# Cables for temporary electrical installations

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Electrical cables used for temporary installations will be at risk of damage from many sources. The fact that installations are temporary means that elements of the installation, if not all, will be brought in for this purpose and then removed, possibly for reuse, upon completion.

BS 7671 makes no distinction between temporary or permanent electrical installations in terms of safety. The fact that an electrical installation is of a temporary nature does not permit a lower standard of installation work - if anything, the requirements for temporary electrical installations are more stringent than those for permanent installations as the operating conditions are more onerous.

This article will look at the requirements for electrical cables for temporary electrical installations from two British Standards - BS 7671:2008 and BS 7909:2008.

**Standards**

**What is BS 7671:2008?**
BS 7671:2008 Requirements for Electrical Installations, IEE Wiring Regulations 17th Edition

**What is BS 7909:2008?**
BS 7909:2008 Code of practice for temporary electrical systems for entertainment and related purposes

**Scope**
To begin with, let's look at the scopes of BS 7671:2008 and BS 7909:2008 and establish the types of installations these standards cover.

**The Scope of BS 7671:2008**
The key point to consider is part viii of Regulation 110.1:

**110.1 GENERAL**
The Regulations apply to the design, erection and verification of electrical installations such as those of:
(viii) construction sites, exhibitions, shows, fairgrounds and other installations for temporary purposes including professional stage and broadcast applications

Further, Regulation 110.1 states:

*The Regulations are intended to be applied to electrical installations generally but, in certain cases, they may need to be supplemented by the requirements or recommendations of other British Standards or by the requirements of the person ordering the work; such cases include the following:*

*(xxix) Design and installation of temporary distribution systems delivering a.c. electrical supplies*

*for lighting, technical services and other entertainment related purposes – BS 7909.*

| BS 7671:2008 | BS 7909:2008 |
|---|---|
| • Construction and Demolition Site Installations<br>• Electrical Installations in Caravan / Camping Parks and Similar Locations<br>• Exhibitions, Shows and Stands, Section 711 also refers to BS 7909<br>• Mobile or Transportable Units<br>• Electrical Installations in Caravans and Motor Caravans<br>• Temporary Electrical Installations for Structures, Amusement Devices and Booths at Fairgrounds, Amusement Parks and Circuses | • Photographic shoots, small or large<br>• TV interviews and documentary work, small or large<br>• Film, TV and similar work indoors and on location<br>• Temporary locally set-up editing or recording facilities<br>• Conferences, product launches, fashion shows, whether small or large<br>• Theatrical, dance, concert and similar events of all types, indoors and outdoors<br>• Touring shows<br>• Outdoor private function, such as a wedding on private property<br>• Horticultural and agricultural shows<br>• Gymkhanas |

**The Scope of BS 7909:2008**

BS 7909:2008 gives recommendations for the management, design, setting-up and operation of temporary electrical systems for the entertainment and similar or related industries. Mobile and transportable units with electrical systems that are used in these industries are also covered.

BS 7909:2008 also gives guidance on matters of common interest to producers, production companies, event organizers and managers, freelance people, facilities and services hire companies, equipment hire companies, equipment manufacturers, electrical consultants, electrical installation contractors, distributors, suppliers of electricity, venues, local authorities and those responsible for safety.

The systems covered by BS 7909:2008 operate at low voltage as defined in BS 7671 supplied from an existing installed electrical system, the public supply, privately owned supplies or from mobile or portable generators; d.c. is not considered. BS 7909:2008 separates the requirements into two areas - small/simple events and activities requiring up to 6 kVA and Large/complex events and activities requiring in excess of 6 kVA.

To summarise, the table shown above indicates which standard applies to the type of temporary electrical installation.

**General requirements for electrical cables for temporary installations**

**BS 7671:2008**

To comply with BS 7671:2008, Regulation 511.1 requires that all electrical equipment, including wiring systems, utilise cables complying with the relevant requirements of the applicable British Standard or Harmonized Standard.

BS 7671:2008 defines a wiring system as:

*An assembly made up of cable or busbars and parts which secure and, if necessary, enclose the cable or busbars*

This can be read to only mean factory-made systems but it is intended to cover all cable types.

Further, Section 522 of BS 7671:2008 requires that the installation method selected shall be such that protection against the expected external influences is ensured in all appropriate parts of the wiring system. Particular care shall be taken at changes in direction and where wiring enters into equipment.

**BS 7909:2008**

BS 7909:2008 has similar requirements to BS 7671 but is more descriptive as it is a code of practice; the general requirements are as follows:

Cables should be run so that they do not create a hazard and are protected from all sources of damage. If possible, cables should be routed clear of passageways, walkways, ladders, stairs, etc. They should not be passed through fire barriers without arrangements to preserve the effectiveness of the barrier.

