



WIRING MATTERS

Summer 08 Issue 27

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concealed in a wall or partition

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Requirements for cables concealed in a wall or partition – A brief overview

by Geoff Cronshaw

A new series of Regulations (522.6.6 - 522.6.8) have been introduced in the 17th Edition of the IEE Wiring Regulations concerning cables concealed in a wall or partition. These new Regulations introduce the concept of skilled person, instructed person and ordinary person.

RCD PROTECTION

It is now a requirement to protect cables concealed in a wall or partition (at a depth of less than 50 mm) by a 30 mA RCD where the installation is not intended to be under the supervision of a skilled or instructed person where other methods

of protection, including the use of cables with an earthed metallic covering, earthed conduit/trunking or mechanical protection, can not be employed.

Irrespective of the depth, a cable in a partition where the construction includes metallic parts other than fixings shall be protected by a 30 mA RCD.

For example, this means that in a domestic installation, where insulated and sheathed cables are concealed in a wall at a depth of less than 50 mm and have no mechanical protection, they need to be installed within the safe zones and protected by a 30 mA RCD.

DEFINITIONS

Skilled person

A person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create.

Instructed person

A person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create.

Ordinary person

A person who is neither a skilled person nor an instructed person.

WIRING SYSTEMS

To conform with the requirements of BS 7671, wiring systems must utilise cables complying with the relevant requirements of the applicable British Standard or Harmonised Standard.

Alternatively, if equipment complying with a foreign national standard, based on an IEC Standard is to be used, the designer or other person responsible for specifying the installation must verify that any differences between that standard and the corresponding British Standard or Harmonised Standard will not result in a lesser degree of safety than that afforded by compliance



Figure 1: RCBO – Residual current circuit-breaker with overcurrent protection



Figure 2: RCCB - Residual current circuit-breaker

with the British Standard.

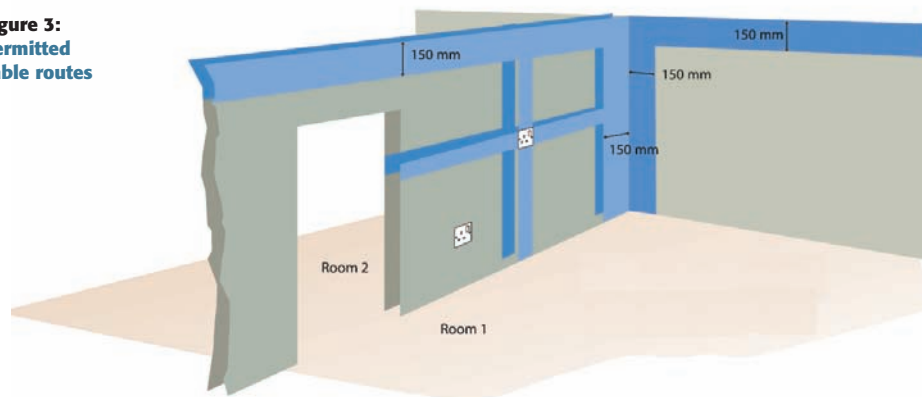
The effect of environmental conditions and general characteristics around various parts of the installation must be assessed to enable suitable electrical equipment, including the wiring system, to be specified.

For example, cables and equipment used in agricultural and horticultural premises should be installed away from areas or routes used by animals or be of a type to withstand such attack.

Any part of the fixed installation which may be exposed to a severe impact must be able to survive it. In workshops, for example, where heavy objects are moved, installation of wiring systems in traffic routes should be avoided or localised protection must be provided.

Therefore, when designing a concealed installation, the designer must select a suitable wiring system. Under the 17th Edition, depending on the type of wiring selected, the method of installation

Figure 3:
Permitted
cable routes



and whether the installation will be under the control of a skilled person, or instructed person or ordinary person will depend whether the concealed wiring will require RCD protection or not.

For example, in a domestic installation, where insulated and sheathed cables are concealed in a wall at a depth of less than 50 mm and have no mechanical protection, they need to be installed within the safe zones and need to be protected by a 30 mA RCD.

Regulations 522.6.6 and 522.6.8 are reproduced here for information.

522.6.6 A cable concealed in a wall or partition at a

depth of less than 50 mm from a surface of the wall or partition shall:

- (i) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or
- (ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of these Regulations for a protective conductor, or
- (iii) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of these

Regulations for a protective conductor, or
(iv) be mechanically protected against damage sufficient to prevent penetration of the cable by nails, screws and the like, or
(v) be installed in a zone within 150 mm from the top of the wall or partition or within 150 mm of an angle formed by two adjoining walls or partitions. Where the cable is connected to a point, accessory or switchgear on any surface of the wall or partition, the cable may be installed in a zone either horizontally or vertically, to the point, accessory or switchgear. Where the location of the accessory, point or switchgear can be



Wiring Matters is produced by IET Services Limited, a subsidiary of The Institution of Engineering and Technology (IET), for the IET. Michael Faraday House, Six Hills Way, Stevenage, Herts, SG1 2AY, United Kingdom Tel: +44 (0)1438 313311 Fax: +44 (0)1438 313465

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IEE Wiring Matters is a quarterly publication from the Institution of Engineering and Technology (IET). The IET is not as a body responsible for the opinions expressed.

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Co-operating Organisations The Institution of Engineering & Technology acknowledges the contribution made by the following organisations in the preparation of this publication: British Electrotechnical & Allied Manufacturers Association Ltd – R Lewington, P D Galbraith, M H Mullins | Department for Communities and Local Government – I Drummond | Electrical Contractors Association – D Locke, S Burchell | City & Guilds of London Institute – H R Lovegrove | Energy Networks Association – D J Start | Electrical Contractors Association of Scotland SELECT – D Millar, N McGuinness | Health & Safety Executive – K Morton | Electrical Safety Council | ERA Technology Limited – M Coates | British Cables Association – C Reed | Scottish Building Standards Agency | DTI – D Tee | CORGI – P Collins | GAMBICA – M. Hadley, A. Sedhev | Lighting Association – K Kearney

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determined from the reverse side, a zone formed on one side of a wall of 100 mm thickness or less or partition of 100 mm thickness or less extends to the reverse side.

522.6.7 Where Regulation 522.6.6 applies and the installation is not intended to be under the supervision of a skilled or instructed person, a cable installed in accordance with Regulation 522.6.6 (v), and not complying with Regulation 522.6.6 (i), (ii), (iii) or (iv), shall be provided with additional protection by means of an RCD having the characteristics specified in Regulation 415.1.1.

522.6.8 Irrespective of the depth of the cable from a surface of the wall or partition, in an installation not intended to be under the supervision of a skilled or instructed person, a cable concealed in a wall or partition the internal construction of which includes metallic parts, other than metallic fixings such as nails, screws and the like, shall:

(i) incorporate an earthed metallic covering which complies with the requirements of these Regulations for a protective conductor of the circuit concerned, the cable complying with BS 5467, BS 6346, BS 6724, BS 7846, BS EN 60702-1 or BS 8436, or
(ii) be enclosed in earthed conduit complying with BS EN 61386 and satisfying the requirements of these Regulations for a

protective conductor, or
(iii) be enclosed in earthed trunking or ducting complying with BS EN 50085 and satisfying the requirements of these Regulations for a protective conductor, or
(iv) be mechanically protected sufficiently to avoid damage to the cable during construction of the wall or partition and during installation of the cable, or
(v) be provided with additional protection by means of an RCD having the characteristics specified in Regulation 415.1.1.

NOTE: If the cable is installed at a depth of 50 mm or less from the surface of a wall or partition the requirements of Regulation 522.6.6 also apply.

RCD PROTECTION

An RCD is a protective device used to automatically disconnect the electrical supply when an imbalance is detected between live conductors. In the case of a single-phase circuit, the device monitors the difference in currents between the line and neutral conductors. If a line to earth fault develops, a portion of the line conductor current will not return through the neutral conductor. The device monitors this difference, operates and disconnects the circuit when the residual current reaches a preset limit, the residual operating current ($I_{\Delta n}$). An RCD on its own does not provide protection against overcurrents. Overcurrent protection is provided by a

fuse or a circuit-breaker. However, combined RCD and circuit-breakers are available and are designated RCBOs.

