BRITISH STANDARD

BS 5266 :
Part 5 : 1999

Emergency lighting

Part 5. Specification for component parts of optical fibre systems

Confirmed
January 2010

ICS 91.160.10; 33.180.01

Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee CPL/34/9, Emergency lighting, upon which the following bodies were represented:

Association of British Theatre Technicians
Association of Building Engineers
Association of County Councils
Association of Manufacturers of Power Generating Systems
British Cable Makers Confederation
British Fire Consortium
Chartered Institution of Building Services Engineers
Chief and Assistant Chief Fire Officers Association
Cinema Exhibitors Association
Department of the Environment, Transport and the Regions (Construction Directorate)
Department of Trade and Industry (Consumer Safety Unit, CA Division)
District Surveyors Association
Electrical Contractors Association
Electricity Association
Engineering Industries Association
GAMBICA (BEAMA Ltd.)
Home Office
Industry Committee For Emergency Lighting Ltd. (ICEL)
Institute of Fire Prevention Officers
Institute of Fire Safety
Institution of Electrical Engineers
Institution of Lighting Engineers
Lighting Industry Federation Ltd.
London Transport
National Illumination Committee of Great Britain
National Inspection Council for Electrical Installation Contracting
Photoluminescent Safety Products Association
Tenpin Bowling Proprietors' Association
Coopted members

This British Standard, having been prepared under the direction of the Electrotechnical Sector Committee, was published under the authority of the Standards Committee and comes into effect on 15 July 1999

Amendments issued since publication

Amd. No.	Date	Comments

The following BSI references relate to the work on this standard:
Committee reference CPL/34/9
Draft for comment 93/206752

ISBN 0 580 33005 2

Contents

Foreword

This British Standard has been prepared by Technical Committee CPL/34/9.

Optical fibre systems can provide a viable alternative solution for emergency lighting applications where the traditional electric lamp systems described in BS 5266 : Part 1 are either impractical, unsuitable or costly, for example, in explosive atmospheres, low level applications, inaccessible positions or small systems.

This standard has been prepared with the specific aim of providing for interchangeability to:

a) allow an emergency lighting system to be designed for an application using component parts from many different manufacturers;

b) allow component parts to be upgraded to keep pace with technological advances or to be changed to accord with aesthetic requirements;

c) allow the potential long life of an optical fibre system to be realized (optical fibres are virtually ageless and only the light source is liable to deteriorate with age).

To avoid the introduction of new test procedures use is made of established test procedures in other British Standards wherever they are considered applicable.

This standard is complementary to BS 5266 : Part 4 which provides specific guidance on design, installation and maintenance of optical fibre emergency lighting systems additional to the general guidance and recommendations given on electric lamp emergency lighting systems in BS 5266 : Part 1.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

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

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 12, an inside back cover and a back cover.

1 Scope

This Part of BS 5266 specifies requirements for optical fibres, lightguides, connectors, emission end mounting arrangements and light sources to be used in optical fibre emergency lighting systems. Constructional and performance requirements are given, including performance under fire conditions.

The standard is applicable to the component parts of an emergency lighting system using optical fibre lightguides to distribute light from a light source to one or more lighting positions remote to that light source.

The standard specifies the use of optical fibres with end illumination and end emission. It is not applicable to optical fibres with end illumination and side wall emission.

NOTE. This Part is to be used in conjunction with BS 5266 : Part 1 and BS 5266 : Part 4.

2 References

2.1 Normative references

This Part of BS 5266 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 page 12. For dated references only, the cited edition applies; any subsequent amendments to or revisions of any of the cited publications apply to this Part of BS 5266 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 Part of BS 5266 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

For the purposes of this Part of BS 5266 the definitions given in BS 5266 : Part 1 : 1988 and BS 5266 : Part 4 : 1999 apply.

4 General

NOTE. The components specified in this Part of BS 5266 are suitable for systems to be used in air. Where component parts are to be used in any other environment, for example in an explosive atmosphere, their suitability for use in that particular environment should be checked with the manufacturer.

4.1 Working life

The manufacturer shall assign a recommended working life to each component part of an optical fibre system, or assembly of such parts to allow the purchaser to plan and make provision for future replacement.

The assigned working life shall be qualified by recommended maintenance where this is necessary to achieve or optimize the working life.

NOTE 1. For innovative materials the results of accelerated ageing tests may be used to establish the potential working life.

NOTE 2. The manufacturer should state the basis upon which the recommended working life has been established.

NOTE 3. In the case of light sources the recommended working life should not include the lamp. However, the light source design should be such as to allow the lamp to achieve the rated life declared by the lamp manufacturer.

NOTE 4. The requirements for battery working life are given in **9.5.2**.

4.2 Corrosion resistance

The component parts of an optical fibre system, particularly metallic parts, shall either have inherent resistance to corrosion or be given a corrosion resistant finish or treatment suitable for the application.

5 Optical fibres

5.1 Composition

Fibres shall:

a) have a silicate core and silicate cladding; or

b) be manufactured from silica; or

c) be manufactured from multi-component glass; or

d) be manufactured from any other material having equivalent light transmission and survivable thermal characteristics.

NOTE 1. Whilst minor dimensional inaccuracies in individual fibres do not significantly affect lightguide performance, manufacturing techniques should be used which keep these inaccuracies to a minimum.

