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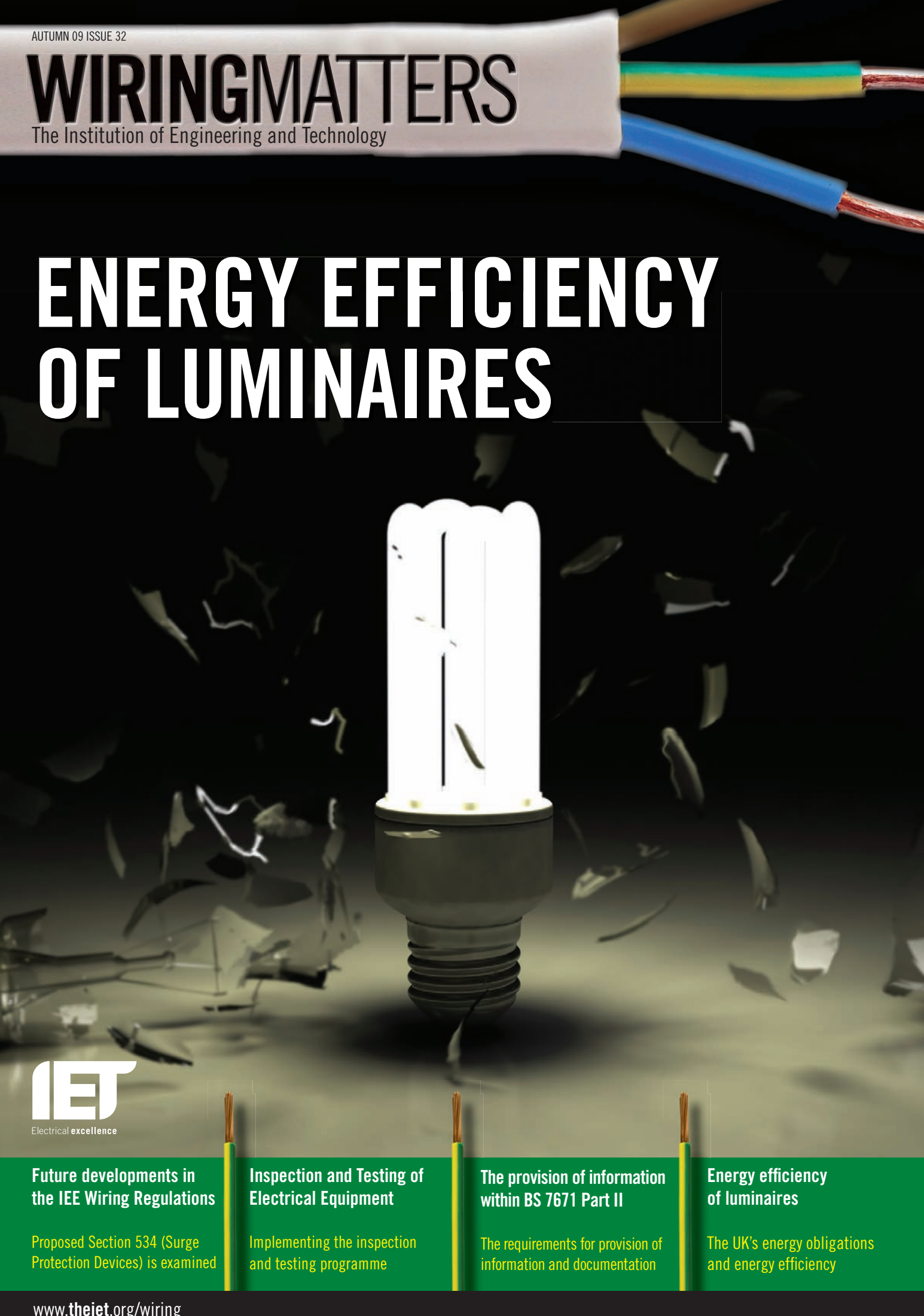

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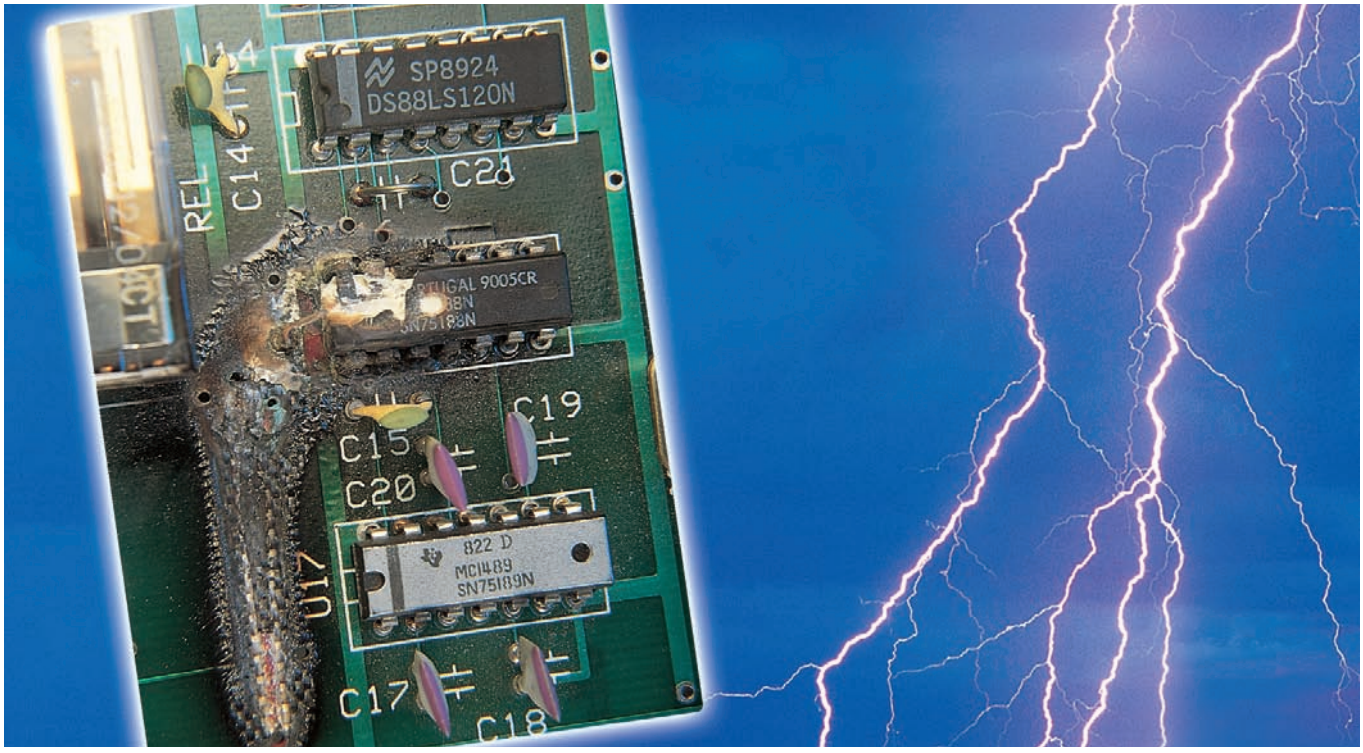


Future developments in the IEE Wiring Regulations (BS 7671:2008)

by Geoff Cronshaw

This article takes a closer look at the proposed new Section 534 (Surge Protection Devices) which it is expected may be included within a future amendment to BS 7671:2008. Section 534 contains requirements for the installation of surge protective devices (SPDs) to limit transient overvoltages where required by Section 443 of BS 7671:2008 or where otherwise specified by the designer. A risk assessment to BS EN 62305, Protection against Lightning also determines the need for SPDs. Surge protective components incorporated into appliances are not taken into account in 534.

Both lightning strikes and electrical switching can inject what are called transient overvoltages into installations. Transient voltages are usually only a few micro seconds in duration. However their peak value can reach 6 kV. Normal electronic equipment cannot withstand this level of voltage.

