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WIRINGMATTERS

The Institution of Engineering and Technology

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Future developments in the IEE Wiring Regulations (BS 7671:2008) A brief overview

by Geoff Cronshaw

This is the second of two articles concerning current areas of development in the CENELEC Harmonization Documents which BS 7671 is based on. In the article in the previous edition of *Wiring Matters* we covered Sections 710, 444 and 534.

Other areas currently under development include:

- Section 719 - Lighting installations for advertising signs
- Section 729 - Operating or maintenance gangways

The particular requirements for each Section of Part 7 (Special installations or locations) supplement or modify the general requirements contained in Parts 1 to 6 inclusive.

Section 719

Section 719, which is still at an early stage of development, applies to lighting installations for advertising signs with a rated output voltage not exceeding 1 000 V, which are illuminated by hot-cathode-fluorescent-lamps, luminous-discharge tubes (neon-tubes), inductive discharge lamps, light emitting diodes (LED) and/or LED modules.

The Section specifies the requirements for the installation and testing of all kinds and sizes of illuminated signs with a no-load rated output-voltage up to 1000 V, including the electrical components and wiring. Installations used for signs, light-artworks and decorative purposes are covered, which may be either fixed or portable, supplied from a low-voltage or extra-low-voltage source by means of a transformer, inverter, converter ballast or similar equipment.

Section 729

Section 729, which is expected to be published as a Harmonized Document in the near future, applies to restricted areas. These are areas such as switchrooms with switchgear and controlgear assemblies with a need for operating or maintenance gangways for authorised persons. This is a completely new section. The current requirements for accessibility of electrical equipment in BS 7671:2008 are contained in Fundamental Principles in Chapter 13.

Regulation 132.12 states: *Electrical equipment shall be arranged so as to afford as may be necessary:*

(i) sufficient space for the initial installation and later replacement of individual items of electrical equipment (ii) accessibility for operation, inspection, testing, fault detection, maintenance and repair.

Regulation 15 of the Electricity at work Regulations has requirements for working space, access and lighting and requires that, for the purposes of enabling injury to be prevented, adequate working space, adequate means of access and adequate lighting shall be provided at all electrical equipment on which or near which work is being done in circumstances which may give rise to danger. Regulation 14 is concerned with work on or near any live uninsulated conductors.

Section 719 - Lighting installations for advertising signs

The current draft of Section 719 includes detailed requirements relating to lighting installations for advertising signs. The draft at present appears to be on the borderline between installation rules and product requirements. This is possibly because these types of products have to be erected and built on site. The current draft of Section 719 includes requirements for protection against electric shock, protection against thermal effects, protection against fire, external influences, identification, wiring systems, voltage drop, electrical connections, equipment - including light sources and testing and inspection.

For example, please see below an extract of clause 719.4 and 719.512.2:

719.41 Protection against electric shock

719.41.A Provisions for basic protection (protection against direct contact)

719.41.A.2 Barriers or enclosures

719.41.A.2.1 Additional mechanical protection shall consist of an enclosure or other means of protection conforming to the following:

a) It shall provide a degree of protection corresponding to at least IP 2X as specified in EN 60529, Table 1.

NOTE 1 The requirements for protection against ingress of solid objects, specified in EN 60529, Table 2, do not apply.

b) If it is constructed from metal parts, these shall be earthed in accordance with clause 8, EN 50107-1.

NOTE 2 Good practice is to install a RCD in the mains supply.

c) If it is constructed from other materials, these shall be materials that have been certified by the supplier as suitable for use in the environment existing close to a tube electrode, LED- modules or any type of lamps. The installer shall obtain from the supplier a guarantee for the materials covering the expected lifetime of the installation.

NOTE 3 Suppliers of such materials should be informed of the temperature, ultraviolet (UV) radiation, ozone and other conditions existing near a tube electrode, LED- modules or any type of lamps. They should also be informed that such materials might be used in exterior situations.

d) Access to the interior of an enclosure shall be by means of a tool, e.g. a screwdriver.

NOTE 4 Other means of additional protection may be permanent, e.g. it may have to be cut away using a knife.

NOTE 5 A fully enclosed sign letter or box sign is considered to be a suitable enclosure for this purpose.

719.41.A.2.2 Additional requirement.

In the case of an illuminated sign with discharge tubes, the connections of the electrodes shall be covered with insulating sleeves or heat shrinkable tubes. These insulating sleeves or shrinkable tubes shall be made of a suitable insulating material which is resistant to the operating voltage, an operating temperature of not less than 180°C, UV radiation and ozone.

NOTE 1 This requirement is intended to prevent a person from touching a live electrode with a test probe, should the discharge tube be broken.

NOTE 2 Figures 1 and 2 show the cross sections of different letter and sign boxes.

719.512.2 External influences

719.512.2.X Drain holes

In sign enclosures intended for external use, arrangements shall be made to allow moisture to drain away. Drain holes or similar apertures used for this purpose shall be sufficiently large, at least 7 mm in diameter, to ensure that they do not get blocked with dirt or debris between maintenance

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visits and to maintain the degree of protection.

As mentioned previously, Section 719 is still at an early stage of development in CENELEC and will require further work by the CENELEC team involved before it is published as a Harmonized Document which is probably two years away.

Section 729 – Operating or maintenance gangways

The scope of this draft Section 729 applies to basic protection and other aspects in restricted access areas with switchgear and controlgear assemblies, including requirements for operating or maintenance gangways.

Please note the following are draft requirements only at this stage and should not be worked to at present.

