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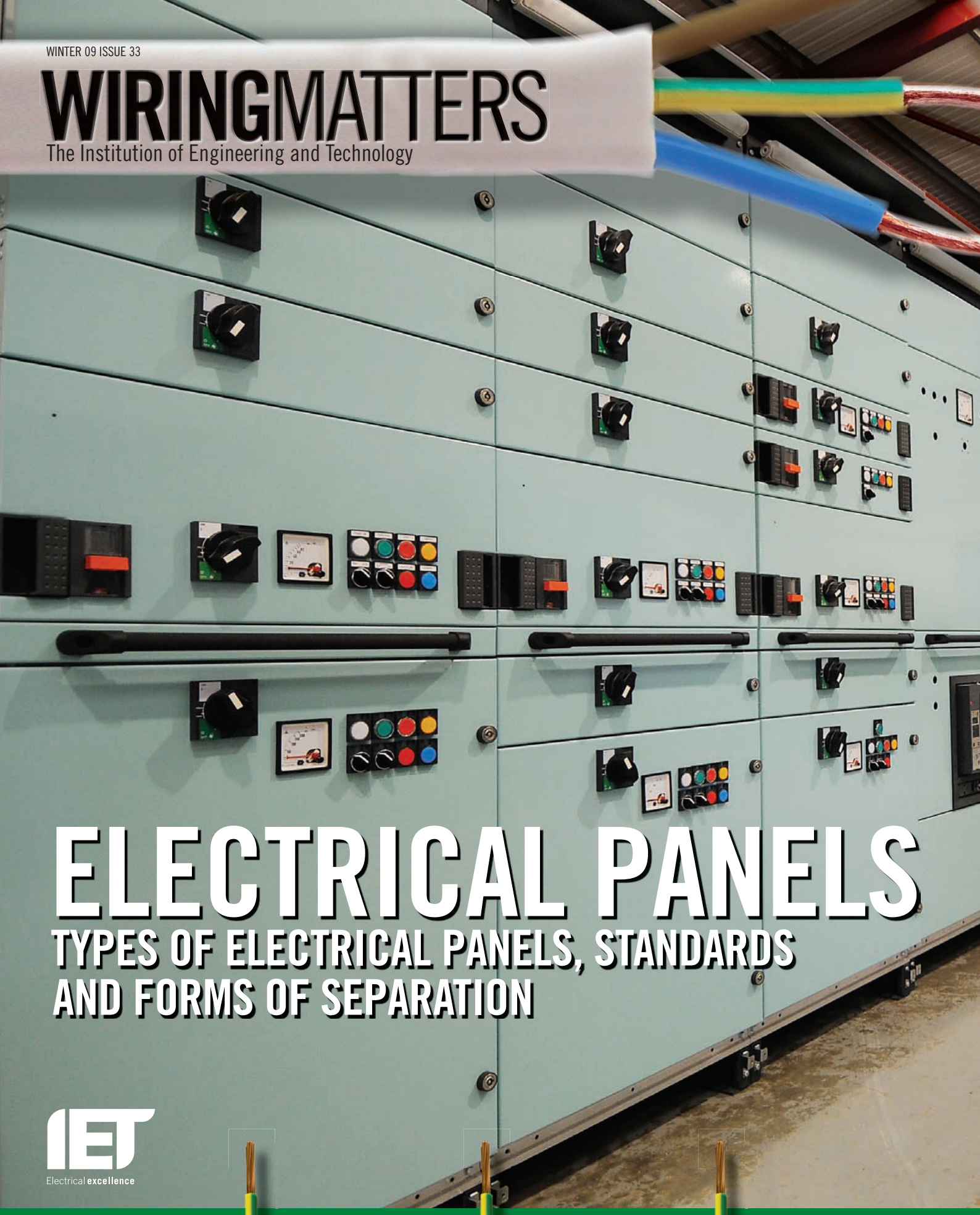
WIRINGMATTERS

The Institution of Engineering and Technology



ELECTRICAL PANELS

TYPES OF ELECTRICAL PANELS, STANDARDS AND FORMS OF SEPARATION

IET
Electrical excellence

Future developments in Standardisation

Supplies to electric vehicles

Energy efficient lighting in domestic premises

How to meet the requirements of the Building Regulations

The use of "Arctic" cable

Cable for use at low-temperature

Types of person and the requirements of the Regulations

Examining skills and competencies

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Future developments in International Standards for **electrical installations**

by Geoff Cronshaw

The IEE Wiring Regulations (BS 7671:2008) are based on European Standards, which in turn are usually based on international standards. The UK participates in both European and international standards work.

One new area of possible development within international standards is a new section 7 providing requirements for the supplies to electric vehicles. This proposed new section 7 would only apply to circuits intended to supply electrical vehicles for charging purposes and would cover the part of the electrical installation providing the connection with an electrical vehicle to the fixed installation.

However, this is only a new work item at this stage and it is important to point out that this may not become an international standard. This article is based on draft proposals and, therefore, the actual requirements (if it became an international standard) would probably be different. Systems for the distribution of electricity to the public are outside the scope of IEC 60364 low voltage electrical installations (and also outside the scope of BS 7671) therefore it is assumed that this new work item applies to private supplies such as dwellings and private commercial and industrial establishments.

The draft proposals may include requirements for the type and current rating of socket outlets, RCD protection, surge protection, measures of protection against electric shock, IP rating of equipment, impact protection against mechanical damage, isolation and switching and fixing arrangements, etc.

Protection against electric shock

It is expected that the protective measures of obstacles, placing out of reach, non-conducting location and protection by earth-free local equipotential bonding would not be permitted.

These measures are contained in Sections 417 and 418 of BS 7671:2008 and are not for general application. The

protective measures of section 417 provide basic protection only and are for application in installations controlled or supervised by skilled or instructed persons. The fault protective provisions of Section 418 are special and, again, subject to control and effective supervision by skilled or instructed persons.

External influences

Presence of water (AD)

Any wiring system or equipment selected and installed must be suitable for its location and able to operate satisfactorily without deterioration during its working life. The presence of water can occur in several ways, e.g. rain, splashing, steam/humidity, condensation and at each location where it is expected to be present its effects must be considered. Suitable protection must be provided, both during construction and for the completed installation.

For example, draft proposals for a connection point installed outdoors requires IPX4 in order to protect against water splashes (AD4).

The IP classification code, BS EN 60529:2004, describes a system for classifying the degrees of protection provided by the enclosures of electrical equipment. The degree of protection provided by an enclosure is indicated by two numerals. The first numeral

Table 1 showing IP characteristic numerals

First characteristic numeral	Second characteristic numeral
(a) Protection of persons against access to hazardous parts inside enclosures (b) Protection of equipment against ingress of solid foreign objects	Protection of equipment against ingress of water

