

Specification for

**Cables with extruded  
cross-linked  
polyethylene or  
ethylene propylene  
rubber insulation for  
rated voltages  
from 3 800/6 600 V up  
to 19 000/33 000 V  
having low emission of  
smoke and corrosive  
gases when affected by  
fire**

# Committees responsible for this British Standard

The preparation of this British Standard was entrusted to Technical Committee GEL/20, Electric cables, upon which the following bodies were represented:

- Association of Consulting Engineers
- Association of Manufacturers of Domestic Electrical Appliances
- BEAMA Electrical Cable and Conductor Accessory Manufacturers' Association
- British Approvals Service for Cables
- British Cable Makers Confederation
- British Iron and Steel Producers Association
- British Plastics Federation
- Department of Trade and Industry (Consumer Safety Unit, CA Division)
- Electricity Association
- Engineering Equipment and Materials Users' Association
- Institution of Electrical Engineers
- London Regional Transport

The following bodies were also represented in the drafting of the standard, through sub-committees and panels:

- ERA Technology Ltd.
- Institution of Incorporated Executive Engineers
- London Underground Ltd.

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# Foreword

This British Standard has been prepared by Technical Committee GEL/20. It specifies requirements for construction and describes tests for cables with thermosetting synthetic insulation for rated nominal voltages from 3 800/6 600 V up to 19 000/33 000 V inclusive which, when assessed by the tests, produce lower levels of smoke and corrosive products under exposure to fire compared with cables conforming to BS 6622.

*Certification.* Attention is drawn to the certification services (see inside back cover) of the British Approvals Service for Cables (BASEC)<sup>1)</sup>. These services include licensing manufacturers to use BASEC certification trade marks as independent assurance that cables or cords have been designed and manufactured to appropriate British Standards. BASEC is a subscriber to an agreement in CENELEC whereby cables or cords coming within Harmonized Code Designations and manufactured under a BASEC licence can carry marks acceptable to other signatory countries (CENELEC “Common Marking”).

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 of itself confer immunity from legal obligations.**

## Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 40, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

<sup>1)</sup> British Approvals Service for Cables, Silbury Court, 360 Silbury Boulevard, Milton Keynes, MK9 2AF.



## 1 Scope

This British Standard specifies requirements for construction and describes tests for cables with thermosetting synthetic insulation for rated nominal voltages from 3 800/6 600 V up to 19 000/33 000 V inclusive which, when assessed by the tests, produce lower levels of smoke and corrosive products under exposure to fire compared with cables conforming to BS 6622.

In this standard corrosive (and acid) gases are those which are determined as hydrochloric acid (HCl).

The cables are single-core or three-core with conductor and insulation screening and are armoured.

The cables are designed for a maximum continuous conductor operating temperature of 90 °C and for a maximum short circuit conductor temperature of 250 °C.

Annex A gives detailed guidance on the selection of cables of appropriate voltage designations for particular systems.

Annex B lists the information required with an enquiry/order for cables together with those tests that are only to be carried out when requested by the customer.

Annex C gives recommendations for the installation of cables.

## 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 page 39. 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 page 40, but reference should be made to the latest editions.

## 3 Voltage designation

The cables are designated by the rated voltages  $U_o$  and  $U$ , expressed in the form  $U_o/U$ , where:

- $U_o$  relates to the power frequency voltage to earth for which the cable is suitable;
- $U$  relates to the power frequency voltage between conductors for which the cable is suitable.

The rated voltages  $U_o/U$  of the cables included in this standard are:

3 800/6 600 V, 6 350/11 000 V,  
8 700/15 000 V, 12 700/22 000 V and  
19 000/33 000 V.

In addition, in the heading of each of the Table 17 to Table 26 the value of  $U_m$  is shown in parentheses where  $U_m$  is the maximum sustained power frequency voltage between conductors for which the cable is suitable.

## 4 Conductors

The conductors shall be either plain annealed copper conductors or plain aluminium conductors and, with the exception of the dimensions of shaped solid aluminium conductors which shall be as given in Table 1, shall conform to BS 6360. When tested in accordance with D.2, the minimum corner radii for shaped solid aluminium conductors shall be as given in Table 1.

Copper conductors shall be stranded (class 2) conductors. Aluminium conductors shall be either solid (class 1) or stranded (class 2) conductors.

The conductors shall be circular, except that the use of shaped conductors, as an alternative to the use of circular conductors, shall be permitted for three-core cables of rated voltages 3 800/6 600 V and 6 350/11 000 V having a conductor cross-sectional area not less than the following:

|                 |                    |
|-----------------|--------------------|
| 3 800/6 600 V:  | 70 mm <sup>2</sup> |
| 6 350/11 000 V: | 95 mm <sup>2</sup> |

Stranded circular conductors shall be compacted or uncompacted.