Where the gangway has unprotected live parts arranged on one side only Clause 729.410.3.7.1 states:

Where the gangway has unprotected live parts arranged on one side only, the minimum distances shall be:
a) width of gangway between the wall and live parts 1000 mm;
b) free passage in front of controls (handles, etc.) 700 mm;
c) height of live parts above the floor 2 500 mm.

Where the gangway has live parts on both sides Clause 729.410.3.7.2 states:

Where the gangway has live parts on both sides the minimum distances shall be:
a) width of gangway between live parts 1 300 mm;
b) minimum distance between the front of the handle and the live parts on the opposite side of the gangway 1 100 mm;
c) minimum free passage in front of controls (handles, isolation position of circuit-breakers, etc.) 900 mm;
d) height of live parts above the floor 2 500 mm.

Clause 729.513.2.3 also has requirements for Access of gangways.

Accessibility

Clause 729.513 requires that the width of gangways and access areas shall be adequate for work, operational access, emergency access, emergency evacuation and for the movement of equipment.

In restricted access areas where the protective measure of barriers or enclosures applies Clause 729.513.2.1 gives the following minimum distances:

a) width of gangways with barriers or enclosures between switch handles 600 mm and circuit- breakers in position "isolation" or switch handles and the wall
b) width of gangway between barriers or enclosures and other barriers or 700 mm enclosures, or barriers or enclosures and the wall
c) height of panelling above the floor 2 000 mm;
d) height of live parts above the floor 2 500 mm.

In restricted access areas where the protective measure of obstacles applies Clause 729.513.2.2 gives the following minimum distances:

a) width of gangway between obstacles and switch handles, or 700 mm obstacles and the wall, or switch handles and the wall
b) height of panelling above the floor 2 000 mm
c) height of live parts above the floor 2 500 mm

Annex A

Annex A contains a number of requirements for closed restricted access areas in order to permit easy evacuation. These include:

- the doors of any equipment inside the location shall close in the direction of the evacuation route.
- Gangways shall permit equipment doors or hinged panels to be opened to a minimum of 90°
- For doors which can be fixed in the open position or circuit-breakers or equipment which are withdrawn fully for maintenance (position: completely extracted) a minimum distance of 500 mm shall be provided between the door edge or circuit breaker/equipment edge and the opposite side of the gangway.
- Minimum passing width.

Annex C

Annex C contains additional information for closed restricted access areas such as requirements for ventilation, air conditioning, construction and lighting.

Important: The UK has a Special national condition relating to clause 729.410.3.7 which states:

In the UK where the gangway has unprotected live parts refer to UK Government guidance on the Electricity at Work Regulations 1989, Statutory Instrument 1989 number 635, guidance document HSR 25.

Therefore this UK special national condition will take preference over the requirements of clause 729.410.3.7 of the Harmonized document.

The HSE guidance document HS(R) 25 explains that the purpose of regulation 15 is to ensure that sufficient space, access and adequate illumination are provided while persons are working on, at or near electrical equipment in order that they may work safely.

HSR 25 also makes reference to Regulation 14 which is concerned with work on or near live conductors which an open switchboard would constitute.

Regulation 14 of the Electricity at work Regulations states that:

No person shall be engaged in any work activity on or near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless:

(a) it is unreasonable in all circumstances for it to be dead; and
(b) it is reasonable in all the circumstances for him to be at work on or near it while it is live; and
(c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

The UK National Committee have established a Working Group to draft Section 729 for including in Amendment number 1 of BS 7671:2008 and therefore the requirements of the electricity at work regulations and guidance document HS(R) 25 will be taken into account.

Conclusion

A future amendment to the IEE Wiring Regulations (BS 7671:2008) incorporating Section 729 is expected in 2011. ■

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Cables for temporary electrical installations