No.	Degree of protection	No.	Degree of protection
0	(a) Not protected (b) Not protected	0	Not protected
1	(a) Protection against access to hazardous parts with the back of the hand (b) Protection against foreign solid objects of 50 mm diameter and greater	1	Protection against vertically falling water drops
2	(a) Protection against access to hazardous parts with a finger (b) Protection against solid foreign objects of 12.5 mm diameter and greater	2	Protected against vertically falling water drops when enclosure tilted up to 15°. Vertically falling water drops shall have no harmful effect when the enclosure is tilted at any angle up to 15° from the vertical
3	(a) Protection against contact by tools, wires or such like more than 2.5 mm thick (b) Protection against solid foreign objects of 2.5 mm diameter and greater	3	Protected against water spraying at an angle up to 60° on either side of the vertical
4	(a) As 3 above but against contact with a wire or strips more than 1.0 mm thick (b) Protection against solid foreign objects of 1.0 mm diameter and greater	4	Protected against water splashing from any direction
5	(a) As 4 above (b) Dust-protected (dust may enter but not in amount sufficient to interfere with satisfactory operation or impair safety)	5	Protected against water jets from any direction
6	(a) As 4 above (b) Dust-tight (no ingress of dust)	6	Protected against powerful water jets from any direction
	No code	7	Protection against the effects of temporary immersion in water. Ingress of water in quantities causing harmful effects is not possible when enclosure is temporarily immersed in water under standardized conditions.
	No code	8	Protection against the effects of continuous immersion in water under conditions agreed with a manufacturer

Electrical excellence

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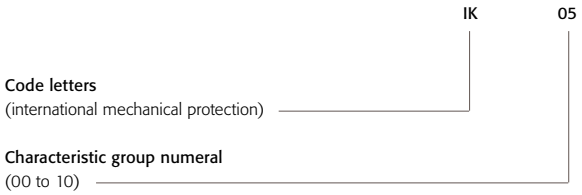

Each characteristic group numeral represents an impact energy value as shown below:

IK Code	IK00	IK01	IK02	IK03	IK04	IK05	IK06	IK07	IK08	IK09	IK10
Impact energy in joules	*	0.15	0.2	0.35	0.5	0.7	1	2	5	10	20

* No protection specified

When higher impact energy is required the value of 50 joules is recommended

Table 2: IK characterisitics of BS EN 62262:2002

indicates protection of persons against access to hazardous parts inside enclosures or protection of equipment against ingress of solid foreign objects. The second numeral indicates protection of equipment against ingress of water (see table 1). More information on the IP classification code is given in IEE Guidance Note 1 - Selection and Erection.

External influences Impact (AG)

The effect of environmental conditions and general characteristics around an installation should always be assessed to enable suitable electrical equipment to be specified. All electrical equipment selected must be suitable for its location, use and method of installation.

Therefore, for equipment installed in a car park site for example, draft requirements may require IK07 or even higher such as IK10 if installed in a more vulnerable location.

The IK classification standard BS EN 62262 describes a system for classifying the degrees of protection provided by enclosures for electrical equipment against external mechanical impacts. The letters IK are followed by two numerals which identify a specific impact energy.

BS EN 62262:2002 specifies a system for classifying the degrees of protection provided by enclosures against mechanical impact (IK code).

The Standard describes only the general requirements and designations for the system.

The application of the system to a specific enclosure type will be covered by the British Standard applicable to that equipment or enclosure. An enclosure is defined as a part providing protection of equipment against certain external influences and protection against contact. This may be considered to include conduit, trunking, etc.

In general, the degree of protection will apply to a complete enclosure. If parts of an enclosure have different degrees of protection, they must be separately identified. The coding is separate from the IP rating and will be marked separately as shown in table 2.

Switchgear and controlgear.

BS 7671:2008 (IEE Wiring Regulations) recognises four distinct types of isolation and switching operation:

(i) isolation
(ii) switching off for mechanical maintenance
(iii) emergency switching
(iv) functional switching.

Draft proposals for supplies to electric vehicles include requirements for emergency switching. It is worth noting that BS 7671:2008 states that a plug and socket outlet or similar device shall not be selected as a device for emergency switching.

Socket-outlets

Draft requirements for socket outlets may include similar requirements to caravan sites. For example, industrial type 16A 200 V – 250 V sockets to IEC 60309-2, with an IP rating of IP44, one socket outlet per car park space, 30 mA RCD protection, and requirements for mounting heights, etc.

Other requirements may include visual indication of mains supply, means of isolation/emergency switching, interlock to prevent the plugging/unplugging of the socket-outlet unless the socket-outlet has been isolated from the supply and precautions to prevent the electrical vehicle to supply the fixed installation.

Conclusion

More and more electrical vehicles are on the market. As a result this new work item has been introduced in order to develop the basic requirements for the connection of the electrical vehicle to the fixed installation. This article is only intended as a brief overview of a possible new work item which may or may not be developed into an international standard. ■

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Energy efficient lighting in domestic premises

by Paul Bicheno

An article in the previous edition of *Wiring Matters* (Autumn 09 Issue 32) looked at 'energy efficiency of luminaires' which highlighted the energy efficiencies of various types of lamps and provided specific information for the phasing out of incandescent type lamps. This article looks at some requirements for energy efficient lighting in domestic premises and includes guidance on some typical scenarios that can be encountered when working on a lighting system.

Building Regulations 2000 energy efficiency requirements

This article will look at the requirements of the Building Regulations 2000 as applicable in England and Wales. Energy efficiency is dealt with by requirements of Regulations 4A, 17C and 17D and Part L of Schedule 1 of the Building Regulations. Regulation 4A relates to thermal elements and so would not be applicable to lighting. Regulation 17C refers to new buildings and 17D refers to consequential improvements to the energy performance of building work to an existing building (with a total useful floor area over 1000 m^2). Part L of Schedule 1 has requirements for conservation of fuel and power and is reproduced in Figure 1. Fixed internal or external lighting systems are included within the scope of a 'fixed building service' as referred to in L1b and L1c of Schedule 1. The type of building work where energy efficient lighting requirements would apply is the provision of a new dwelling, an extension to an existing dwelling or material change of use of a building to a dwelling and the replacement of a lighting system as part of rewiring works. For domestic premises there are two approved documents that provide guidance on complying with Part L, L1A *Conservation of fuel and power in new dwellings* and L1B *Conservation of fuel and power in existing dwellings*. Included are specifications for the provision of energy efficiency fixed internal and external lighting and is summarized in Figure 2.

L1. Conservation of Fuel and Power

Reasonable provision shall be made for the conservation of fuel and **power** in buildings by:

a) limiting heat gains and losses:
   i. Through thermal elements and other parts of the building fabric;
   ii. From pipes, ducts and vessels used for space heating, space cooling and hot water services;
b) providing **fixed building services** that:
   i. Are energy efficient;
   ii. Have effective controls; and
   iii. Are commissioned by testing and adjusting as necessary to ensure they use no more fuel and power than is reasonable in the circumstances; and
c) providing to the owner sufficient information about the building, the **fixed building services** and their maintenance requirements so that the building can be operated in such a manner as to use no more fuel and **power** than is reasonable in the circumstances.

Note: bold text highlights requirements related to lighting.

Figure 1: Schedule 1 Part L1 (Conservation of fuel and power)

Fixed internal lighting

Provide light fittings (including the lamp, control gear, housing, reflector, shade or diffuser) that can only takes lamps having a luminous efficacy greater than 40 lumens per circuit-watt.

Provide fixed energy efficient light fittings (as above) that number no fewer than the greater of:
a. one per 25 m^2 of dwelling floor area (excluding garages), or
b. one per four fixed lighting fittings.

Fixed external lighting

Fixed external lighting should enable the effective control and/or the use of efficient lamps such that:
a. Either, the lamp capacity does not exceed 150 Watts per light fitting and the lighting automatically switches off;
   i. When there is enough daylight; and
   ii. When it is not required at night; or
b. The light fittings have sockets that can only be used with lamps having an efficacy greater than 40 lumens per circuit-watt.