## 5 Conductor screen

### 5.1 General

A conductor screen consisting of an extruded layer of semi-conducting compound, which shall be cross-linked during the manufacture of the cable, shall be applied over the conductor. The extruded layer shall be continuous and shall cover the surface of the conductor completely.

NOTE A semi-conducting tape may be applied prior to the extruded layer, at the discretion of the manufacturer.

Table 1 — Dimensions of shaped solid aluminium conductors

| Nominal cross-sectional area of conductor<br>mm <sup>2</sup> | Nominal dimensions of conductor |             |                   |                     | Minimum corner radius of conductor<br>mm |
|--------------------------------------------------------------|---------------------------------|-------------|-------------------|---------------------|------------------------------------------|
|                                                              | Width<br>mm                     | Depth<br>mm | Back radius<br>mm | Corner radius<br>mm |                                          |
| 70                                                           | 11.3                            | 7.9         | 9.9               | 2.8                 | 2.6                                      |
| 95                                                           | 13.9                            | 9.1         | 11.4              | 2.8                 | 2.6                                      |
| 120                                                          | 15.8                            | 10.2        | 12.6              | 3.0                 | 2.8                                      |
| 150                                                          | 17.9                            | 11.3        | 13.9              | 3.0                 | 2.8                                      |
| 185                                                          | 20.5                            | 12.6        | 15.4              | 3.0                 | 2.8                                      |
| 240                                                          | 24.0                            | 14.5        | 17.5              | 3.0                 | 2.8                                      |
| 300                                                          | 27.3                            | 16.2        | 19.5              | 3.0                 | 2.8                                      |

The extruded conductor screen shall be applied in the same operation as the insulation and fully bonded to the insulation.

## 5.2 Materials

The resistivity of the extruded conductor screen shall not exceed 500  $\Omega$  m at 90 °C when measured in accordance with Annex E. As part of the complete cable, the screen shall conform to the compatibility requirements of 20.3.

## 5.3 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of hydrochloric acid (HCl) shall be not greater than 0.5 % (*m/m*).

## 6 Insulation

### 6.1 General

The insulation shall be either cross-linked polyethylene (XLPE) or ethylene propylene rubber compound (EPR) in accordance with Table 2.

The insulation shall be applied by extrusion and cross-linked to form a compact and homogeneous layer.

The colour of the insulation shall be such that it is easily distinguishable from the screening materials.

### 6.2 Thickness

The thickness of the insulation, when determined by taking the average of a number of measurements in accordance with Annex F, shall be not less than the relevant value given in Table 17 to Table 26 for the minimum average thickness; the smallest of the measured values shall be not less than the value specified for the minimum thickness at a point.

The thickness of any tape or extruded conductor or insulation screen shall not be included in the measured insulation thickness.

### 6.3 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl shall be not greater than 0.5 % (*m/m*).

## 7 Insulation screen

### 7.1 General

An insulation screen shall be applied to all cables and shall consist of a semi-conducting layer in combination with a metallic screen.

The semi-conducting layer shall be applied directly over the insulation of each core and the metallic screen shall either be applied around each core (see 7.3) or be a collective screen applied at a stage after the cores have been laid up together (see clauses 9, 10 and 11).

### 7.2 Semi-conducting layer

#### 7.2.1 General

The semi-conducting layer shall be one of the following:

- a) a semi-conducting tape applied over a semi-conducting coating; or
- b) an extruded layer of semi-conducting compound.

#### 7.2.2 Semi-conducting taped screens

When a taped form of screening is used, the semi-conducting coating shall be applied to cover completely the surface of the insulation and this coating shall be followed by a semi-conducting tape applied helically with an overlap.

#### 7.2.3 Semi-conducting extruded screens

Extruded screens shall consist of semi-conducting compound, which shall be cross-linked during the manufacture of the cable. The semi-conducting layer shall be continuous and shall cover the surface of the core completely.

The extruded layer shall be applied in the same operation as the insulation.

The resistivity of the extruded insulation screen shall not exceed 500  $\Omega$  m at 90 °C when measured in accordance with Annex E. As part of the complete cable, the screen shall conform to 20.3.