Unwanted tripping

Unwanted tripping of RCDs can occur when a protective conductor current or leakage current causes unnecessary operation of the RCD. An RCD must be so selected and the electrical circuits so subdivided that any protective conductor current that may be expected to occur during normal operation of the connected load(s) will be unlikely to cause unnecessary tripping of the device.

Discrimination

Where two, or more, RCDs are connected in series, discrimination must be provided, if necessary, to prevent danger. During a fault, discrimination will be achieved when the device electrically nearest to the fault operates and does not affect other upstream devices. Discrimination will be achieved when 'S' (Selective) types are used in conjunction with downstream general type RCDs. The 'S' type has a built-in time delay and provides discrimination by simply ignoring the fault

for a set period of time allowing more sensitive downstream devices to operate and remove the fault. For example, when two RCDs are connected in series, to provide discrimination, the first RCD should be an 'S' type. RCDs with built in time delays should not be used to provide personal protection.

Labelling

Regulation 514.12.2 requires that where an installation incorporates an RCD a notice shall be fixed in a prominent position at or near the origin of the installation. The Regulation requires that the notice shall be in indelible characters not smaller than illustrated in BS 7671, see fig. 4.

Testing

Refer to Regulations 612.8.1, 612.13.1 and 415.1.1 for requirements in terms of verification of installed RCDs.

CONCLUSION

Under the 17th Edition, designers will now have to determine from the client whether the installation is going to be under the supervision of a skilled person, instructed person or ordinary person. ■

This installation, or part of it, is protected by a device which automatically switches off the supply if an earth fault develops. Test quarterly by pressing the button marked 'T' or 'Test'. The device should switch off the supply and should then be switched on to restore the supply. If the device does not switch off the supply when the button is pressed, seek expert advice.

Figure 4: Labelling requirement of 514.12.2

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Supplementary equipotential bonding

by Mark Coles

Courtesy of Yorkshire Water

Questions relating to the requirements for supplementary equipotential bonding are frequently asked; a very common one is *where* should it be installed.

This article looks at the requirements for supplementary equipotential bonding in BS 7671:2008, where supplementary equipotential bonding should be installed and offers help on the process of evaluation.

TERMINOLOGY

Firstly, it is important that the terminology is correct. Earthing and bonding are two different concepts yet the terms are often used together. Once we have established that "earth-bonding"* is a nonsensical expression and should never be used, we can look at the requirements of supplementary equipotential bonding in BS 7671:2008.

*Earthing and bonding are two separate concepts

Earthing

Connection of the exposed-conductive-parts of an installation to the main earthing terminal of that installation.

An example of earthing is where the metallic outer-case of a class I appliance is connected by the circuit protective conductor to the means of earthing providing a safe path for fault or high leakage/high protective conductor currents.

Equipotential bonding

Electrical connection maintaining various exposed-conductive-parts and extraneous-conductive-parts at substantially the same potential.

There are two types of equipotential bonding conductor:

Main protective bonding conductor *Used to connect extraneous-conductive-parts, such as a metallic water pipe, to the main earthing terminal.*

Supplementary equipotential bonding conductors *Used to supplement to fault protection by maintaining various exposed conductive-parts and extraneous-conductive-parts at substantially the same potential, such as the connection of all exposed-conductive-parts and extraneous-conductive-parts that can be touched by livestock in an agricultural installation.*

HISTORY

The change from the 14th to the 15th Edition of the IEE Wiring Regulations in 1981 created a big upheaval in the electrical installation industry as many new

concepts were introduced and many existing practices were expanded or enhanced - one of those being supplementary equipotential bonding. To a great extent, the 15th Edition was based on CENELEC harmonised documents (HDs) (more so now with the introduction of the 17th Edition).

HD 384.4.41 was the basis for Chapter 41 of the 15th Edition - *Protection against electric shock*, which had requirements for supplementary equipotential bonding in Regulation 413-7, reproduced here:

413-7 *Within the zone formed by the main equipotential bonding, local supplementary equipotential bonding connections shall be made to metal parts, to maintain the equipotential zone, where those parts -*

- (i) are extraneous conductive parts, and*
- (ii) are simultaneously accessible with exposed conductive parts or other extraneous conductive parts, and*
- (iii) are not electrically connected to the main equipotential bonding by permanent and reliable metal-to-metal joints of negligible impedance.*

NOTE - *Where local equipotential bonding is provided in accordance with Regulation 413-7, metalwork which may be required to be bonded includes baths and exposed metal pipes, sinks, taps, tanks, and radiators and, where practicable, accessible structural metalwork*

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Where doubt exists regarding the effectiveness of supplementary equipotential bonding, Regulation 415.2.2 requires that the resistance, R , between simultaneously accessible exposed-conductive-parts and extraneous-conductive-parts fulfils the following condition:

$$\text{In a.c. systems } R \leq \frac{50 \text{ V}}{I_a}$$

Where:

I_a is the operating current in amperes of either:

- the protective device for RCDs, $I_{\Delta n}$.
- overcurrent devices, the current causing automatic operation in 5 s

Example 1

Let's take the scenario that the protective device is an RCD rated at 30 mA:

$$R \leq \frac{50 \text{ V}}{I_a}$$

$$R \leq \frac{50 \text{ V}}{0.03}$$

$$R \leq 1666 \Omega$$

Therefore, a maximum resistance of 1666 Ω will ensure there is sufficient current to operate the RCD. Note that the touch voltage may rise above 50 v; the value of 50 v is used as a constant in the formula to ensure sufficient current is flowing to operate the RCD.

Example 2

Let's take the scenario that the protective device is a BS EN 60898 Type B circuit-

breaker, rated at 32 A. First we must establish the current causing operation of the circuit-breaker by referring to the correct time/current characteristics graph in Appendix 3 of BS 7671.

Therefore, looking at fig. 1 (extract from fig.3.4 of BS 7671:2008), we can establish that the current causing operation of the circuit breaker is 160 A.

$$R \leq \frac{50 \text{ V}}{I_a}$$

$$R \leq \frac{50 \text{ V}}{160}$$

$$R \leq 0.31 \Omega$$

Therefore, a maximum resistance of 0.31 Ω will ensure there is sufficient current to operate the circuit breaker within five seconds.

Note that in fig. 1 the current causing operation of the device between 0.1 and 5 s is the same; this will not be the case for fuses. If many circuits are present in a particular area and are protected by different protective devices/types, etc., the worst case characteristic should be used.

The IET publication, Guidance Note 3, with the latest edition due for imminent publication, advises that the resistance of supplementary equipotential bonding conductors should be no more than 0.05 Ω . When verifying supplementary equipotential bonding conductors, Regulation 612.2.1 requires that a

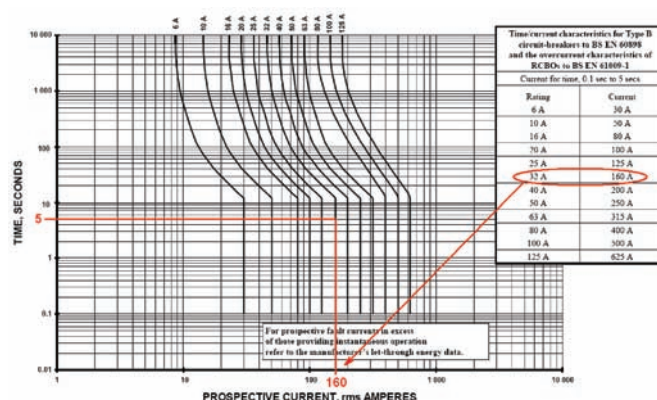


Figure 1: Time/current characteristics of circuit-breakers to BS EN 60898 Type B and BS EN 61009-1

continuity test be made with a recommendation that the test instrument has a no-load voltage of between 4 V and 24 V, d.c. or a.c. and a short-circuit current of not less than 200 mA.

WORKING STANDARDS

The installation of supplementary equipotential bonding does not mean that a lower standard of work is permitted, nor the requirements for fault protection or the need to disconnect the supply for other reasons, such as protection against fire, thermal stresses in equipment, etc., can be omitted.