NOTE 2. Optical fibres for visible light applications need not be manufactured to the same purity or dimensional accuracy as optical fibres for data and communication transmission applications but the use of fibres of higher purity and dimensional accuracy is not excluded.

NOTE 3. Recommendations for safety when handling and using optical fibres are given in annex E of BS 5266 : Part 4 : 1999.

The core and cladding shall be hot drawn to provide a homogeneous fibre of circular cross-section and uniform construction. Multimode transmission shall be provided.

5.2 Refractive index

Fibres shall have a step index profile.

5.3 Numerical aperture

Fibres shall have a numerical aperture greater than 0.45 and less than 0.8.

5.4 Spectral bandwidth

Fibres shall have a spectral bandwidth between 400 nm and 700 nm.

5.5 Fibre attenuation loss

The fibre bundle shall have a fibre attenuation loss not greater than 500 dB/km (0.5 dB/m) at 550 nm.

6 Lightguides

6.1 Classification

There are two categories of lightguide.

a) *Category 1*: A lightguide possessing no inherent integrity under fire conditions and limited resistance to environmental conditions and/or mechanical damage. Intended for applications where these aspects will be addressed by other means.

b) *Category 2*: A lightguide possessing fire integrity not less than that corresponding to Category B of BS 6387 : 1994. Resistance to environmental conditions and/or mechanical damage may be inherent to the construction or provided by other means.

6.2 Fibre bundles

Individual fibres shall be laid up in random formation to produce a bundle of circular cross-section.

At least 80 % of the surface area of a bundle shall be formed by active fibre cores. It shall be permissible for propagation to occur through the fibre cladding to maximize transmission of light.

NOTE 1. Fibre bundles should generally be flexible to allow bending during installation but it is acceptable to fuse fibres together to form a solid bundle where this will have advantages. Fusing may be for the entire length of the bundle or at discrete points such as at connectors.

It shall be permissible for fibre bundles to incorporate one or more strength members where necessary to minimize fibre breakage during installation. Strength members shall be electrically non-conductive.

NOTE 2. Strength members should preferably be placed around the outer edge of the bundle adjacent to the covering or inner layer of a multi-layer construction to avoid blank spots in the active area.

6.3 Covering material and its application

6.3.1 *General*

Material in contact with optical fibres shall be such that it does not affect their physical or optical properties and does not have a long term detrimental effect upon the fibre material.

6.3.2 *Hydrogen diffusion*

Either the covering material shall be resistant to hydrogen diffusion, or the manufacturer shall provide information with the lightguide on how to protect the fibres from hydrogen diffusion.

6.3.3 *Application of covering*

Where a single layer covering is used it shall be homogeneous and closely applied to the fibre bundle. For a multi-layer covering the inner layer shall be such as to maintain the fibre bundle in accordance with **6.2**.

It shall be possible to remove the covering, or inner layer, without damage to the fibres.

NOTE. A coating or wrapping may be applied to the fibre bundle prior to application of the covering or inner layer to assist with its removal.

6.4 Temperature and bending characteristics

6.4.1 Lightguides shall be tested in accordance with **6.4.2** and shall conform to the following.

a) The change in fibre attenuation loss between 20 °C and 0 °C shall not exceed 0.5 dB.

b) When the lightguide is bent with an internal bending radius not exceeding 8 times the nominal outer diameter of the lightguide, at 20 °C and at 0 °C, the fibre attenuation loss shall not increase by more than 0.5 dB.

It shall be permissible for stiffness to be incorporated into the lightguide by, for example, armouring or strength members to ensure that a smaller bending radius is not introduced during installation.

6.4.2 The light transmittance loss of the lightguide shall be measured using a light source and a detector. The light transmittance loss shall be measured before and after bending the lightguide with an internal bending radius not exceeding 8 times the nominal outer diameter of the lightguide in accordance with the method given in annex B of BS 6387 : 1994. The test shall be carried out at 20 °C and at 0 °C. The changes in attenuation loss can be calculated from the light transmittance losses by subtraction; the coupling losses, being the same, cancel out.

6.5 Resistance to impact

6.5.1 Covering materials shall provide protection against impact damage during handling, installation and subsequent service. The resistance provided shall be clearly detailed in the design information provided by the manufacturer to allow special handling techniques to be used or additional protection to be provided as part of the installation procedure. When tested in accordance with **6.5.2** lightguides shall conform to **6.5.3**.

6.5.2 Lightguides shall be subjected to impacts using the apparatus and method given in annex C of BS 6387 : 1994. Six lightguides complete with connectors shall be tested. The test shall be carried out at ambient temperature (20 °C) and at −15 °C ± 2 °C. At each temperature the light transmittance loss shall be measured before and after the test and the change in fibre attenuation loss calculated in accordance with **6.4.2**. The covering shall be examined after the test with normal or corrected vision without magnification.

6.5.3 After the test, the covering, in the case of a single layer covering, or the outer layer, in the case of a multilayer covering, shall not show any cracking. The fibre attenuation loss shall not have increased by more than 0.5 dB.

6.6 Fire characteristics

6.6.1 *Performance under fire conditions*

6.6.1.1 A sample of lightguide without connectors shall be tested in accordance with BS 4066 : Part 1 or BS 4066 : Part 2 as appropriate to its construction and shall conform to the requirements of that standard.