**Table 2 — Cross-linked polyethylene (XLPE) and ethylene propylene rubber compound (EPR) insulation**

| Test                                                                                                                                                           | Requirements |            | Test method in accordance with BS 6469 |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|------------|----------------------------------------|--------|
|                                                                                                                                                                | XLPE         | EPR        | Section                                | Clause |
| <i>Properties in the state as delivered</i>                                                                                                                    |              |            | 1.1                                    | 9      |
| Minimum tensile strength (N/mm <sup>2</sup> )                                                                                                                  | 12.5         | 4.2        |                                        |        |
| Minimum elongation at break (%)                                                                                                                                | 200          | 200        |                                        |        |
| <i>Properties after ageing in air oven</i>                                                                                                                     |              |            | 1.2                                    | 8.1    |
| Temperature (°C)                                                                                                                                               | 135 ± 2      | 135 ± 2    |                                        |        |
| Duration (h)                                                                                                                                                   | 7 × 24       | 7 × 24     |                                        |        |
| Maximum variation for tensile strength <sup>a</sup> (%)                                                                                                        | 25           | 30         |                                        |        |
| Maximum variation for elongation at break <sup>a</sup> (%)                                                                                                     | 25           | 30         |                                        |        |
| <i>Properties after ageing in air bomb</i>                                                                                                                     |              |            | 1.2                                    | 8.2    |
| Temperature (°C)                                                                                                                                               | —            | 127 ± 1    |                                        |        |
| Duration (h)                                                                                                                                                   | —            | 40         |                                        |        |
| Maximum variation for tensile strength <sup>a</sup> (%)                                                                                                        | —            | 30         |                                        |        |
| Maximum variation for elongation at break <sup>a</sup> (%)                                                                                                     | —            | 30         |                                        |        |
| <i>Shrinkage test</i>                                                                                                                                          |              |            | 1.3                                    | 10     |
| Temperature (°C)                                                                                                                                               | 130 ± 2      | —          |                                        |        |
| Duration (h)                                                                                                                                                   | 1            | —          |                                        |        |
| Maximum shrinkage (%)                                                                                                                                          | 4            | —          |                                        |        |
| <i>Ozone resistance test</i>                                                                                                                                   |              |            | 2.1                                    | 8.1    |
| Temperature (°C)                                                                                                                                               | —            | 25 ± 2     |                                        |        |
| Duration (h)                                                                                                                                                   | —            | 30         |                                        |        |
| Ozone concentration (ppm V/V)                                                                                                                                  | —            | 250 to 300 |                                        |        |
| Requirement                                                                                                                                                    | —            | no cracks  |                                        |        |
| <i>Hot set test</i>                                                                                                                                            |              |            | 2.1                                    | 9      |
| Temperature (°C)                                                                                                                                               | 200 ± 2      | 250 ± 3    |                                        |        |
| Duration (min)                                                                                                                                                 | 15           | 15         |                                        |        |
| Mechanical stress (N/mm <sup>2</sup> )                                                                                                                         | 0.2          | 0.2        |                                        |        |
| Requirements                                                                                                                                                   |              |            |                                        |        |
| Maximum elongation under load (%)                                                                                                                              | 175          | 175        |                                        |        |
| Maximum elongation after unloading (%)                                                                                                                         | 15           | 15         |                                        |        |
| <sup>a</sup> The variation is the difference between the respective values obtained prior to and after heat treatment expressed as a percentage of the former. |              |            |                                        |        |

The insulation screen shall be capable of removal without impairing the performance of the insulation. If the screen is cold strippable, the force required to remove the screen, when tested in accordance with **D.3**, shall be not less than 18 N and not more than 80 N.

NOTE Whether or not a specific type of insulation screen is required and, if it is extruded, whether or not it is cold strippable, are subject to the purchaser's contract (see Annex B).

#### 7.2.4 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl shall be not greater than 0.5 % (m/m).

#### 7.3 Metallic screen on each core

If a metallic screen is applied directly over the core of single-core cables or each core in three-core cables, it shall consist of either helically applied copper tape(s) or a concentric layer of copper wires applied helically or in waveform. The metallic screens of the cores in three-core cables shall be in contact with each other.

NOTE 1 Semi-conducting tape or a semi-conducting extruded layer conforming to 7.2.4 may be applied over the semi-conducting insulation screen as a bedding for the metallic screen at the discretion of the manufacturer.

If copper wires are applied the average gap between adjacent wires shall not exceed 4 mm, with no gaps exceeding 8 mm.

NOTE 2 A copper equalizing tape may be applied at the discretion of the manufacturer.

NOTE 3 The technical requirements are subject to the purchaser's contract (see Annex B).