Atmospheric events

Lightning is the visible discharge of static electricity. The current contained within a lightning strike varies considerably with the atmospheric conditions. Associated with this sudden discharge of current is a magnetic field that surrounds the lightning perpendicular to the direction of travel. Lightning can impress a voltage onto a low voltage power network (or any metallic service) in a number of different ways: resistively, inductively or capacitively

Switching events

Generally, any switching operation, fault initiation, interruption, etc., in an electrical installation is followed by a transient phenomenon in which overvoltages can occur. The sudden change in the system can initiate damped oscillations with high frequencies (determined by the resonant frequencies of the network), until the system is stabilised to its new steady state. The magnitude of the switching overvoltages depends on several parameters, such as the type of circuit, the kind of switching operation (closing, opening, restriking), the loads and the protection device. In most cases, the maximum overvoltage is up to twice the amplitude of the system voltage but higher values can occur, especially when switching inductive loads (motors, transformers) or capacitive loads or even resistive loads connected very near to the terminals of a supply transformer. Also, interruption of short-circuit currents can cause high overvoltages. If current chopping occurs, relatively high energy can be stored in inductive loads and oscillations can occur on the load side of the opening switch or protective device. As detailed within BS EN 62305

"Protection against lightning", surges present a risk of dangerous sparking or flashover leading to possible fire and electric shock hazards. Surges also present risk of disruption, degradation and damage to electrical and electronic equipment leading to costly system downtime.

Surge Protection Devices

A surge protective device (SPD) is a device that is intended to limit transient over voltages and divert damaging surge current away from sensitive equipment. SPDs must have the necessary capability to deal with the current levels and durations involved in the surges to be expected at their point of installation.

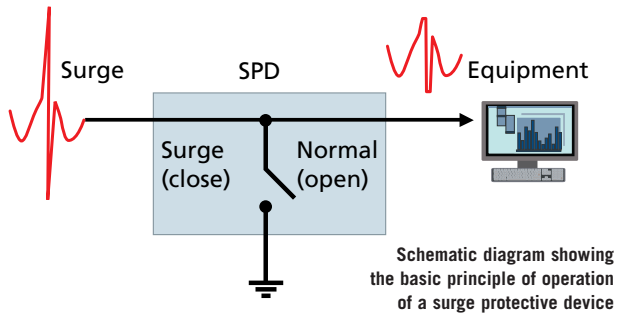
Installation of a surge protective device

SPDs can operate in one of two ways, based on the component technologies within them. One way is as a voltage switching device where under normal conditions, the device is an open circuit. However at a certain threshold voltage the SPD conducts and diverts the current through it. It has two states ON and OFF, hence the name of voltage switching. Air gap technology is an example of a voltage switching device.

Another way is as a voltage limiting device. Voltage limiting type SPDs again present an open circuit under normal circuit conditions. When an over voltage is detected the device begins to conduct, dropping its resistance dramatically such that the overvoltage is limited and the surge current is diverted away from the protected equipment. Metal Oxide Varistors (MOVs) are a common example of voltage limiting devices. Advanced SPDs often utilise hybrid technologies combining voltage switching with voltage limiting components.

Selection of SPDs

Section 534 contains requirements for the selection of SPDs in order to ensure that the correct type of SPD is installed at the correct position within an installation. Typically, Type 1 SPDs are used at the origin of the installation, Type 2 SPDs are used at distribution boards and Type 3 SPDs are used near terminal equipment. Combined Type SPDs are classified with more than one



Schematic diagram showing the basic principle of operation of a surge protective device

Type, e.g. Type 1+2, Type 2+3. Type 1 SPDs are only used where there is a risk of direct lightning current.

Section 534 advises that in selecting an SPD, the key parameter is its limiting voltage performance (protection level Up) during the expected surge event. The SPD energy withstand (e.g I_{imp}) also needs to be sufficient for its location within the installation. An SPD with a low protection level will ensure adequate protection of the equipment, while an SPD with a high energy withstand may only result in a longer operating life. All SPDs are to comply with BS EN 61643.

Connection of SPDs

Section 534 contains a number of requirements for the Connection of SPDs depending on the type of supply and system earthing.

BS 7671:2008 lists five types of earthing system: TN-S, TN-C-S, TT, TN-C, and IT.

T = Earth (from the French word *Terre)*
N = Neutral
S = Separate
C = Combined
I = Isolated (The source of an IT system is either connected to earth through a deliberately introduced earthing impedance or is isolated from Earth. All exposed-conductive-parts of an installation are connected to an earth electrode.)

When designing an electrical installation, one of the first things to determine is the type of earthing system. The distributor will be able to provide this information.

The system will either be TN-S, TN-C-S (PME) or TT for a low voltage supply given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002. This is because TN-C requires an exemption from the Electricity Safety, Quality and Continuity

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Regulations, and an IT system is not permitted for a low voltage public supply in the UK because the source is not directly earthed. Therefore TN-C and IT systems are both very uncommon in the UK.

Therefore, for example, Section 534 requires that SPDs at or near the origin of the installation (if there is a direct connection between the neutral conductor and the protective conductor at or near the origin) shall be connected between each line conductor and the protective conductor/main earthing terminal which ever is the shorter distance.

Clause 534.2.3 of the proposed Section 534 selection of Surge Protective Devices (SPDs)

Clause 534.2.3 requires that SPDs shall be selected in accordance with the following requirements:

- voltage protection level (Up)
- continuous operating voltage (Uc)
- temporary overvoltages (TOVs)
- nominal discharge current (Inspd) and impulse current (Iimp)
- prospective fault current and the follow current interrupt rating

Co-ordination of SPDs

Occasionally it may be required to limit the voltage to the protected equipment to an even lower value. In this case two SPDs are used in a co-coordinated approach to minimise the let-through voltage.

Protection against overcurrent and consequences of SPDs end of life

Clause 534.2.4 has requirements for the protection against SPD short-circuits by Overload Circuit Protective Devices.

Fault protection integrity

Clause 534.2.5 has requirements to ensure that fault protection, shall remain effective in the protected installation even in case of failures of SPDs.

SPD installation in conjunction with RCDs

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 (IΔn). 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 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.

Clause 534.2.6 of Section 534 is concerned with ensuring that the correct type of RCD is selected in conjunction with the correct type of SPD. Where SPDs are installed on the load side of an RCD, the operation of the SPD could potentially cause the RCD to operate unless it is of the S type. Where SPDs are installed on the supply side of an RCD the operation of the SPD will not affect the RCD. Clause 534.2.6 states:

Where SPDs are installed in accordance with 534.2.1 and are on the load side of a residual current device, an RCD with or without time delay, but having an immunity to surge currents of at least 3kA 8/20, shall be used.

NOTE 1: S-type RCDs satisfy this requirement.

NOTE 2: In the case of surge current higher than 3 kA 8/20, the RCD may trip causing interruption of the power supply.

SPD status indication

Section 534 requires indication to be provided by a status indicator local to the SPD itself and/or remote, that the SPD no longer provides (or provides limited) overvoltage protection.

Critical length of connecting conductors

To gain maximum protection the supply conductors shall be kept as short as possible, to minimise additive inductive voltage drops across the conductors. Current loops shall be avoided. Clause 534.2.9 has specific requirements on conductor lengths.

Cross-section of connecting conductors

Clause 534.2.10 states:

The connecting conductors of SPDs shall either:

i) have a cross-sectional area of not less than 4 mm^2 copper (or equivalent) if the cross-sectional area of the line conductors is greater than or equal to 4 mm^2, or

ii) have a cross-sectional area not less than that of the line conductors, where the line conductors have a cross-sectional area less than 4 mm^2.

Where there is a structural lightning protection system, the minimum cross-sectional area for Type 1 SPDs shall be 16 mm^2 copper, or equivalent.

Further information

Important: this article is only intended as a brief summary of possible forthcoming requirements in BS 7671. Persons involved in this area should seek specialist advice. For further information on the installation of surge protective devices see HD 60364-5-534.

Conclusion

Section 534 may or may not be included in amendment number 1 of BS 7671:2008 depending on the decision of the National Wiring Regulations Committee (JPEL/64). A future amendment to the IEE Wiring Regulation (BS 7671:2008) is expected during 2011.

