends to zero.

NOTE. Attenuation per kilometre of an optical fibre is measured in dB/km.

#### 3.1.4 bandwidth

- a) That value numerically equal to the lowest modulation frequency at which the magnitude of the baseband transfer function of an optical fibre decreases to a specified fraction, generally to one half, of the zero frequency value.
- b) A measure of the capacity of an optical fibre to transmit high speed data.

NOTE. The bandwidth is limited by several mechanisms:

- a) in multimode fibres, mainly modal distortion and material dispersion;
- b) in singlemode fibres, mainly material and waveguide dispersion.

### 3.1.5 basic fibre optic subsystem

The serial combination of an optical transmitter, optical receiver and the interconnecting fibre optic span.

#### 3.1.6 cable assembly

An optical cable that is terminated with optical fibre connectors.

#### 3.1.7 chip defect

Material broken away from the fibre following the generation of crack defects.

#### 3.1.8 cladding

That dielectric material of an optical fibre surrounding the core.

#### 3.1.9 cladding diameter

The diameter of the circle defining the cladding centre.

#### 3.1.10 connector

See optical fibre connector (3.1.32).

#### 3.1.11 connector plug

A male-type part of an optical fibre connector.

#### 3.1.12 core

The central region of an optical fibre through which most of the optical power is transmitted.

#### 3.1.13 core diameter

The diameter of the circle defining the core centre.

#### 3.1.14 crack defect

A stress fracture either wholly within the fibre or intersecting the fibre surface.

#### 3.1.15 fibre optic cabling

All of the installed optical fibre components and all accessories including closures.

#### 3.1.16 fibre optic span

A series of one or more terminated optical fibre elements which may contain complex passive components.

#### 3.1.17 Fresnel reflection

The reflection of a portion of the light incident on a planar interface between two homogeneous dielectric media having different refractive indices.

#### 3.1.18 fusion splice

A splice accomplished by the application of localized heat sufficient to fuse or melt the ends of two lengths of optical fibre, to produce a single continuous optical fibre.

#### 3.1.19 index matching material

A material, often a liquid or cement whose refractive index is nearly equal to the core refractive index, used to reduce Fresnel reflections from an optical end-face.

#### 3.1.20 insertion loss

The extra optical attenuation caused by the insertion of an extra optical component into an optical system.

**3.1.21 joint**

An assembly designed to permit connection between two or more optical fibres.

**3.1.22 jumper**

A cable assembly, permanently assembled at both ends with connector components principally for connection to transmission equipment.

**3.1.23 material dispersion**

That dispersion attributable to the wavelength dependence of the refractive index of material used to form the fibre.

**3.1.24 mechanical splice**

A fibre splice accomplished by fixtures or materials rather than thermal fusion.

**3.1.25 modal distortion**

In a multimode optical fibre, that distortion resulting from the propagation of different modes having different properties.

**3.1.26 mode field diameter**

For Gaussian distributions in singlemode fibres, the diameter at the  $1/e$  points of the optical field amplitude distribution equivalent to the  $1/e^2$  points of the optical power distribution.

**3.1.27 multimode optical fibre**

An optical fibre in the core of which the radiation of two or more bound modes can propagate at the wavelength of interest.

**3.1.28 node**

A point of flexibility and/or interconnection within the fibre optic cabling.

**3.1.29 numerical aperture (N.A.)**

- a) A measure of the capacity of the following:
  - 1) an optical fibre to accept light;
  - 2) an optical transmitter to inject light into an optical fibre;
  - 3) an optical receiver to accept light from an optical fibre.
- b) The sine of the vertex half-angle of the largest cone of meridional rays that enter or leave the core of an optical system or element multiplied by the refractive index of the medium in which the vertex of the core is located.

**3.1.30 optical cable**

An assembly comprising one or more optical fibres or fibre bundles inside a common covering designed to protect them against mechanical stresses and other environmental influences while retaining the transmission quality of the fibres.

NOTE. It may also contain metallic conductors.

**3.1.31 optical fibre**

A filament shaped optical waveguide made of dielectric materials.