6.6.1.2 Lightguides of category 2 (complete with connectors) shall be tested, in addition, to a minimum of category B as given in annex D of BS 6387 : 1994. Light transmittance loss before and after the test shall be measured in accordance with **6.4.2** (at 20 °C) and the fibre attenuation loss shall not have increased by more than 1.0 dB.

NOTE. Destruction of the covering does not constitute a test failure.

6.6.2 *Corrosive and acid gas emission*

NOTE 1. For the purposes of this specification, corrosive and acid gases are taken to be those gases which are determined as containing hydrochloric acid (HCl) or which produce hydrochloric acid on contact with water vapour, moisture or other elements.

In the case of lightguides for use within buildings, when a sample of the lightguide covering is tested in accordance with BS 6425 : Part 1 it shall have an HCl emission not greater than 0,5 % by volume.

NOTE 2. The use of lightguides having reduced HCl emission for installation external to buildings is not precluded.

6.6.3 *Smoke emission*

A sample of lightguide without connectors shall be tested in accordance with BS 7622 : Part 1 and BS 7622 : Part 2 and shall give a minimum transmittance of 60 %.

6.7 Colour

The covering or the outer layer of a multi-layer covering shall be red conforming to Colour 539 of BS 381C : 1996 and the colour shall be either throughout the whole of the covering, or outer layer, or on the surface.

It shall not be possible to remove the colour by lightly rubbing the covering ten times with a piece of cotton wool soaked in water.

6.8 Marking

Lightguides shall be marked on the outer surface with the following information:

a) the number of this British Standard, i.e. BS 5266 : Part 5 : 1999 clause **6**[1)];

b) the wording 'Emergency lighting — Optical fibres';

c) the fibre attenuation loss, e.g. < 400 dB/km >;

d) the numerical aperture (NA);

e) a manufacturer's identifying type name or number;

f) lightguide category, i.e. Cat 1 or Cat 2.

NOTE. The manufacturer's name or trade mark may also be added.

It shall be permissible for the origin of lightguides to be indicated by the use of an identification thread or threads. Where coloured threads are used to identify the manufacturer, the colours shall be as given in PD 2379. The colours shall be easy to recognize or shall become recognizable by cleaning with a suitable solvent.

EXAMPLE: Typical marking would be:

BS 5266 : Part 5 : 1999 clause **6** Emergency lighting — Optical fibres Cat 1

< 400 dB/km > NA 0.6 Manufacturer's name and type number

Marking shall be repeated at intervals not exceeding 2 m between the end of one inscription and the beginning of the next and shall be provided by printing (including electrostatic printing), indenting, or embossing characters. Printed marking shall be either black or white characters, which shall be legible and permanent. After the test given in **6.7** the marking shall be clearly legible.

6.9 Information to be provided by the manufacturer

With each lightguide, the manufacturer shall supply one of the following:

a) an instruction leaflet giving details of correct handling and storage of lightguides to ensure safety of personnel and prevent damage to the lightguide, and also details of correct installation techniques;

b) a general leaflet in which reference is made to a detailed manual which is available from the manufacturer, and which gives details of handling, storage and installation of lightguides, with illustrations as necessary.

NOTE. The manual may be specific to lightguides or generalized and combined with details of associated equipment to form a comprehensive document. Alternatively it may be prepared for a specific application.

The manufacturer shall also supply the following information:

1) the acceptance angle of the lightguide (see **4.6.2** of BS 5266 : Part 4 : 1999);

2) details of the optical performance of the lightguide;

3) details of the lightguide construction and materials;

4) information on how to protect the fibres from hydrogen diffusion, if applicable (see **6.3.2**).

[1)] Marking BS 5266 : Part 5 : 1999 on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of the standard. The accuracy of the claim is solely the claimant's responsibility. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.

7 Connectors

NOTE. The detailed construction and dimensions of connectors are not specified in this standard. It is desirable that an industry-wide standardized connector system is evolved.

7.1 Plug and socket connectors

NOTE 1. Plug connectors are attached to lightguides and socket connectors to equipment (see **3.3** of BS 5266 : Part 4 : 1999).

Connectors for connecting lightguides to equipment shall be of the following types.

a) *Type 1 (small) connectors.* This type shall be used for connecting lightguides to emission end mounting arrangements.

NOTE 2. They may also be used to connect single lightguides or multiple small lightguides to other equipment.

The connector shall have a two-pin bayonet type locking mechanism which provides a positive and error free connection to ensure mechanical and optical performance. The locking pins shall be on the socket connector.

NOTE 3. Plug connectors may be either straight or right angle entry and may incorporate a flexible strain relief at the lightguide inlet.

NOTE 4. Within plug connectors bare fibres may have a smaller bending radius than that given in **6.4** providing the fibre manufacturer's recommendations for bending radius are observed.

Socket connectors shall be securely fastened to equipment in a manner that ensures the optical performance of the equipment and mechanical integrity of the connection.

b) *Type 2 (large) connectors (also known as common ends).* This type shall be used to connect large single lightguides or multiple small lightguides to equipment, for example, to light sources.

The socket connector shall incorporate a retaining screw, captive pin or similar mechanism to ensure that a plug connector, once mated, remains so until deliberately disconnected. The retaining mechanism, of whatever form, shall be designed to be resistant to loosening by vibration. Plug connectors shall have a corresponding recess to accept the retaining mechanism.

7.2 Adaptor connectors

Adaptor connectors shall be manufactured as double ended socket connectors.