Acknowledgements

Thanks to Furse, Hager and Schneider Electric for some of the images and information contained in this article. ■

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In-Service Inspection and Testing of Electrical Equipment

by Paul Bicheno

In-service inspection and testing of electrical equipment, commonly known as 'Portable Appliance Testing', is a vital part of making sure that the various types of electrical equipment within a work environment are maintained in a safe condition. Many questions are put to the IET on this subject so this article looks at discussing some of these, including legislation related to in-service inspection and testing, training required to carry out formal inspection and testing, test equipment and implementation of an inspection and testing programme.

What is the Legislation for in-service inspection and testing of electrical equipment?

In-service inspection and testing is not a specific legal requirement. Regulation 4(2) of the Electricity at Work Regulations 1989 states 'As may be necessary to prevent danger, all systems shall be maintained so as to prevent, so far is as reasonably practicable, such danger'. Electrical equipment forms part of an electrical system and as such would need to be maintained in some way to ensure safety. However, it is recognised that regular in-service inspection and testing of electrical equipment is required to maintain equipment and thus comply with this regulation. Anyone who inspects and tests an electrical equipment system must be competent to undertake such work as they control that part of the electrical system while carrying out the maintenance activity.

The Provision and Use of Work Equipment Regulations 1998 requires work equipment to be constructed in such a way that it is suitable for the purpose for which it is to be used. Regulation 4(1) states: 'Every employer shall ensure that work equipment is so constructed or adapted as to be suitable for the purpose for which it is used or provided'. Regulation 5(1) is specifically related to

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maintenance and states: 'Every employer shall ensure that work equipment is maintained in an efficient state, in efficient working order and good repair'. In this regulation 'efficient' means the condition of the equipment in relation to health and safety. Therefore, in-service inspecting and testing of electrical equipment should be included within the maintenance regime for a work environment.

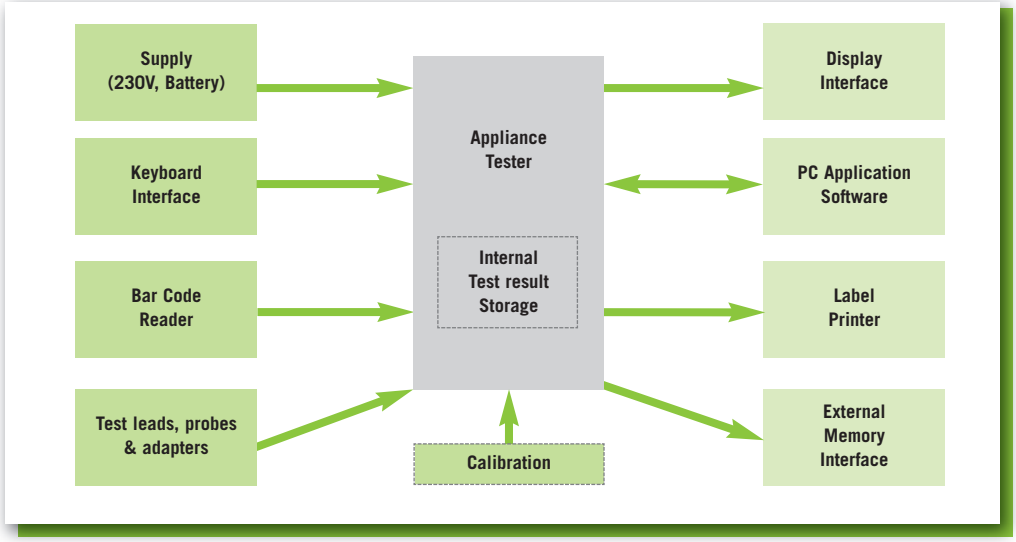

Fig. 1 Block diagram of typical appliance tester interfaces

What training is required to carry out in-service inspection and testing?

Regulation 16 of the Electricity at Work Regulations requires persons to be competent to prevent danger and injury. Therefore persons performing inspection and testing of electrical equipment should be trained to do so in order to make sure of their own safety and the safety of others. The training should cover all the appropriate technical knowledge required to perform the activity including the understanding of the results generated.

There are specific training courses related to in-service inspection and testing of electrical equipment available from a number of electro-technical training providers, which are typically one day courses. City and Guilds has a formal qualification in this subject, namely the *Level 3 Certificate for the Code of Practice for In-Service Inspection and Testing of Electrical Equipment (2377)*. This has two specific qualifications. The first is the *Level 3 Certificate in Management of Electrical Equipment Maintenance*. As the title implies this qualification is aimed at managers and administrators of work places that need to implement an inspection and testing regime. This would equally apply to organisations providing maintenance and testing services. The second is the *Level 3 Certificate for the Inspection and Testing of Electrical Equipment*. This qualification is aimed at persons undertaking and recording the inspecting and testing of electrical equipment.

Some training providers offer courses that lead to gaining the City and Guilds qualifications. Others offer courses that are aligned to the IET Code of Practice for In-service Inspection and Testing but are not a formal qualification. As a minimum a course syllabus should be confirmed that it aligns to the Code of Practice. When choosing a training course it is worth considering that the electrical industry recognises the formal City and Guilds qualifications e.g. 2382 for requirements for electrical installations BS 7671 and 2391 certificate in inspecting, testing and certification of electrical installations as part of the evidence for competency. Therefore it would seem logical to choose a course that leads to gaining the appropriate 2377 qualification. It is also worth checking the types of appliance test equipment a training provider would use during a course to align with what an organisation already uses or intends to use, so that the training directly relates to what will be used in practice. Some training providers offer customized courses in this respect.

What PAT tester functionality and accessories are available?

Figure 1 shows a block diagram of the typical appliance tester interfaces. Manufacturers typically produce a range of appliance tester products that have various levels of interfaces and functionality aimed at small to large volume testing. The standard related to this test equipment is BS EN 61010 *Safety requirements for electrical equipment for measurement, control and laboratory use*. The appliance test units can be powered via a 230 V supply or a battery pack and so can be a desktop unit or hand held unit. The units have a keyboard interface for entering appliance details along with specific buttons for selecting the various test functions. There are various display options from alphanumeric to graphical displays. The units with graphical displays include useful graphical help for the various tests. Units also now have various sizes of onboard memory to enable storage of a number of appliance details and associated test results. Bar code readers are available as an input device. This enables the user to read an associated appliance label that has details of the appliance. This means the user does not have to manually enter details again where it is included in a continuous testing regime.

The bar code labels can be generated via a dedicated label printer used as an output device. The printed labels would have an appliance number and bar code that includes the relevant appliance details.

There are also various other types of appliance labels available. There are simple combinations of write-on pass and fail adhesive labels, plug-top specific labels, cable lead labels and equipment tags. Also, some of these include the provision of laminates to protect the label information. There are also appliance register sheets and appliance certificate of inspection and