**3.1.32 optical fibre connector**

An optical fibre component normally attached to a cable or piece of apparatus, for the purpose of providing interconnection/disconnection of optical cables.

**3.1.33 optical fibre coupler**

A passive device whose purpose is to transfer optical power between two or more ports in a predetermined manner.

NOTE. The ports may be connected to waveguides, sources, detectors, etc.

**3.1.34 optical fibre element**

An unterminated optical fibre which may contain splices and other complex optical components.

**3.1.35 optical fibre pigtail**

A short length of optical fibre usually attached to a component and intended to facilitate jointing between that component and another optical fibre or component.

**3.1.36 optical loss**

See attenuation (3.1.2).

**3.1.37 optical receiver**

See receive FO terminal device (3.1.45).

**3.1.38 optical time domain reflectometer (OTDR)**

An instrument capable of characterizing optical fibre and joints using optical time domain reflectometry.

**3.1.39 optical time domain reflectometry**

A technique for characterizing an optical fibre whereby an optical pulse is transmitted through the optical fibre and the optical power of the resulting light scattered and reflected back to the input is measured as a function of time.

**3.1.40 optical transmitter**

See transmit FO terminal device (3.1.53).

**3.1.41 patchcord**

A cable assembly, permanently assembled at both ends with connector components principally for cross-connection within a patching facility.

**3.1.42 pigtail**

See optical fibre pigtail (3.1.35).

**3.1.43 pit defect**

A localized surface mark.

**3.1.44 primary coating**

A thin coating applied directly to the cladding to preserve the integrity of the cladding surface.

**3.1.45 receive FO terminal device**

A fibre optic terminal device including one or more optical detectors and having one or more optical inputs.

**3.1.46 refractive index**

At a point in a medium and in a given direction, the ratio of the velocity of light in vacuum to the phase velocity of a sinusoidal phase wave propagating in that given direction.

3.1.47 scratch defect

A linear extended surface mark.

3.1.48 secondary coating

A coating applied directly to the primary coating to reinforce the protection of the optical fibre during handling and cabling.

3.1.49 singlemode optical fibre

An optical fibre in which the radiation of only one bound mode can propagate at the wavelength of interest.

3.1.50 splice

A permanent joint whose purpose is to couple optical power between two optical fibres.

3.1.51 spectral window

A wavelength region in an optical waveguide over which the transmission loss is acceptably low such that system operation can be readily achieved.

3.1.52 transmission window

See spectral window (3.1.51).

3.1.53 transmit FO terminal device

A fibre optic terminal device including one or more optical sources and having one or more optical outputs.

3.2 Symbols

The following symbols are used in figures throughout the text.

|                               |  |
|-------------------------------|--|
| Connector plug                |  |
| Fibre optic span              |  |
| Jumper or patchcord           |  |
| Splice (fusion or mechanical) |  |
| Mated connector pair          |  |
| Reference lead                |  |

4 Optical fibre safety

4.1 General

The primary safety issues relating to optical fibre are as follows:

- risks of inhaling fumes from, or allergic reactions to, chemicals used to prepare and process optical fibres for the subsequent application of connectors or jointing mechanisms;
- risks of optical fibre fragments piercing the skin (and the eyes) which can lead to infection and complications because of the difficulty of removing them;
- risks from exposure of the skin (and the eyes) to optical power either direct from sources (laser or LED) or from free interfaces (connectors, fractured optical fibres or joints).

**WARNING.** It is essential that the installer should have documented procedures for substances that are hazardous to health. In particular attention is drawn to the Control of Substances Hazardous to Health Regulations : 1988 [1].

Working areas should provide sufficient space for safe operation, supervision and maintenance of all installation practices. The following working practices should be adopted throughout the installation and operation of fibre optic cabling.

4.2 Chemical hazard

**4.2.1** Certain chemicals used to prepare and clean optical fibres may be considered hazardous when inhaled or ingested by mouth. Others such as the epoxide resins used in the production of joints may cause allergic reactions.

The practices described in 4.2.2 to 4.2.7 should be adopted. Failure to do so may endanger the health of those involved.

