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WIRINGMATTERS

The Institution of Engineering and Technology

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Energy efficiency of low-voltage installations

Code of Practice
In-Service Inspection and Testing of Electrical Equipment

Unlawful killing
Inadequate testing leads to damning verdict over tragedy

IET Electrical excellence

Energy efficiency of low-voltage electrical installations

One new area of possible development within international standards is to integrate requirements for energy efficiency into IEC 60364 (the international standard that the wiring regulations (BS 7671) are based on). In this second article we take a closer look at energy efficiency of low-voltage electrical installations.

By Geoff Cronshaw

In order to make improvements we need to be able to measure the amount of electrical energy consumed and monitor and control energy effectively.

Energy measurement is essential for energy management. Therefore, the design of the electrical distribution system needs to be carried out in such a way that will allow the metering and control of the various electrical loads in an installation.

A further key point when designing a new installation includes determination of the most energy-efficient location of the transformers and switchboards in an installation in order to reduce the electrical losses within the electrical distribution system.

The objective is to locate the transformer and switchboard at the centre of the group of loads they are feeding. Also, in order to have an energy efficient installation, losses in equipment need to be as low as possible.

Maintenance is also important. For example, a lighting installation should be maintained to keep its visual performance within the design limits. The lighting designer will have selected a certain illumination level for the particular activity and presumed a frequency of lamp replacement and a frequency of cleaning. ▶

Photo of Panel mounting and DIN rail mounting KWh meters with pulsed output.

◀ Measurement and control

It is understood that there is no obligation on an electricity supplier to provide any other metering than that required to obtain the basic data to enable tariff charges to be applied.

While this may be adequate for the smaller installation, it does not give sufficient information to allow a larger consumer to allocate costs to various facilities or to control consumption.

Therefore, to be able to measure the amount of electrical energy consumed and monitor and control energy effectively metering equipment needs to be allowed for at the planning stage. Although this will increase the initial cost of the switchboards, it will prove more economical than having to add metering at a later date.

How metering information will be used needs careful consideration. The system may be required to measure power quality, voltage levels and loads. It may also produce alarms, control loads or change tariffs if preset limits are exceeded.

Consideration should be given to the environment where the meter is installed which should be in accordance with the manufacturer's instructions. Metering needs to be installed in an area that is accessible for the meter reader and where the display can easily be read.

Areas where the instrument is likely to be subjected to excessive heat, moisture, and vibration should be avoided. Meters are available that provide pulse generation. These can be linked to building management systems to provide an electrical pulse proportional to a unit of measurement. ▶

IET Electrical excellence

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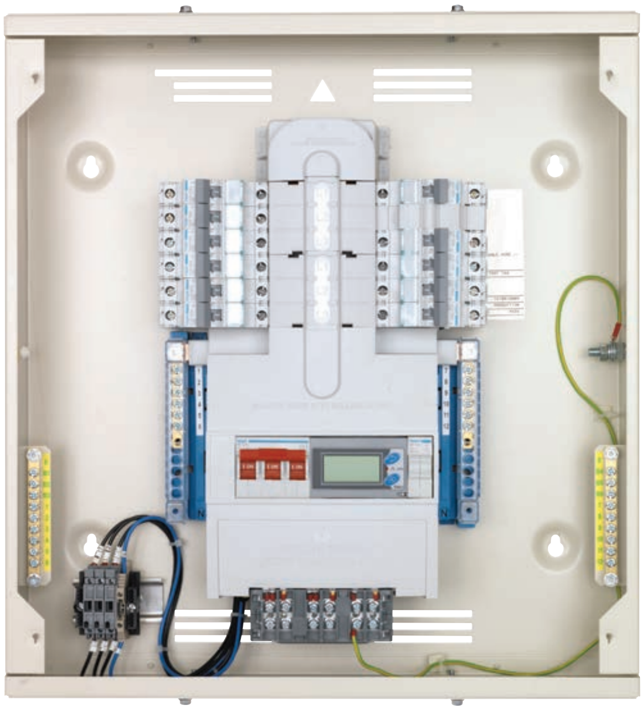
Photo of a Panel mounting and DIN rail mounting multifunction meter. Displays phase sequence, volts, amps, power factor, and system KW, KVAr, PF, frequency, KWh, and KVArh.