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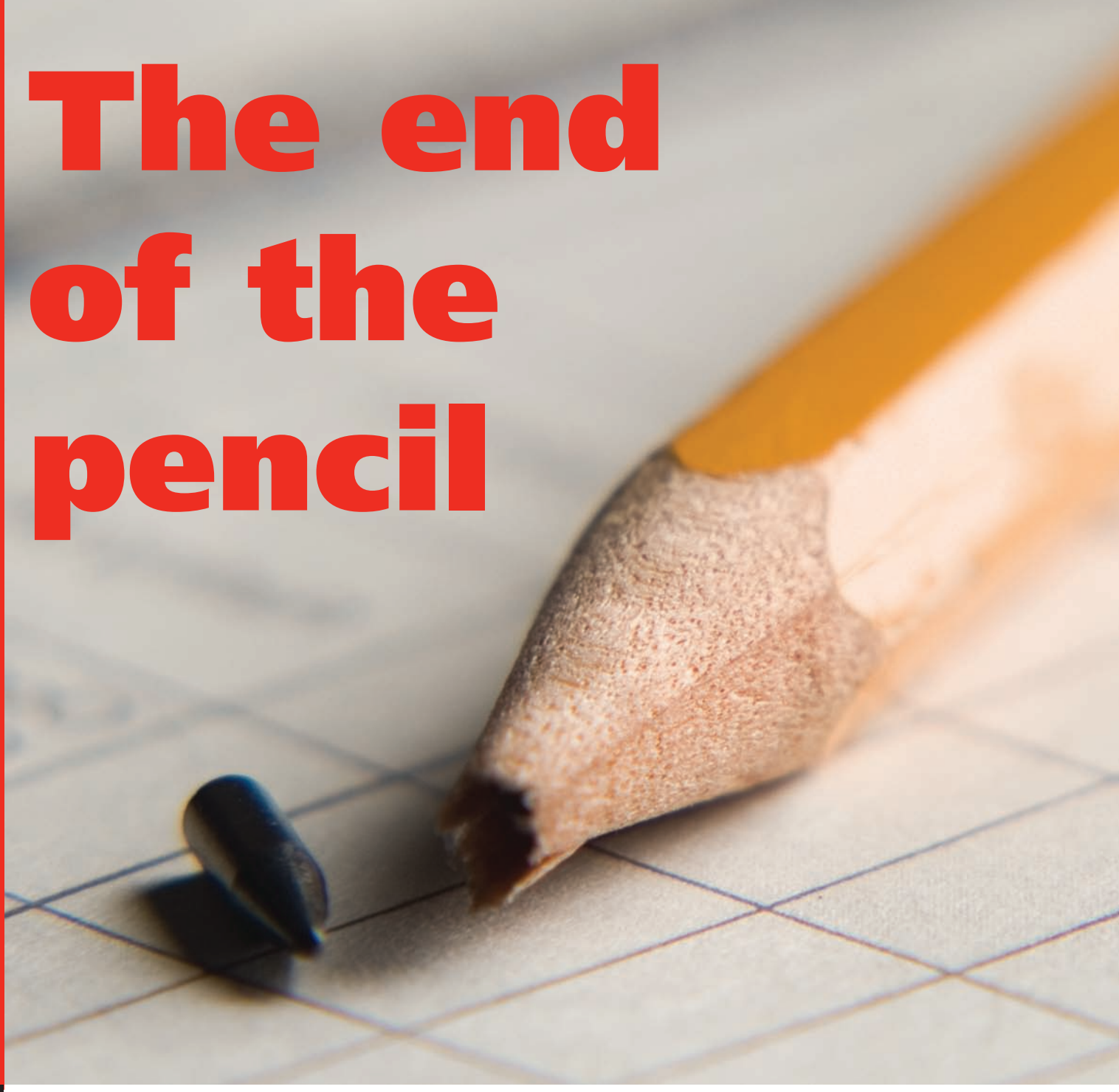

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test sheet sets that can be used for manual recording. There are a number of leads and adapters available to enable an array of appliances to be tested including 13A BS 1363 plug to IEC socket, extension lead and various 13A BS 1363 plug to industrial type sockets. Some units include an external memory interface where data can be copied to a memory device for copying to a central data system. There is also powerful PC application software packages specifically designed to interface with the test units. These offer the functionality to store appliance details and tests results, customer details and equipment registers, issue testing certificates and management of the testing schedules. PDA versions are also available. Manufacturers also normally offer a calibration service for the appliance test unit.

The testing units have a number of test functions including the following;

- Earth continuity testing (class I)
- Insulation testing
- Functional testing Load/leakage or touch current testing
- Built in fuse check

Some units include functionality to enable a test to run continuously to enable the user to check various parts of the appliance like flexing a lead throughout its length rather than just a one shot test. This is also useful when conducting a current or load test on an appliance that has a long start up period e.g. some information technology equipment.

Test units also have functionality for carrying out testing in a manual or automatic mode. Manual test mode is where a particular test is initiated by the user as a one shot test. Automatic mode is where the user selects a predefined test routine, typically for class I or II type appliances. Prompts are included at appropriate points in the sequence. These are useful for semi-skilled type users as they provide the various prompts on the unit display interface.

Implementing in-service inspection and testing

An inspection and testing regime should include a process that comprises user checks, formal visual inspection and formal inspection and testing of the electrical equipment. Depending on the type of organisation this regime can be implemented as an ongoing maintenance program or at a point prior to the change of ownership of electrical equipment. The regime can be implemented by using an internal organization resource or utilising an external organisation that offers an inspection and testing service. The regime will need to include the use of the appropriate testing equipment, trained personnel and a system to formally record inspection and testing. The record keeping system should include an equipment register, equipment formal inspection and test records, equipment labelling, faulty equipment register, equipment repair register and test instrument records. Labelling of equipment should be used to indicate that it requires routine inspection and testing along with the safety status. This should also include information to ascertain when it is next due for testing. It is also important to label equipment that has been deemed faulty so that it is clear that it should not be used.

Although the Electricity at Work Regulations 1989 does not have a specific requirement to keep records, the HSE Memorandum of guidance (HSR25) advises that records of maintenance, including the test results should be kept throughout the life of an electrical system. This serves two purposes. The first enables the duty holder to show that electrical equipment has been maintained and also enables the effectiveness of the maintenance regime to be monitored. The records could also be used to make further judgements on whether the intervals between inspection and testing can be altered.

The legislation does not set statutory periods for formal visual inspection and testing. However, the IET Code of Practice and HSE publications include guidance for recommended initial intervals related to user checks, formal visual inspection and combined inspection and testing for different types of electrical equipment in different environments. These should not be interpreted as what the law requires but as a recommended starting point.

The appliance test unit itself should also be included within a maintenance program to make sure that the results produced remain within specification, e.g. via an in-house or external calibration service.

Within a business or organisation there should be regular team meetings that includes health and safety matters like electrical safety. This can be used for managers to brief employees on electrical safety matters and just as importantly for employees to highlight any electrical safety issues that can then be passed to appropriate safety

department, engineering department or management to deal with. Users should be briefed on the use of electrical equipment. This should include checking that the electrical equipment safety status is clearly identified via a label and to carry out basic user checks prior to use. The second point is important since although equipment could be labelled correctly as safe, it could have been done some time ago so the user should not just rely on the label.

Bigger organisations have the benefit that various groups of job functions are available to implement an efficient system. For example, with the advent of numerous items of IT equipment, an IT department can have personnel trained to carry out the initial checks as they would normally be carrying out other activities on the equipment before being put into use. Subsequent checks could then be carried out by engineering departments. In addition many organisations implement multi-skilled training programmes where non electrical personnel are also formerly trained to carry out the inspection and testing, thus increasing the level of maintenance.

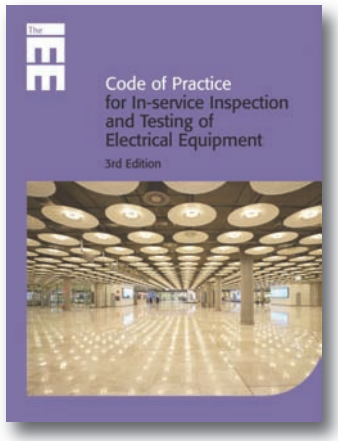
It is worth highlighting that domestic premises have many items of electrical equipment that other than when new, are not subjected to ongoing inspection and testing. Therefore an inspection and testing regime could be implemented that would aid making the home safer. There are organisations that offer inspection and testing services for electrical equipment in both business and landlord premises that could easily offer the same service for domestic premises. These companies also offer microwave oven leakage testing which could also be included.

Additional information

The IET publish the *Code of Practice for In-Service Inspection and Testing of Electrical Equipment* (3rd edition). This can be obtained from IET publishing (*http://www.theiet.org/publishing/books/wir-reg/cop.cfm*). The model forms for in-service inspection and testing included within this publication are available to download from the IET website via the following link *www.theiet.org/publishing/wiring-regulations/forms*. They are included within the document 'BS 7671:2008 forms' that can be downloaded from this page.