**4.2.2** Work should be carried out in well ventilated areas or forced ventilation should be provided. Prolonged and repeated breathing of vapour or fumes should be avoided.

**4.2.3** Precautions should be taken to avoid contact with eyes or skin or clothing.

**4.2.4** Eating and smoking should not be permitted in the vicinity of processing chemicals used since this may represent an enhanced hazard due to potential ingestion or explosion.

**4.2.5** In case of contamination a basic first aid kit should be available together with a ready supply of water.

**4.2.6** All chemicals should be stored in clearly and correctly marked containers and should be securely stoppered when not in use.

All chemicals should be safely disposed of following use and upon reaching relevant expiry dates.

**4.2.7** Fire extinguishing equipment of the relevant type should be available where required.

Where a gaseous flooding system is used for extinction of fire in a working area:

- safety information should be clearly displayed;
- a manual disable function should be available and its use clearly explained to those persons working in the area;
- all escape routes should be clearly marked.

### 4.3 Optical fibre hazard

**4.3.1** Good housekeeping should be adopted to minimize the quantity of optical fibre waste. It is essential that exposed optical fibre ends should be kept away from the skin and eyes.

**4.3.2** Waste fragments should be treated with care and collected (not with bare or unprotected hands) together with other waste materials and disposed of in suitable containers via an approved agency.

### 4.4 Optical power hazard

**4.4.1** The installer and user are often unable to determine the nature or level of the incident power. For this reason the issue of optical safety is particularly critical and the practices described in **4.4.2** to **4.4.5** should be adopted.

**4.4.2** Under no circumstances should a connector end-face, prepared optical fibre or fractured optical fibre be viewed directly unless the power emitted from the optical fibre is known to be safe (as defined in BS EN 60825) and under local control.

This allows inspection of components using locally injected visible light but prevents the inspection of components using light injection from a remote non-controlled location.

**4.4.3** The provision of the correct safety labelling is a mandatory requirement on all products where transmission equipment features an optical hazard as defined in BS EN 60825. It is essential that all potential hazard areas are similarly marked.

**4.4.4** Adaptors within patch panel closures and free connectors should be permanently capped to prevent accidental eye or skin contact which might result in injury.

**4.4.5** The user should ensure that all authorized personnel are aware of the relevant safety issues and should obtain training where appropriate.

## 5 Installation specification

### 5.1 General

Following due consideration of the design issues discussed in annex B, it is recommended that an installation specification be produced by or on behalf of the user. The installation specification should comprise the following:

- operational requirement;
- technical specification;
- scope of work;
- contractual terms and conditions.

The production of an installation specification allows effective comparison of technical and commercial submissions by potential installers and should be agreed between the user and the installer prior to the commencement of the installation.

### 5.2 Operational requirement

#### 5.2.1 Infrastructure

It is recommended that a clear description of the proposed infrastructure should be produced including the following.

- a) *Topology*, detailing the locations (each containing one or more nodes) to be interconnected by the cabling infrastructure. Requirements for the extension of the cabling into existing or new locations should be detailed.
- b) *Application*, detailing the application(s), highlighting, where relevant, current and future requirements for compliance with national and international communications standards. The number of communications routes between each node should be specified, with suitable allowance for service expansion where relevant.
- c) *Lifetime*, detailing the requirements for the physical and operational lifetime of the installed cabling infrastructure.
- d) *Routeing*, detailing the routes into which cabling is to be installed.
- e) *Hazards*, identifying and classifying hazardous areas within the proposed routes and working areas. The user should provide relevant information and drawings clearly identifying the boundaries of hazardous, or potentially hazardous, areas together with the classification of those areas.
- f) *Environment*, defining the installation environment within the routes and stating any conditions which may assist in the choice of cabling components or may affect the fibre optic cabling both during and following installation.

Common factors affecting component choice and installation methods include the following:

- temperature, humidity, vibration;
- exposure to UV, chemical attack or physical damage;
- presence of hazards as detailed above (in particular the presence, or potential presence, of contaminating, toxic or explosive materials).

NOTE. Certain environments may place restrictions on the use of fusion splicing (which generally use an open electric arc).