Figure 2: Provision of energy efficient fixed internal and external lighting

When looking to comply with L1c. the occupier of the premises should be given details on the types of lamps to obtain as replacements, including the style, rating and connection so as to continue the benefits of energy efficiency. This is important if the premises have a mixture of dedicated energy efficient light fittings and their associated lamps and retrofit energy efficient lamps.

What is an energy efficient light fitting?

An energy efficient light fitting as specified in the Approved Documents L1A and L1B (Figure 2) is one that comprises the lamp, control gear, housing, reflector, shade or diffuser. This specifies that the fitting will only be capable of accepting lamps that have a luminous efficacy greater than 40 lumens per circuit-watt, where 'circuit-watts' is the power that the light fitting control gear and lamp consumes. The lamps would typically be of the compact fluorescent type with pin-based connections and so would not accept lamps of the traditional Edison Screw (SC) or Bayonet Cap (BC) connection types. In the context of energy efficient lighting the whole fitting would typically be referred to as a 'dedicated fitting' and there are a number of traditional fitting designs available.

In addition to a dedicated energy efficient light fitting, compact fluorescent lamps are available that that have integrated control gear with the traditional SC and BC connections types that also have a luminous efficacy greater than 40 lumens per circuit-watt. A number of lamp designs have been developed to enable the replacement of traditional lamp designs (e.g. traditional GLS, candle, mini globe, reflector) used in existing light fittings. Table 1 provides some information on the equivalent energy efficient lamp for a particular traditional lamp. The traditional tungsten filament and tungsten halogen type lamps do not meet the 40 lumens per circuit-watt requirement and so are not regarded as energy efficient lamps.

Energy saving GU10 type

Traditional	Energy efficient
100W	20-23W
75W	15-19W
60W	11-14W
40W	8-9W
25W	5-7W

Table 1: Equivalent energy efficient lamp for a particular traditional lamp

Image courtesy of Philips

halogen lamps are available that consume less power than standard halogen lamps, typically up to 30%, that can be used to retrofit into existing GU10 type fittings. Light Emitting Diode (LED) array lamps are now available that consume a small amount of power and have a longer life than the compact fluorescent types. These can be used to replace halogen lamps in existing light fittings or can be installed as part of a new LED fitting or arrangement. There are also LED lamps available for the replacement of traditional incandescent lamps, typically up to 40W.

Replacing an existing light fitting

For this scenario the replacement of a light fitting in domestic premises would need to consider when the premises was built or created from a material change of use. If it is post 6th April 2006 then the premises is likely to already include some dedicated low energy light fittings as the building works would have looked to comply with the requirements given in Approved Document L1A. The dedicated low energy light fittings are likely to in be in areas such as the lounge, dining room, kitchen and hallways as these normally have lights switched on for the most hours in a day, so any replacement of these fittings would need to be of the dedicated low energy type so as to retain the energy efficient status. Replacement of a light fitting that is not an energy efficient type could be carried out but it should be recognised that the continual maintenance with regards to replacement of lamps may not be possible due the phasing out programme of incandescent lamps.

For older domestic premises that did not need to meet the provision of energy efficient light fittings, the Building Regulations does not specifically state that the replacement of a light fitting has to be with an energy efficient type as the requirements relate to extensions to a dwelling, where a dwelling is created from a material change of use or an existing lighting system is being replaced as part of rewiring works. Replacing a light fitting is not replacing a lighting system and it is unlikely that the occupier would be in a worse position with regards to their energy usage. However, the occupier should be encouraged to have an energy efficient light fitting.

Rewiring a lighting circuit

For this scenario the rewiring of a lighting circuit in a dwelling would need to comply with the conservation of energy and power requirements related to a fixed building service as detailed in Approved Document L1B (Figure 2). The appropriate number of fixed internal energy efficient dedicated type light fittings should be installed in the main living areas where lighting is on for the most number of hours. Any fixed external lighting that forms part of the rewiring work as supplied by the fixed electrical installation should also comply with the requirements for external lighting.

Installing lighting as part of building works for an extension to domestic premises

For this scenario the installation of additional fixed internal and/or external lighting in a dwelling due to building work, such as an extension would need to comply with the conservation of energy and power requirements related to a fixed building service as detailed in Approved Document L1B (Figure 2). For a newer dwelling that includes a number of energy efficient light fittings, reasonable provision of energy efficient lighting is expected in the extension so that the occupier continues to obtain the benefits. For an older dwelling that does not have any energy efficient light fittings then there will be an obvious benefit of installing energy efficient light fittings as part of the building work. The guidance does

recognise flexibility, so it could be reasonable to install energy efficient fittings in main living areas that did not previously have any rather than the extension to fulfil the requirements. However as already highlighted there are a number of energy efficient lighting solutions available , therefore energy efficient solutions should be agreed with the occupier, especially if the phasing out of traditional lamps is highlighted as part of the selection process.

Code for sustainable homes

The technical guidance for the provision of energy efficient lighting in approved document L1A for new dwellings is the minimum standard. In April 2007 the Government introduced the 'Code for Sustainable Homes' which is a national standard for the design and construction of sustainable new homes. The Code sets minimum standards for energy and water use for homes within England. From 1st May 2008 it was mandatory for a new home to have a rating against the code. The Code supports the government target that all new homes will be zero carbon from 2016. The associated technical guidance document includes requirements for the provision of energy efficient light fittings that exceed the current requirements of Building Regulations.

Additional information

The energy saving trust is an independent organisation that promotes action on energy saving issues (www.energysavingtrust.org.uk). The following publications relating to energy efficient lighting are available;

- Energy efficient lighting – guidance for installers and specifiers (CE61)
- Low energy domestic lighting (GIL20)
- Cost benefit of lighting (CE56)
- Energy saving lamps should be marked with the energy saving recommended certification mark. This means they have been independently tested to verify their overall quality and energy efficiency claims.

Certification mark

- A guide to energy saving light bulbs is available from the Lighting Association website (http://www.lightingassociation.com/pdf/EST_lighting_English_Final09.pdf)
- Aurora has a useful tool for showing the benefits of using energy efficient lamps along with a range of energy efficient lighting solutions. www.aurora.eu.com/EnergyCalculator.aspx www.aurora.eu.com/lowenergy

- Information on the Code for Sustainable Homes is available from the Communities and Local Government website (http://www.communities.gov.uk/planningandbuilding/buildingregulations/legislation/codesustainable/)

- Building Regulations approved documents along with the government proposals for the development of Part L are available from the government planning portal (www.planningportal.gov.uk).

- Local Authority Building Control (www.labc.uk.com)

Types of person and the requirements of the **Wiring Regulations**

by Jon Elliott

BS 7671 contains requirements for the design and construction of electrical installations with the intention of producing an installation which is both safe to use and which is capable of being employed for its intended purpose (120.1 refers). The scope of installation types covered by BS 7671 is very broad. Indeed, the ever increasing complexity of installations and the continuing development and subsequent recognition of technical innovations and products necessitates the inclusion of additional requirements. To illustrate this, the scope of BS 7671 has been expanded in the 17th Edition to include requirements relating to installations in Marinas, Exhibitions, Shows and Stands, Solar Photovoltaic supply systems and Mobile and Transportable units and, indeed, will expand still further when amendment one is released mid 2011.

It is not uncommon for the design, construction and initial verification of a small domestic, industrial or commercial installation or additions or alterations on such installations to be carried out by one and the same person. However, the design of more complex or specialist installations will typically be carried out by a number of individuals given specific duties or areas of responsibility or by design consultancies. The actual installation process will then often be performed by a specialist electrical contractor as will the required inspection, testing and certification. It is also not uncommon for a separate body to be taken on to commission the installation prior to handover. Increasingly, different aspects of the overall project such as the installation of fire protection and fire alarm systems, lightning protection and, indeed, items of complex or specialist production equipment will be dealt with by separate contractors.