by Mark Coles

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

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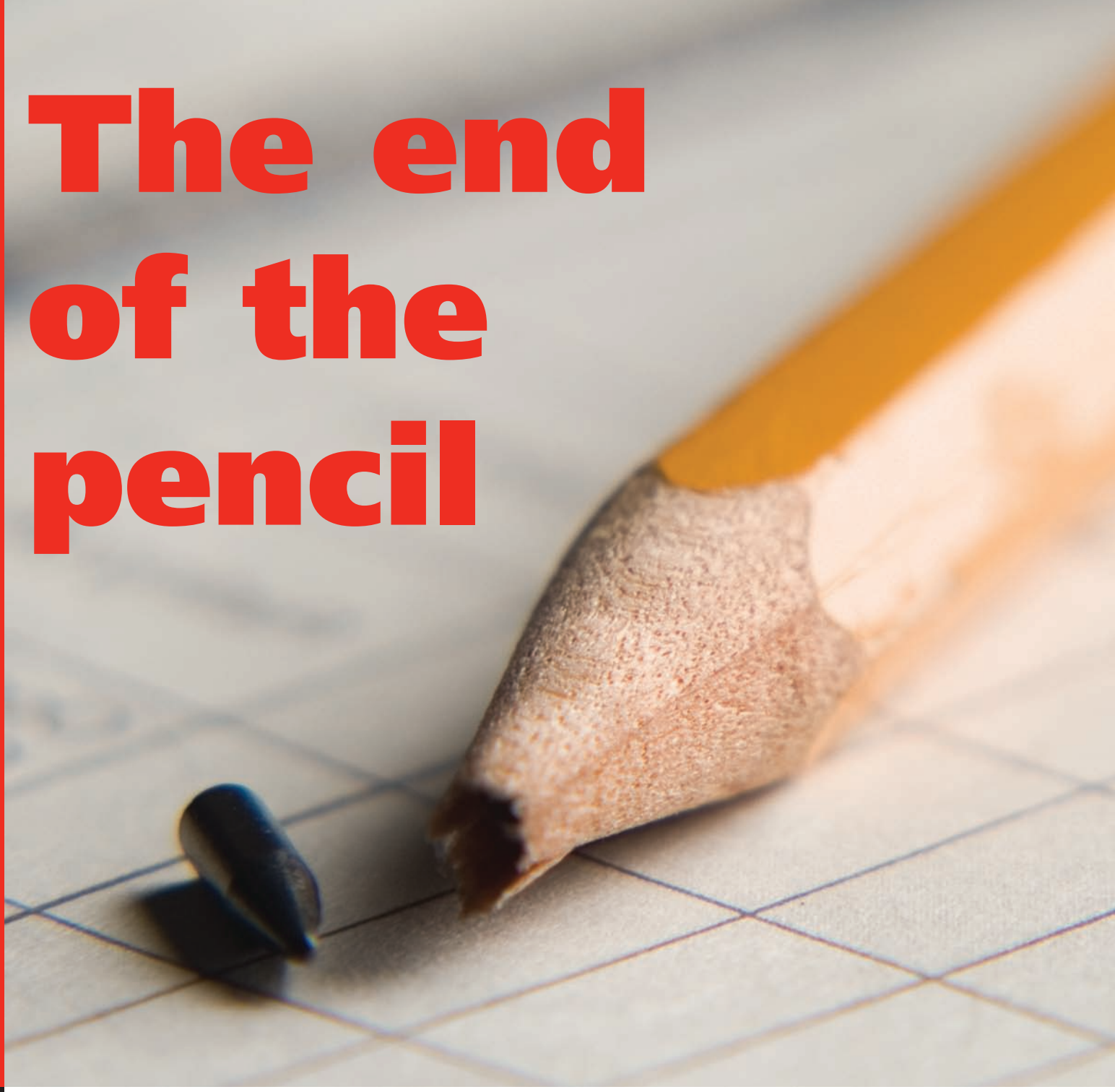

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Regulation	Cable requirements and text of the Regulation
704.522.8.11	For reduced low voltage systems, low temperature 300/500 V thermoplastic (BS 7919) or equivalent flexible cables shall be used. For applications exceeding reduced low voltage, flexible 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: - a plug as specified in BS EN 60309-2; - a flexible cable type H07RN-F (BS 7919) or equivalent, with a protective conductor and having the following characteristics: length: 25 m maximum - for current rating 16A: minimum cross-sectional area: 2.5 mm^2. 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 - colour identification in accordance with Table 51. - 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: (i) Thermoplastic or thermosetting insulated only cable (BS 6004, BS 7211, BS 7919) installed in conduits in accordance with BS EN 61386-1 (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: (i) A plug complying with BS EN 60309-2, and (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 (iii) a connector, if any, compatible with the appliance inlet installed under Regulation 721.55.1. Table 721 - Minimum cross-sectional areas of flexible cords and cables for caravan connection
	Rated current A / **Minimum cross-sectional area mm^2** 16 / 2.5 25 / 4 32 / 6 63 / 16 100 / 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 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. The routes of cables buried in the ground shall be marked at suitable intervals. Buried cables shall be protected against mechanical damage. 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. NOTE 2: Where mechanical protection of cables is provided: - 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. - cable trunking systems and cable ducting systems shall comply with BS EN 50085 series with a classification 5 J regarding protection against impact. 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. 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.