Levels of toxic emission from the installed cabling (particularly during combustion) should be detailed.

### 5.2.2 Operational capability

It is recommended that the desired operational capability should be defined to include the following:

- optical power budgets of transmission equipment to be used;
- bandwidth requirements of transmission equipment to be used;
- transmission windows of transmission equipment to be used.

### 5.3 Technical specification

The technical specification forms a basis against which all components and techniques used within the installation are assessed. It should be based upon the information provided in the guidance notes (see annex B) and should include the following.

#### a) *Identification scheme:*

- 1) nodes;
- 2) routes;
- 3) optical cables and optical fibre elements;
- 4) closures.

#### b) *Optical fibre(s):*

- 1) physical parameters;
- 2) optical parameters.

#### c) *Optical cable(s):*

- 1) physical parameters;
- 2) environmental parameters.

NOTE. Additional information may be found in annex A of IEC 794-1 : 1993.

#### d) *Blown fibre duct:*

- 1) physical parameters;
- 2) environmental parameters.

#### e) *Connectors:*

- 1) physical parameters;
- 2) random mated, worst case, insertion loss, return;
- 3) loss (where relevant).

#### f) *Joints:*

- 1) random mated, worst case, insertion loss, return;
- 2) loss (where relevant).

#### g) *Closures:*

physical parameters.

### 5.4 Scope of work

#### 5.4.1 *Pre-installation*

##### 5.4.1.1 *Civil works*

Any building work required on each route should be detailed, together with a clear statement of responsibility for the identification, design and completion of the works involved.

The responsibility for obtaining all necessary clearances and permits should also be defined.

##### 5.4.1.2 *Route preparation*

All known route information should be detailed, and requirements for the installation of drawpits, ductwork, traywork, trunking and other cable installation accessories should be stated.

A clear statement of responsibility for the identification, design and completion of the works should be included. The responsibility for obtaining all necessary clearances and permits should also be defined.

##### 5.4.1.3 *Bill of materials*

Exact quantities of all cabling components and installation accessories should be detailed, and those areas requiring evaluation and/or verification should be stated clearly.

##### 5.4.1.4 *Survey status*

The need for a survey by the installer should be defined and, where relevant, the areas to be assessed during such a survey should also be detailed.

#### 5.4.2 *Installation*

##### 5.4.2.1 *Contract interfaces*

Contractual interfaces for the installation should be detailed including responsibilities for the following:

- a) documentation of existing cabling;
- b) proving compatibility of existing cabling components and items to be issued to the installer by, or on behalf of, the user;
- c) storage of materials;
- d) installation of optical cable by a third party.

##### 5.4.2.2 *Programme*

The required programme of installation should be detailed and any access and/or site limitations should be stated clearly. Implications of other works should be made known to the installer where they may affect the programme.

Any limitations to access in terms of time and personnel together with restrictions on personnel movement, vetting and clearance levels should be clearly stated.

Requirements for progress meetings should be detailed.

**5.4.2.3 Cable installation**

Requirements for warning signs, marking and labelling to be applied to the optical cables and closures should be detailed.

**5.4.2.4 Earthing**

Requirements for the protective and functional earthing of cabling components and closures should be detailed. It is essential that the relevant national standards should be complied with.

**5.4.2.5 Connectivity**

Requirements for jointing and termination of optical fibre elements at each node should be detailed.

**5.4.2.6 Testing**

Requirements for final cabling acceptance should be detailed.

**5.4.2.7 Documentation**

Levels of documentation to be supplied both during and following installation should be detailed.

**5.4.3 Post-installation****5.4.3.1 Reinstatement**

Requirements for the reinstatement of all routes should be detailed.

A clear statement of responsibility for the identification, design and completion of the works should be included. The responsibility for obtaining all necessary clearances and permits should also be defined.

**5.4.3.2 Spares**

A list should be prepared of recommended spare materials and components to be supplied including optical cable, cable assemblies, closures, test equipment and test leads.

**5.4.3.3 Ancillary services**

Ancillary services should include repair and maintenance contracts, optical safety training, analysis training, user-based maintenance training.