BS 7671 also contains requirements for the inspection, testing and certification of the installation both during the initial verification process and periodically throughout the life of the installation. As mentioned above, the person or company carrying out initial installation work must also be capable of inspecting, testing and certificating the work that they have carried out. However persons or companies carrying out periodic inspections and producing reports on the condition of an existing installation, whether or not

originally installed by them, need to look at the installation in a different way. They are in effect commenting upon the continuing suitability for use of the installation based upon their observations and the results of a range of tests which they have performed. However unlike when performing initial verification, they need to bear in mind when the installation was first installed and hence what requirements were in force at that time. They also need to apply judgement as virtually all installations will, with the passing of time, show some signs of damage, deterioration and general wear-and-tear which may or may not have diminished the safety of the installation.

The issue of maintainability of an installation is also addressed within BS 7671 albeit briefly. Persons maintaining an installation may require either basic or in-depth knowledge of the installation or the equipment therein dependent upon the duties they are required to perform and their level of responsibility. In larger, more complex installations a person or persons will be required to have oversight of and responsibility for the work activities carried out by the maintenance staff in their employ.

Upon completion the installation has to perform properly the tasks for which it is designed. However, persons making use of, or operating the installation will require different capabilities depending upon the nature and complexity of the premises and its intended purpose. In domestic premises, a user should be able to operate the switchgear to control lighting and other final circuits within the installation, periodically press the integral test button on residual current devices, reset overcurrent protective devices and possibly replace fuses. In a factory environment a machine operator should be sufficiently knowledgeable to use those pieces of equipment to which they have been assigned such that they are safe and productive. This will require guidance of both what should be done and what should not. A deep knowledge or understanding of the workings of the machinery may not be necessary. However, the operator will need to be aware of their limitations and as such when it will be necessary to call on persons with greater expertise for assistance.

BS 7671 also contains a number of limitations as to what class of person may perform particular activities covered by the requirements therein. These limitations are put in place either on account of particular hazards which might only be avoided by a person possessing a requisite level of knowledge, such as for example the use of protective measures where obstacles or placing out of reach is to be used to provide basic protection (417.1 refers) or where continued monitoring of the effectiveness of the supply and earthing arrangements is necessary to ensure safe use (717.411.4 refers).

It can be seen therefore that
- there are many different types of installation covered by the scope of BS 7671
- electrical installations are designed, constructed, inspected, tested, certificated, used and maintained by a diverse range of people
- these people will need different skills sets depending upon how they are involved with the construction, use or upkeep of the installation.

BS 7671 recognises three types of person which are defined in Part 2:

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

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

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

Some clarification of what is meant by these definitions is given in Appendix 5 which classifies external influences and is expanded upon below.

Ordinary person

Being neither electrically skilled nor instructed, ordinary persons do not have sufficient knowledge, experience or supervision to avoid the dangers which electricity may create. Residents of domestic premises and the users of caravans, boats and leisure craft are typical examples as are employees within the workplace unless specifically identified as being skilled or instructed in connection with their work activities. It should be noted at this point that all domestic premises should be designed to be suitable for use by ordinary persons. As such, it is neither here nor there whether the current or prospective occupier is other than an ordinary person.

Instructed person

Both persons with some electrical knowledge and those with none may be classified as instructed persons.

This would include for example operators of machinery in an industrial environment and some grades of maintenance staff employed to carry out specific duties for which they have received specific and sufficient instruction. It would also by necessity include trainees and apprentices who have to be given increasing opportunities, albeit whilst suitably supervised, in order to allow them to become skilled themselves in time.

At the other extreme it is necessary from time to time for electrical plant rooms to be cleaned or redecorated. At such times the decorators should be informed of particular hazards which may exist in the particular locations in which they are working. Nevertheless supervision by a suitably skilled person may still be necessary in some circumstances even when basic instruction has been given. Clearly in such cases it will fall upon someone to carry out a risk assessment...

Skilled person

Persons become skilled as a result of a number of factors including guided learning achieved from completion of appropriate education and training within a further or higher education establishment and supervised work experience within the work environment in which they wish to become skilled. Generally speaking, becoming skilled takes a considerable period of time during which a transferable skills and underpinning knowledge base is developed which can then applied to differing situations as the trainee is given ever more practical experience. On completion of a number of predefined objectives, which typically include both practical and theoretical tests, a person is judged to be skilled at a particular level such as electrician, approved

Capability of persons

BA1	Ordinary	Uninstructed persons		
BA2	Children	Children in locations intended for their occupation NOTE - This class does not necessarily apply to family dwellings	Nurseries	Requirement for inaccessibility of electrical equipment. Limitation of temperature of accessible surfaces
BA3	Handicapped	Persons not in command of their physical and/or intellectual abilities (sick person, old persons)	Hospitals	Requirement for inaccessibility of electrical equipment. Limitation of temperature of accessible surfaces
BA4	Instructed	Persons adequately advised or supervised by skilled persons to enable them to avoid dangers which electricity may create (operating and maintenance staff)	Electrical operating areas	
BA5	Skilled	Persons with technical knowledge knowledge or sufficient experience to enable them to avoid dangers which electricity may create (engineers and technicians)	Closed electrical operating areas	

Extract from Appendix 5 of BS 7671 (Concise list of external influences)

electrician, electrical fitter, technician or the like.

However it should always be borne in mind that there are many aspects in which persons may be skilled within a particular occupation and as such when a person considers their suitability or that of their staff to perform particular tasks they should be considering whether the required skills are possessed in order to complete the task in hand properly and safely. An electrician for example who since their initial training has always worked in domestic premises and is fully conversant with the range of activities typical to such premises may be completely out of their depth if placed in an industrial or commercial installation. Similarly although many of the skills picked up by an electrician during their training and day-to-day work experience will be transferable to new situations it may on occasion be necessary for additional skills to be learned to enable particular specialised equipment to be installed and/or maintained; or to attend subject updating activities in order to refresh or update their knowledge. This brings us to the issue of competency.

Competency

The publication of the 17th Edition saw the introduction of a definition of competent person:

Competent person. *A person who possesses sufficient technical knowledge, relevant practical skills and experience for the nature of the electrical work undertaken and is able at all times to prevent danger and, where appropriate, injury to him/herself and others.*