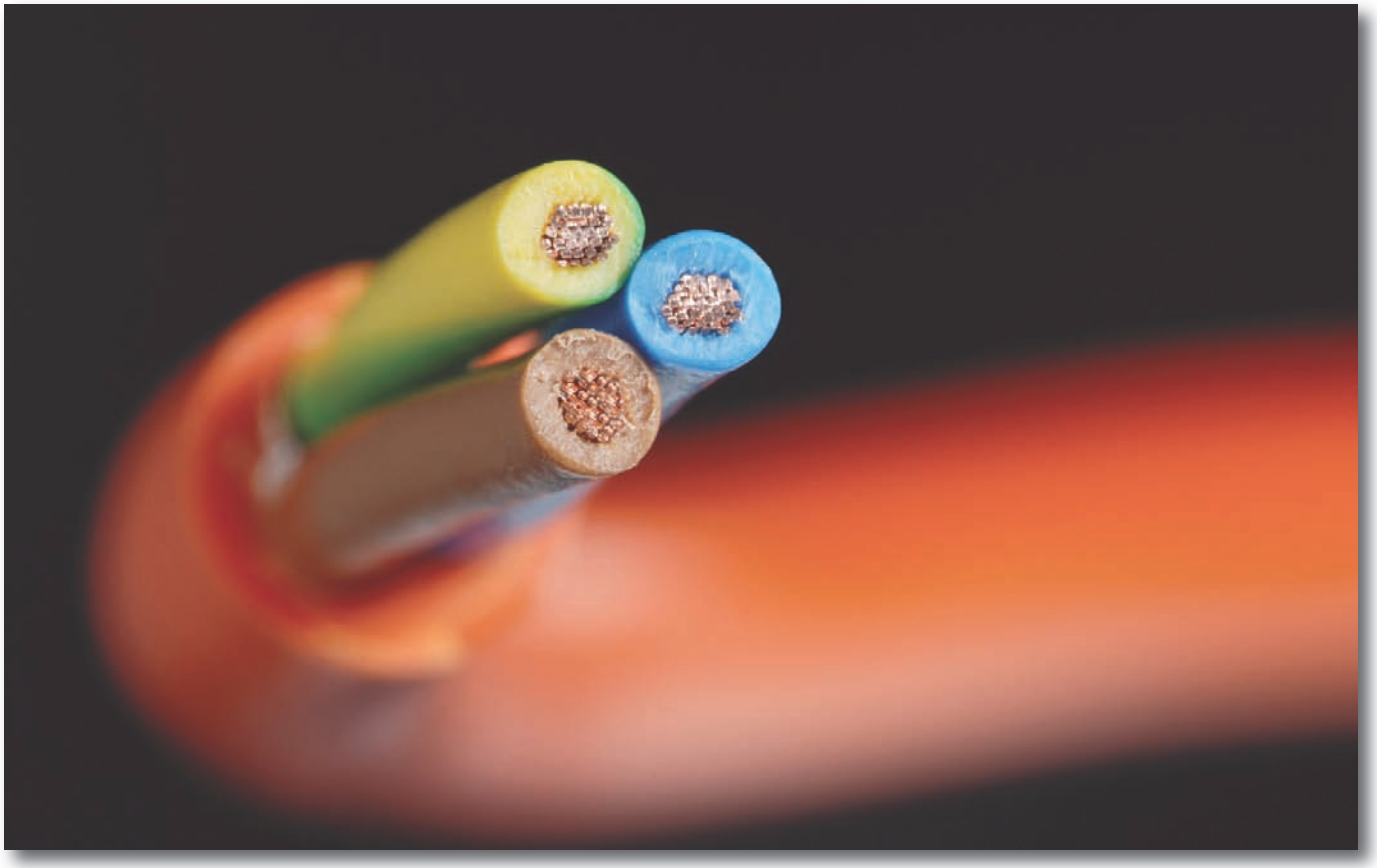
The cable can often be seen supplying caravans or used at live musical events, it can even be purchased from DIY shops in the form of a ready-made extension reel with BS 1363 13 A accessories for use at 230 V 1Ø. As can be seen from Table 7B of BS 7540, the cable was not designed for and is not suitable 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: — use on ELV systems (110 V centre tapped) on building sites in the UK; — use with temporary traffic light systems when suitably protected. The cables are not suitable for: — outdoor use at standard voltages — 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 ■



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The requirements for provision of information and documentation within BS 7671

by Jon Elliott

This article seeks to bring to the reader's attention to the many requirements within the 17th Edition relating to provision of information considered necessary for the safe and effective use of electrical installations. It summarises the fundamental requirements for provision of information and documentation laid down in Chapter 13, highlights particular situations where the requirements for identification and notices given in Section 514 apply and states the identification and labelling requirements specific to isolation and switching.

In the next edition of *Wiring Matters*, we will concentrate on the specific requirements for safety services, special installations and locations and the information items which relate to inspection, testing and reporting.

A number of new requirements have been introduced in the 17th Edition which will be discussed at the appropriate place within these articles.

Introduction

Ever since the First Edition of the Wiring Regulations was published, there have been requirements for the identification of potential hazards relating to an electrical installation. As installations increase in complexity the number of instances requiring clear identification and labelling has also increased and, as BS 7671 expands to encompass a greater number of special installations and locations, the need to leave behind concise instructions for users of the installation and others who may work on or near the installation in the future becomes greater.

The vast majority of requirements relating to the provision of identification and warning notices appear in Section 514 and are therefore assumed to be relatively familiar to users of BS 7671. As such, the majority of requirements therein will not be discussed in any real detail in this article.

Fundamental requirements

Chapter 13 lays down the fundamental requirements for electrical installations. Within this chapter there are a number of requirements pertinent to this article.

Regulation 132.2 requires the person(s) responsible for the design of an installation to obtain, by various means, information relating to the characteristics of the supply arrangement. These details along with all other relevant documentation specific to the installation are required to be made available on completion of work by Regulation 132.13. Regulation 134.1.3 gives the fundamental requirements for the identification of conductors and, where necessary terminals, while Regulation 134.1.7 calls for the provision of warning signs and notices as a measure to minimise the risk of danger or injury to persons working on or otherwise using the installation.

Protection against shock

The 17th Edition gives greater recognition to the use of double or reinforced insulation as a protective measure within an installation. Regulation 412.2.1.1 requires Class II equipment to be identified by the following symbol:

Regulations 412.2.1.2 and 412.2.1.3 call for the following symbol to be displayed when supplementary or reinforced

The protective conductors associated with the electrical installation in this location MUST NOT BE CONNECTED TO EARTH.

Equipment having exposed-conductive-parts connected to earth must not brought into this location.

CAUTION

This installation has wiring colours to two versions of BS 7671. Great care should be taken before undertaking extension, alteration or repair that all conductors are correctly identified.

insulation is applied to equipment:

Regulation 412.2.4.1 states that neither of the above symbols should be displayed on a wiring system being used where double or reinforced insulation is being employed to provide basic and fault protection.

Barriers and enclosures are widely employed in installations as a means of preventing contact with live parts. If a barrier or enclosure prevents access to equipment, such as a capacitor, which may retain an electrical charge sufficient to pose a danger after being switched off then Regulation 416.2.5 requires a warning label to be displayed warning of this risk on said barrier or enclosure.