The Health and Safety Executive publish guidance related to in service inspection and testing of electrical equipment obtainable from HSE books (*www.hsebooks.co.uk*) as follows:
Maintaining portable and transportable electrical equipment (HSG107)
Maintaining portable electrical equipment in offices and other low-risk environments (INDG236)
Maintaining portable electrical equipment in hotels and tourist accommodation (INDG237)
Also Memorandum of guidance on the Electricity at Work Regulations 1989 (HSR25)

The IET offers the following two courses relating to In-service inspection and testing of electrical equipment;
Certificate of Competence Management of Electrical Equipment Maintenance (City and Guilds 2377-100)



Certificate of Competence for the Inspection and Testing of Electrical Equipment (City and Guilds 2377-200)
Further information on these courses can be obtained via the IET courses unit, telephone 01438 767289 (*www.theiet.org/careers/courses/electrical/index.cfm*)

Specific information on the City and Guilds 2377 qualification can be obtained from their website *www.cityandguilds.com*.

The following list details of some equipment manufacturers of portable appliance test equipment:
Fluke (UK) Ltd
www.fluke.co.uk
(**Robin Electronics**
www.robinelectronics.co.uk)
Kewtech
www.kewtechcorp.com
Martindale Electric
www.martindale-electric.co.uk
Megger
www.megger.com/uk
Metrel
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The provision of information within BS 7671 Part II

by Jon Elliott

Part one of this article, which appeared in the last issue of *Wiring Matters*, looked at the requirements within BS 7671 relating to the provision of information considered necessary for the safe and effective use of electrical installations. In this part we will be concentrating on those requirements relating to the provision of information which apply to safety services; special installations and locations; and inspection, testing, certification and reporting.

Safety services

Within BS 7671, Chapter 56 contains requirements for safety services such as emergency lighting, fire detection and alarm systems and industrial safety systems. Regulation 560.7.5 requires that any switchgear and controlgear should be clearly identified to indicate its purpose. Such clear identification is essential as switch/controlgear for emergency services must be placed in a location where it is only accessible by skilled or instructed persons. This may, in many cases result in it being placed remotely from the equipment or circuits being controlled. It is a general requirement that the purpose of each device provided to act as an isolator is, as a result of its physical location or through labelling, clearly understandable (537.2.2.6 refers). As such, except for the most straightforward of installations, it will be necessary to label or otherwise identify both the isolator and the item of equipment wherever an isolator is placed remote to the item of equipment being controlled.

In many cases, arrangements for safety services may need to be understood or, in the case of fire rescue service lifts and communications systems, operated by persons who are not familiar with the building or the installation therein. As a result Chapter 56 contains a number of requirements designed to make the information necessary for the safe and proper use of safety services readily available. These requirements are described below:

- Full details should be given of all electrical safety services within the building or location and should be displayed close to the relevant distribution board (560.7.9 refers). This information should be conveyed as clearly as possible and as such a single line schematic diagram would be sufficient in some cases.
- Any drawings relating to the

safety services should be displayed at the origin of the installation. These drawings should clearly identify the location of

- All items of electrical control equipment and distribution boards. Any equipment identification designations used should be clearly stated on the drawings
- each item of safety equipment. The particulars and purpose of each item of equipment and the relevant individual circuit identification designation being clearly stated
- any special switching or monitoring equipment associated with a power supply for a safety service including visual or audible warning equipment (560.7.10 refers)

- A schedule of all items of current using equipment (as defined in Part 2 of BS 7671) which is connected to the safety power supply. Characteristics such as rated current (as defined), starting time and starting current should be stated for each item. Where convenient, this information may be given on the circuit diagrams.
- The operating instructions for all items of safety equipment and electrical safety services should be made readily available. These instructions should be specific to the actual installation in question as an aid to the operation of the safety services therein (560.7.12 refers).

It will of course be necessary to comply with the requirements of other relevant standards relating to safety services too. By way of example, BS 5839-1: 2002 (2008) *Fire detection and fire alarm systems for buildings – Part 1: Code of practice for design, installation, commissioning and maintenance*.) contains a number of requirements pertinent to this article such as:

- With the exception of the main isolator serving the whole building, any isolator or protective device that could be used to isolate the supply to the fire alarm system should be clearly labelled:
  - "FIRE ALARM" where a protective device not containing a switch serves only the fire alarm system.
  - "FIRE ALARM. DO NOT SWITCH OFF" where a switching device, whether incorporating a protective device or not, serves only the fire alarm system.
  - "WARNING. THIS SWITCH ALSO CONTROLS THE SUPPLY TO THE FIRE ALARM SYSTEM" where a switch disconnects the supply to both the fire alarm system and other circuits (clause 25.2 f refers).
- Clause 40 requires adequate records and other documentation to be provided to the user or purchaser. This would include certificates covering the design, installation and commissioning of the alarm system; an operation and maintenance manual for the system; as fitted drawings and a log book in which to record maintenance and testing activities, fire alarm signals and false alarms.
- Clause 41 covers the certification requirements for the design, installation, and commissioning of the installation

Inspection and testing

An electrical installation should be subjected to inspection and testing both during construction and on completion before being taken into service to confirm that the relevant requirements of BS 7671 have been met (610.1 refers). It should also be subjected to periodic re-inspection and testing to confirm, so far as is reasonably practicable, that the installation remains in a satisfactory condition for continued service (621.1). Whenever inspection and testing is carried out it is very important that the person carrying out the work has access to the relevant information about the installation such as, in the case of initial verification, details relating to the design including the methods of protection employed, schedules for distribution circuits and boards and details of any installed equipment which might suffer damage or cause misleading readings to be given during testing (610.2). In the case of periodic inspection and testing, the inspector should have access to the Electrical Installation Certificate (EIC) relating to the original installation, the relevant certification - whether further Electrical Installation Certificates or Minor Works Certificates - to cover additions and alterations made after the original installation was completed and also the reports covering any periodic inspection and testing carried out previously (621.1).

Where a person carrying out inspection and testing has access to the results of previous inspection and

testing it becomes possible for them, by comparison of results, to observe signs of deterioration which may have occurred over time such as, for example, a trend showing falling insulation resistance which might indicate mechanical damage or material deterioration to the insulation of a cable, or a marked increase in conductor resistance which is perhaps a symptom of a poor connection caused by corrosion within a terminal or a loose connection or similar.

Whilst carrying out an inspection on an installation, regulation 611.3 states that the inspection should confirm the presence of the following forms of identification, labelling or similar

- identification of conductors
- labelling of protective devices, switches and terminals
- provision of danger signs and other warning signs where required
- provision of diagrams, instructions and similar information

On completion of the initial verification of an installation or changes to an existing installation an Electrical Installation Certificate and schedule(s) of inspection and schedule(s) of test results should be produced and given to the person ordering the work (631.1; 632.1). Where the work carried out does not include the provision of a new circuit, a Minor Works Certificate may be issued to cover the work (631.3). On completion of a periodic inspection a Periodic Inspection Report and schedule(s) of inspection and schedule(s) of test results should be produced and given to the person ordering the inspection (631.2; 634.1). In each case, the certificate, report and schedules should be based upon the model forms contained in Appendix 6.

Special installations and locations

Part 7 of BS 7671 contains requirements specific to special installations and locations which supplement or modify the general requirements (700 refers). Within Part 7 there are a number of requirements of relevance to this article and these are considered below.

Swimming pools

Regulation 702.410.3.4.1 permits the installation of socket-outlets within zone 1 of a location containing a swimming pool supplied by either SELV or electrical separation, in both instances the source of which being installed beyond zones 0 and 1 unless protected by a 30 mA RCD or by automatic disconnection of supply with additional protection provided by 30 mA RCD. However wherever a socket-outlet is so located, a notice must be installed to inform persons carrying out maintenance or cleaning that any equipment connected via the socket-outlet may only be used when the pool is not occupied by people.

Agricultural and horticultural premises

Regulation 705.514.9.3 requires that the user of the installation be provided with a plan indicating the location of all installed electrical equipment and the routing of any concealed cables. Knowledge of the routing of buried cables is particularly important in agricultural premises as virtually any area of unpaved or

INSTRUCTIONS FOR ELECTRICITY SUPPLY

BERTHING INSTRUCTIONS FOR CONNECTION TO SHORE SUPPLY

This marina provides power for use on your pleasure craft with a direct connection to the shore supply which is connected to earth. Unless you have an isolating transformer fitted on board to isolate the electrical system on your craft from the shore supply system, corrosion through electrolysis could damage your craft or surrounding craft.