**5.4.4 Regulatory issues**

Applicable legislation and regulations should be clearly stated and should include the following:

- building regulations relating to the installation;
- specific site regulations;
- relevant national legislation, regulations and requirements relating to safe working practices;
- relevant national regulatory requirements for telecommunications network apparatus.

**5.4.5 Site contacts**

The user should provide details of the site contacts with responsibilities for the following:

- operational requirements;
- site information (including knowledge of all hazardous areas);
- technical requirements.

**5.5 Contractual terms and conditions**

Contract terms and conditions should be defined prior to submission and the installation specification should refer to any specific operational limitation which may alter the contract. It is essential that contract terms should be agreed by all parties prior to commencement of work.

**5.6 Changes and variations to installation specification**

It is common for the initial specification to be modified prior to the commencement of the installation. Further modifications may be agreed during the course of the installation.

All modifications, changes and variations should be clearly documented in an agreed manner to provide adequate traceability.

**6 Quality plan****6.1 General**

It is essential that the methods, techniques and processes to be adopted during installation should be in accordance with the installation specification.

Clauses **7** to **12** detail the recommendations which relate to the installation of fibre optic cabling including the following:

- acceptance test methods and inspection criteria for cabling components;
- cable installation;
- acceptance test methods and inspection criteria for installed cabling;
- documentation of installed fibre optic cabling;
- repair and maintenance of installed cabling.

It is recognized that organizations operating a quality assurance system in accordance with BS EN ISO 9000 may have a standard approach to all installation projects. However, installations may vary with regard to the contractual interfaces present. It is recommended that a quality plan should be submitted to the user prior to the installation of each fibre optic cabling infrastructure which is relevant to that installation.

The purpose of the quality plan is to provide the user and installer with a detailed proposal which indicates the procedures to be implemented to ensure that the installation proceeds according to the agreed programme and technical specification.

The quality plan should reflect the contractual interfaces which relate to the task defined within the installation specification and should clearly identify the measures to be adopted to facilitate straightforward transfer of responsibilities at these interfaces.

## 6.2 Cabling component acceptance tests

### 6.2.1 *Optical cable and blown fibre components* (see 7.2 and 7.3)

The proposed test procedures should be detailed including the following:

- a) test schedule (at contractual interfaces);
- b) operating wavelength;
- c) test method;
- d) limitations of measurement;
- e) acceptance criteria (and requirements for correlation with other results);
- f) sampling level;
- g) provision of test results and certificate of conformance.

### 6.2.2 *Connectors* (see 7.5)

The proposed inspection procedures should be detailed to include the sampling level and provision of certificate of conformance.

### 6.2.3 *Cable assemblies* (see 7.6)

The proposed test and inspection procedures should be detailed including the following.

- a) *Optical performance testing*
  - 1) operating wavelength;
  - 2) test method;
  - 3) limitations of measurement;
  - 4) acceptance criteria;
  - 5) sampling level;
  - 6) provision of results;
  - 7) provision of certificates of conformance.
- b) *Visual inspection*
  - 1) definition of connector end-face zones;
  - 2) acceptance criteria;
  - 3) sampling level;
  - 4) provision of certificate of conformance.

### 6.2.4 *Cabling component compatibility*

Where existing cabling components are to be provided by, or on behalf of, the user the installer should define the procedures to be adopted to ensure compatibility between those components and any others to be used during the installation.

## 6.3 Laid cable acceptance (stage I) tests (see clause 8)

The proposed test procedures should be detailed including the following:

- a) test schedule;
- b) operating wavelength;
- c) test method;
- d) limitations of measurement;
- e) acceptance criteria (and requirements for correlation with other results);
- f) sampling level;
- g) provision of test results.

## 6.4 Final cabling acceptance (stage II) tests (see clause 10)

The proposed test procedures should be detailed in accordance with 6.3 and in addition wavelength correction should be applied where relevant.

## 6.5 Details of test equipment and test leads

All items of inspection and test equipment to be used should be defined and information provided.

Also the test leads to be used should be defined stating the methods used to achieve the desired launch conditions.