The protective measure of earth-free local equipotential bonding is not widely used, indeed, is only to be used in special circumstances. Earth-free local equipotential bonding may only be employed in parts of an installation controlled by, or under the supervision of skilled or instructed persons.

Nevertheless, there remains a significant risk of the protective measure being rendered ineffective by the introduction of a connection to Earth by those not familiar with it. As such Regulation 418.2.5 requires the warning notice, which appears in Regulation 514.13.2, to be displayed in a prominent position at every point of access to an area so protected. See above, top.

This warning notice is also required to be displayed in a similar manner and for the same reasons, by Regulation 418.3 at all points of entry to an area where, another relatively infrequently employed protective measure, electrical separation to supply two or more items of equipment, is being employed.

Common rules

The general requirements relating to identification and labelling are dealt with in the 514.1 group of regulations which require, except where no possibility of confusion exists, the provision of clear and unambiguous marking of each item of switchgear and controlgear (Regulation 514.1.1 refers), wiring (514.1.2) and at the point of connection between conductors identified in accordance with 17th Edition requirements and those requirements of earlier versions of The Regulations (514.1.3). In the case of installations containing wiring which has been identified in accordance with more than one Edition of BS 7671, Regulation 514.14.1 requires the warning notice (shown left bottom) to be posted on or near the relevant distribution board. Reference can be made to Appendix 7 if further guidance is required on this matter.

Although rarely seen in installations, where it is considered necessary to be able to distinguish electrical conduits from other building services, Regulation 514.2 requires such a conduit to be coloured orange.

In general, the cores of cables should be identified by colour and/or lettering and/or numbering (514.3.1 refers) in accordance with Table 51, which is reproduced overleaf.

Regulation 514.4.2 gives a number of requirements for protective conductors, perhaps the most important of which being that single core cables coloured green/yellow throughout their length should not be used for any purpose other than as a protective conductor and may not be over-marked at their terminations other than to aid circuit identification as permitted by Regulation 514.5.2.

WARNING - DUAL SUPPLY

Isolate both mains and on-site generation before carrying out work.

Isolate the mains supply at . . . . . .

Isolate the generator at . . . . . .

Where an installation contains PEN conductors, Regulation 514.4.3 requires them to be either identified by:

- green-and-yellow throughout their length with blue markings at the terminations
- blue throughout their length with green-and-yellow markings at the terminations

Regulation 514.4.6 states that bare conductors, which should be identified in accordance with Table 51, may be so identified by the application of tapes, sleeves, discs or paint. Regulation 514.4.5 prohibits the use of the single colour green.

Regulation 514.6 states that identification by colouring or numbering is not required for:

- concentric conductors
- the metal sheath or armouring of cables being used as a protective conductor
- bare conductors in situations where permanent identification is not practicable
- exposed-conductive-parts and extraneous-conductive-parts used as a protective conductor

All protective devices such as fuses, circuit-breakers and RCDs are required to be so arranged or identified such that the circuit which they protect can be identified by Regulation 514.8.1.

Regulation 514.9.1 describes those items of information which should be provided, preferably in close proximity to the relevant part of the installation, detailing the type of wiring and nature of each circuit, methods used to provide basic and fault protection, sufficient information to allow the correct identification of isolation and switching devices and equipment or circuits considered to be vulnerable if particular tests were to be carried out.

Regulation 514.10 contains requirements for the application of warning notices in situations where a nominal voltage exceeding 230 volts exists and would not normally be expected.

When an installation contains one or more RCDs, which is increasingly the case, a label reminding the user of the installation to press the integral test button quarterly (every 3 months) is required by Regulation 514.12.2. An explanation of the use of the integral test facility of an RCD is required by Regulation 721.515.1, amongst other instructions, to advise the user of a caravan. However, it should be noted that the requirements for periodic testing and periodic operation of the integral test facility of RCDs are not applicable to installations for outdoor (amenity) lighting, highway power supplies and street furniture where said installations are subject to a programmed inspection and testing procedure (559.10.7.1 refers).

According to Regulation 514.13.1 a label to BS 951 carrying the wording *SAFETY ELECTRICAL CONNECTION - DO NOT REMOVE* should be installed wherever a connection is made with:

- an earthing conductor and an earth electrode
- a bonding conductor and an extraneous-conductive-part
- the main earthing terminal and marshalling terminals where these are separate from the main switchgear

Where a distribution board has wired from it circuits having a high protective conductor current, Regulation 543.7.1.5 requires these circuits to be identified such that anyone carrying out alterations and/or additions at said distribution board in the future is aware of their presence.

Isolation and switching

Understandably, the 17th Edition contains a number of requirements relating to identification and labelling in relation to isolation and switching and these are summarised below. In situations where it is not possible for live parts to be isolated by a single device, Regulation 514.11 requires the posting of a warning notice stating this. This requirement is expanded upon in Regulation 537.1.6.

In installations which include a generator which can be used in parallel as an additional source of supply, Regulation 514.15 requires the warning notice shown above to be posted at:

- the origin of the installation
- the meter position if situated remote from the origin
- the distribution board or consumer unit to which the generator is connected
- ALL points of isolation provided for BOTH sources of supply

Regulation 537.2.1.3 requires that when an installation, an enclosure, or an item of equipment contains live parts which are connected to more than one supply and unless an interlock arrangement has been provided to disconnect all such supplies before access to live parts can be achieved, a warning notice informing persons of this situation should be displayed in a prominent position.