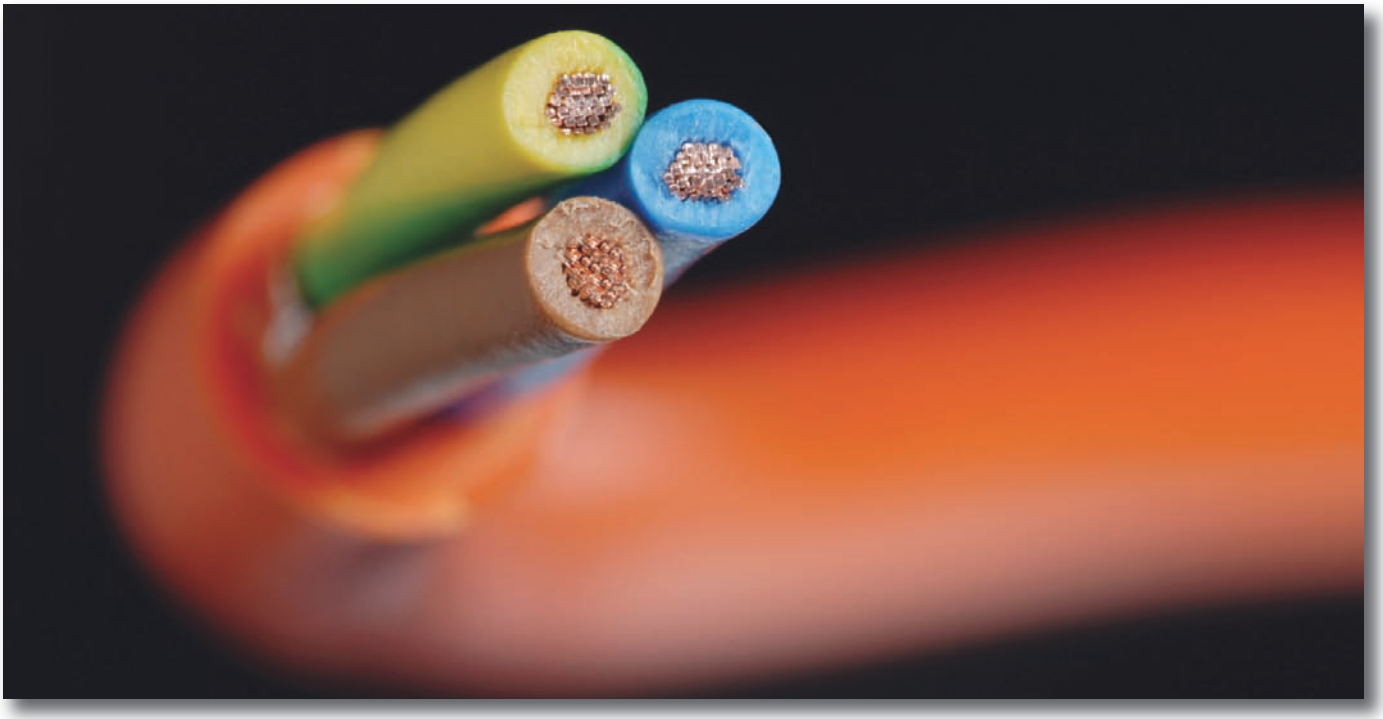
The wording of this definition is very closely based upon the content of Regulation 16 of the Electricity at Work Regulations 1989 and the guidance provided on this regulation by the Health and Safety Executive in their publication HSR25 *Memorandum of guidance on the Electricity at Work Regulations 1989*. It is very similar to the definition of skilled person. Regulation 16 of EWR 1989 is reproduced below:

No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent danger or, where appropriate, injury, unless he possesses such knowledge or experience, or is under such degree of supervision as may be appropriate having regard to the nature of the work.

Looking at this it can be seen that Regulation 16 recognises that competency may be achieved from an individual having sufficient knowledge and experience to avoid danger or injury, or from their being supervised to some extent by someone having such knowledge and experience. As such it can be seen that either a skilled or an instructed person and indeed even an ordinary person may, in some circumstances, be considered to be competent.

However an extremely important aspect of competency, too frequently overlooked, is the need for persons to know the limits of their ability and technical knowledge. This failure is clearly demonstrated by the unacceptably high number of deaths and injuries that occur to persons employed to work on or near electrical installations and persons under their control or indeed to persons using installations designed or installed by someone purported to be competent. It is inevitable that a person will experience new situations, products and working practices in the course of their career, however they must always work within their limits and where necessary either complete the necessary subject updating or engage the services of a specialist possessing the required competencies to carry out the work on their behalf.

In the next edition of *Wiring Matter*s we will look at particular requirements within BS 7671 where the type of person involved is of some significance. ■



The use of "Arctic' cable

by Mark Coles

In *Wiring Matters* Summer 2009, Issue 31, an article was published entitled Cables for temporary installations and included a sub-section headed *The use of "Arctic" cable*. The IET's technical helpline took a number of calls with a common theme - i.e. can blue-sheathed cable, made to BS 6500, be used for 230 V a.c. single-phase supplies to equipment in temporary use? The answer is yes but not at temperatures lower than +5°C. The following is intended to clarify.

Introduction

It is common to see blue-sheathed flexible cables, sometimes referred to as "Arctic" cable, used on temporary low-voltage installations, such as construction sites, fairgrounds and musical events. In addition to blue, this type of cable is available in many different colours, such as yellow and orange and some cables even have the word *ARCTIC* embossed throughout the length. Not all cables are suitable for all applications. It is, therefore, important to establish the suitability of the cable in question prior to selection by referencing the standard to which the cable is manufactured. Two standards for flexible cable will be considered here - BS 7919 and BS 6500.

Cables to BS 7919

Electric cables — Flexible cables rated up to 450/750 V, for use with appliances and equipment intended for industrial and similar environments

Ordinary duty low temperature PVC insulated and sheath 300/500 V flexible cable, manufactured to BS 7919 Table 44 (not harmonised), commonly referred to as 3183A (Arctic Grade Flex), was specifically designed and, hence, included in the British Standard, for use at 110 V a.c. from centre tapped transformers (55 V - 0 - 55 V). The cable is suitable for installation and handling down to a temperature of -25°C, e.g. suitable for construction site installations and is often seen in

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

Table 7B: Cables conforming to BS 7919 – Guide to use

use on temporary road works for supplies to traffic lights; Table 7B from BS 7450, refers. Note that cables to BS 7919 Table 44 have not been harmonised to European HDs. This is because the use of 110 V a.c. supplies from centre tapped transformers (55 V - 0 - 55 V) is a UK only practice and is not recognised or practised elsewhere.

BS 6500

Electric cables - Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments

Ordinary duty PVC insulated and sheath 300/500 V flexible cable to BS 6500, commonly referred to as 3183Y (harmonised number H05VV-F), is suitable for use at 230 V a.c. The cable is suitable for installation and handling down to a temperature of +5°C.

Cable standard	Suitable voltage	Lowest temperature for installation and handling
BS 7919 Table 44	110 V a.c. (55 V - 0 - 55 V)	-25°C
BS 6500	up to 300 V a.c. 1Ø or 500 V a.c. 3Ø	+5°C

Neither BS 6500 nor BS 7919 requires the cable to be marked with the word *Arctic*. Should any cable be marked as *Arctic*, it is solely the responsibility of the manufacture to justify any such claim. The only PVC flexible cable that could be classified as being suitable for low temperature use is a cable to BS 7919 Table 44 as it can be installed and handled down to a temperature of -25°C; it would seem logical that only this cable would/should have the term '*ARCTIC*' marked on it.

Summary

The table shown above summarises this article.

Further reading

- BS 6500:2000 - Electric cables - Flexible cords rated up to 300/500 V, for use with appliances and equipment intended for domestic, office and similar environments
- BS 7540-3:2005 Electric cables - Guide to use for cables with a rated voltage not exceeding 450/750 V - Part 3: National standard cables not included in HD 21 and HD 22
- BS 7919:2001 Electric cables - Flexible cables rated up to 450/750 V, for use with appliances and equipment intended for industrial and similar environments ■

Image courtesy of Schneider Electric

Electrical Panels by Mark Coles

Introduction

At many events in which the IET participate, such as the ELEX and InterBuild shows, questions are asked about standards to which hand-wired electrical control panels are to comply. This article looks at types and forms of electrical panels, uses, competency and the standards to which they are to comply.