Regulation 522.6.1 requires that the correct wiring system is selected for the application to minimize the risk of damage arising from mechanical stress, e.g. by impact, abrasion, penetration, tension or compression during installation, use or maintenance.

Fundamentally, this means that if there is a danger of a metallic part

not forming part of the electrical installation becoming live due to damage to a cable, then the protection of that cable is paramount and must form part of the design. Simply installing supplementary equipotential bonding as a means of omitting mechanical protection will just result in more metallic parts becoming live in the event of damage to a cable.

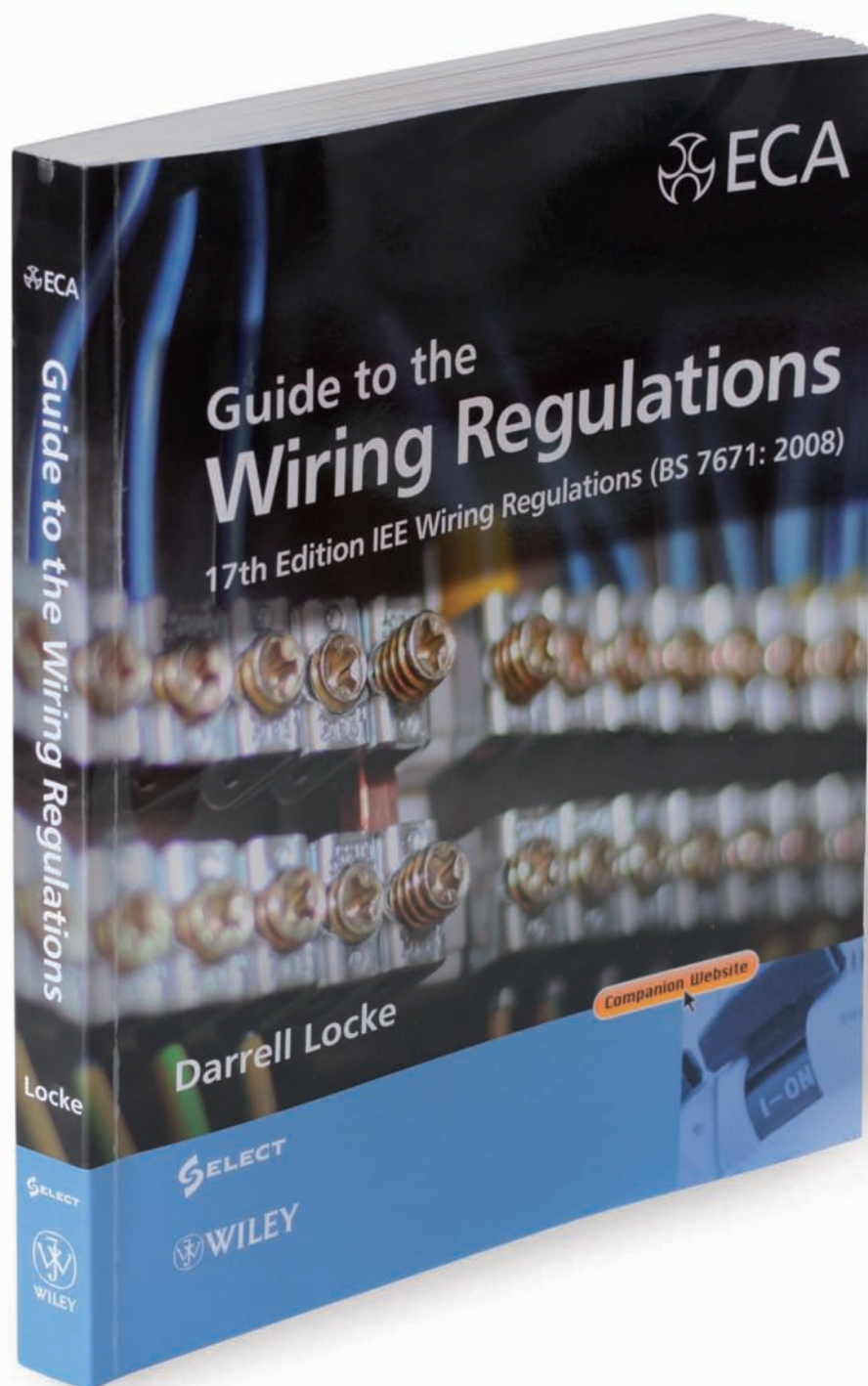
SIZING OF SUPPLEMENTARY EQUIPOTENTIAL CONDUCTORS

BS 7671:2008 has requirements for the sizing of supplementary equipotential bonding conductors in Regulation 544.2, the table shown overleaf, fig. 2, will aid with the choice of conductor.

WHERE SUPPLEMENTARY EQUIPOTENTIAL BONDING IS REQUIRED

Ultimately, responsibility is with the designer of the installation, who is a competent person, fully aware of the installation conditions and will use their skill and engineering

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Size of CPC mm ²	Minimum cross-sectional area of supplementary bonding conductors					
	Exposed-conductive-part to extraneous-conductive-part		Exposed-conductive-part to exposed-conductive-part		Extraneous-conductive-part to extraneous-conductive-part (1)	
	mechanically protected mm ²	mechanically protected mm ²	mechanically protected mm ²	mechanically protected mm ²	mechanically protected mm ²	mechanically protected mm ²
1.0	1.0	4.0	1.0	4.0	2.5	4.0
1.5	1.0	4.0	1.5	4.0	2.5	4.0
2.5	1.5	4.0	2.5	4.0	2.5	4.0
4.0	2.5	4.0	4.0	4.0	2.5	4.0
6.0	4.0	4.0	6.0	6.0	2.5	4.0
10.0	6.0	6.0	10.0	10.0	2.5	4.0
16.0	10.0	10.0	16.0	16.0	2.5	4.0

Figure 2: Minimum cross-sectional area of supplementary equipotential bonding

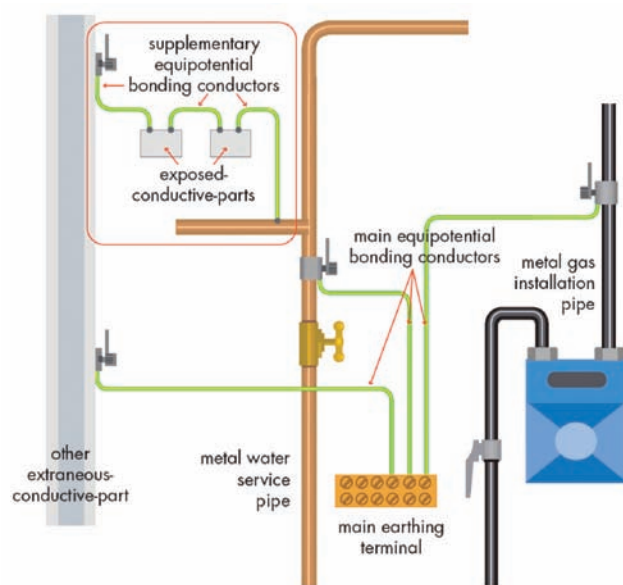


Figure 3: Application of supplementary equipotential bonding

judgement to design the installation accordingly.

Where supplementary equipotential bonding is required, it may involve the entire installation, a part of the installation, an item of equipment or a location, etc. Where supplementary equipotential bonding is installed, it should include all simultaneously accessible exposed-conductive-parts of fixed

equipment and all extraneous-conductive-parts.

Exposed-conductive-part
Conductive part of equipment which can be touched and which is not normally live, but which can become live when basic insulation fails.

An example of an exposed-conductive-part is the metallic outer case of an electrical class I

appliance, designed to be connected to the means of earthing at all times of operation

Extraneous-conductive-part

A conductive part liable to introduce a potential, generally Earth potential, and not forming part of the electrical installation.