## 8 Laying-up

### 8.1 General

For three-core cables, the cores shall be laid-up with a right-hand direction of lay. Fillers shall be used if necessary to form a substantially compact and circular cable. The fillers shall be compatible with adjacent materials. For cables not having a metallic screen on each core, the shape of the filler shall not prevent electrical contact between the insulation screen and the semi-conducting inner covering.

NOTE For cables to which an extruded inner covering is to be applied, a binder may be applied over the laid-up cores at the discretion of the manufacturer.

If a binder is applied and the individual cores are not metal screened, then the binder, unless semi-conducting, shall have a maximum cover of 50 %.

### 8.2 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl of filler and binder tape(s) shall be not greater than 0.5 % (*m/m*).

## 9 Inner covering

### 9.1 General

Three-core cables that are to have a collective metallic screen (see clause 10) shall have an inner covering, extruded or lapped, applied around the laid-up cores unless the separation layer (see 11.1) serves as the inner covering. For cables not having a metallic screen on each core, the inner covering shall be semi-conducting.

NOTE If the inner covering is extruded, the fillers may be applied integrally with the inner covering.

The materials used for the inner covering shall be suitable for the operating temperature of the cable and compatible with the other materials used in the cable construction.

Compliance shall be checked by the compatibility test given in 20.3.

### 9.2 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl shall be not greater than 0.5 % (*m/m*).

## 10 Collective metallic screen

Three-core cables not having a metallic screen over each individual core shall have a collective screen applied over the inner covering.

The collective metallic screen shall consist of a concentric layer of copper wires applied helically or in waveform. The average gap between adjacent wires shall not exceed 4 mm with no gaps between them exceeding 8 mm.

NOTE 1 Alternatively the armour may act as the collective metallic screen.

NOTE 2 This does not preclude three-core cables which have a metallic screen over each individual core from having a collective metallic screen.

## 11 Armour

### 11.1 Separation layer

If a collective metallic screen of dissimilar metal to the armour is applied, an extruded separation layer shall be applied between the two layers of metal. The material shall conform to the requirements given in Table 4.

NOTE The nominal and minimum thicknesses of the separation layer are specified in Table 17 to Table 26.

When the thickness of the separation layer is measured in accordance with Annex F, the smallest of the measured values shall be not less than the relevant value specified in Table 17 to Table 26 for the minimum thickness at a point.

### 11.2 Metal layer

For the armouring of three-core cables, round galvanized steel wires shall be used.

For the armouring of single-core cables either round aluminium wires or aluminium strips shall be used.

The armouring shall conform to the following.

- a) When determined in accordance with D.4, the diameter of the round armour wires, whether galvanised steel or plain aluminium, shall not fall below the relevant nominal value specified in Table 17 to Table 26 by more than 5 %.
- b) When determined in accordance with D.6, the mass of the zinc coating of galvanized steel armour wire shall be not less than that given in Table 3.
- c) When determined in accordance with D.5, the thickness and width of individual strips of aluminium armour shall not differ from the relevant values specified in Table 17 to Table 26, as appropriate, by more than 5 %.
- d) When subjected to the test given in D.7, the mechanical characteristics of the galvanized steel armour shall be such that none of the wires break.

e) When tested in accordance with **D.8**, the tensile strength of aluminium wires shall be not less than 125 N/mm<sup>2</sup>.

f) When tested in accordance with **D.8**, the tensile strength of the individual strips of aluminium armour shall be not less than 145 N/mm<sup>2</sup>.

Armour shall be applied helically in a single layer with a left-hand lay.

Joints in steel wire armour shall be brazed or welded and any surface irregularity removed.

Joints in aluminium wire or strip shall be made by cold pressure or fusion welding and all surface irregularities removed.

A joint in any wire or strip shall be not less than 1 m from the nearest joint in any other armour wire or strip in the completed cable.

**Table 3 — Mass of zinc coating**

| Nominal diameter of armour wire<br>mm | Minimum mass of zinc coating per square metre<br>g |
|---------------------------------------|----------------------------------------------------|
| 1.6                                   | 172                                                |
| 2.0                                   | 180                                                |
| 2.5                                   | 195                                                |
| 3.15                                  | 206                                                |

### 11.3 Binder tape

NOTE A suitable binder tape or tapes may be applied over the armour at the discretion of the manufacturer.

No protective compounds, e.g. bitumen, shall be applied over the armour.

### 11.4 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl of the binder tape(s) and separation layer shall be not greater than 0.5 % (m/m).

## 12 Oversheath

### 12.1 General

The material for a synthetic extruded oversheath shall conform to the requirements given in Table 4 and in **12.2**, **12.3** and **12.4**.