NOTE 1. Lightguide ends should normally be touching in an adaptor connector to minimize insertion losses.

NOTE 2. An adaptor connector may incorporate a focusing arrangement.

NOTE 3. An index matching substance may be used between lightguide ends to reduce insertion losses.

Adaptor connectors shall be sealed against environmental contamination.

NOTE 4. Where an index matching substance is used this may provide the means of environmental protection.

7.3 Construction

Durability in excess of 500 mating cycles shall be achieved by connectors. Durability of connectors shall be tested by physically connecting and disconnecting five sample pairs of plug and socket connectors 500 times. At the end of the test each sample pair shall have less than 2 dB coupling loss change measured at 20 °C using the method given in **6.4.2** and the bayonet action shall be positive and provide a secure connection.

7.4 Fire performance

Adaptor connectors, when tested as part of a lightguide to category B as given in annex D of BS 6387 : 1994 shall conform to **6.6.1.2**.

7.5 Lightguide termination

7.5.1 *General*

A lightguide termination shall consist of:

a) anchoring: i.e. a means of permanently attaching the lightguide (covering and fibre bundle) to the connector body (see **7.5.2**); and

b) sealing: i.e. a means of securing the fibre bundle into the connector (see **7.5.4**).

NOTE. Terminations for use in explosive atmospheres may need to incorporate special arrangements to prevent, for example, gas travelling through the lightguide construction to safe areas especially where the explosive atmosphere is under positive pressure.

7.5.2 *Anchoring*

Lightguides shall be anchored using one or more of the following methods.

a) *Potting.* It shall be permissible for the potting process given in **7.5.4.1** to be used also as a method of anchoring the lightguide. The potting material shall adhere securely to the covering material and ensure that it is permanently retained in the connector. It shall be permissible to surface treat the covering to ensure adhesion of the compound.

It shall be permissible for two different potting compounds to be used, one for the fibres and one for the covering. If two different compounds are used, compounds shall be selected which have no chemical effect upon each other.

b) *Crimping.* Crimped terminations shall be made using a process which does not damage the fibre bundle or impose stress such that damage will occur when the lightguide is handled or subjected to bending.

c) *Compression.* A compression ring or similar arrangement shall be used. The force that the compression device is able to exert on the lightguide and shall be physically limited to that required to securely retain the lightguide in the connector and shall ensure that overtightening is prevented to avoid crushing of the fibre bundle.

NOTE. These methods of anchoring may also be used to anchor any armouring or other mechanical protection incorporated into the lightguide construction.

7.5.3 *Environmental protection*

Where a termination requires protection against the ingress of water, dust, dirt, or other detrimental substance this shall be provided by means of a shroud or similar device.

NOTE. The shroud may be rigid or flexible as required by the application and may either form part of the connector construction or be provided as a separate item.

7.5.4 *Sealing*

7.5.4.1 *Potting method*

After removal of the covering and cleaning/wetting as required the fibre bundle shall be secured into the plug connector using a potting compound. The compound shall permeate the whole of the fibre bundle and fill the whole of the connector and, when cured, shall be permanently retained in the connector. A compound shall be used for which the manufacturer is able to provide documented evidence that it has the following properties:

a) negligible shrinkage over the lightguide operating temperature range and a coefficient of expansion similar to that of the body material;

b) immunity to detriment, for the service life of the lightguide, due to heat, ultra-violet radiation, or other effect that can reasonably be expected to occur at the point of connection;

c) no long term detrimental chemical effect upon the fibre or connector.

It shall be permissible for different compounds to be used for the two categories of connector.

To ensure retention of the potting compound in the connector it shall be permissible to mill, key, or otherwise roughen the internal surface of the connector.

Fibre bundles shall retain their circular cross-section as far as practical when assembled in a connector.

NOTE. Fibres may take random positions in relation to their lightguide when multiple lightguides are assembled into a single connector.

7.5.4.2 *Fusion method*

Where the potting method of terminating a fibre bundle in a connector is not appropriate for the application, heat fusion of fibres into the connector shall be used. A heat treatment process shall be used which does not cause damage to the fibre bundle and connector.

7.5.4.3 *Strength members*

Where a lightguide contains one or more strength members the method of connector attachment shall ensure that these are securely anchored.

Where strength members are taken through to the connector face they shall be positioned around the perimeter of the fibre bundle to avoid blind spots in the active area.

7.5.4.4 *End polishing*

When the potting compound has fully cured and cooled and a period of time has been allowed for the termination to stabilize as recommended by the manufacturer of the potting compound, or the termination produced by the fusion process has cooled, surplus material shall be trimmed from the connector end using a method which does not cause cracking of the fibres. The end shall then be polished to achieve a surface finish better than 5 μm to minimize light transmittance losses.

The finished face of the fibre bundle shall be flush with the end of the connector and the polished end shall be flat and perpendicular to the connector axis within ±0.25 mm.

7.5.5 *Protective transit covers*

After completion of all manufacturing processes and before packing for despatch the polished connector ends shall be fitted with protective transit covers to protect the connector ends during transit and installation.

Transit covers shall either:

a) be manufactured from clear plastics or similar transparent material to facilitate post-delivery inspection without the need to remove the cover from the connector; or

b) be easily removable for post delivery inspection and replaceable after inspection.

Transit covers shall be marked with the wording 'Protective cover — Do not discard'.