Isolators are provided to put a deliberate break in conductors in order to disconnect the supply from those downstream parts of the installation. If the position of the contacts or other means of providing this break in continuity is not externally visible (which is not common in modern switchgear), a clear and reliable indication of their position, which occurs only once the isolated position has been achieved, must be provided (537.2.2.2 refers). Regulation 537.2.2.6 requires that the purpose of every device that is to be used to provide isolation should be clear either as a direct result of its position, as would be the case with an isolator forming an integral part of an item of equipment, or as a result of labelling, which would be appropriate where an isolator was mounted in a location remote to the item of equipment which it controlled.

In such a case it would, in all but the most simple of installations, be necessary to place a notice local to both the isolator and the item of equipment in question.

Switching off for mechanical maintenance is a function similar to isolation whereby electrically actuated

equipment is made safe for persons to work on, in, or near, whether or not they are electrically skilled.

Where a device is provided for this purpose, Regulation 537.3.2.4 requires it to be so placed and marked such that its purpose is apparent and such it can be used as intended. A similar requirement applicable to devices provided for emergency switching in given in Regulation 537.4.2.7.

Part 2 defines emergency switching as "an operation intended to remove, as quickly as possible, danger, which may have occurred unexpectedly".

Regulation 537.6.4 requires that firefighter's switches must be coloured red. It also requires an identification plate with the wording *FIREFIGHTER'S SWITCH* of specified overall dimensions and letter size to be placed on, or close to, said switch. Its ON and OFF positions must be clearly identifiable by a Person standing in front of it as installed, the OFF position being at the top. If more than one firefighter's switch is installed on a building, Regulation 537.6.3 (iv) requires those parts of the installation so controlled to be clearly stated alongside the appropriate device.

Section 559.10 gives requirements for outdoor lighting installations, highway power supplies and street furniture. Regulation 559.10.7.2 requires a label to be placed externally on any temporary supply unit stating the maximum sustained current which may be supplied by said unit.

In the next issue of *Wiring Matters*, we will concentrate on the identification and labelling requirements for safety services, inspection and testing and special installations and locations. ■

Function	Alphanumeric	Colour
Protective conductors		Green-and-yellow
Functional earthing conductor		Cream
AC power circuit (1)		
Line of single-phase ciruit	L	Brown
Neutral of single or three-phase circuit	N	Blue
Line 1 of three-phase AC circuit	L1	Brown
Line 2 of three-phase AC circuit	L2	Black
Line 3 of three-phase AC circuit	L3	Grey
Two-wire unearthed DC power circuit		
Positive of two-wired circuit	L+	Brown
Negative of two-wired circuit	L-	Grey
Two-wire earthed DC power circuit		
Positive of (negative earthed) circuit	L+	Brown
Negative of (negative earthed) circuit(2)	M	Blue
Positive of (positive earthed) circuit(2)	M	Blue
Negative of (positive earthed) circuit	L-	Grey
Three-wire earthed DC power circuit		
Outer positive of two-wire circuit derived from three-wire system	L+	Brown
Outer negative of two-wire circuit derived from three-wire system	L-	Grey
Positive of three-wire circuit	L+	Brown
Mid-wire of three-wire circuit(2)(3)	M	Blue
Negative of three-wire circuit	L-	Grey
Control circuits, ELV and other applications		
Line conductor	L	Brown, Black, Red, Orange, Yellow, Violet, Grey, White, Pink or Turquoise
Neutral or mid-wire(4)	N or M	

NOTES:
(1) Power circuits include lighting circuits
(2) M identifies either the mid-wire of a three-wire DC circuit or the earthed conductor of a two-wired earthed DC circuit
(3) Only the middle wire of three-wire circuits may be earthed
(4) An earthed PELV conductor is blue

Table 51: Identication of conductors

The Institution prepares regulations for the safety of electrical installations for buildings, the IEE Wiring Regulations (BS 7671), which has now become the standard for the UK and many other countries. It has also prepared the Code of Practice for Installation of Electrical and Electronic Equipment In Ships (BS 8450) and recommends, internationally, the requirements for Mobile and Fixed Offshore Installations. The Institution provides guidance on the application of BS 7671 through publications focused on the various activities from design of the installation through to final test and certification with further guidance for maintenance. This includes a series of eight Guidance Notes, two Codes of Practice and model forms for use in wiring installations.

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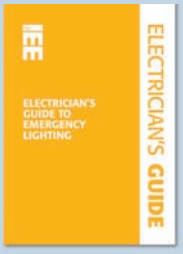

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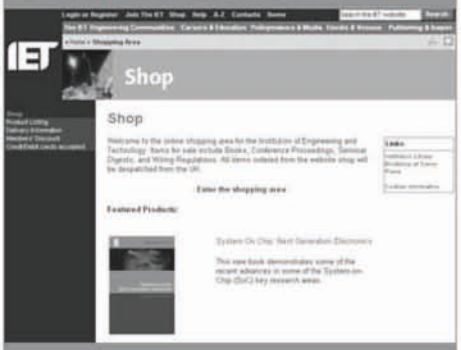

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Protection against **Electric Shock**

by Paul Bicheno

This article is the second part of two that looks at summarising protective measures applied to special installations or locations defined in Part 7 of the 17th Edition of the IEE wiring Regulations (BS 7671:2008). In particular, this article looks at Sections 712 to 753.