NOTE Oversheaths are normally black but colours other than black may be provided by agreement between the manufacturer and the purchaser, subject to their suitability for the particular conditions under which the cables are to be used.

### 12.2 Thickness

NOTE The nominal and the minimum thicknesses of the oversheath are specified in Table 17 to Table 26.

When the thickness of the oversheath is measured in accordance with Annex F, the smallest of the measured values shall not be less than the relevant value specified in Table 17 to Table 26 for the minimum thickness at a point.

### 12.3 Spark test

When tested in accordance with BS 5099, no failure shall occur.

### 12.4 Corrosive and acid gas emission

When tested in accordance with BS 6425-1, the level of HCl shall be not greater than 0.5 % (m/m).

## 13 Marking

### 13.1 Marking of oversheath

The external surface of all cables shall be legibly marked with the following elements of marking.

| Element                                                                | Example of marketing |
|------------------------------------------------------------------------|----------------------|
| a) Electric cable                                                      | ELECTRIC CABLE       |
| b) Voltage designation                                                 |                      |
| 3 800/6 600                                                            | 6 600 V              |
| 6 350/11 000                                                           | 11 000 V             |
| 8 700/15 000                                                           | 15 000 V             |
| 12 700/22 000                                                          | 22 000 V             |
| 19 000/33 000                                                          | 33 000 V             |
| c) British Standard number                                             | BS 7835 <sup>a</sup> |
| d) Manufacturer's identification                                       | XYZ                  |
| e) The number of cores, type and nominal area of conductor as follows: |                      |
| 1) Copper conductor cables                                             | 3 × 50               |

NOTE 1.3 × 50 indicates a three-core cable with 50 mm<sup>2</sup> copper conductors.

2) Aluminium conductor 3 × 50AL cables

NOTE 2.3 × 50AL indicates a three-core cable with 50 mm<sup>2</sup> aluminium conductors.

<sup>a</sup> Marking BS 7835 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.

The marking of elements a) to d) shall be by embossing or indenting on the oversheath.

Elements a), b) and c) shall appear, in any sequence that is deemed to neither confuse nor conflict, on two or more primary lines along the axis of the cable, approximately equally spaced around the circumference of the cable. Elements d) and e) shall appear on at least one line.

NOTE 1 This may be one of the primary lines, or a secondary line or lines.

NOTE 2 Elements d) and e) may appear in any sequence that is deemed to neither confuse nor conflict, and need not all be on the same line.

Table 4 — Test requirements for oversheath

| Test                                                                                                                                                           | Requirements | Test method in accordance with BS 6469 unless otherwise stated |        |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|----------------------------------------------------------------|--------|
|                                                                                                                                                                |              | Section                                                        | Clause |
| <i>Properties in the state as delivered</i>                                                                                                                    |              | 1.1                                                            | 9      |
| Minimum tensile strength (N/mm <sup>2</sup> )                                                                                                                  | 10           |                                                                |        |
| Minimum elongation at break (%)                                                                                                                                | 100          |                                                                |        |
| <i>Properties after ageing in air oven</i>                                                                                                                     |              | 1.2                                                            | 8.1    |
| Temperature (°C)                                                                                                                                               | 100 ± 2      |                                                                |        |
| Duration (h)                                                                                                                                                   | 7 × 24       |                                                                |        |
| Minimum tensile strength (N/mm <sup>2</sup> )                                                                                                                  | 10           |                                                                |        |
| Maximum variation <sup>a</sup> (%)                                                                                                                             | 40           |                                                                |        |
| Minimum elongation at break (%)                                                                                                                                | 100          |                                                                |        |
| Maximum variation <sup>a</sup> (%)                                                                                                                             | 40           |                                                                |        |
| <i>Bending test at low temperature</i>                                                                                                                         |              | 1.4                                                            | 8.2    |
| Temperature (°C)                                                                                                                                               | – 15 ± 2     |                                                                |        |
| Requirement                                                                                                                                                    | no cracks    |                                                                |        |
| <i>Elongation test at low temperature</i>                                                                                                                      |              | 1.4                                                            | 8.4    |
| Temperature (°C)                                                                                                                                               | – 15 ± 2     |                                                                |        |
| Minimum elongation without break (%)                                                                                                                           | 30           |                                                                |        |
| <i>Impact test at low temperature</i>                                                                                                                          |              | 1.4                                                            | 8.1    |
| Temperature (°C)                                                                                                                                               | – 15 ± 2     |                                                                |        |
| Requirement                                                                                                                                                    | no cracks    |                                                                |        |
| <i>Pressure test at high temperature</i>                                                                                                                       |              | 3.1                                                            | 8.1    |
| Test conditions                                                                                                                                                |              |                                                                |        |
| Force exerted by the blade                                                                                                                                     | See note     |                                                                |        |
| Duration of heating under load                                                                                                                                 | See note     |                                                                |        |
| Temperature (°C)                                                                                                                                               | 80 ± 2       |                                                                |        |
| Maximum indentation (%)                                                                                                                                        | 50           |                                                                |        |
| <i>Water immersion test</i>                                                                                                                                    |              | 99.1                                                           | 14     |
| Temperature (°C)                                                                                                                                               | 70 ± 2       |                                                                |        |
| Duration (h)                                                                                                                                                   | 7 × 24       |                                                                |        |
| Maximum variation of tensile strength <sup>a</sup> (%)                                                                                                         | 30           |                                                                |        |
| Maximum variation of elongation at break <sup>a</sup> (%)                                                                                                      | 30           |                                                                |        |
| <i>Insulation resistance constant</i>                                                                                                                          |              | Annex P of this standard                                       |        |
| Minimum <i>K</i> value (MΩ km)                                                                                                                                 | 0.0035       |                                                                |        |
| <i>Acidic and corrosive gases evolved</i>                                                                                                                      |              | BS 6425-1                                                      |        |
| Level of HCl [% (m/m)]                                                                                                                                         | ≤ 0.5        |                                                                |        |
| NOTE See 8.2 of BS 6469-3.1:1992.                                                                                                                              |              |                                                                |        |
| <sup>a</sup> The variation is the difference between the respective values obtained prior to and after heat treatment expressed as a percentage of the former. |              |                                                                |        |