7.6 Information to be provided by the manufacturer

The manufacturer shall make available the following information in a catalogue or the like:

a) such data as may be required on the mechanical, optical and fire performance to correctly select (from an available range) and use connectors;

b) full and detailed instructions for assembly onto lightguides or other items of equipment.

NOTE. The information may also be made available in the form of a leaflet despatched with the connector(s).

8 Emission end mounting arrangement

8.1 Construction and fire integrity

NOTE 1. Emission end mounting arrangements should normally be made of metal.

The mounting arrangement shall have a mechanical means of retaining it in place on the mounting surface. An arrangement employing self weight shall not be used.

NOTE 2. The means of retention may be incorporated in the design, for example, spring loaded clips, or may be separately applied using, for example, screws or clips.

NOTE 3. The Building Regulations [1] require that where there is any piercing of a fire barrier it has to be made good such that the fire integrity of the barrier is maintained.

8.2 Focusing arrangement

Where an optical performance other than that provided by the bare lightguide end is required it shall be permissible for the mounting arrangement to incorporate a focusing system.

Focusing shall be achieved by means of shaped surfaces, mirrors, lenses, or prisms. The design of the focusing system shall be such as to ensure that chromatic dispersion does not occur and that glare is minimized in accordance with the recommendations in **5.5** of BS 5266 : Part 1 : 1988. Where the focusing system is intended to be removable from the mounting arrangement it shall not be possible to remove it without the use of a tool.

NOTE. Focusing systems which are a permanent fixture in the mounting arrangement are preferred to avoid loss during installation and maintenance operations.

A means of locking the focus setting shall be provided. It shall not be possible to alter the focus setting without the use of a tool. Where specified by the purchaser the means of focus locking shall be resistant to vibration (see clause **10**a)).

8.3 Decorative or protective cover

NOTE 1. The mounting arrangement may incorporate a cover of either transparent or translucent material to provide decorative appearance or physical/environmental protection to the lightguide end and/or any focusing arrangement.

Covers provided for environmental protection shall have a smooth, wipe clean, exterior surface. The cover shall provide a degree of protection of at least IP54 in accordance with section **9** of BS EN 60598-1 : 1997. A higher protection rating shall be provided where required by the application or where specified by the purchaser (see clause **10**b)).

If a cover is provided, it shall either:

a) be a separate item attached to the mounting arrangement; or

b) be moulded onto the end of the lightguide.

If the cover is moulded onto the end of the lightguide, the lightguide with the cover in place shall conform to **6.3.2**, **6.4.1**a, and **6.6**.

The cover shall be manufactured from material that is stable to ultraviolet radiation and does not yellow.

NOTE 2. If the cover is a separate item, the use of a cover mechanically retained in position by, for example, spring clips, screws, or similar devices is recommended rather than a lay-in type to prevent easy dislodgement and possible loss or damage.

Where a protective cover is provided specifically to prevent damage by vandalism it shall not be possible to remove the cover without the use of a tool.

8.4 Information to be provided by the manufacturer

The manufacturer shall make available the following information:

a) full and detailed instructions for installation of the mounting arrangement;

b) the total light output of the emission end mounting arrangement and its intensity distribution.

NOTE. The information may be made available in the form of a leaflet despatched with the mounting arrangement, or in the form of a catalogue, comprehensive manual, or any appropriate combination.

9 Light source

9.1 Elements of a light source

A light source shall consist of the following elements:

a) an enclosure (see **9.3**);

b) a source of light (see **9.4**);

c) controlgear (see **9.5**), which may incorporate facilities for remote control by a central system, for example, a building management system (BMS);

d) lamp monitoring (see **9.6**);

e) fault indication (see **9.7**), which may incorporate facilities for remote fault indication;

f) a power supply (see **9.9**).

NOTE. Light sources may either:

1) have a self-contained power source; or

2) be supplied from a central power source.

9.2 Construction

The light source shall conform to BS EN 60598-2-22.

NOTE. Guidance on the projectional aspect of light source design is given in BS 1915, BS 4120 and BS 5550 : Subsection 2.7.2.

9.3 Enclosure

9.3.1 *Mounting arrangement*

The mounting arrangement of the light source shall be suitable for installation on normally flammable surfaces in accordance with BS EN 60598-1.

Fixing points, either internal or external to the enclosure, shall be provided to allow installation of the light source on a vertical or a horizontal surface. See also **9.12**.

9.3.2 *Ventilation*

The light source shall be ventilated to remove waste heat generated by the lamps and any controlgear.

NOTE. Ventilation may be achieved by means of natural convection and radiation or by means of forced air movement. Forced air may be provided by means of a fan within the light source or by an external fan.

If specified by the purchaser, the manufacturer shall provide openings in the enclosure for the attachment of ventilation ductwork (see clause **10**c)). If openings for ductwork are specified, the opening size, duct length, optimal air flow rate and whether the heated air is to be pressurized or extracted out of the light source enclosure shall be agreed between the manufacturer and the purchaser.

If specified by the purchaser for a light source which is to be installed in conditions of abnormal dust or air pollution air filters shall be included in the ventilation openings (see clause **10**d)). The manufacturer shall adjust the air flow rate in accordance with the added resistance. An allowance shall be made for filter contamination.

A high temperature detector shall be incorporated into the control circuitry to trigger an alarm in the event of inadequate ventilation. This shall illuminate an exclusive visual fault indicator and activate the common audible fault indicator (see **9.7**).