An example of an extraneous-conductive-part is a metallic water pipe which is buried in the ground and subsequently enters a building

To generalise, as stated earlier, supplementary equipotential bonding is required where a disconnection time can not be met or where a Special Installation or Location, i.e. those in Part 7 of BS 7671:2008, has an increased risk of electric shock. The following Sections of Part 7 directly reference supplementary equipotential bonding - note that other measures will be necessary to meet the requirements of BS 7671:2008.

Section 701 - Locations containing a Bath or Shower

Section 701 now has a relaxed requirement for supplementary equipotential bonding when the following three conditions of Regulation 701.415.2 are met;

- (i) All final circuits of the location comply with the requirements for automatic disconnection
- (ii) All final circuits of the location have additional

protection by means of a 30 mA RCD

(iii) All extraneous-conductive-parts of the location are effectively connected to the protective equipotential bonding

Section 702 - Swimming Pools and Other Basins

Supplementary equipotential bonding will connect all extraneous-conductive-parts in zones 0, 1 and 2 to the protective conductors of exposed-conductive-parts of equipment situated in these zones, in Regulation 702.411.3.3.

Regulation 702.522.21 requires that in zones 0, 1 and 2, any metallic sheath or metallic covering of a wiring system shall be connected to the supplementary equipotential bonding. The note at the end of this Regulation states that cables should preferably be installed in conduits made of insulating material. This is a relaxation from the 16th Edition as Regulation 602-06-01 states that in zones A and B, a surface wiring system shall not employ metallic conduit or metallic trunking or an exposed metallic cable sheath or an exposed earthing or bonding conductor.

Regulation 702.55.1 permits the installation of an electric heating unit embedded in the floor, provided that it incorporates an earthed metallic sheath, is covered by an embedded earthed metallic grid and connected to the supplementary

equipotential bonding of the location (other requirements are also necessary).

Section 705 - Agricultural and Horticultural Premises

Supplementary equipotential bonding is required to connect all exposed-conductive-parts and extraneous-conductive-parts that can be touched by livestock, the metal grid laid in the floor, concrete reinforcement in general or reinforcement of cellars for liquid manure (other requirements are also necessary), in Regulation 705.415.2.1.

Regulation 705.544.2 requires that supplementary equipotential bonding conductors are protected against mechanical damage and corrosion and chosen to avoid electrolytic effects, with examples given as:

- (i) Hot-dip galvanized steel strip with dimensions of at least 30 mm × 3 mm
- (ii) Hot-dip galvanized round steel of at least 8 mm diameter
- (iii) Copper conductor having a minimum cross-sectional area of 4 mm². Other suitable materials may be used.

Section 706 - Conducting Locations with Restricted Movement

In a conducting location with restricted movement, Regulation 706.410.3.10 requires that a supply to fixed equipment shall incorporate supplementary equipotential bonding is used to connect exposed-

conductive-parts of fixed equipment and the conductive parts of the location where automatic disconnection of the supply is the protective measure. Part e) of this Regulation requires that where the protective measure is PELV, equipotential bonding is provided between all exposed-conductive-parts, all extraneous-conductive-parts inside the conducting location with restricted movement, and the connection of the PELV system to Earth.

Section 740 - Temporary Electrical Installations for Structures, Amusement Devices and Booths at Fairgrounds, Amusement Parks and Circuses

Regulation 740.415.2.1 reiterates the requirements of 705.415.2.1, shown above under Agricultural and Horticultural Premises.

CONCLUSION

To summarise, supplementary equipotential bonding is required where a disconnection time can not be met or where a Special Installation or Location, i.e. those in Part 7 of BS 7671:2008, has an increased risk of electric shock. Confusion created by Regulation 413-7 of the 15th Edition of the IEE Wiring Regulations, which effectively required supplementary equipotential bonding to connect all accessible metallic parts within the equipotential zone, has been clarified by Regulations

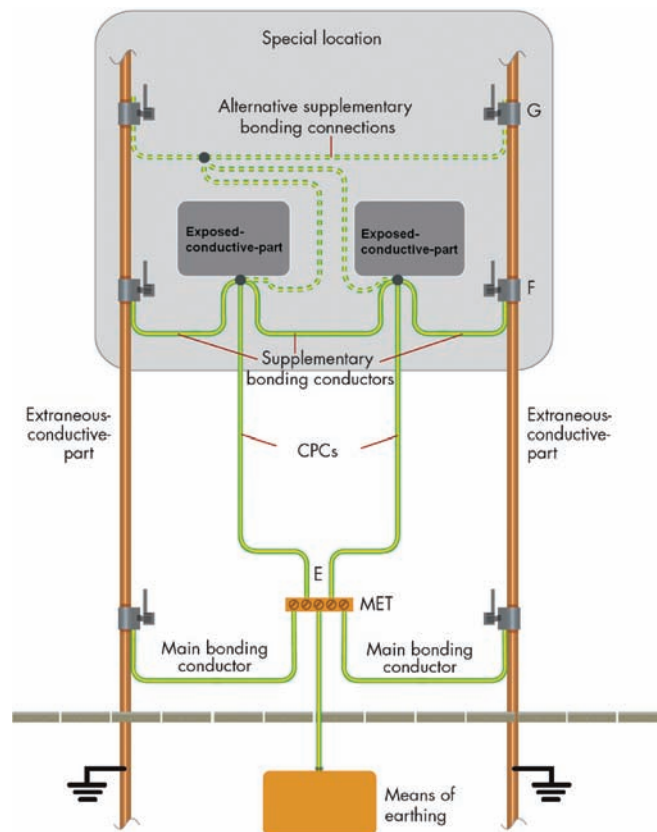


Figure 4: Application of supplementary equipotential bonding in a Special Location

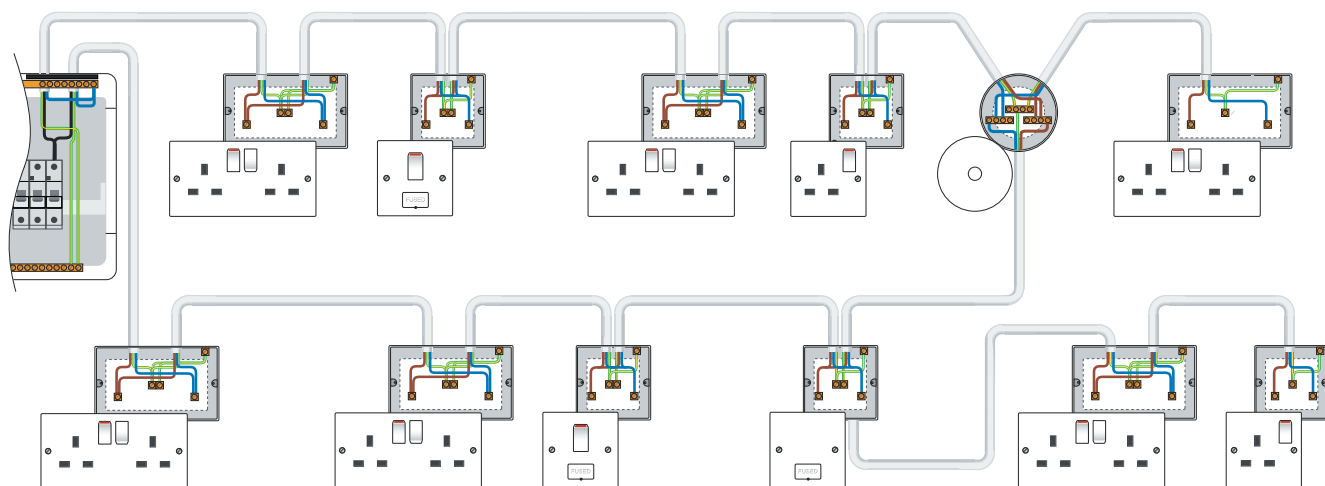
411.3.2.6 and 415.2. Other installations, such as those of hazardous locations, will have further requirements for supplementary equipotential bonding to reduce the risks of sparking due to the build up of static electricity, for example. In such installations, the requirements of BS 7671 will be supplemented by the requirements or recommendations of other British Standards or by the requirements of the person ordering the work.