Photo of Panel mounted pre wired meter and CT.



Current transformers

Essential to the operation of the meter is the current transformer (CT).

The function of the current transformer, is to transform the high current levels to match the input requirements of the meter. In most cases the input value of the meter is 5A. For example the rating plate of a CT may show 400/5. The high value represents the maximum current of the circuit, and is referred to as the primary value. The low value is referred to as the secondary value.

The accuracy is expressed as a percentage ie class 1 is 1 per cent, class .5 is 0.5 per cent.

Losses in the wiring and transformers

Cables

Appendix 4 of BS 7671 is an informative appendix. The appendix includes tabulated current-carrying capacities for some of the most commonly used cables in the electrical installation industry.

These include single and multicore 70-degree thermoplastic and 90-degree thermosetting insulated cables with copper conductors, 70-degree thermoplastic insulated and sheathed flat cable with protective conductor (copper), a range of armoured cables, and mineral insulated cables. Also a range of cables with aluminium conductors. Tables

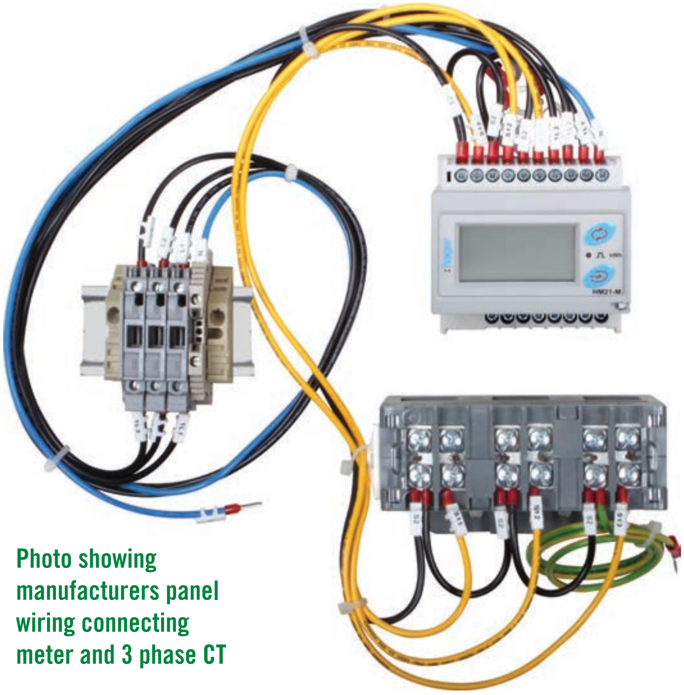


Photo showing manufacturers panel wiring connecting meter and 3 phase CT

4D1A to Tables 4J4A contain the current carrying capacities in amperes for the various types of cable.

The current-carrying capacity of a cable corresponds to the maximum current that can be carried in specified conditions without the conductors exceeding the permissible limit of steady-state temperature for the type of insulation concerned.

The values of current tabulated represent the effective current-carrying capacity only where no rating factor is applicable. Otherwise, the current-carrying capacity corresponds to the tabulated value multiplied by the appropriate factor or factors for ambient temperature, grouping and thermal insulation as well as depth of burial and soil thermal resistivity, for buried cables, as applicable.
Where harmonic currents are present further factors may need to be applied.

Circuits must be designed that are fit for purpose and suitable for the load they are intended to supply. They should be correctly designed in accordance with BS 7671.

Chapter 43 deals with protection against overcurrent and also thermal constraints, Chapter 42 has requirements for protection against thermal effects, Chapter 41 deals with protection against electric shock and gives the disconnection times that must be met whilst Section 525 deals with voltage drop.

However, the procedure generally used for the selection of a cable size leads to the minimum admissible cross-sectional area, which also minimises the initial investment cost of the cable. It does not take into account the cost of the losses that will occur during the life of the cable.

In order to the reduce energy losses as a result of the conductors operating at high temperatures, requires that cable size selection be considered on wider grounds to reduce loses, which is one aspect of energy efficiency being considered.