## 6.6 Test equipment calibration

All items of test equipment should be covered by a calibration system meeting the requirements of the relevant standard. Information regarding the calibration status of the test equipment should be provided within the quality plan.

## 6.7 Documentation

The proposed level of documentation to be provided both during and following the installation should be detailed and agreed between the installer and user.

# 7 Cabling component acceptance

## 7.1 General

This clause defines the recommended practices to be undertaken by the installer following receipt of the following cabling components:

- a) optical cable (7.2);
- b) blown fibre components (7.3);
  - 1) blown fibre;
  - 2) blown fibre duct.
- c) closures (7.4);
- d) connectors (7.5);
- e) cable assemblies (7.6) comprising the following;
  - 1) pigtails;
  - 2) jumpers;
  - 3) patchcords.
- f) free-issue components (7.7).

The installer's responsibility with regard to establishing cabling component compatibility is given in 7.8.

The installer's responsibility with regard to establishing the validity of the documentation covering existing fibre optic cabling is given in 7.9.

## 7.2 Optical cable

### 7.2.1 General

Optical cables frequently undergo a great number of stages during the installation of fibre optic cabling. Early diagnosis of faults is essential and is in the interest of both user and installer alike.

With reference to B.7, optical cable should be procured against a specification containing physical and optical requirements. This subclause defines the recommended practices for the inspection of optical cable prior to installation.



### 7.2.2 *Physical acceptance criteria*

The optical cable should be inspected for conformance against its physical specification in so far as is practicable without its removal from its means of transport, generally a drum or reel. The inspection should include the following.

#### a) *Internal construction*

The quantity and identification of optical fibre elements, presence of moisture barrier, strength member etc.

#### b) *External construction*

Cable diameter, condition of external sheath, marking, identification.

A certificate of conformance against the specification should be obtained from the manufacturer.

### 7.2.3 *Optical acceptance criteria*

#### 7.2.3.1 *General*

The optical cable should be tested for conformance with its optical specification.

Using an optical time domain reflectometer (OTDR) operating at the relevant wavelength (and in accordance with manufacturer's instructions and specification) the optical cable should be tested in accordance with the method detailed in A.4.1.

Details of measurement procedure should be provided together with the type, serial number and proof of calibration of the measurement equipment.

Each optical fibre element (or a sample as defined within the quality plan) should be tested and a permanent record retained. The optical cable should be assessed against the criteria of 7.2.3.2 and 7.2.3.3.

#### 7.2.3.2 *Length*

For OTDR measurements, the relevant refractive index, provided by the manufacturer, should be used. Alternatively, a suitable value should be used such that any errors introduced are understood and agreed between the installer and the user.

It should be noted that the length measured relates to the length of optical fibre within the cable and this may differ from the actual length of the cable. Within complex constructions the optical fibres may be of different lengths within a given length of optical cable. Where relevant, information should be sought from the manufacturer.

Following clarification of the above factors, where relevant, it should be established that the optical fibres measured are of a length equal to or longer than that of the optical cable as supplied (consistent with design factors and subject to the resolution of the measurement).

#### 7.2.3.3 *Attenuation coefficient*

The attenuation coefficient of optical fibre elements should be measured to ensure compliance with the specification. Measurements made are subject to the restrictions detailed in A.2.2.

Any non-compliance should be reported to the manufacturer. Typical issues are as follows:

- localized loss events;
- attenuation coefficient in excess of specification;
- variations in attenuation coefficient.

Optical fibre specifications may allow minor discontinuities in the attenuation profile. The cable manufacturer should produce test records for the optical cable and also the optical fibre used within the cable. If the cabling processes can be shown not to have produced or exaggerated such discontinuities and providing that the uncabled optical fibre can be shown to have met its specification then the optical cable should be accepted.

#### 7.2.3.4 *Optical fibre design parameters*

A certificate of conformance against the specification should be obtained from the cable manufacturer.

### 7.3 *Blown fibre components*

#### 7.3.1 *Blown fibre*

Blown fibre should be inspected for conformance with its physical and optical specifications in so far as is practicable without its removal from its means of transport, generally a spool. The inspection should include the following:

- spool label information, including optical fibre design, colour, length, attenuation coefficient and bandwidth;
- condition of external covering.