The letters and figures shall consist of upright block characters. The characters shall have a minimum height of 3 mm.

The distance between the end of the one element of marking and the beginning of the next identical element of marking shall be not greater than 550 mm, for elements a), b) and c), and not greater than 1 100 mm for elements d) and e).

Compliance shall be checked by visual examination and measurement.

### 13.2 Identification of year of manufacture

A means of identifying the year of manufacture of the cable shall be provided throughout the length of the cable, either internally or by marking on the surface of the cable.

If the identification is internal the distance between the end of one mark and the beginning of the next mark shall be not greater than 550 mm.

NOTE As an alternative internal marking, an identification thread may be used.

If the identification is by marking on the surface, the maximum distance between marks shall be as specified in 13.1 for elements d) and e).

### 13.3 The mark of an approval organization

If the mark of an approval organization is used it shall be provided throughout the length of the cable.

If this mark is applied to the cable it shall be on the surface in the form of the symbol(s) specified by the approval organization, and the maximum distance between marks shall be as specified in 13.1 for elements d) and e).

NOTE As an alternative to the mark of the approval organization, an identification thread may be incorporated into the cable, as specified by the approval organization.

### 13.4 Additional marking

Where additional marking is made it shall be throughout the length of the cable.

NOTE It may be on the external surface of the cable, or by means of a tape or thread within the cable, or by a combination of these methods.

If the additional marking is applied to the surface of the cable it shall not render illegible the marking specified in 13.1 to 13.3.

The additional marking, however made, shall be repeated at intervals not exceeding 1 100 mm.

## 14 Sealing and drumming

Before despatch, the manufacturer shall cap the ends of all cable in order to form a seal to prevent the ingress of water during transportation and storage.

Cable drums shall be lagged in order to protect the cable from damage, and the end of the cable projected from the drum shall also be protected from damage.

Each drum shall bear a distinguishing number on the outside of the flange and particulars of the cable, i.e. voltage, length, conductor size and cable type. The gross mass shall be shown and the direction for rolling shall be indicated by an arrow.

## 15 Schedule of tests

Testing shall be carried out in accordance with the schedule of tests given in Table 5.

NOTE The last column in Table 5 shows the category of each test, i.e. R, RS, SS and T.

The categories and corresponding designations are as follows.

a) *Routine tests* (R): tests made at the manufacturer's works on all cables in the finished state or as appropriate, e.g. spark test, during manufacture.

b) *Regular sample tests* (RS): tests made at the manufacturer's works on representative samples selected regularly by the manufacturer, or as specified by the purchaser at the time of enquiry or order.

c) *Special sample tests* (SS): tests made on samples if specified by the purchaser at the time of enquiry or order at a frequency agreed between the purchaser and the manufacturer, provided the quantity ordered exceeds 10 km (see Annex D).

d) *Type tests* (T): tests made on specimens of cables as produced by a specific manufacturer to demonstrate the manufacturer's ability to satisfactorily produce a range of cables designed to conform to this standard. These tests, after they have been successfully completed, need not be repeated unless changes are made which might affect conformity to the requirements (see Annex G).