One of the fundamental principles for electrical installations is protection for safety (Section 131) in which Regulation 131.2 Protection against electric shock requires protection to prevent a person or livestock coming into contact with live parts by the provision of basic protection (direct contact) as well as fault protection (indirect contact) to prevent an electric shock when an exposed conductive part becomes live due to a fault. The technical requirements of this principle are dealt with in Part 4 of the Regulations by Chapter 41 "Protection Against Electric Shock". This chapter highlights four protective measures that are generally permitted (Regulation 410.3.3);

- Automatic disconnection of supply (Section 411)
- Double or reinforced insulation (Section 412)
- Electrical separation for the supply to one item of current using equipment (Section 413)
- Extra –low voltage SELV and PELV (Section 414)

The application of one or more of these protective measures in an installation needs to take into account the external influence. Section 415 also gives requirements to provide additional protection by the provision of a residual current device (RCD) and supplementary equipotential bonding for certain conditions, including special installations or locations. For special installations or locations there are particular requirements for each Section that either supplement or modify the requirements of the protective measures defined in Chapter 41. Table 1 overleaf summarises the application of the above protective measures for the listed special installations or locations, highlighting the specific supplementary or modified requirements for a protective measure. In certain instances there are additional general requirements as well as additional protection (Section 415) requirements which enhance the protective measures.

In addition to the general protective measures already highlighted there is the protective measure of obstacles and placing out of reach (Section 417). It is worth highlighting that this is a protective measure that only provides basic protection and would only be applicable in installations that are restricted to skilled or instructed persons under the supervision of skilled persons. There are also other protective measures that are applicable in an installation that is controlled or under the supervision of

	Automatic Disconnection of Supply (411)	Double or Reinforced Insulation (412)	Electrical Separation –supplying single item of equipment (413)	Extra Low Voltage (414)	General Requirements and Additional Protection (415)
Solar photovoltaic (PV) power supply systems (712)	On the a.c side of the PV system, the PV supply cable is to be connected to the supply side of the protective device for automatic disconnection of circuits supplying current using equipment. Where the PV power supply system does not provide at least simple separation between the a.c side and d.c side, an RCD shall be installed for fault protection. This shall be a type B to IEC 60755 amendment 2. However the RCD is not required if the PV convertor is not able to feed d.c fault currents into the electrical installation.	Protection by the use of Class II or equivalent insulation shall preferably be adopted on the d.c side of the PV system.	General requirements of this Section apply if this measure is used.	Applying this measure means the nominal voltage Uo is replaced for a PV system by the open circuit voltage under standard test conditions $U_{oc\ STC}$ and is not to exceed 120V d.c. (Uoc STC is the voltage across an unloaded PV module, PV string, PV array, PV generator or on the d.c side of the PV inverter).	PV equipment on the d.c side of a PV system shall be considered to be energized, even when the system is disconnected from the a.c side.
Mobile or transportable units (717)	Automatic disconnection of the supply is to be provided by an RCD. Accessible conductive parts of the unit shall be connected via finely stranded main protective bonding conductors to the main earthing terminal within the unit. A TN-C-S system shall not be used to supply the unit, unless the installation will be under continuous supervision by skilled or instructed persons and the suitability and effectiveness of the earthing has been confirmed before any connection is made. An IT system can be provided with particular requirements (see Regulation 717.411.6.2)	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	Socket outlets intended to supply current using equipment outside the unit are to be protected by a 30 mA RCD with the characteristics specified in Regulation 415.1.1. An exception to this requirement is if the socket outlets are supplied with protection by SELV, PELV or electrical separation.
Electrical installations in Caravans and motor caravans (721)	Use of this measure requires a 30 mA RCD (complying with BS EN 61008-1 or BS EN 61009-1) with the characteristics specified in Regulation 415.1.1. The wiring system is to include a circuit protective conductor connected to the protective contact of the caravan supply inlet, exposed conductive parts of the electrical equipment and the protective contacts of the caravan socket outlets. Structural metallic parts which are accessible from within the caravan shall be connected via main protective bonding conductors to the main earthing terminal within the caravan. The use of a TN-C-S system is not permitted as a supply to a caravan.	General requirements of this Section apply if this measure is used.	Not permitted except for shaver socket outlets	General requirements of this Section apply if this measure is used.	Any part of a caravan installation operating at extra-low voltage is to comply with Section 414 (Protective Measure: Extra-low voltage provided by SELV or PELV). For extra-low voltage d.c power sources the nominal voltages of 12V, 24V and 48V are generally applicable. (48V is not to be exceeded). If a.c extra-low voltage is required the nominal rms voltages of 12V, 24V, 42V and 48V are generally applicable.
Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses (740)	Where RCDs are used in a supply to an a.c motor they should be of the time delayed type (BS EN 60947-2) or S-type (BS EN 61008-1 or BS EN 61009-1) to prevent unwanted tripping. Where the type of system earthing is TN, a protective earthed neutral (PEN) conductor shall not be used downstream of the origin of the temporary electrical installation. An IT system shall not be used if an alternative is available. IT systems can be used for d.c applications if continuity of service is needed.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	General requirements of this Section apply if this measure is used.	One or more RCDs not exceeding 300 mA are to be provided at the origin of the installation. The RCD is to incorporate a time delay (BS EN 60947-2) or be of the S-type (BS EN 61008-1 or BS EN 61009-1) to provide discrimination where final circuit RCDs are installed. Final lighting circuits, socket outlet circuits up to 32A and mobile equipment connected by means of a flexible cable or cord up to 32A shall be protected by 30 mA RCDs with the characteristics specified in Regulation 415.1.1. The supply to a battery operated emergency lighting circuit is to be connected to the same RCD protecting the lighting circuit. An RCD is not required for circuits protected by SELV or PELV, circuits protected by electrical separation or lighting circuits placed out of arm's reach provided they are not supplied by socket outlets for household or similar purposes or socket outlets according to BS EN 60309-1. In locations intended for livestock, supplementary bonding is required to connect all exposed conductive parts and extraneous conductive parts that can be touched by livestock. This is to include a metal grid if installed in the floor of the location. Extraneous conductive parts in, or on a floor e.g. reinforced concrete are to be connected to the supplementary equipotential bonding. It is recommended that spaced floors made of prefabricated concrete elements be part of the equipotential bonding. This is to erected and protected against mechanical stresses and corrosion.
Floor and ceiling heating systems (753)	An RCD with a rated residual operating current not exceeding 30 mA is to be used as a disconnecting device. For heating units without exposed conductive parts a conductive covering e.g. a grid with a spacing of not more than 30mm is to be provided above the floor heating elements or under ceiling elements and connected to the protective conductor of the electrical installation	General requirements of this Section apply if this measure is used.	Not permitted	General requirements of this Section apply if this measure is used.	A circuit supplying heating equipment of Class II construction or equivalent insulation requires additional protection by a 30 mA RCD with the characteristics specified in Regulation 415.1.1
Note:	A number of references are made to an RCD with the characteristics specified in Regulation 415.1.1. This describes the requirement for an RCD to have a rated residual operating current not exceeding 30 mA and an operating time not exceeding 40 ms at a residual current of 5 times the 30 mA rated residual operating current (e.g. trip in less than 40 ms at a residual current of 150 mA).				