9.3.3 *Connectors*

The light source shall have only socket connectors (see **7.1**).

NOTE. More than one type of connector may be used for multiple outlet light sources.

9.3.4 *Access to interior*

It shall not be possible to gain entry to the interior of the light source or any separate controlgear or battery enclosure without the use of a tool.

9.4 Source of light

9.4.1 *Lamp*

NOTE. The term lamp includes any means of converting electrical energy into visible light having the spectral bandwidth specified in **5.4**.

The type of lamp used in the light source shall be chosen to suit the application taking into consideration **22.6** and **22.16** of BS EN 60598-2-22 : 1999 and shall have a colour rendering index (Ra) not less than 40.

9.4.2 *Arrangement of lamps*

9.4.2.1 *General*

The arrangement of lamps in the light source shall be as specified in **9.4.2.2**, **9.4.2.3**, **9.4.2.4** or **9.4.2.5** as appropriate.

9.4.2.2 *Single lamp*

In this arrangement, a single lamp shall provide the full light output required to give the minimum illuminance necessary for the emergency lighting system (see **5.3** of BS 5266 : Part 1 : 1988 and annexes A and B of BS 5266 : Part 4 : 1999).

9.4.2.3 *Dual lamp*

Two lamps shall operate together, their combined light output being twice that required to give the minimum illuminance (see **9.4.2.2**), i.e. failure of either lamp will give minimum illuminance at all times.

9.4.2.4 *Lead and standby lamp*

Two lamps shall be provided only one of which operates at any one time to provide the light output required to give the minimum illuminance (see **9.4.2.2**).

The system shall be such that the lead lamp is monitored for integrity and upon failure the standby lamp is automatically brought into service. The monitoring circuit shall prevent hunting of the lead lamp circuit in the event of repeated restriking of the lamp, for example, upon discharge lamp failure.

If specified by the purchaser the control circuitry shall be provided with a means of automatically alternating the lead lamp, for example, at every energization, to even out lamp usage (see clause **10**e)).

With all forms of light source arrangement it shall be permissible to use more than one lamp or set of lamps to illuminate more than one lightguide input end.

9.4.2.5 *Combined arrangements*

It shall be permissible for a dual lamp light source arrangement or a lead and standby lamp light source arrangement to be made up from single lamp light sources with the necessary combining controlgear.

NOTE 1. The controlgear for each lamp may be separate from the lamp in accordance with **9.5.1** or it may be combined in a common enclosure.

NOTE 2. Where controlgear is combined in the same enclosure precautions should be taken to ensure that failure of the controlgear for one lamp does not affect the operation of the other lamp.

9.4.3 *Light control*

Light produced by the lamps shall be combined using an optical mirror system or by bifurcation of lightguides.

Lightguide ends shall be illuminated so that the uniformity of input luminous intensity is better than 0.7.

NOTE 1. The optical mirror system may be arranged to illuminate more than one lightguide or, alternatively, more than one mirror system may be used to maximize the utilization of light from the lamps.

Where more than one lightguide connector is provided it shall not be necessary for each to achieve the same light output.

NOTE 2. The manufacturer may provide outputs of different light intensity for the purchaser to utilize with different size lightguides.

9.4.4 *Focusing*

Before, during, or after the lamp output combination process it shall be permissible to include a focusing system to focus the available light onto the lightguide(s) to improve efficiency.

The focusing system shall comprise shaped surfaces, mirrors, lenses, or prisms The material to be used for the system shall be chosen, or subsequently treated, to resist electrostatic attraction of dust, tarnishing, and deterioration due to electromagnetic radiation from lamps and heat.

NOTE 1. Care should be taken in the design of the focusing system to ensure that chromatic dispersion does not occur and that heat focused onto the lightguide(s) does not cause connector performance to be impaired.

NOTE 2. Lamps having an integral focusing system may be used.

9.5 Controlgear

9.5.1 *General*

It shall be permissible to place the controlgear (including the battery in the case of a self contained system) in the light source enclosure, unless the heat from the lamp would be detrimental to it in which case it shall be placed in a separate enclosure conforming to **22.15** of BS EN 60598-2-22 : 1999.

9.5.2 *Battery and charger*

For self-contained systems the battery shall be of the sealed rechargeable type and shall conform to BS EN 60528, BS EN 60622 or BS EN 60896-1 and BS 6290 : Part 4, according to its construction. The battery shall be chosen to have a minimum working life of 10 years or the assigned working life of the light source whichever is the shorter.

The battery shall have the capacity to:

a) maintain the lamps operational for the rated duration as given in **6.12** of BS 5266 Part 1 : 1988;

b) maintain the audible and visible fault indicators (see **9.7**) operational for a period of at least 350 h.

c) supply a deep discharge protection device, if fitted (see **9.5.4**).

The periods specified in items a) and b) shall run sequentially, i.e. the battery shall have the capacity to maintain the lamps operational for the rated duration at the end of which it shall still have the capacity to maintain the fault indicators for 350 h.

The controlgear shall contain a battery charger. Failure of the charger or the mains supply to the charger shall illuminate an exclusive visual fault indicator and activate the common audible fault indicator (see **9.7**).

Failure of the battery charger shall not prevent the lamps and fault indicators from operating on any residual charge contained in the battery.