Cables laid along floors should be arranged to cause minimum obstruction and should be secured in position if disturbance is likely. Cables on the ground, which cross pedestrian and vehicle routes, should be protected from damage and ramped.

Overhead cables that cross pedestrian walkways should be at least 3.5 m above the ground. Overhead cables that cross routes over which vehicles might pass should be at least 6 m above the ground.

Special attention should be paid to safety exit routes. Local or other responsible authority requirements should be met and a risk assessment made and acted upon for the arrangements made.

Electrical cables temporarily buried in the ground should have a minimum voltage designation of 450 V/750 V and the routes should be marked at suitable intervals. If necessary cable with integral armouring should be used, or additional mechanical protection provided, to prevent damage.

Cables should not be run in a manner that will allow them to overheat and should not be placed close to sources of heat. Excess cable should be laid out in a linear fashion and not left coiled whilst carrying current. Connectors should not be placed in gullies, gutters, drains or depressions that might fill with water.

Where distribution circuits are in excess of 125 A, single core cables are used for ease of installation. In this case all line, neutral and CPC single core cables for each circuit should be run together with minimum separation to facilitate identification and to minimize the effects of EMI. Care should be taken that line and neutral cables for a circuit are not separated by ferrous metal to avoid eddy current heating.

**The requirements for cables for temporary electrical installations in BS 7671:2008**

BS 7671:2008 makes reference to cable types in the Regulations set out on page 8.

**The requirements for cables for temporary electrical installations in BS 7909:2008**

BS 7909:2008 makes reference to cable types in clause 7.3.3 with the following requirements:

- All cables for the temporary distribution should be multicore except for circuits above 125 A where single core cables are usually provided for portability
- All multi-core cables used for temporary distribution should

| Regulation | Cable requirements and text of the Regulation |
|---|---|
| 704.522.8.11 | For reduced low voltage systems, low temperature 300/500 V thermoplastic (BS 7919) or equivalent flexible cables shall be used. For applications exceeding reduced low voltage, flexible cable shall be H07RN-F (BS 7919) type or equivalent having 450/750 V rating and resistant to abrasion and water. |
| 705.422.8 | NOTE: For example, cables of the type H07RN-F (BS 7919) for outdoor use are in compliance with this requirement. |
| Fig. 708 | The means of connection between the caravan pitch socket-outlet and the leisure accommodation vehicle should be an assembly of the following:<br>- a plug as specified in BS EN 60309-2;<br>- a flexible cable type H07RN-F (BS 7919) or equivalent, with a protective conductor and having the following characteristics:<br><br>length: 25 m maximum<br>- for current rating 16A: minimum cross-sectional area: 2.5 $mm^2$.<br><br>For higher current ratings, the cross-sectional area must be chosen so that secure tripping of the overcurrent protective device is achieved at the lowest fault current calculated at the end of the cord extension set<br>- colour identification in accordance with Table 51.<br>- a connector as specified in BS EN 60309-2. |
| 717.52.1 | Flexible cables (for connecting the unit to the supply) in accordance with H07RN-F (BS 7919), or cables of equivalent design, having a minimum cross-sectional area of 2.5 $mm^2$ copper shall be used. The flexible cable shall enter the unit by an insulating inlet in such a way as to minimize the possibility of any insulation damage or fault which might energize the exposed-conductive-parts of the unit. |
| 717.52.2 | (The following or other equivalent cable types are permitted for the internal wiring of the unit:<br><br>(i) Thermoplastic or thermosetting insulated only cable (BS 6004, BS 7211, BS 7919) installed in conduits in accordance with BS EN 61386-1<br>(ii) Thermoplastic or thermosetting insulated and sheathed cable (BS 6004, BS 7211, BS 7919), if precautionary measures are taken to prevent mechanical damage due to any sharp-edged parts or abrasion. |
| 721.55.2.6 | The means of connection to the caravan pitch socket-outlet shall be supplied with the caravan and shall comprise the following:<br><br>(i) A plug complying with BS EN 60309-2, and<br><br>(ii) a flexible cord or cable of 25 m (±2 m) length, harmonized code designation H05RN-F (BS 7919) or equivalent, incorporating a protective conductor, with a colour identification according to Table 51 and of a cross-sectional area in accordance with Table 721, and<br><br>(iii) a connector, if any, compatible with the appliance inlet installed under Regulation 721.55.1.<br>Table 721 - Minimum cross-sectional areas of flexible cords and cables for caravan connection |
| | **Rated current A** / **Minimum cross-sectional area $mm^2$**<br>16 / 2.5<br>25 / 4<br>32 / 6<br>63 / 16<br>100 / 35 |
| A721.521.2 | Cables should be of stranded construction and should comply with BS 6004, BS 6500, BS 7211 or BS 7919. |
| 740.521.1 | Cables and cable management systems<br><br>Conduit systems shall comply with BS EN 61386 series, cable trunking systems and cable ducting systems shall comply with the relevant part 2 of BS EN 50085, tray and ladder systems shall comply with BS EN 61537. All cables shall meet the requirements of BS EN 60332-1-2. Cables shall have a minimum rated voltage of 450 / 750 V, except that, within amusement devices, cables and cords having a minimum rated voltage of 300 / 500 V may be used.<br><br>The routes of cables buried in the ground shall be marked at suitable intervals. Buried cables shall be protected against mechanical damage.<br><br>NOTE 1: Conduit classified as 450 N regarding protection against compression and classified as normal regarding protection against impact, according to BS EN 50086-2-4, is considered to fulfil the above requirement. Armoured cables or cables protected against mechanical damage shall be used wherever there is a risk of mechanical damage due to external influence, e.g. > AG2. Mechanical protection shall be used in public areas and in areas where wiring systems are crossing roads or walkways.<br><br>NOTE 2: Where mechanical protection of cables is provided:<br><br>- conduit systems shall comply with BS EN 61386-21 with a classification of heavy regarding protection against compression and be classified as heavy regarding protection against impact. Metallic and composite conduit systems shall be class 3 regarding protection against corrosion, i.e. medium protection inside and high protection outside.<br><br>- cable trunking systems and cable ducting systems shall comply with BS EN 50085 series with a classification 5 J regarding protection against impact.<br><br>Where subjected to movement, wiring systems shall be of flexible construction. Where flexible conduit systems are provided they shall comply with BS EN 61386-23.<br><br>NOTE 3: Cables of type H07RNF or H07BN4-F (BS 7919) together with conduit complying with BS EN 61386-23 are deemed to satisfy this requirement. |