Electrical panels come in many shapes and sizes (of course) and have many applications. Consider a simple empty box which is then firmly fixed to the ground or building structure, adapted to enclose electrical equipment and terminations to perform a particular function - the empty box becomes an electrical panel and issues relating to electrical safety are to be considered.

Factory built panels and Forms of Electrical Separation

BS EN 60439-1:1999 gives guidance on the forms of separation applicable to factory-built switchgear and controlgear assemblies (switchboards, motor control centres, distribution boards, busbar trunking systems, etc.), known as type-tested and partially type-tested assemblies. These forms of separation provide protection against contact with live parts (known as basic protection) belonging to adjacent devices and protection from the probability of initiating arcing faults and the passage of foreign bodies between units of the assembly. The Standard also gives guidance on other requirements for protection against electric shock.

Four forms of separation are indicated in the main text of BS EN 60439-1:1999 but there is no specific detail given on how these forms are to be achieved. It is stated in the Standard that the form of separation should be agreed between manufacturer and designer/user. It shall be remembered that higher forms of separation specified will increase costs but will give better operational flexibility regarding safe working when connecting in additional circuits or carrying out maintenance. This 'trade-off' must be carefully assessed.

The four forms given have basic definitions and applications but Forms 2 to 4 can be further subdivided into more specific 'Types' (applications) by discussion and agreement with manufacturers.

Form 1

This form provides for an enclosure to provide protection against direct contact with live parts but does not provide any internal separation of switching, isolation or control items or terminations. These overall assemblies are often known as 'wardrobe' type with large front opening doors, usually with an integral door-interlocked isolator. Operating the isolator interrupts all functions but allows the door to be opened to gain access to the assembly for installation or maintenance. Such assemblies normally have lower fault withstand and it may be inconvenient to shut down a whole plant or system for a simple maintenance or repair operation.

Form 2

The overall assembly enclosure provides protection against direct contact with live parts; separation is provided between the busbar assembly and switching, isolation, control items and terminations. There is very little advantage of this over Form 1 and the style is similar. Form 2 can be subdivided into:

- Type 1 - in which the busbars are separated by insulation of the bars.
- Type 2 - in which the busbars are separated by metallic or non-metallic rigid barriers.

Form 3

The enclosure provides protection against direct

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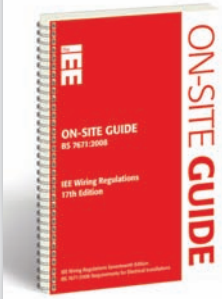

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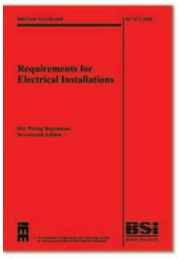
The Institution prepares regulations for the safety of electrical installations for buildings, the IEE Wiring Regulations (BS 7671), which has now become the standard for the UK and many other countries. It has also prepared the Code of Practice for Installation of Electrical and Electronic Equipment 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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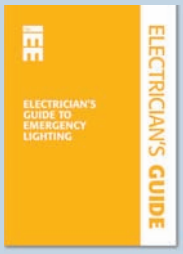

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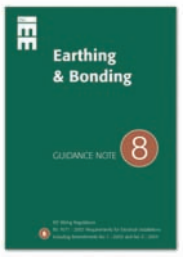

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contact with live parts and also separation is provided between the busbars and switching, isolation or control items and between all these items. Outgoing terminals are not separated from each other, or perhaps from the busbars. Form 3 can be subdivided into:

■ Form 3a - in which outgoing terminals are not separated from the busbars.

■ Form 3b - in which outgoing terminals are separated from the busbars.

Form 3b can be further subdivided into:

– Type 1 - in which the busbars are insulated for separation.

– Type 2 - in which busbar separation is by metallic or non-metallic rigid barriers or partitions.

Form 4
The enclosure provides protection against direct contact with live parts and internal separation of the busbars from all switching, isolation and control items and outgoing terminations and separation of all items and outgoing terminations from each other. This allows for access to any single item, such as a switch-fuse or starter and its outgoing terminations, to enable work to be carried out whilst the assembly remains operational. Protection is also provided against an arcing fault in one device affecting other items. This is the usual form specified for commercial and industrial switchgear and controlgear assemblies but the designer has to consider whether, due to the extra cost, such requirements are necessary or justified. Form 4 can be subdivided into seven types:

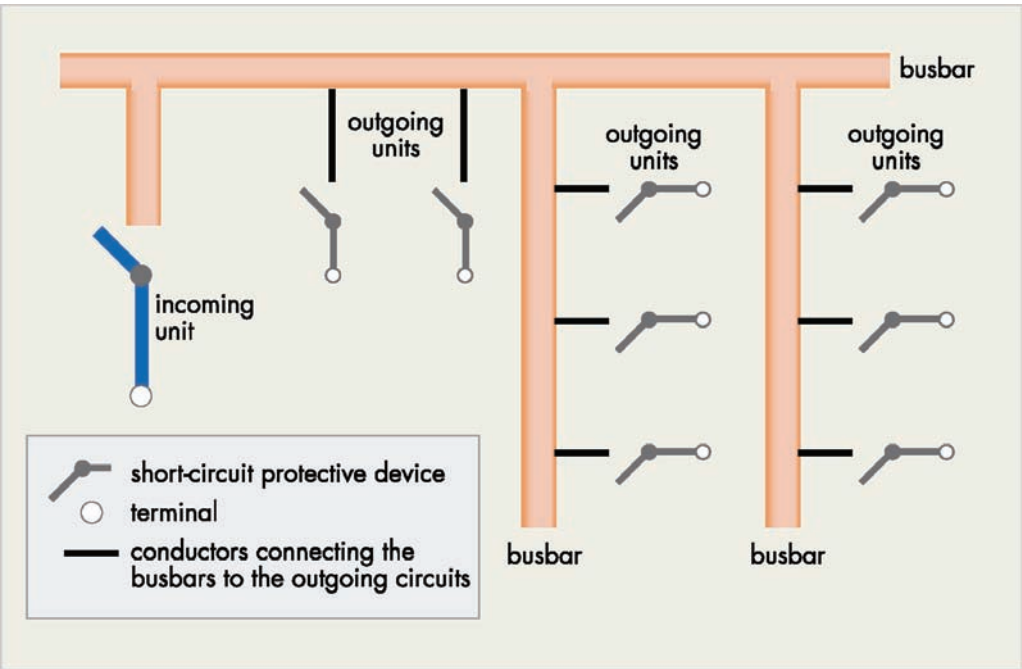


Figure 1: Form 1 construction

Type 1 - in which the busbars are separated by insulation ff coverings. Terminals for external conductors are in the same compartment as the associated item of switchgear, etc., but cables may be glanded elsewhere.

Type 2 - in which the busbars are separated by metallic or non-metallic rigid barriers or partitions. Terminals or external conductors are in the same compartment as the associated item of switchgear, etc., but cables may be glanded elsewhere.

Type 3 - in which separation requirements are by metallic or non-metallic rigid barriers or partitions. Terminals or external conductors are in the same compartment as the associated item of switchgear, etc. and each item has its own integral cable glanding facility.

Type 4 - in which the busbars are separated by insulated coverings. Terminals for external conductors are not in the same compartment as the associated item of switchgear, etc., but in separate enclosed spaces. However, cables may be glanded elsewhere.