9.5.3 *Supply circuits*

Where more than one set of controlgear is contained in a single enclosure, for example, for a dual lamp light source, it shall be permissible to supply each set of controlgear from a different supply circuit to minimize loss of emergency lighting in the event of supply circuit failure.

9.5.4 *Deep discharge protection*

For self-contained light sources a deep discharge protective device shall be provided to protect the battery in the event of charger failure. The device shall have the following characteristics.

a) The minimum tripping voltage shall be 0.9 V/cell for nickel/cadmium batteries and 1.6 V/cell for lead-acid batteries.

b) The response time shall be between 0.5 s and 5.0 s inclusive.

c) Operation of the protective device shall trigger a battery charger output fault indicator in accordance with **9.7**.

9.6 Lamp monitoring

A means of monitoring each lamp shall be provided to detect lamp failure.

NOTE. Detection may be by electrical or optical sensing and may be arranged to inhibit operation of, or disconnect, the failed lamp controlgear to prevent damage or prevent interference with the operation of other lamps.

The detector shall illuminate an exclusive visual fault indicator and activate the common audible fault indicator (see **9.7.1**).

9.7 Fault indicators

9.7.1 General

9.7.1.1 Exclusive internal visual fault indicators shall be provided for the following:

a) inadequate ventilation (see **9.3.2**);

b) battery charger supply or output failure (see **9.5.2**);

c) lamp failure (see **9.6**).

The indicators shall be amber or yellow in accordance with BS EN 60073, have a diameter not less than 10 mm, a viewing angle not less than 40°, and an output of not less than 300 mcd.

Visual indicators shall only be cancelled by clearance of the fault condition.

9.7.1.2 A common internal audible fault indicator shall be provided to operate simultaneously with any of the visual fault indicators. This shall have a sound output not less than 95 dB(A) at 3 m.

NOTE. The operating frequency should be chosen to prevent confusion with emergency services equipment, such as fire alarms and fire-fighters' distress signal units.

The audible and visual signals shall be pulsed in unison at a rate 0.5 Hz, with a 1:1 mark/space ratio.

9.7.2 *Remote indicator facility*

If specified by the purchaser, a set of terminals shall be provided for the connection of a full duplicate set of audible and visual fault indicators remote to the light source or for transmitting fault information to a central control system (BMS or similar) (see clause **10**f)).

9.7.3 *Muting facility*

If specified by the purchaser, the audible fault indicator shall be provided with muting facilities as follows (see clause **10**g)):

a) *permanent disconnection*: by means of a switch, link, or similar device within the light source;

NOTE 1. This facility is intended for use where a remote indicator facility is provided and local audible indication is not required.

b) *temporary muting*: by means of an electrically operated hold-off device or similar arrangement within the light source controlled by a remote non-latching switch which can be operated by a competent person to mute the audible indicator after investigation of a fault.

Muting shall be cancelled by the following:

1) loss of mains supply;

2) a timer such that the indicator is reactivated at intervals not exceeding 4 h. The timer shall be adjustable between 1 h and 4 h to allow it to be adjusted to suit different applications.

NOTE 2. This facility is intended for use where the light source is located in a noise sensitive area and rapid cancellation of the audible fault indication is required.

c) *temporary disablement*: by means of an electrically operated hold-off device or similar arrangement within the light source activated by a central control system (BMS or similar) or a communications link monitor. Loss of control system or communications link integrity shall restore the audible indicator to the operational condition.

NOTE 3. This facility is intended for use where fault data is transmitted to a central control system (BMS or similar) and local audible indication is not required.

NOTE 4. The remote switch or BMS connection may incorporate a passive or active circuit, powered from the light source, to facilitate monitoring of the circuit.

If specified by the purchaser the hold-off device specified in items b) and c) shall produce an output sufficient to operate a visual indicator which shall be located adjacent to the muting switch to provide a continuous visual reminder that a fault condition exists (see clause **10**h)). The visual indicator shall be in accordance with **9.7.1**.

9.8 Lamp circuit switch

If specified by the purchaser, an electrically operated, non-latching switching device or similar arrangement shall be incorporated in the lamp circuit to prevent operation which would exhaust a self-contained battery, for example, when the premises are unoccupied (see clause **10**i)).

Operation of the lamp circuit switch shall not result in the generation of a fault indication.

9.9 Power supply

The electrical power supply to the light source shall be:

a) *alternating current*: provided at nominal mains supply voltage and frequency; or

b) *alternating current*: provided at extra-low voltage at mains frequency or high frequency with a simulated sinusoidal waveform; or

c) *direct current*: provided at low or extra-low voltage.

It shall also be permissible to use any combination of the above within the light source (and any related adjacent controlgear enclosure) after conversion by the controlgear.

Because, to ensure continuity of emergency lighting, it is not considered appropriate for the light source or any related adjacent controlgear enclosure to contain a device to cut off all sources of supply when the interior is accessed, all energized parts shall be shrouded to give a degree of protection of at least IP4X in accordance with BS EN 60529 : 1992 to prevent accidental contact. When tested using the test probe specified in BS EN 61032 it shall not be possible to make contact with any energized parts.

Circuit protection shall be provided within the controlgear to ensure that failure of individual components or particular parts of the circuitry do not render the light source completely inoperative.

9.10 Photometric data

The manufacturer shall measure and make available details of the output light intensity at every lightguide connector when:

a) all lamps are illuminated;

b) a maximum of 50 % of the number of lamps have failed.