Table 1 – Summary of the general protective measure requirements for Special installations or locations (712 to 753)

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	Obstacles and placing out of reach (417)	Non-conducting Location (418.1)	Earth free local equipotential bonding (418.2)	Electrical separation – supplying more than one item of equipment (418.3)
Solar photovoltaic (PV) power supply systems (712)	Permitted	Not permitted on the d.c side of the PV installation	Not permitted on the d.c side of the PV installation	(Note 1)
Mobile or transportable units (717)	Not permitted	Not permitted	Not recommended	(Note 1)
Electrical installations in Caravans and motor caravans (721)	Not permitted	Not permitted	Not permitted	(Note 2)
Temporary electrical installations for structures, amusement devices and booths at fairgrounds, amusement parks and circuses (740)	Use of obstacles is not permitted. Placing out of arm's reach is permitted for electric dodgems, provided they operate at voltages not exceeding 50V a.c or 120V d.c and are electrically separate from the supply via a transformer or generating set.	Not permitted	Not permitted	(Note 1)
Floor and ceiling heating systems (753)	Not permitted	Not permitted	Not permitted	Not permitted
Note 1:	Although the use of this measure is not specifically restricted by a Regulation in Part 7 for this location this method of protection is not recognised for general application and is only to be applied where the installation is under the supervision of skilled or instructed persons so that unauthorized changes cannot be made.			
Note 2:	Although the use of this measure is not specifically restricted by a Regulation in Part 7 for this location there are specific restrictions in the use of electrical separation supplying only a single piece of equipment for this location that effectively restricts the use of this measure (refer to Electrical Separation for this specific location in Table 1).			

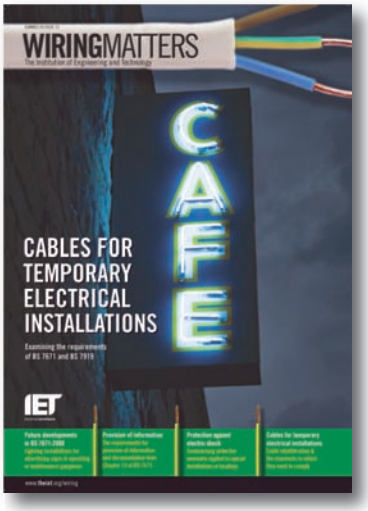
Table 2 – Specific protective measures applied to special installations or locations (712 to 753)

skilled or instructed persons (Section 418) to avoid unauthorized changes, these are:

■ Non-conducting location (Section 418.1)
■ Earth-free equipotential bonding (Section 418.2)
■ Electrical separation for the supply to more than one item of current using equipment (Section 418.3)
Each of these protective measures requires all electrical equipment to have basic protection in compliance with Section 416 along with specific requirements for each to provide fault protection.

Due to the nature of these types of protective measures there are a number of restrictions in relation to special installations or locations. Table 2 summarises the application of the above protective measures for the listed special installations or locations.

The IET Guidance Note 7 – Special Locations deals with special installations or locations. This is being aligned and updated to the 17th Edition and will provide additional guidance to the information provided here. ■



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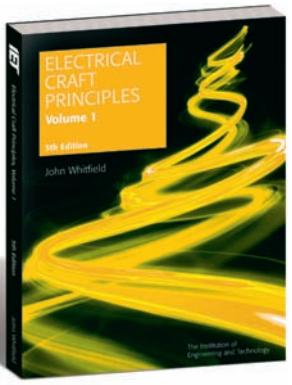

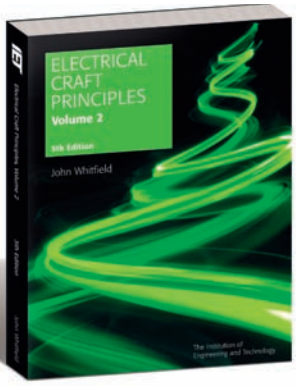

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