ON ARRIVAL

(i) Ensure the supply is switched off and disconnect all current-using equipment on the craft, before inserting the craft plug. Connect the flexible cable **firstly** at the pleasure-craft inlet socket and **then** at the marina socket-outlet.

(ii) The supply at this berth is * V, * Hz. The socket-outlet will accommodate a standard marina plug colour * (technically described as BS EN 60309-2, position 6 h).

(iii) For safety reasons, your craft must not be connected to any other socket-outlet than that allocated to you and the internal wiring on your craft must comply with the appropriate standards.

(iv) Every effort must be made to prevent the connecting flexible cable from falling into the water if it should become disengaged. For this purpose, securing hooks are provided alongside socket-outlets for anchorage at a loop of tie cord.

(v) For safety reasons, only one pleasure-craft connecting cable supplying one pleasure craft may be connected to any one socket-outlet.

(vi) The connecting flexible cable must be in one length, without signs of damage, and not contain joints or other means to increase its length.

(vii) The entry of moisture and salt into the pleasure-craft inlet socket may cause a hazard. Examine carefully and clean the plug and socket before connecting the supply.

(viii) It is dangerous to attempt repairs or alterations. If any difficulty arises, contact the marina management.

BEFORE LEAVING

(i) Ensure that the supply is switched off and disconnect all current-using equipment on the craft, before the connecting cable is disconnected and any tie cord loops are unhooked.

(ii) The connecting flexible cable should be disconnected **firstly** from the marina socket-outlet and **then** from the pleasure-craft inlet socket. Any cover that may be provided to protect the inlet from weather should be securely replaced. The connecting flexible cable should be coiled up and stored in a dry location where it will not be damaged.

unmetalled surface may be subjected to ploughing over either in connection with crop production or as a way to recover tracks and access ways to a more usable condition for vehicles. Regulation 705.522 specifies minimum depths at which buried cables should be installed, in the case of areas not comprising arable or cultivated ground the minimum specified depth is 0.6 m with added mechanical protection. However, it is not inconceivable that successive ploughing in such areas could result in a penetration of the ground to such a depth, in which case virtually no amount of mechanical protection would resist the force produced by a tractor...

A typical agricultural and horticultural premises will consist of a number of separate buildings. The electrical installation in each building or distinct separate part thereof should be protected by a single isolation device (705.537.2 refers). Furthermore any circuits which provide a supply to circuits which are only used seasonally at for example harvest time should be provided with an isolator which disconnects all live conductors when operated. Any isolators so provided should be clearly marked to indicate which building or part of the installation they control.

Where high density livestock rearing is employed and where the supply of food, water, air or lighting cannot be ensured in the event of a power supply failure, a secure source of supply should be arranged typically in the form of a back-up supply (705.560.6 refers). Where electrically powered ventilation is required in such cases it is necessary to install either temperature and supply voltage monitoring, or a standby source of supply such as a generator having sufficient capacity to allow an adequate level of ventilation to be maintained. Where a standby source is selected, a notice must be posted adjacent to it making it clear that it should be subjected to testing periodically in accordance with manufacturer's instructions.

Marinas and caravans

Persons berthing vessels in marinas or using caravans are viewed as ordinary persons as defined in BS 7671. That is to say they are seen as being neither electrically skilled nor sufficiently instructed to avoid the dangers which electricity may create. As a result, BS 7671 recommends that marina operators provide user instructions to any persons making use of the electrical supply points provided (fig 709.3 note 1 refers). Fig 709.3 of Section 709 is an example set of instructions for the connection of vessels to supply points in marinas and is reproduced above.

In the case of caravans regulation 721.514.1 requires that instructions for use be provided to allow the caravan to be used safely. These instructions should include information relating to the function and use of the integral test button of the RCD – this requirement could be met by posting the RCD notice described in 514.12.2 at the consumer unit - and the use of the main isolating switch. It also requires the posting of the user instructions for connection and disconnection as given in fig 721 of Section 721. Regulation 721.537.2.1.1.1 requires these user instructions to be posted near the main isolation switch inside the caravan which effectively means next to the consumer unit.

Annex A to Section 721 contains guidance on the use of extra-low voltage d.c. installations associated with caravans. This annex is informative and as such does not contain requirements. It does however contain a number of recommendations regarding instructions for use in A721.514.1 and warning notices to be displayed on or near the auxiliary battery compartment in A721.55.3.5 and A721.55.3.7.

Exhibitions, shows and stands

An emergency switch should be provided for circuits used to supply signs, lamps or exhibits in such installations. This switch should be easily visible, accessible and the items controlled by each switch clearly stated (711.559.4.7 refers).

Solar photovoltaic power supply systems

It is extremely problematic to make dead all parts of a solar photovoltaic power supply system – particularly between the PV array (as defined) – more commonly referred to as a solar panel – and the device providing isolation before the PV convertor as some degree of generation will occur at any level of ambient light. For this reason, regulation 712.537.2.2.5.1 requires all junction boxes on PV arrays and the PV generator (an installation comprising a number of PV arrays) to carry a warning label stating that parts therein may remain live after operation of the isolator before the PV convertor.

Mobile and transportable units

These units are in many cases capable of being connected to a very wide range of supplies. In order to make possible their safe connection to a supply, and hence enable their safe use, instructions for connection should be posted, preferably close to the supply inlet connector(s) detailing:

- the unit's earthing arrangement
- the type of supply/supplies which may be connected to the unit
- the unit's voltage rating
- the number of phases of the installation within the unit and the phase configuration
- the unit's maximum power requirement ■

Energy efficiency of **luminaires**

by Mark Coles

For more than 100 years, the incandescent lamp has been used in dwellings as the main source of light but, as these lamps are extremely inefficient, they are now being phased out. As world leaders are committed to reducing the emission of greenhouse gases by curtailing energy consumption, incandescent lamps will be gradually replaced by suitable energy-efficient lamps.

This article looks at the UK's energy obligations and the energy efficiency of lamps.

The Kyoto Protocol

The Kyoto Protocol of The United Nations Framework Convention on Climate Change (UNFCCC) was endorsed by 186 countries in September 2008. The treaty is legally binding which commits industrialised countries to reduce their "collective" greenhouse gas emissions to 5.4% below 1990 levels by 2012.

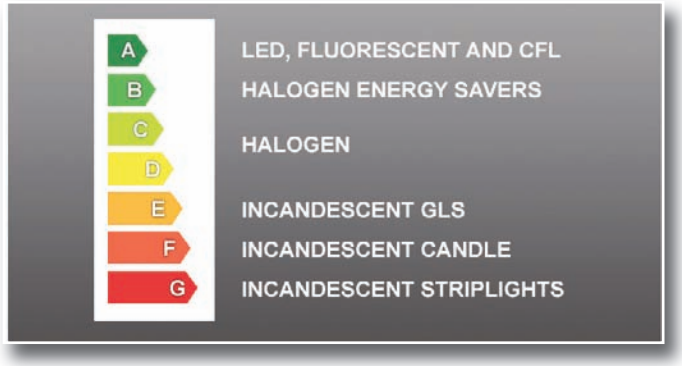
There is slight flexibility within the agreement whereby, for example, a high polluting country struggling to meet targets could finance a carbon-reducing project in another country to offset their own carbon production.