FURTHER INFORMATION

- BS 7671:2008 Requirements for Electrical Installations, IEE Wiring Regulations,

- Seventeenth Edition Guidance Note 3 - Inspection and Testing
- PD CLC/TR 50404:2003 Electrostatics — Code of practice for the avoidance of hazards due to static electricity
- BS EN 60079 Electrical apparatus for explosive gas atmospheres (suite of standards)
- BS EN 60079-14:2003 Electrical apparatus for explosive gas atmospheres - Part 14: Electrical installations in hazardous areas (other than mines) ■

Thanks to Richard Rennie of Yorkshire Water for the image used.



IEE Ring final circuit meeting by Jon Elliott

On Wednesday 31st October 2007, a public meeting was held in the Council Chamber at Savoy Place, London - home of the IET, to discuss the perceived merits and shortcomings of ring final circuits. The meeting was well attended with an audience of approximately 100 people.

The programme for the meeting was as follows:

- Introduction by Chairman Mr N C Friswell
- The History of the Ring Circuit by Mr D W M Latimer
- 2.40pm Disadvantages of the Ring Circuit by Mr H R Lovegrove
- 3.10pm Advantages of the Ring Circuit by Mr M White
- 3.40pm Comfort Break (10 mins)
- 3.50pm General Discussion & Comments
- 4.40pm Chairman's Summary

All three papers were well received. Some of the main points that came out of the meeting were as follows:

1. Earth Continuity – advantage of the ring circuit?

The presentation by Mr White claimed that if one cpc was to become disconnected at a point around the ring, there would still be earth continuity (albeit of higher resistance) via the remaining cpc at each socket-outlet within the circuit. To this extent, the ring circuit is safer than the radial circuit. It is acknowledged that loss of the earth conductor on a radial circuit may not be noticed until a shock is received.

2. Ring circuits – less protective devices needed?

Another positive attribute

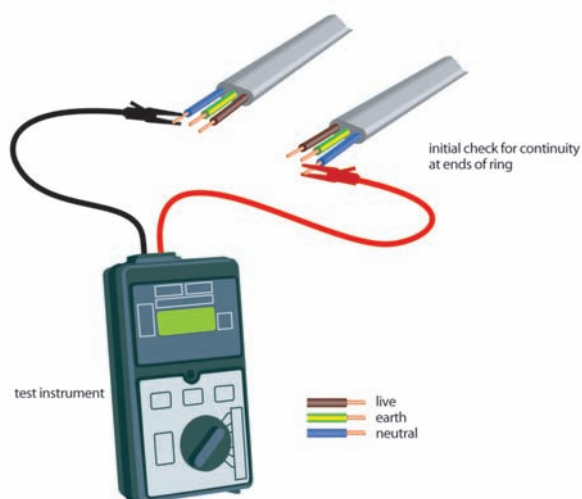
claimed for ring circuits was reduction in the number of protective devices needed at distribution boards when compared to radial circuits.

3. Amount of copper used in an installation?

The presentation by Mr Lovegrove claimed that radial circuits offer greater

flexibility, require the use of less cable, shorter installation time, lower installation cost and a smaller drain on the world's resources of copper.

Conversely, the presentation by Mr White claimed one of the primary aims when ring circuits were developed after the Second World War was to minimise the use of



copper in the face of shortages of materials during the massive reconstruction that was required following the cessation of hostilities. It was agreed that both ring and radial circuits may both be best suited to certain applications.

4. Testing and quality of workmanship?

The presentation by Mr Lovegrove claimed numerous disadvantages of the ring circuit including:

- difficulty in complying with Regulation 433-02-04 (433.1.5 in the 17th Edition) concerning distributing the load evenly in a ring circuit,
- lack of training to familiarise electricians from other countries to a wiring practice that is not common in other countries,
- susceptibility to fault conditions from additions and alterations to the circuit,
- testing and fault finding is more time consuming and costly,
- fault conditions are not apparent when in use.

On the other hand, the presentation by Mr White claimed that the ring circuit has proved its value over the last 60 years. The testing regime has been proven to work effectively and problems seldom arise on either ring or radial circuits if they are installed and tested correctly.

Mr Lovegrove's view on

the potential problems that could be attributed to ring circuits received support from the floor however, a number of people held the view that ring circuits did not present a problem on larger projects that are designed and specified by consultants, who monitor the installations as they progress and ensure testing is carried out properly by electricians who are skilled and competent. Better training of electricians is required.

5. EMC issues

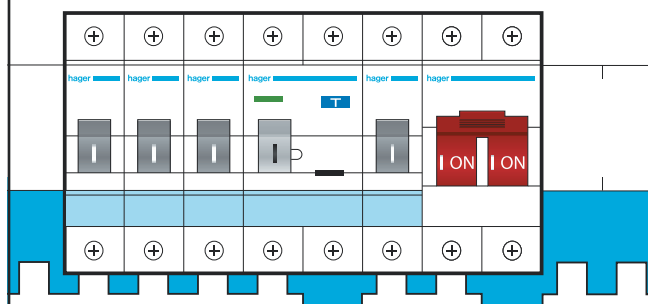
Some members of the audience raised the issue of EMC and ring circuits if the circuit was not installed and tested correctly. It was stated that this issue is the subject of a report being produced by a group of experts of the Stakeholder Advisory Group on ELF EMFs (SAGE).

CONCLUSIONS

To summarise the following points arose from this meeting:

- both ring and radial final circuits have their place in a modern electrical installation and neither circuit layout should be used to the exclusion of the other
- more guidance on these circuit arrangements is required in IEE Guidance Notes
- Better initial training was required for persons working in the electrical installation industry, including domestic installers ■

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543.7 and lighting circuits by Mark Coles

Following on from the article on Regulation 543.7 of BS 7671 in the last issue of *Wiring Matters* (Spring 08, Issue 26), many readers contacted the IET to discuss wider issues relating to high protective conductor currents. This article looks further at lighting circuits.

Where high protective conductor currents of sufficient magnitude exist, protective measures are to be taken, the requirements of which can be found in 543.7 of BS 7671:2008. The last issue of *Wiring Matters* generally covered those requirements but particular issues are apparent.

HIGH-FREQUENCY FLUORESCENT LUMINAIRES

It is known that electronic ballasts in high-frequency fluorescent luminaires create currents in the protective conductor. The electronic control gear operates lamps at frequencies in the region of 40 kHz and designers limit the capacitance between

conductors to keep leakage currents as low as possible; this is usually achieved by restricting the length of conductors within the luminaire to a minimum. Electronic ballasts have *primary and secondary* circuits, often referred to as "hot" and "cold", i.e. 230 vac 50 Hz supply (cold) and 40 kHz output (hot). Capacitive coupling between the primary and secondary circuits also contribute to leakage currents.

For luminaires incorporating a.c. supplied electronic ballast and electronic dimming ballasts, the leakage current may be greatly dependent upon the spacing between the lamp and the earthed starting aid

due to the high frequency operation of the lamp. Information from the manufacturer/data sheets must be sought to establish leakage current as types or models of luminaires will have different characteristics.

CONVENTIONAL LUMINAIRES

The table in fig. 1 shows expected leakage currents extracted from *BS EN 60598-1:2004 Luminaires - General requirements and tests*.

Compliance is checked in accordance with Clause 7 of BS EN IEC 60990 - *Methods of measurement of touch current and protective conductor current*.

MEETING THE REQUIREMENTS OF BS 7671:2008

Regulations 543.7.1.1 and 543.7.1.2 have requirements for individual items of equipment with high protective conductor currents in excess of 3.5 mA; it is, therefore, unlikely that individual modern luminaires will have leakage currents of that magnitude.

Regulation 543.7.1.3 is specific, however, when the accumulative protective conductor current of the circuit is likely to exceed 10 mA. In this case, the following options are permitted:

(i) A single protective conductor having a cross-

sectional area of not less than 10 mm²

(ii) A single copper protective conductor having a cross-sectional area of not less than 4 mm², with additional protection against mechanical damage, for example, within a flexible conduit
(iii) Two individual protective conductors
(iv) An earth monitoring system to BS 4444 may be installed which, in the event of a continuity fault occurring in the protective conductor, automatically disconnects the supply to the equipment

For the majority of lighting circuits in commercial installations, it is unlikely that items (i), (ii) and (iv) offer sensible solutions; this leaves item (iii).