Type 5 - in which busbars are separated by metallic or non-metallic rigid barriers or partitions. Terminals for external conductors are not in the same compartment as the associated item of switchgear, etc., but in separate enclosed spaces and terminals may be separated by insulated coverings. Cables may be glanded in common cabling chambers.

Type 6 - in which all separation requirements are by metallic or non-metallic rigid barriers or partitions. Terminals for external conductors are not in the same compartment as the associated item of switchgear, etc., but in separate enclosed spaces and cables are glanded in common cabling chambers.

Type 7 - in which all separation requirements are by metallic or non-metallic rigid barriers or partitions. Terminals for external conductors are not in the same compartment as the associated item of switchgear, etc., but in separate enclosed spaces and the termination for each item has its own integral glanding facility (see Figure 2). Switchboard manufacturers therefore cannot give all-embracing assurances for safe working, according to the form of separation with parts of the assembly energized. Specifying a particular form of separation will not guarantee this for any given form number.

General
Assemblies are to be designed and constructed so as to be able to withstand the thermal and dynamic stresses resulting from fault currents up to their rated values.

The installation designer must specify the prospective fault current conditions at the point of installation. Busbar systems for switchgear and controlgear should be adequately rated for the normal duty and maximum fault current level expected

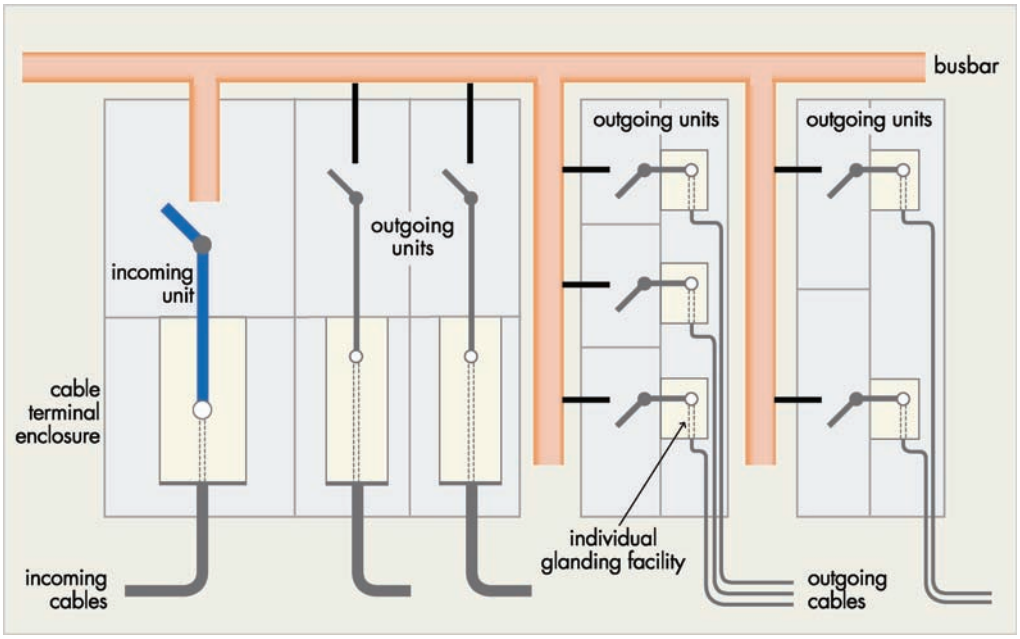


Figure 2: Form 4 construction

and should be well supported and braced, as the electromechanical stresses under fault conditions can be severe.

Bespoke panels

Many electrical panels are made for bespoke applications which require much more consideration than selecting factory built units from a catalogue. The environmental and local conditions will have the greatest influence on the choice of panel. The following issues will need to be considered when choosing the correct panel for the application:

■ **weather** - if the panel is to be located outdoors, a feeder-pillar or telecommunications cabinet for example, the weather will be a factor in deciding the overall IP rating of the cabinet; see BS EN 50529

■ **material** - the material of manufacture is an important issue - metallic or a type of plastic, for example. Plastic materials are usually much lighter than metallic; metallic units are often made from aluminium, sometimes stainless steel

■ **mechanical impact** - if there is a mechanical impact issue, such as the risk of being struck by moving objects, BS EN 62262 provides information on the IK rating of enclosures

■ **vandalism** - if the panel is susceptible to unauthorised entry or vandalism a locking mechanism will need to be considered in addition to vandal-proof fixings

■ **hazardous locations** - panels installed in hazardous locations will need to meet the requirements of BS EN 60079 suite of standards, e.g. Group I: electrical apparatus for mines susceptible to firedamp; Group II: electrical apparatus for places with an explosive gas atmosphere other than mines susceptible to firedamp with sub-division IIA, IIB or IIC

■ **temperature** - ambient temperature expected and the amount of heat emitted by internal components; external low temperatures may mean that internal heating would be required; high external temperatures (solar gain) may call for internal cooling

■ **electromagnetic** compatibility and interference issues may need to be addressed

A concise list of external influences can be found in Appendix 5 of BS 7671:2008.

Electrical safety

When constructing a bespoke electrical panel, the requirements of BS 7671 are to be considered. The method of protection against electric shock will be established based on the environment in which the panel is located and the particular application. Regulation 410.3.3 requires that in each part of an installation, one or more protective measures are to be applied, taking account of the conditions of external influence. BS 7671 generally recognises the following four methods of protection against electric shock:

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

In electrical installations the most commonly used protective measure is automatic disconnection of supply. Automatic disconnection of supply is a protective measure in which:

(i) basic protection is provided by basic insulation of live parts or by barriers or enclosures, and
(ii) fault protection is provided by protective earthing, protective equipotential bonding and automatic disconnection in case of a fault.

Regulation 412.2.4.1 states that the requirements for basic and fault protection can be met if the rated voltage of the cable(s) is not less than the nominal voltage of the system and at least 300/500 V and that adequate mechanical protection of the basic insulation is provided. Adequate implies the non-metallic sheath of the cable or non-metallic trunking or ducting complying with the BS EN 50085 series, or non-metallic conduit complying with the BS EN 61386 series.

Note that the where a lid or door in an insulating enclosure can be opened without the use of a tool or key, all conductive parts which are accessible when the lid or door is open must be behind an insulating barrier (providing a degree of protection not less than IPXXB or IP2X) preventing persons from coming unintentionally into contact with those conductive parts. This insulating barrier shall be removable only by the use of a

tool or key; Regulation 412.2.2.3 refers.

Slotted trunking, Figure 3, will not meet the IPXXB or IP2X requirement of Regulation 412.2.2.3, therefore, if the panel remains fully energised upon opening, only insulted and sheathed cables or wiring from SELV or PELV sources should be installed within the trunking. If non-sheathed cables operating at voltages in excess of the SELV and PELV requirements of Regulation 414.1.1 are installed in slotted trunking, a further barrier must be installed preventing access.

It should also be realised that Regulation 8 of the Electricity at Work Regulations places an absolute requirement (one that shall be met regardless of cost or any other consideration) on protective conductor connections to earth:

… a conductor shall be regarded as earthed when it is connected to the general mass of earth by conductors of sufficient strength and current-carrying capability to discharge electrical energy to earth.

It may be questioned whether the termination of steel or aluminium wire armour (where used as a protective conductor) with glands into metal gland plates, which themselves may only be bolted to the switchgear or controlgear frame, is an adequate connection. Cable gland 'earth tags' and supplementary connections to the equipment earth terminals may be necessary. In any case it should be ensured that any paint or other surface finish on the switchgear does not prevent effective electrical continuity between the adjacent parts. During site installation and commissioning, tests as required by BS 7671 Part 6 should be carried out on the complete assembly, plus any other specific tests advised by the manufacturer or required by the client, user or engineer. It is not usual to carry out a repeat of specialist tests, e.g. a flash test at site; however, in the event of such a requirement or request, the manufacturer's advice should be sought.