The European Union

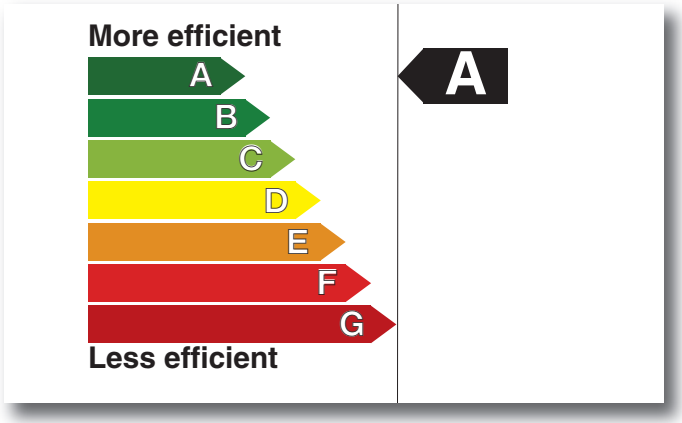
The European Union (EU) currently consists of 27 member states (the four countries of the UK and Northern Ireland count as one member-state). It is estimated that lighting accounts for 20% of a member state's energy usage, therefore, extensive work has gone in to developing and introducing directives which will reduce and control the energy consumption of lighting for commercial and residential/domestic applications. The EU has effectively agreed that inefficient lamps will be phased out gradually from the EU market starting in September 2009 and finishing in September 2012.

Energy Efficiency Label

The Energy Labelling Directive, (EEL) 98/11/EC & Eco-Label 2002/747/EC,



Energy classification - typical lamp types



Energy efficiency label

acknowledges the growing energy consumption of household appliances, it shows the actual energy consumption of appliances and sets minimum standards for household appliances. By law, the EU Energy Label must be displayed on all new household products of the following types displayed for sale or hire:

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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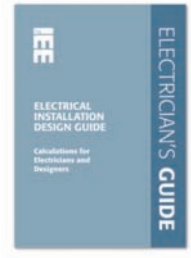

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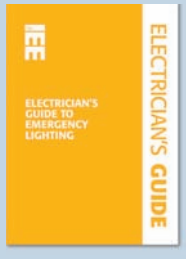

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The Labelling Directive does not apply to:

- lamps with a light output in excess of 6500 lm
- lamps rated at less than 4 W
- reflector lamps - note that only non-directional lamps are currently considered as light is emitted equally in all directions, whereas directional/reflector lamps direct light to where it is needed, therefore, directional lamps are considered to be more efficient
- lamps operated from batteries
- lamps not primarily for illumination

Incandescent lamps offer a low efficacy as the majority of energy consumed is converted into heat. A typical range would be 8-14 lumens per watt (lm/W). Luminous efficacy is a figure of merit for light sources and is the ratio of luminous flux (in lumens) to power (usually measured in Watts). As most commonly used, it is the ratio of luminous flux emitted from a light source to the electrical power consumed by the source and, therefore, describes how well the source provides visible light from a given amount of electrical power. This is also referred to as luminous efficacy of a source.

Table 1 shows general luminous efficacies and efficiencies of common lamp types.

The timetable

From September 2009, lamps equivalent in light output to 100 W incandescent lamps and above will have to be graded as C class, therefore, 100 W incandescent lamps, which are class E, will not meet this requirement. Running concurrently, lower wattage incandescent lamps of F and G classes will be phased out so that only E-class incandescent lamps will remain. By the end of 2012, the efficiency level will be made progressively better, moving to class C, effectively completely phasing-out clear incandescent lamps.

Halogen clear lamps (xenon-filled) which reach class C will remain on the market until 2016. Unless new technologies emerge, all remaining clear lamps will be extra-low voltage halogen, supplied by transformer, from 2016, reaching class B.

Under certain conditions, special purpose incandescent lamps, for example, those used in household appliances such as ovens or fridges, traffic lights, infrared lamps, tanning lamps and lamps used within the entertainment industry, are exempted from the current requirements of the directive.

Table 2, shows the timetable of phasing out incandescent lamps. Note that an energy efficient lamp is often only part of a luminaire - where a luminaire may comprise of a lamp, control gear, shade/reflector/diffuser, etc. There is a strategy to deal with ballasts of luminaires, known as Tertiary Implementing Measures. Table 3, overleaf, shows the timetable of requirements for lamps/ballasts/luminaires in relation to the specific type of discharge lamp used. There are more rigorous requirements for a Stage 3 to be implemented from 2017.

	Type	Overall luminous efficacy (lm/W)	Overall luminous efficiency
Incandescent	5 W tungsten incandescent	5	0.7%
	40 W tungsten incandescent	12.6	1.9%
	100 W tungsten incandescent	13.8	2.0%
	200 W tungsten incandescent	15.2	2.2%
	100 W tungsten glass halogen	16.7	2.4%
	200 W tungsten glass halogen	17.6	2.6%
	500 W tungsten glass halogen	19.8	2.9%
	Tungsten quartz halogen	24	3.5%
	Photographic and projection lamps	35	5.1%
Light-emitting diode	White LED	10 - 150	1.5 - 2.2%
Arc lamp	Xenon arc lamp	30 - 50	4.4 - 7.3%
	Mercury-xenon arc lamp	50 - 55	7.3 - 8.0%
Fluorescent	9–26 W compact fluorescent	46 - 72	8 - 11%
	T12 tube with magnetic ballast	60	9%
	T5 tube	70 - 100	10 - 15%
	T8 tube with electronic ballast	80 - 100	12 - 15%
Gas discharge	Metal halide lamp	65 - 115	9.5 - 17%
	High pressure sodium lamp	85 - 150	12 - 22%
	Low pressure sodium lamp	100 - 200	15 - 29%

Table 1 - General luminous efficacies and efficiencies of common lamp

Clear Lamps			
Stage	**Date**	**Phasing-out**	**Replacements**
1	1 September 2009	All clear lamps > 950 lm (≈ 80 W GLS)	Energy class C
2	1 September 2010	All clear lamps > 725 lm (≈ 65 W GLS)	Energy class C
3	1 September 2011	All clear lamps > 450 lm (≈ 45 W GLS)	Energy class C
4	1 September 2012	All clear lamps > 60 lm (≈ 12 W GLS)	Energy class C
5	1 September 2013	Increased quality requirements	Energy class C
Review	2014	–	
6	1 September 2016	All clear lamps > 60 lm	Energy class B
Clear Lamps			
Stage	**Date**	**Phasing-out**	**Replacements**
1	1 September 2009	All non-clear lamps	Energy class A

Table 2 - Timetable showing the phasing out incandescent lamps

Building Regulations

Building Regulations set the minimum standards to which new or refurbished installations are to comply and, in terms of the requirements for lighting, the following information applies:

Building Regulations of Scotland

The Building Regulations (Scotland) 2004 - Guidance is available in Section 6, Energy, of the Technical Handbooks.

Building Regulations of Northern Ireland

Building Regulations (Northern Ireland) 1994 Guidance is available in Technical Booklet F: Conservation of Fuel and Power (Dec 2008, revised 2006)

Building Regulations of England and Wales

Part L (Conservation of fuel and power) April 2006

- L1A Conservation of fuel and power in new dwellings
- L1B Conservation of fuel and power in existing dwellings
- L2A Conservation of fuel and power in new buildings other than dwellings
- L2B Conservation of fuel and power in existing buildings other than dwellings

Guidance is available to Part L (Conservation of fuel and power) in four Approved Documents. The Building Regulations of England and Wales applies to dwellings and buildings other than dwellings.

As an aside, there are proposed changes to Part L and Part F (Means of Ventilation) of the Building Regulations. The UK Government is currently considering transferring responsibility for Building Regulations in Wales to the Welsh Assembly, in which case, these proposals will only apply in England. A consultation paper was published on 18 June 2009, with a closing date of 17 September 2009.

The consultation sets out the proposed changes to Part L and Part F of the Building Regulations that are planned to come into force in 2010, these include a range of measures, such as, a strategy for training and dissemination designed to further improve the levels of compliance and performance in buildings.

In its Building a Greener Future - Policy Statement (July 2007), the Government set out that new homes will be net zero carbon from 2016. As steps to achieving this target, energy efficiency standards for new homes are to be improved by 25 % in 2010 and 44 % in 2013 relative to the then current 2006 standards.

The Government also wants to introduce improved energy efficiency standards for new non-domestic buildings, and in its 2008 Budget announced an ambition for all new non-domestic development to be net zero carbon from 2019.

Proposals for a similarly phased improvement beginning with 25 % in 2010 and plan to consult on the further trajectory towards zero carbon new non-domestic buildings.