Therefore, looking at fig.1, if eleven class I luminaires are installed on one circuit, for example, the designed protective conductor current is greater than 10 mA, i.e. 11 mA, then duplicate protective conductors would be required for that circuit. Regulation 543.7.1.4 requires that the end of each protective conductor is terminated independently at all connection points throughout the circuit, i.e. separate terminals at the distribution board, luminaire, lighting distribution unit and at the light switch.

It is unlikely that luminaires are provided with two earth terminals

but compliance may be achieved by installing a four-terminal connection block within the luminaire.

Regulation 543.7.1.3 (iii) states that one of the protective conductors could be an earthed metallic conduit, metallic sheath of MICC or armour the armour of a SWA cable. Class I luminaires mounted directly onto metallic lighting trunking may meet this requirement, similarly if luminaires are linked by earthed metallic conduit.

A different process may be required when installing luminaires in a ceiling grid supplied from lighting distribution units through a plug and outlet arrangement. Links to individual luminaires will be unaffected as the protective conductor current is likely to be less than 3.5 mA per luminaire. Depending on what is connected to the overall circuit, it may only be necessary to take the high integrity protective connection as far as the lighting distribution unit/switching point, see fig. 2.

FURTHER INFORMATION

- BS 7671:2008
- *Wiring Matters* - Spring 08, Issue 26 - www.theiet.org/wm
- Guidance Note 1 - Selection and Erection (imminent publication)
- BS EN 60598-1:2004 Luminaires - General requirements and tests
- BS EN IEC 60990 - Methods of measurement of touch current and protective conductor current ■

Luminaire type		Maximum, r.m.s. values of leakage current mA
Class II ¹		0.5
Portable, class I ²		1.0
Fixed, class I up to 1 kVA rated input increasing by 1.0 mA/kVA up to a maximum of 5.0 mA ¹		1.0
1	Measured in accordance with 5.1.1 of IEC 60990 weighted for perception reaction (a.c.)	
2	Measured in accordance with 5.1.2 of IEC 60990 weighted for let-go (a.c.)	

Table 1: Leakage current from conventional luminaires extracted from BS EN 60598-1, clause 10.3

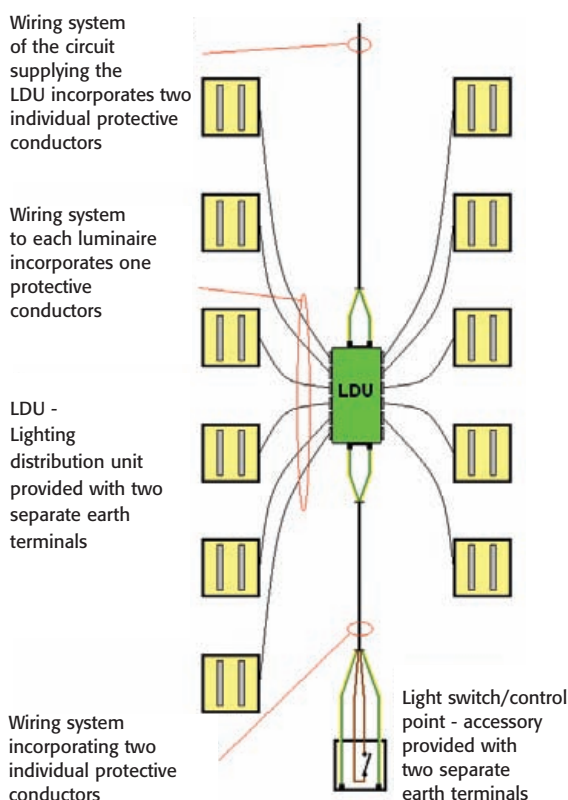
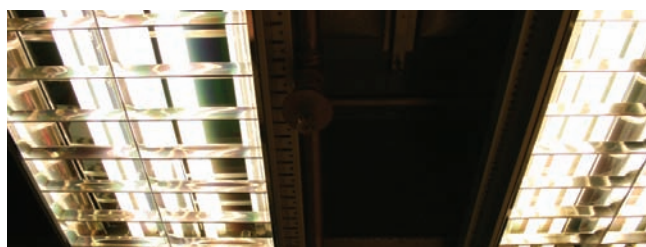


Figure 2: Lighting distribution with high integrity earthing



The Regulatory Reform (Fire Safety) Order 2005, BS 7671: 2008 and requirements for firefighters' switches

by Jon Elliott



As a result of the introduction of the 17th Edition of the Wiring Regulations, it has been necessary to revise the series of Guidance Notes published by the IEE to accompany the Wiring Regulations so that their content relates to the current requirements of both BS 7671 and relevant statutory legislation.

Since BS 7671 was last amended (in March 2004) significant changes have occurred in a number of Statutory Instruments which have a direct influence on its content. One such change was the introduction of the Regulatory Reform (Fire Safety) Order in 2005.

This article briefly introduces this Order and summarizes some of the requirements therein which have an influence on those involved in electrical installation and maintenance. It also looks at

in particular the requirements for firefighters' switches contained in both the Order and BS 7671: 2008 to highlight the relationship between the statutory and non-statutory requirements they contain respectively relating to this topic.

THE REGULATORY REFORM (FIRE SAFETY) ORDER 2005

The Regulatory Reform (Fire Safety) Order 2005 (henceforth referred to as the Order) has a direct influence on many other pieces of primary and secondary statutory legislation, requiring modifications and, in some cases, partial or full revocation of the requirements therein. It replaces fire certification under the Fire Precautions Act 1971 with a general duty to ensure, so far as is reasonably practicable, the safety of employees and a general duty, in relation to

non-employees to take such fire precautions as may reasonably be required to ensure that premises are safe.

The Order came into effect fully in October 2006 and has an effect on over 70 pieces of fire safety legislation. It applies to non-domestic premises in England and Wales, including any communal areas of blocks of flats or houses in multiple occupation and places a number of legal obligations and responsibilities upon the individual identified therein as the *responsible* person.

The responsible person has duties placed upon them to:

- carry out a risk assessment to confirm that any fire safety precautions in place within the premises are adequate (article 9). It also requires this risk assessment to be

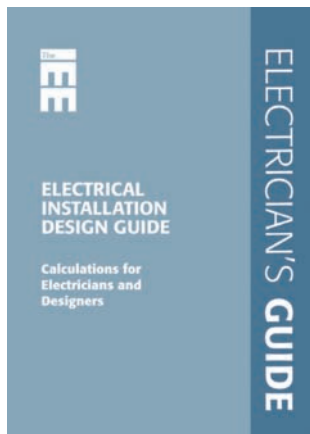
regularly updated

- take the necessary general fire precautions (article 10)
- make arrangements for planning, organisation, control, monitoring and review of preventative and protective measures (article 11)
- ensure that premises under their control are adequately equipped with fire-fighting and fire detection / alarm equipment (article 13)
- maintain the accessibility of escape routes to emergency exits at all times; confirm that emergency exits lead as directly as possible to a place of safety; ensure that emergency doors open outwards; and confirm the adequacy of provision of indication signs and emergency lighting arrangements (article 14)
- put in place and keep up



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a suitable maintenance regime to ensure any equipment provided for the purposes of fire safety remains functional (article 17)

- appoint competent persons to assist them to comply with their duties under this Order (article 18)
- put in place and provide adequate safety training (article 21)

Of course, the Order also places a duty on employees to take reasonable care and to co-operate with their employer in relation to the duties placed upon them. Article 23 requires employees to:

- take reasonable care for the safety of themselves and of other persons who may be affected by their acts or omissions at work;
- co-operate with their employer as regards any duty or requirement imposed by or under any provision of the Order, so far as is necessary to enable that duty or requirement to be performed or complied with; and
- inform their employer or any other employee with specific responsibility for the safety of fellow employees—
 - (i) of any work situation which they would reasonably consider represented a serious and immediate danger to safety; and
 - (ii) of any matter they would reasonably consider represented a shortcoming in the employer's protection arrangements for safety, in so far as that situation or matter either affects the

safety of the employee or arises out of or in connection with their activities at work, that has not previously been reported to the employer.