Where the disposition of lamps within the light source prevents them from providing equal output, the 50 % figure shall be that when the worst lamps are operating.

9.11 Marking

The light source exterior, including any separate controlgear/battery enclosure, shall be marked with the relevant information specified in BS EN 60598-1 and BS 7671, and with the following information:

a) a warning of the electrical voltage hazard present;

b) a warning of the burns hazard presented by the lamps;

c) a warning regarding the need to protect eyes against lamp intensity (where internal parts do not provide suitable screening);

d) if the light source has been designed for use with more than one source of electrical supply (where appropriate);

e) type of replacement lamp to be used;

f) light output, in candelas, available at each lightguide connector;

g) the total coupling loss at each lightguide connector;

h) name and/or trademark of manufacturer and an identifying type name or number for the light source.

Marking shall be designed as far as possible to conform to, and use pictograms contained in, BS 5378. All marking shall be legible, durable, and permanently attached.

9.12 Information to be provided by the manufacturer

The manufacturer shall make available the following information in a catalogue or the like:

a) such data as may be required to carry out the design calculations given in BS 5266 : Part 1 and BS 7671;

b) information to enable the user properly to select and use the light source;

c) details of the hazards associated with the light source to enable the user to implement all necessary safety procedures;

d) detailed instructions for installation of the light source to achieve the assigned working life.

NOTE. The information may also be made available in the form of a leaflet despatched with the light source.

10 Information to be supplied by the purchaser

The following information shall be supplied by the purchaser at the time or enquiry and order:

a) if the means of locking the focus setting is to be resistant to vibration (see **8.2**);

b) the required protection level for the cover if greater than IP54 (see **8.3**);

c) if openings are required in the light source enclosure for attachment of ventilation ductwork (see **9.3.2**);

d) if air filters are required in the ventilation openings (see **9.3.2**);

e) if control circuitry for a lead and standby lamp arrangement is required to have a means of automatically alternating the lead lamp (see **9.4.2.4**);

f) if a remote indicator facility is required (see **9.7.2**);

g) if the audible fault indicator is to be provided with muting facilities (see **9.7.3**);

h) if the hold-off device is required to drive a visual fault indicator (see **9.7.3**);

i) if a switching device is required in the lamp circuit (see **9.8**).

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List of references (see clause **2**)

Normative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 381C : 1996	*Specification for colours for identification, coding and special purposes*
BS 4066 :	*Tests on electric cables under fire conditions*
BS 4066 : Part 1 : 1980	*Method of test on a single vertical insulated wire or cable*
BS 4066 : Part 2 : 1989	*Method of test on a single small vertical insulated wire or cable*
BS 5266 :	*Emergency lighting*
BS 5266 : Part 1 : 1988	*Code of practice for the emergency lighting of premises other than cinemas and certain other specified premises used for entertainment*
BS 5266 : Part 4 : 1999	*Code of practice for design, installation, maintenance and use of optical fibre systems*
BS 5378 :	*Safety signs and colours*
BS 6290 :	*Lead-acid stationary cells and batteries*
BS 6290 : Part 4 : 1997	*Specification for classifying valve regulated types*
BS 6387 : 1994	*Specification for performance requirements for cables required to maintain circuit integrity under fire conditions*
BS 6425 :	*Tests on gases evolved during the combustion of materials from cables*
BS 6425 : Part 1 : 1990	*Method for determination of amount of halogen acid gas evolved during combustion of polymeric materials taken from cables*
BS 7622 :	*Measurement of smoke density of electric cables burning under defined conditions*
BS 7622 : Part 1 : 1993	*Test apparatus*
BS 7622 : Part 2 : 1993	*Test procedure and requirements*
BS 7671 : 1992	*Requirements for electrical installations. IEE Wiring Regulations. Sixteenth Edition*
PD 2379 : 1994	*Register of colours of manufacturers' identification threads for electric cables and cords*
BS EN 60073 : 1997	*Basic and safety principles for man-machine interface, marking and identification. Coding principles for indication devices and actuators*
BS EN 60285 : 1995	*Alkaline secondary cells and batteries. Sealed nickel-cadmium cylindrical rechargeable single cells*
BS EN 60529 : 1992	*Specification for degrees of protection provided by enclosures (IP code)*
BS EN 60598 :	*Luminaires*
BS EN 60598-1 : 1997	*General requirements and tests*
BS EN 60598-2 :	*Particular requirements*
BS EN 60598-2-22 : 1999	*Luminaires for emergency lighting*
BS EN 60622 : 1996	*Sealed nickel-cadmium prismatic rechargeable single cells*
BS EN 60896 :	*Stationary lead-acid batteries. General requirements and methods of test*
BS EN 60896-1 : 1992	*Vented types*
BS EN 61032 : 1998	*Protection of persons and equipment by enclosures. Probes for verification*

Informative references

BSI publications

BRITISH STANDARDS INSTITUTION, London

BS 1915 : 1968	*Specification for still projectors*
BS 4120 : 1968	*Methods for the measurement of performance of still projectors*
BS 5550 :	*Cinematography*
BS 5550 : Part 2 :	*16 mm film*
BS 5550 : Part 2 : Section 2.7	*Projection*
BS 5550 : Part 2 : Subsection 2.7.2 : 1982	*Specification for the performance of 16 mm sound-film projectors*

Other publication

[1] GREAT BRITAIN. The Building Regulations 1991, London, The Stationery Office.

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