Competency

As with all installations, work must only be undertaken by competent persons. BS 7671 is not a statutory document and it is not a legal requirement to follow the practices referred to within. Primarily, the main piece of legislation to consider is the Electricity at Work regulations 1989 (EWR). The EWR states that all systems are to be safe so as to prevent danger and prevent the risk of injury.

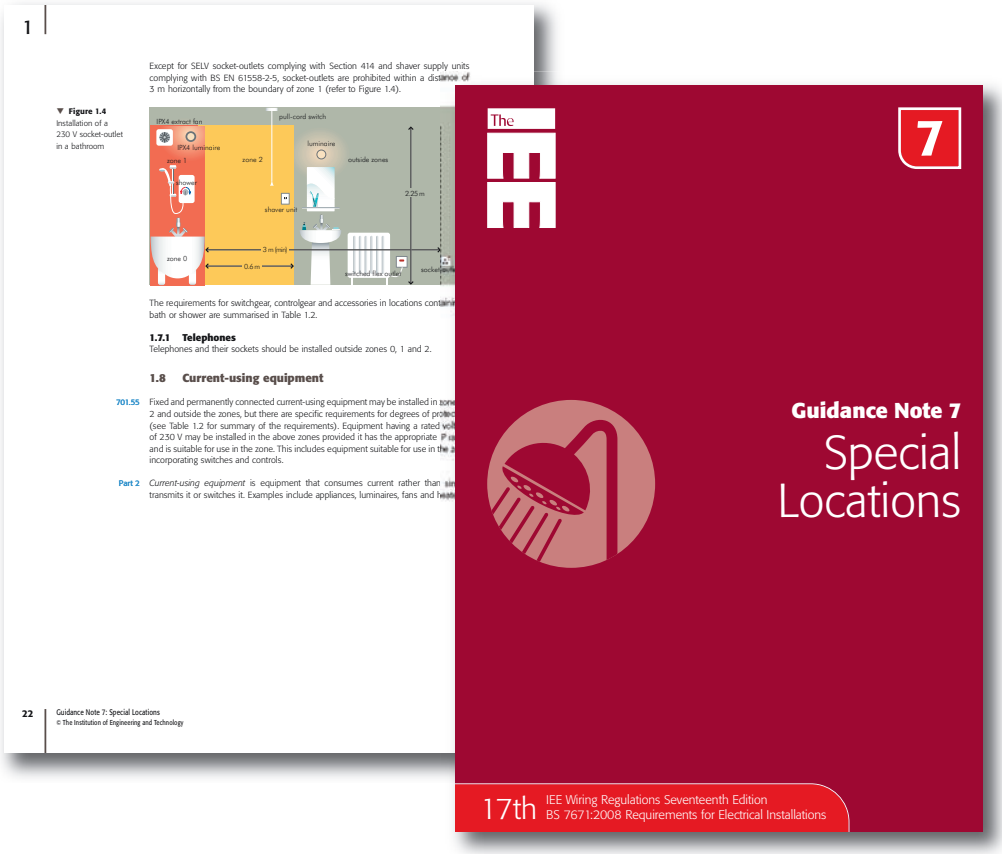
The designer and installer must be aware of the statutory requirements under the Electricity at Work Regulations and the Construction (Design & Management) Regulations 2007 (CDM 2007), etc., for the safe design, construction, operation and provision for maintenance of electrical equipment assemblies. Adequate access, working space and lighting need to be provided where work is to be carried out on or near equipment, in order that persons may work safely.

The Memorandum to the Electricity at work Regulations 1989, HS(R)25, records that the IEE Wiring Regulations is widely recognised and accepted in the UK and compliance with them is likely to achieve compliance with relevant aspects of the 1989 Regulations in point 7 of the introduction. ■

References and further information

- BS 7671:2008 Requirements for Electrical Installations, IEE Wiring Regulations, Seventeenth Edition
- Electricity at Work regulations 1989 - www.opsi.gov.uk/si/si1989/Uksi_19890635_en_1.htm
- Memorandum of guidance on the Electricity at Work Regulations 1989 (HSR25) - free download - www.hse.gov.uk/pubns/books/hsr25.htm
- The Construction (Design & Management) Regulations 2007 - www.hse.gov.uk/construction/cdm.htm
- Guidance Note 1 - Selection and Erection
- BS EN 50529:1992 *Degrees of protection provided by enclosures (IP code)*
- BS EN 62262:2002 *Degrees of protection provided by enclosures for electrical equipment against mechanical impacts (IK code)*
- BS EN 60079 *Electrical apparatus for explosive gas atmospheres* suite of standards
- BS EN 60439-1:1999 *Low-voltage switchgear and controlgear assemblies. Type-tested and partially type-tested assemblies*
- BS EN 50085-1:2005 *Cable trunking systems and cable ducting systems for electrical installations. General requirements*
- BS EN 61386-1:2008 *Conduit systems for cable management. General requirements*
- BEAMA Guide to verification of low voltage power switchgear and control gear - www.beama.org.uk/UserFiles/file/publications/installation/BAVG.pdf

Figure 3: Slotted trunking



New IEE Guidance **Note 7**

by Geoff Cronshaw

The IEE Wiring Regulations 17th Edition (BS 7671:2008) includes additional sections on special locations that were not included in the previous edition; as follows: Marinas (Section 709), Exhibitions, shows and stands (Section 711), Floor and ceiling heating systems (Section 753), Mobile and transportable units (Section 717), Fairgrounds, amusement parks and circuses (Section 740), and Photovoltaic power systems (Section 712). The special locations that were contained in the previous edition of BS 7671 have been revised to align with the latest IEC and CENELEC standards.

All those involved in electrical installation work need to be familiar with these new requirements.

Help is at hand, in the form of a new edition of IEE Guidance Note 7 (Special Locations).

For example: Section 701 locations containing a bath or shower. What's new?

Changes to the zonal system, RCD protection on all bathroom circuits, 230 V socket outlets permitted 3 m horizontally from the boundary of zone 1; supplementary equipotential bonding may be omitted subject to the Regulations being met. Chapter 1 of IEE Guidance Note 7 gives detailed requirements.

RCD Protection

Regulation 701.411.3.3 now requires that additional protection shall be provided for all circuits of the location by the use of one or more RCDs having the characteristics specified in Regulation 415.1.1. This is a significant change. Previously (601-09-02), only fixed current using equipment (other than electric showers) located in zone 1 required 30 mA RCD protection and current using equipment (other than fixed current using equipment – such as a washing machine, if suitable for use in a bathroom, connected through a fused connection unit) in zone 3 required 30mA RCD protection. Regulation 701.411.3.3 means that all circuits, including lighting, electric showers, heated towel rails, etc., require RCD protection, not exceeding 30 mA.

230 volt socket-outlets

Another significant change is introduced by Regulation 701.512.3. This now permits 230 V socket-outlets to be installed in a room containing a bath or shower providing they are installed 3 m horizontally from the boundary of zone 1. This change resolves the ambiguity that existed between locations containing a bath or shower and a bedroom containing a shower.

How to order your copy of IEE Guidance Note 7 (available from the 30th November 2009).

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