PROVISION OF FIREFIGHTERS' SWITCHES

The Order contains a number of statutory requirements relating to firefighters' switches for luminous tube signs, etc. We shall consider these in conjunction with the non-statutory requirements of 537.6 of BS 7671: 2008. Note, provision of firefighters' switches is also considered in IEE Guidance Note 2 - *Isolation & switching* and Guidance Note 4 - *Protection against fire*.

Article 37 (4) of the Order states that a firefighters' switch must be so placed and coloured or marked as

to satisfy such reasonable requirements that a fire and rescue authority may impose so that it is readily recognisable by and accessible to firefighters. However, article 37 (5) states that if a firefighters' switch complies in position, colour and marking with the current edition of the IEE Wiring Regulations, fire and rescue authorities should not impose any further requirements pursuant to paragraph (4).

BS 7671:2008 contains a number of requirements relating to firefighters' switches which are summarized below.

1. A firefighters' switch should be provided on the low-voltage side of a circuit that supplies

- any exterior electrical installation, or
- an interior discharge lighting installation (not including a portable luminaire of rating not exceeding 100 W) that operates at a voltage in excess of low voltage (537.6.1 refers).

It should be noted at this point that in relation to the provision of firefighters' switches, installations in covered markets, arcades or shopping malls are considered to be exterior installations, while a temporary installation in a permanent building intended for hosting exhibitions is not.

2. Wherever practically possible, every exterior installation covered by the

requirements of 537.6.1 above within a single premises such as, for example, a covered market, should be controlled by a single firefighters' switch to simplify the process of making dead all circuits therein operating a voltage exceeding low voltage. Further, any internal installation subject to the requirements of 537.6.1 in each single premises should be controlled by a single firefighters' switch, this switch being independent of a firefighters' switch for any exterior installation of the same premises; 537.6.2 refers.

3. Any firefighters' switch provided should:

- in the case of an exterior installation, be outside the building and be placed adjacent to the equipment it controls. Alternatively where switch and equipment are not adjacent to each other, notices should be placed adjacent to both the switch, indicating what it controls and the equipment controlled, indicating the location of the appropriate switch
- for an interior installation, the switch should be placed in the main entrance of the building or other location agreed to by the local fire authority

- in all cases, the switch should be in a conspicuous position that remains accessible to firefighters. The switch should be mounted at a height not more than 2.75 m from the ground or the standing beneath the switch
- where more than one switch is provided on any building, notices are required clearly describing the installation or part thereof which each switch controls (537.6.3 refers)

4. Any firefighters' switch provided should be so placed to facilitate operation by a fire-fighter and:

- be coloured red
- be accompanied by a durable notice with the wording as shown below. The lettering should be in 36 point
- have its ON and OFF positions clearly marked such that it is legible to a person standing in a position to operate the switch
- have its OFF position uppermost
- be so constructed such that it cannot be inadvertently switched to the OFF position

It is worth mentioning at this point that the topic of firefighters' switches is a good example of the

simplified structure of the Wiring Regulations. Whilst all requirements relating specifically to such switches can now be found in 537.6, previously in the 16th Edition it would have been necessary to have consulted regulations 476-03-05, 476-03-06 and 476-03-07 to determine in which installations such switches were required, how they should be arranged and where they should be located and Regulation 537-04-06 for requirements relating to the switch itself and its identification and labelling.

SUMMARY

The Fire Safety (Regulatory Reform) Order 2005 is

probably the single most influential statutory instrument in the field of protection against fire. Its introduction has consolidated the general fire safety precautions of a large number of pieces of legislation, many of which have been modified by the Order and some of which have been partially or fully revoked. It has introduced a risk assessment driven approach to considering whether fire precautions which have been provided are adequate and it has placed far greater emphasis on the need to plan, organize, control, monitor and review any preventative

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or protective measures relating to the fire safety of a building.

Article 37 of the Order contains a number of specific requirements relating to the selection and installation of firefighters' switches. These were considered in conjunction with the requirements for firefighters' switches in 537.6 of BS 7671: 2008.

The relationship between the statutory requirements of the Order and the non-statutory requirements of the 17th Edition relating to firefighters' switches should be noted. The Order contains the broad and non-

specific requirement that such a switch *"must be so placed and coloured or marked as to satisfy such reasonable requirements that a fire and rescue authority may impose so that it is readily recognisable by and accessible to firefighters"*.

In contrast, 537.6 of BS 7671 contains a number of clear and specific requirements on when such switches are required, where the switches should be installed, at what height they should be installed, what colour they should be, how they should be identified, in what position the switch should be when

OFF and indeed contains a requirement to provide a means to prevent inadvertent re-closing.

Although the detailed requirements of BS 7671 are of themselves non-statutory, article 37 (5) of the Order makes it clear that *"if a firefighters' switch complies in position, colour and marking with the current edition of the IEE Wiring Regulations, fire and rescue authorities should not impose any further requirements..."* on such matters. It can be seen therefore that meeting the requirements of BS 7671 for the selection and

installation of firefighters' switches will in itself meet the relevant statutory requirements of the relevant fire safety legislation.

As a result of the simplified structure of the 17th Edition, all requirements relating to firefighters' switches can now be found in 537.6.

The newly revised Guidance Note 2 *Isolation and Switching* and Guidance Note 4 *Protection against fire* will be available shortly.

More information can be found here: <http://www.opsi.gov.uk/si/si2005/20051541.htm> ■

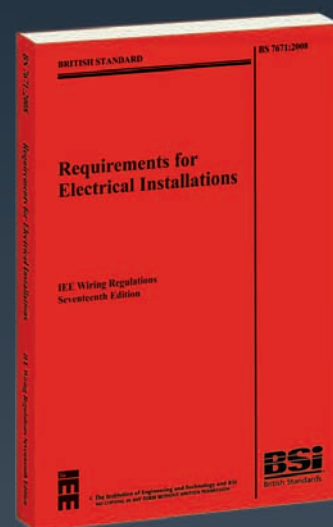


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Changes to the Building Regulations by Paul Cook

Since of the publication of the IEE's *Electrician's Guide to the Building Regulations* in 2005, there have been many changes to the Building Regulations that electricians (and designers) need to be aware of, for example:

- when rewiring a house, Part L of the building regulations requires you to install energy efficient luminaries
- conservatories are not Special Locations - alterations and additions to existing circuits comprising of sockets-outlets and lights, not requiring a new circuit, can be installed without notifying building control
- wireless interlinks between fire alarms are acceptable

The *Electrician's Guide to the Building Regulations*, prepared to provide all the information an electrician needs when carrying out domestic installation work, has been completely revised to include changes to the Building Regulations and also to align with the requirements of the 17th Edition of BS 7671.

A chapter has also been included on the Scottish Building Regulations.

APPROVED DOCUMENT P - ELECTRICAL INSTALLATIONS

The changes to Approved

Document P generally concern work which is, or is not, notifiable. Guidance is given on a range of particular situations, for example:

Conservatories and attached garages

Conservatories and attached garages are not Special Locations. Work within these structures is not notifiable unless it involves the installation of a new circuit or the extension of a circuit from a kitchen, Special Location or associated with a Special Installation.

Detached garages and sheds

Detached garages and sheds are not Special Locations. Work within these structures is notifiable only if it involves new outdoor wiring.

Outside lights

The installation of equipment attached to the outside wall of a house, for example, security lighting, air conditioning equipment, radon fans, etc., is not notifiable provided that there are no outdoor connection units or joint boxes and the work does not involve the installation of a new circuit or the extension of a circuit from a kitchen or Special Location.