**Cable Reference**

| 12 | 345 - 6 | 789 |
|---|---|---|

| | |
|---|---|
| **1 Basic Standards** | |
| H | Harmonized Standards |
| A | Authorized National Standards (derived from a harmonized cable standard) |
| N | Non-Authorized National Standards |
| **2 Rated voltage** | |
| 03 | 300/300 V |
| 05 | 300/500 V |
| 07 | 450/750 V |
| 1 | 600/1000 V |
| **3 & 4 Insulation and sheathing material** | |
| B | Ethylene propylene rubber (EPR) |
| E | Polyethylene (PE), low density (LDPE) |
| E2 | Polyethylene, high density (HDPE) |
| E4 | Polytetrafluoroethylene (PTFE) |
| E6 | Ethylene tetrafluoroethylene (ETFE) |
| E7 | Polypropylene (PP) |
| G | Ethylene vinyl acetate (EVA) |
| J | Glass fibre braid (GFB) |
| N | Polychloroprene (PCP) |
| N4 | Chlorosulphonated polyethylene (CSP) |
| Q | Polyurethane (PU) |
| Q2 | Polyethylene terephthalate (PETP) |
| Q4 | Polyamide (PA) |
| R | Natural rubber |
| S | Silicone |
| **3 & 4 Insulation and sheathing material** | |
| T | Textile braid |
| V | Polyvinyl chloride (PVC) |
| V2 | Heat-resistant polyvinyl chloride (HR PVC) |
| X | Cross-linked polyethylene (XLPE) |
| **5 Special construction and shapes** | |
| H | Flat construction with divisible cores |
| H2 | Flat construction, non-divisible core |
| H5 | Two or more cores twisted together, non-sheathed |
| **6 Type of conductor** | |
| A | Aluminium |
| | Copper (no code letter) |
| F | Flexible for movable installations (Class 5 IEC 228) |
| H | Highly flexible for movable installations (Class 6 IEC 228) |
| K | Flexible for fixed installations (Class 5 IEC 228) |
| R | Stranded (Class 2 IEC 228) |
| U | Solid (Class 1 IEC 228) |
| Y | Tinsel |
| **7 Number of cores** | |
| **8 Protective conductor** | |
| X | Without protective core |
| G | With protective core |
| **9 Nominal cross-sectional area of conductors in mm²** | |
| **Additional designations** | |
| **Concentric conductors and screens** | |
| A | Concentric aluminium conductor |
| C | Concentric copper conductor |
| A7 | Aluminium/Laminate screen |
| C4 | Overall copper braid screen |
| C5 | Cores individually copper braid screen |
| C7 | Lapped copper (wire, tape or strip) screen |
| **Special components** | |
| D3 | Central strainer (textile or metallic) |
| D5 | Central filler (not load bearing) |
| **Armours** | |
| Z2 | Steel wire armour |
| Z3 | Flat steel wire armour |
| Z4 | Steel tape armour |
| Z5 | Steel wire braid |

**Fig. 1 - Designation system for cables complying with the European Harmonization Standard**

have line(s), neutral and CPC conductors present and correctly terminated throughout the entire distribution.