A certificate of conformance should be obtained from the manufacturer.

#### 7.3.2 *Blown fibre duct*

Blown fibre should be inspected for conformance with its physical specification in so far as is practicable without its removal from its means of transport, generally a drum. The inspection should include the following:

- internal construction: number of tubes (in multiway duct);
- external construction: outer diameter, condition of sheath, marking, identification, seals.

## 7.4 Closures

### 7.4.1 External physical features

The closure should be inspected against the design requirements of the specification. The inspection should include the following:

- mechanical construction: dimensions, material, mounting facilities, environmental sealing;
- entry points for optical cable: quantity and dimensions
- entry points for adaptors: quantity and dimensions
- glands: material, quantity and fitting;
- adaptors: manufacturer, quantity and fitting;
- temporary seals: quantity and fitting;
- labelling and identification.

### 7.4.2 Internal physical features

The closure should be inspected against the design requirements of the specification.

The inspection should include the following:

- optical cable strain relief fittings;
- internal optical fibre management system: protection, strain relief, routeing (and maintenance of minimum bend radii);
- earthing fittings (where appropriate).

## 7.5 Connectors

With reference to **B.9**, connectors (plugs and adaptors) should be procured against a specification containing physical and optical requirements. The optical specification is relevant only when the connectors are applied to the optical cable (see **7.6** and clause **9**). This clause defines the recommended practices for the inspection and acceptance of connectors prior to installation.

The connectors should be inspected for conformance against the physical specification. The inspection should include the following:

- type of connector;
- manufacturer;
- mechanical compatibility with the optical cables to be terminated.

A certificate of conformance against the specification should be obtained from the supplier.

## 7.6 Pigtail, jumper and patchcord cable assemblies

### 7.6.1 General

It is essential that all preterminated components should exhibit optical performance as defined within the installation specification. Where the preterminated components are produced by the installer the following practices are recommended to ensure satisfactory performance. Where the preterminated components are procured by the installer a certificate of conformance should be obtained from the supplier.

Subclauses **7.6.2** and **7.6.3** detail the recommended practices to assess the optical performance of the products.

Subclauses **7.6.4** and **7.6.5** detail the recommended practices to assess the mechanical aspects of the connector end-faces which are responsible for extended operational life.

### 7.6.2 Insertion loss

For short cable assemblies the most relevant optical parameter is the insertion loss of the connector applied to the cable. The insertion loss of each termination (or a sample as defined within the quality plan) should be measured and its performance recorded for analysis. (See for example IEC 874-1 (method 7)).

Details of measurement procedures should be provided with the components and the type, serial number and proof of calibration of measurement equipment should be recorded. (See for example IEC 874-1).

### 7.6.3 Return loss

Where relevant, return loss should be measured (see **B.9.1**). The return loss of each termination (or a sample as defined within the quality plan) should be measured and its performance recorded for analysis. The method of measurement should be defined within the quality plan.

Details of measurement procedures should be provided with the components and the type, serial number and proof of calibration of the measurement equipment should be recorded.

### 7.6.4 Connector end-face: visual acceptance

The condition of each terminated optical fibre end-face (or a sample as defined within the quality plan) should be inspected in accordance with the method and acceptance criteria defined in **A.7.1** and **A.7.2**.

### 7.6.5 Optical fibre–connector bond: visual acceptance

The condition of each terminated optical fibre end-face (or a sample as defined within the quality plan) should be inspected in accordance with the method and acceptance criteria defined in **A.7.4**.

### 7.6.6 Connector end-face protection

All exposed connector end-faces should be fitted with protective caps.

## 7.7 Free-issue components

Subclauses **7.2** to **7.6** detailed the recommended practices for the acceptance testing and inspection of cabling components manufactured, or procured, by the installer. Other components to be incorporated into a fibre optic cabling infrastructure may be supplied to the installer by, or on behalf of, the user. These include the following:

- uninstalled optical cables;
- installed optical cables;
- pigtail, jumper or patchcord cable assemblies.