Outside socket-outlets

The installation of a socket-outlet on an external wall is

Approved Document	Examples of domestic changes
P - Electrical safety	What is and what is not notifiable
B - Fire Safety	Changes in the detail of requirements for a standard house and specific reference to BS 5839-6 for large houses.
L - Conservation of fuel	Requirements for energy efficient luminaries, including for rewires, (see below)
M - Access and facilities for disabled	Switches, sockets, controls throughout the dwelling to be readily accessible
V - Ventilation	Reference to whole house ventilation systems

Table 1: Approved Documents

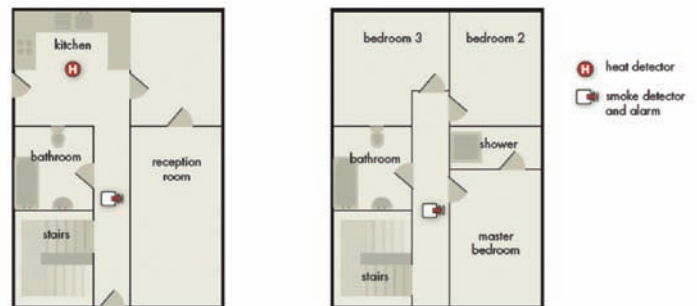


Figure 1: Minimum requirements for smoke alarms (standard house, no storey exceeds 200 m² floor area) with the kitchen not separated from the circulation space by a door

notifiable, since the socket-outlet is an outdoor connection unit.

APPROVED DOCUMENT B - FIRE SAFETY

A standard house, single storey or multi-storey with no storey exceeding 200 m² floor areas, must be fitted with interlinked smoke alarms installed as follows:

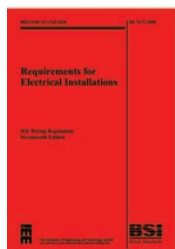
1. In circulation areas between sleeping places and places where fires are most

likely to start e.g. kitchens and living rooms

2. In circulation spaces within 7.5 m of the door to each habitable room
3. At least one on every storey
4. If the kitchen is not separated from the circulation area by a door, a compatible interlinked heat detector or heat alarm must additionally be installed in the kitchen.

Detectors and alarms are required to have a standby

The Institution prepares regulations for the safety of electrical installations for buildings, the IEE Wiring Regulations (BS 7671) which have now become the standard for the UK and many other countries. It also recommends, internationally, the requirements for ships and offshore installations. The Institution provides guidance on the application of the installation regulations through publications focused on the various activities from design of the installation through to final test and then maintenance. This includes a series of eight guidance notes, two codes of practice, a CD-ROM, and model forms for use in wiring installations. **During the course of 2008 all guidance publications will be updated to align with the 17th Edition of the IEE Wiring Regulations**



REQUIREMENTS FOR ELECTRICAL INSTALLATIONS

BS 7671: 2008
(IEE Wiring Regulations,
17th Edition)

The Wiring Regulations are the national standard to which all domestic and industrial wiring must conform. Substantial changes have been incorporated in BS 7671: 2008 to align with European documents. Essential for all electricians, electrical contractors and their managers, installation designers, and students in further education and professional training.

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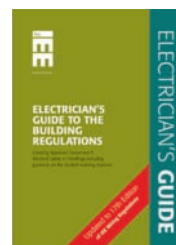


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power supply, for example, a battery or capacitor. The interconnection may be by radio links.

See fig 1. of an installation for a standard house, where no storey exceeds 200 m² floor area, with the kitchen not separated from the circulation space by a door

PART L - CONSERVATION OF FUEL AND ENERGY

In new buildings, extensions and rewires to existing buildings, the minimum number of fixed energy efficient light fittings must be either:

1. One per 25 m² of the floor area, excluding garages, or
2. One energy-efficient light fitting per four fixed light fittings.

Energy efficient fittings are fixed light fittings that can only accept lamps with a luminous efficacy exceeding 40 lumens per circuit-watt, such as compact fluorescent lamps. Lamp holders which accept Edison screw or bayonet lamps do not, unless they are of a certain unique non-standardised type made to accept only lamps of the required efficacy. The lamp holder must not accept lamps of a lesser efficacy than that specified.

PART M - ACCESS AND FACILITIES FOR THE DISABLED

The Building Regulations are now understood to require switches, socket-outlets and controls in dwellings to be installed so that all persons, including those whose reach is limited, can easily use

them. One way of satisfying the requirements is to install switches, socket-outlets and controls throughout the dwelling in accessible positions; detailed guidance is given.

It is also worth noting Part C, *Airtightness* and Part E, *Acoustics*, since each of these can impose requirements on the installation of, for example, luminaires. In the case of Part C (see BS 9250 *Code of practice for the design of airtightness of ceilings in pitched roofs*), it may be necessary to make good the breaching of an acoustic barrier between, for instance, flats and could, therefore, affect the installation of wall mounted socket-outlets, switches, luminaires, etc., in both walls and ceilings.

17TH EDITION OF BS 7671

The *Electrician's Guide to the Building Regulations* has been completely revised to reflect changes in both the Building Regulations and the Wiring Regulation.

Perhaps the most significant changes in the 17th Edition are the requirements for RCDs. Additional 30 mA RCD protection is required in dwellings for:

- all socket outlets for general use,
- all bathroom circuits,
- all circuits with cables buried in walls at a depth less than 50 mm unless protected by an earthed metal sheath, steel conduit or similar
- all circuits supplying

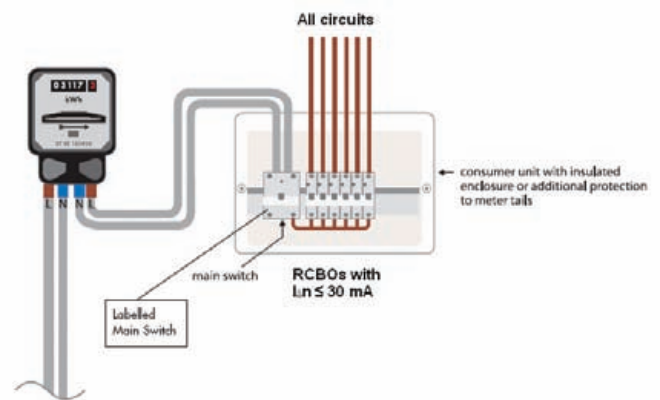


Figure 2: Split consumer unit with separate main switch and two 30 mA RCDs, suitable for all installations

	Lighting	Other uses
(i) Low voltage installations supplied directly from a public low voltage distribution system	3%	5%
(ii) Low voltage installations supplied from private LV supply (*)	6%	8%

(*) The voltage drop within each final circuit should not exceed the values given in (i). Where the wiring systems of the installations are longer than 100 m, the voltage drops indicated above may be increased by 0.005% per metre of the wiring system beyond 100 m, without this increase being greater than 0.5%. The voltage drop is determined from the demand by the current-using equipment, applying diversity factors where applicable, or from the value of the design current of the circuit.

Table 2: Voltage drop

mobile equipment outdoors

- all circuits with cables installed in walls or partitions of metallic construction.

The Guide provides a range of solutions, for example, see fig. 2.

DISCONNECTION TIMES

For TN Systems, a 0.4 s disconnection time is required for all final circuits up to 32 A rating with a 5 s disconnection time allowed for distribution circuits and final circuits of rating exceeding 32 A.

VOLTAGE DROP

The requirements are deemed to be satisfied if the voltage drop between the origin of the installation (usually the supply terminals) and any socket-outlet or the terminals of fixed current-using equipment does not exceed the following, see table 2.

The book is a must for all electricians and designers. ■

The Electrician's Guide to the Building Regulations (2nd edition) will be published in the summer.



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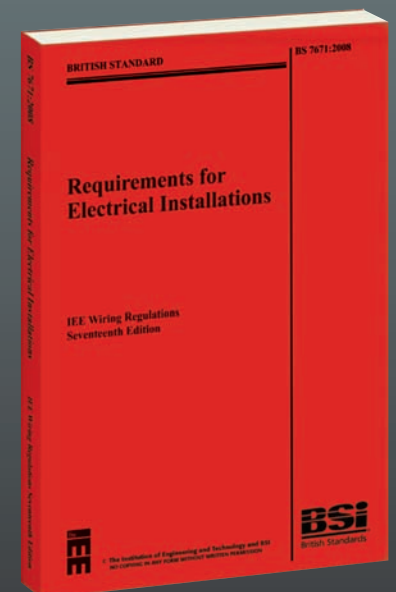
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