## 16 Test conditions

### 16.1 Ambient temperature

Tests shall be made at an ambient temperature of  $20\text{ }^{\circ}\text{C} \pm 15\text{ }^{\circ}\text{C}$  unless otherwise specified for a particular test.

### 16.2 Frequency and waveform of power frequency test voltages

Unless otherwise specified for a particular test, alternating test voltages shall have a frequency between 49 Hz and 61 Hz. The waveform shall be substantially sinusoidal.

## 17 Routine tests

### 17.1 General

Routine tests shall be as given in Table 6.

### 17.2 Conductor resistance

The d.c. resistance of each conductor shall conform to BS 6360 when measured and corrected to  $20\text{ }^{\circ}\text{C}$  in accordance with that standard.

### 17.3 Partial discharge

When tested in accordance with Annex H, the magnitude of the discharge on each core at the voltage given in Table 7 shall not exceed 10 pC.

Table 5 — Schedule of tests

| Tests                                               | Requirements<br>(clause reference) | Test procedure     | Category of<br>test<br>(see clause 14) |
|-----------------------------------------------------|------------------------------------|--------------------|----------------------------------------|
| <i>Tests on components</i>                          |                                    |                    |                                        |
| Conductor:                                          |                                    |                    |                                        |
| a) construction                                     | 4                                  | Visual examination | RS                                     |
| b) corner radii of shaped solid aluminium conductor | 4                                  | <b>D.2</b>         | SS                                     |
| Conductor screen:                                   |                                    |                    |                                        |
| a) application                                      | 5.1                                | Visual examination | RS                                     |
| b) resistivity                                      | 5.2                                | Annex E            | T and SS                               |
| c) corrosive and acid gas                           | 5.3                                | BS 6425-1          | T                                      |
| Insulation:                                         |                                    |                    |                                        |
| a) material                                         | —                                  | See Table 2        | RS                                     |
| 1) hot set test                                     | —                                  | See Table 2        | T                                      |
| 2) other requirements                               |                                    |                    |                                        |
| b) colour                                           | 6.1                                | Visual examination | RS                                     |
| c) thickness                                        | 6.2                                | Annex F            | RS                                     |
| d) corrosive and acid gas                           | 6.3                                | BS 6425-1          | T                                      |
| Semi-conducting insulation screen:                  |                                    |                    |                                        |
| a) taped screen:                                    |                                    |                    |                                        |
| 1) application                                      | 7.2.2                              | Visual examination | RS                                     |
| 2) corrosive and acid gas                           | 7.2.4                              | BS 6425-1          | T                                      |
| b) extruded screen:                                 |                                    |                    |                                        |
| 1) application                                      | 7.2.3                              | Visual examination | RS                                     |
| 2) resistivity                                      | 7.2.3                              | Annex E            | T and SS                               |
| 3) cold strippability                               | 7.2.3                              | <b>D.3</b>         | SS                                     |
| 4) corrosive and acid gas                           | 7.2.4                              | BS 6425-1          | T and RS                               |
| Laid-up cores:                                      | 8                                  | Visual examination | RS                                     |
| Fillers and binders — corrosive and acid gas        | 8.2                                | BS 6425-1          | T                                      |
| Inner covering:                                     |                                    |                    |                                        |
| a) application                                      | 9.1                                | Visual examination | RS                                     |
| b) corrosive and acid gas                           | 9.2                                | BS 6425-1          | T and RS                               |
| Collective metallic screen                          | 10                                 | Visual examination | RS                                     |
| Armour:                                             |                                    |                    |                                        |
| a) separation layer:                                |                                    |                    |                                        |
| 1) material                                         | 11.1                               | See Table 4        | T                                      |
| 2) thickness                                        | 11.1                               | Annex F            | RS                                     |
| 3) corrosive and acid gas                           | 11.4                               | BS 6425-1          | T and RS                               |
| b) metal layer:                                     |                                    |                    |                                        |
| 1) galvanized steel wires:                          |                                    |                    |                                        |
| i) diameter of wires                                | 11.2 a)                            | <b>D.4</b>         | SS                                     |
| ii) mass of zinc coating                            | 11.2 b)                            | <b>D.6</b>         | SS                                     |
| iii) wrapping test                                  | 11.2 d)                            | <b>D.7</b>         | SS                                     |
| 2) aluminium wires (round):                         |                                    |                    |                                        |
| i) diameter of wires                                | 11.2 a)                            | <b>D.4</b>         | SS                                     |
| ii) tensile test                                    | 11.2 e)                            | <b>D.8</b>         | SS                                     |
| 3) aluminium strips:                                |                                    |                    |                                        |
| i) dimensions                                       | 11.2 c)                            | <b>D.5</b>         | SS                                     |
| ii) tensile test                                    | 11.2 f)                            | <b>D.8</b>         | SS                                     |
| c) binding tape: corrosive and acid gas             | 11.4                               | BS 6425-1          | T                                      |