The UK Government is also committed to addressing the energy efficiency of existing buildings and the consultation therefore proposes appropriate changes to the requirements when people elect to carry out building work to existing buildings.

When the proposed energy efficiency standards in Part L are strengthened in 2010 there is likely to be a tendency to more airtight buildings. It is therefore necessary to propose changes to Part F of the Building Regulations at the same time to ensure that adequate means of ventilation is provided.

More information at can be found at *www.communities.gov.uk/publications/planningandbuilding/partlf2010consultation*

Thanks

The Lighting Industry Federation (LIF) *www.lif.co.uk*
The Lighting Association *www.lightingassociation.com/*

		IM fluorescent lamps	IM high-pressure lamps
Stage 1 from 2010	Lamp	Phasing out of T5/T8 with RA < 80	Obligation to provide technical information on websites and in documentation
		Phasing out of T8 "halophosphate" lamps	
		Phasing out of CFL-2 pin lamps (magnetic control gear operation)	
		Obligation to provide technical information on websites and in documentation	
	Ballasts	Ballast EEI = min B2	No special requirements
		Dimmable EBs: EEI = min A1	
		$P_{58} \leq 1$ W	
		For new lamps: EEI = min A3	
		The EEI class of ballast must be indicated	
	Luminaire	Luminaire energy limit values = sum of ballast limit values (number of ballasts installed)	
		After Sept 2010: Technical information must be provided on websites and in documentation for luminaires > 2000 lm	
Stage 2 from 2012	Lamp	Phasing out of T10 and T12 lamps	Phasing out of inefficient HS and HI lamps (E27, E40 and PGZ12 base)
			Phasing out of HPM lamps from 2015
	Ballast	$P_{58} \leq 0.5$ W	Introduction of efficiency limit values for HID EBs
			The energy efficiency of all HID EBs must be indicated e.g. $\eta = 78$ %
	Luminaire	Luminaire energy limit values = sum of ballast limit values (number of ballasts installed)	Technical information must be provided on websites and in documentation for luminaires > 2000 lm
		Luminaires must be compatible with stage 3 ballasts, except for luminaires ≥ IP4X	
There are more rigorous requirements for a Stage 3 to be implemented from 2017.			

Table 3 - Timetable of requirements for lamps/ballasts/luminaires in relation to the specific type of discharge lamp used

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STOP PRESS

News from HSE

Effective from the 1st September 2009, the Health and Safety Executive will be making guidance materials from the HSG; HSR; and L series - many of relevance to persons working on or close to electrical installations - available as freely downloadable PDF documents. In all HSE will make around 230 publications available, with some 50 or so of its most popular titles becoming freely available in 'printer friendly' format from 1 September. The remaining 180 or so publications will be converted to this format by 31 March 2010.

It is the view of the IET that many of these documents such as for example HSR 25 (Memorandum of guidance on the Electricity at Work Regulations 1989) are essential reading for all involved in work with electrical installations. As such this move to make such publications freely available is welcomed.
Further details may be obtained from *www.hse.gov.uk/news/2009/hse-books.htm*

17th Edition Qualifications - The clock is ticking for Qualified Supervisors and Responsible Persons

The Electrotechnical assessment scheme (EAS) specification describes:

i) The minimum requirements for an enterprise (e.g. contractor) to be recognized by a certification body as competent to undertake electrical installation work, (design, construction, installation and verification) in England and Wales. It also includes the minimum technical competence requirements for enterprises to be considered competent to carry out electrical installation work in dwellings in accordance with Part P of the Building Regulations (Appendix 7).
ii) The competence requirements for registered qualified supervisors and responsible persons of the competent enterprises (Appendix 5)
iii) Particular requirements for compliance with the Scottish building standards (Appendix 8)
iv) Interpretation of the general requirements for bodies operating product certification (including process and service) schemes of EN 45011 (Appendix 9)

The Electrotechnical assessment specification has been prepared by a management committee that includes representatives of the competent person scheme providers, trade associations, the department for Communities and Local Government, the Electrical Safety Council and the Institution of Engineering and Technology (IET). The IET has accepted ownership of the specification and provide administrative support to the management committee.

Updated in 2009, the document requires:

- Proposed Qualified Supervisors and Responsible Persons to hold an appropriate BS 7671: 2008 qualification awarded by a body regulated by the Qualifications and Curriculum Authority or the Scottish Qualifications Authority within 12 months of acceptance by the Certification or Registration Body.
- Registered Qualified Supervisors and Responsible Persons to hold an appropriate BS 7671: 2008 qualification awarded by a body regulated by the Qualifications and Curriculum Authority or the Scottish Qualifications Authority by the first surveillance visit after 31 December 2010, but by no later than 31 December 2011.

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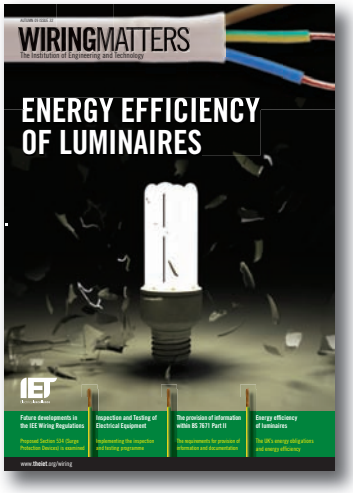

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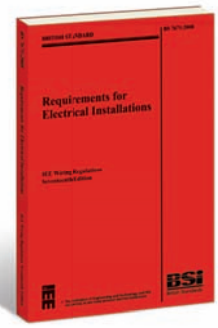

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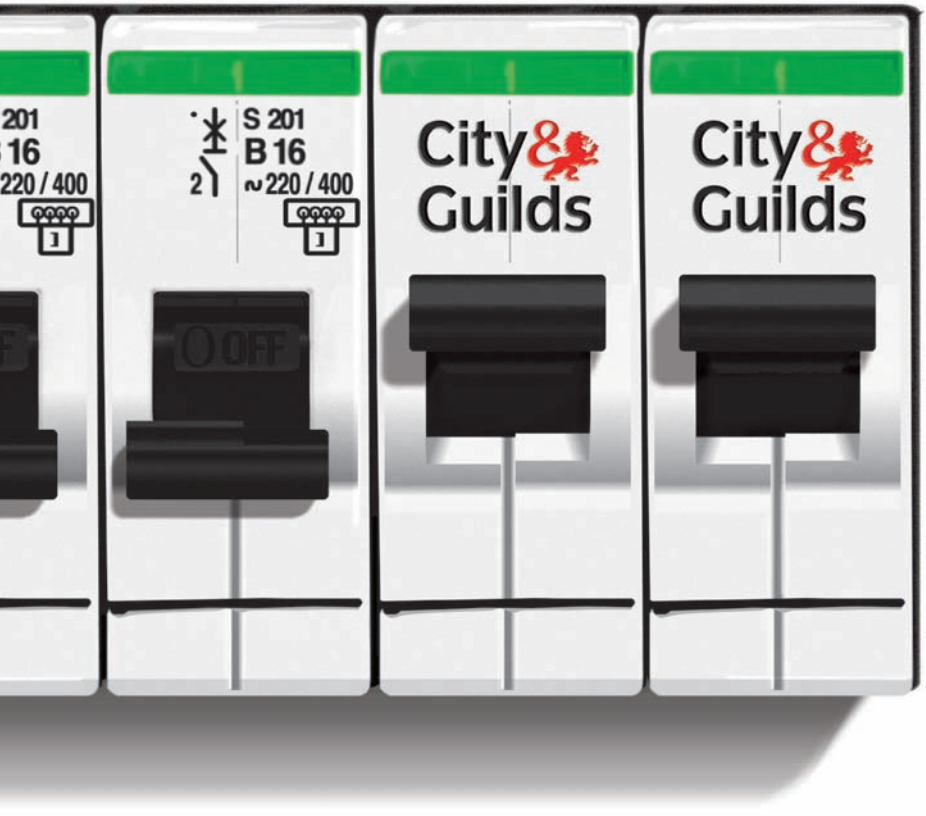

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