- Cables should be flexible and of suitable conductor size and mechanical strength for their intended duty
- Cables for indoor use should be PVC or rubber sheathed as specified in BS 6500 or equivalent, with a minimum voltage designation of 300/500 V (ordinary duty flexible as a minimum, as defined in BS 7540-1).
- Cables for outdoor use should be rubber insulated and sheathed as specified in BS 7919 (H07RN-F or equivalent), with a minimum voltage designation of 450/750 V (heavy duty flexible as a minimum, as defined in BS 7540-1) and resistant to abrasion and water.
- Identification of conductors should comply with BS 7671, Table 51.
- Any cables liable to come into contact with high temperature luminaires should conform to BS 4533-102.17.
- Cables with armour protection are not usually necessary.

## Identifying cables

Cables can be identified with a voltage grade stating the maximum system working voltage for which they are suitable. Conduit wiring cables (6491X), etc., are designated 450/750 V and are harmonized within CENELEC under HD 21 and HD 22. Wiring cables, such as flat-twin and earth (6242Y), are designated 300/500 V and are not harmonized but are constructed to a British Standard. Armoured cables are designated 600/1000 V and are not harmonized but are also constructed to a British Standard. There is no difference in utilizing types of any of these designations on the UK 230/400 V supply system.

BS 7540:2005 (series) is a guide to use for cables with a rated voltage not exceeding 450/750 V and gives installation application advice.

Figure 1 shows the designation system for cables complying with the European Harmonization Standard.

## The use of "Arctic" cable

It is common to see blue-sheathed flexible cables, sometimes referred to as "arctic" cable used on temporary low-voltage installations. In addition to blue, this type of cable is available in many different colours, such as yellow and orange. Manufactured to BS 7919 (not harmonized), this type of cable was designed and is suitable for use on reduced low-voltage systems only, e.g. construction site installations, e.g. 110 V centre tapped transformers at 55 V - 0 - 55 V and often seen on temporary road works traffic lights. Table 7B from BS 7450 shown on the opposite page refers.

The cable can often be seen supplying caravans or used at live musical events, it can even be purchased from DIY shops in the form of a ready-made extension reel with BS 1363 13 A accessories for use at 230 V 1Ø. As can be seen from Table 7B of BS 7540, the cable was not designed for and is not suitable for these purposes.

| Cable type | Standard reference BS 7919:2000 | Recommendations for use | Comments |
|---|---|---|---|
| Ordinary duty low temperature PVC sheathed cord circular | Table 44 | The cables are suitable for:<br><br>— use on ELV systems (110 V centre tapped) on building sites in the UK;<br>— use with temporary traffic light systems when suitably protected.<br>The cables are not suitable for:<br>— outdoor use at standard voltages<br>— in industrial* or agricultural buildings. | Usage on UK building sites, with ELV (110 V centre tapped) may include hand-held tools. |
| * Admissible, however, in tailors' workshops and similar premises | | | |

**Table 7B from BS 7540-3:2005— Cables conforming to BS 7919 — Guide to use**

**References for further reading**

**BS 1363 (suite)**
13 A plugs, socket-outlets, adaptors and connection units
**BS 6004:2000**
Electric cables - PVC insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring
**BS 6500:2000** Electric cables. Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments
**BS 7211:1998** Electric cables. Thermosetting insulated, non-armoured cables for voltages up to and including 450/750 V, for electric power, lighting and internal wiring, and having low emission of smoke and corrosive gases when affected by fire
**BS 7540-3:2005** Electric cables - Guide to use for cables with a rated voltage not exceeding 450/750 V - Part 3: National standard cables not included in HD 21 and HD 22
**BS 7671:2008** Requirements for Electrical Installations, IEE Wiring Regulations 17th Edition
**BS 7909:2008** Code of practice for temporary electrical systems for entertainment and related purposes
**BS 7919:2001** Electric cables - Flexible cables rated up to 450/750 V, for use with appliances and equipment intended for industrial and similar environments
**HD 21 (suite)** The first part of the suite is: HD 21.1 S4:2002 Cables of rated voltages up to and including 450/750 V and having thermoplastic insulation - Part 1: General requirements
**HD 22** The first part of the suite is: HD 22.1 S4:2002 Cables of rated voltages up to and including 450/750 V and having cross-linked insulation - Part 1: General requirements
**IET** Guidance Note 1 - Selection and Erection ■