Table 5 — Schedule of tests

| Tests                                                                                     | Requirements<br>(clause reference)             | Test procedure                                 | Category of<br>test<br>(see clause 14) |
|-------------------------------------------------------------------------------------------|------------------------------------------------|------------------------------------------------|----------------------------------------|
| Oversheath:<br>a) material<br>b) thickness,<br>c) spark test<br>d) corrosive and acid gas | —<br><b>12.2</b><br><b>12.3</b><br><b>12.4</b> | See Table 4<br>Annex F<br>BS 5099<br>BS 6425-1 | T<br>RS<br>R<br>T and RS               |
| <i>Tests on complete cables</i>                                                           |                                                |                                                |                                        |
| Cable marking                                                                             | <b>13</b>                                      | Visual examination                             | R                                      |
| Conductor resistance test                                                                 | <b>17.2</b>                                    | BS 6360                                        | R                                      |
| Voltage test on complete cable length                                                     | <b>17.4</b>                                    | <b>17.4.2</b>                                  | R                                      |
| Partial discharge test                                                                    | <b>17.3</b>                                    | Annex H                                        | R                                      |
| 4 h voltage test on sample                                                                | <b>19.2</b>                                    | <b>D.9</b>                                     | SS                                     |
| Sequential type tests                                                                     | <b>20.2</b>                                    | <b>20.2</b>                                    | T                                      |
| Compatibility test                                                                        | <b>20.3</b>                                    | <b>J.4</b>                                     | T                                      |
| Abrasion test                                                                             | <b>20.4</b>                                    | Annex M                                        | T                                      |
| Test for shrinkage of sheath on cable                                                     | <b>20.5</b>                                    | Annex N                                        | T                                      |
| Tests under fire conditions                                                               |                                                |                                                |                                        |
| a) fire test on single cable                                                              | <b>19.3</b>                                    | BS 4066-1                                      | SS                                     |
| b) test for flame propagation                                                             | <b>20.6</b>                                    | BS 4066-3                                      | T                                      |
| c) smoke emission                                                                         | <b>20.7</b>                                    | BS 7622                                        | T and RS                               |
| Adherence of screens at short circuit temperatures<br>(optional)                          | <b>22.1</b>                                    | <b>22.2</b>                                    | T                                      |

**17.4 Voltage test on complete cable****17.4.1 Requirement**

No breakdown of the insulation shall occur when the completed cable is subjected to a power frequency voltage of the magnitude given in Table 8.

**17.4.2 Method**

Apply the voltage between the conductor(s) and the metallic screen(s) with the metallic screen(s) earthed. Raise the voltage gradually and maintain at the full value for 5 min.

Table 6 — Routine tests

| Test                           | Requirement<br>(clause reference) | Test procedure     |
|--------------------------------|-----------------------------------|--------------------|
| Cable marking                  | <b>13</b>                         | Visual examination |
| Spark test on oversheath       | <b>12.3</b>                       | BS 5099            |
| Conductor resistance           | <b>17.2</b>                       | BS 6360            |
| Voltage test on complete cable | <b>17.4</b>                       | <b>17.4.2</b>      |
| Partial discharge              | <b>17.3</b>                       | Annex H            |

Table 7 — Voltage for partial discharge test

| Rated voltage, $U_o$<br>kV | Test voltage r.m.s.<br>kV |
|----------------------------|---------------------------|
| 3.8                        | 5.7                       |
| 6.35                       | 9.6                       |
| 8.7                        | 13.1                      |
| 12.7                       | 19.1                      |
| 19.0                       | 28.5                      |

Table 8 — Voltage for test on complete cable

| Rated voltage, $U_o$<br>kV | Test voltage r.m.s.<br>kV |
|----------------------------|---------------------------|
| 3.8                        | 11                        |
| 6.35                       | 15                        |
| 8.7                        | 22                        |
| 12.7                       | 30                        |
| 19.0                       | 45                        |

**18 Regular sample tests**

Regular sample tests shall be as given in Table 9.

**19 Special sample tests****19.1 General**

Special sample tests shall be as given in Table 10.