Transformers

There are basically two types of loss in transformers. These are iron losses and copper losses. Iron losses occur in the magnetic core of the transformer, causing it to heat up. Iron losses can be divided into two components, hysteresis losses, and eddy current losses. In general it is understood that iron losses of a transformer remain constant regardless of load conditions which means that the iron loss on no load will be the same as the iron loss on full load.

Copper losses (load losses) are due to the heating effect of the primary and secondary currents passing through their respective windings.

No-load and load losses in a transformer result in a loss of efficiency. They are the reason for the major running cost of a transformer. They result in heat, which is normally dissipated to the atmosphere. Load losses depend on the load factor (LF). It is understood that in the UK the average industrial load factor on a transformer is probably between 50 and 60 per cent, but where security of supply is of supreme importance the use of two transformers reduces this value to below 50 per cent. Even lower load factors can apply where both load growth and supply security have to be taken into account.

Therefore a key requirement when considering energy efficiency is to decide on the load factor of the transformer at the planning stage in order to run the transformer at its most efficient.

Current-using equipment

Current-using equipment efficiency is based on control of the loads (the right energy at the right time).

Motor control

As mentioned previously in the UK BEAMA have identified that most pump and fan applications are driven by very simple control systems where the motor runs at constant speed and the required flow variation is obtained by using a valve or damper to restrict the flow. This means that the energy consumption falls very little when the flow decreases. At 80 per cent of the nominal flow the energy consumption remains almost the same. ▶


Lighting control sensors providing occupancy and night level detection

◀ A more efficient option is to use a Variable Speed Drive (VSD) to adjust the speed of the motor or fan to deliver the required flow. For fans, savings can be in the region of 50 per cent and for pumps about 30 per cent savings are seen.

Lighting

As mentioned previously, lighting can represent over 35 per cent of energy consumption in buildings depending on the application. Solutions for lighting control may save up to 50 per cent on the electricity compared to a traditional installation. These systems should be flexible and designed for the comfort of the users. The solutions can range from very small and local controls such as occupancy sensors, up to sophisticated customised and centralised solutions that are part of complete building automation systems.

Lighting controls

Automatic lighting controls for residential buildings are easy-to-install devices which are able to detect the presence of people and only switch on lights when required. Lighting controls eliminate wasted energy and save energy simply by switching lights off when not required. Automatic lighting controls for commercial, public and industrial buildings are again easy-to-install devices that are able to automatically switch off lights when no occupants are detected or there are suitable levels of natural light.

When considering the design and installation of lighting controls there are a number of important points to consider. First, it is important to take into account the type of space, how it is used and the amount of daylight available. The type and use of space, together with the type of luminaires installed, will determine the type of sensor and therefore the control used.

Safety is also an important consideration. The operation of automatic lighting controls should not endanger the occupants of the building. This may happen if a sensor switches off all the lighting in a space without daylight. It is therefore important that lighting controls are designed correctly to ensure the safety of occupants and save energy.

Commissioning should be included as an essential part of the installation of lighting controls. Commissioning could include calibrating photoelectric controls, checking that occupancy sensors are working, and setting a suitable delay time for occupancy sensors.

Maintenance

A lighting installation should be maintained to keep its visual performance within the design limits. The designer will have selected a certain illumination level for the particular activity and presumed a frequency of lamp replacement and a frequency of cleaning. The frequency of lamp replacement and cleaning will be appropriate to the environment, including accessibility and the type of luminaire (light fitting). When assessing maintenance requirements the first step is to seek information on the initial design assumptions.

Maintaining a lighting installation as intended will ensure the efficiency of the installation is not degraded. Reduced maintenance may result in reduced operational performance and, in extremes, lead to danger. Maintaining a lighting installation in good order is also important for maintenance of staff morale and provision of a good impression to customers – flickering, failed and discoloured lamps may discourage staff and turn customers away.

There are two aspects to luminaire maintenance: luminaire cleaning and lamp replacement.

Wall and ceiling cleaning

Room lighting levels, as well as depending upon the cleanliness of the luminaires, also depend on the cleanliness of the room, particularly ceilings and walls. This factor is called the room surface maintenance factor (RSMF).

The designer will have assumed a factor for this and may well have assumed a cleaning time for the walls and ceiling. Again, the intervals between the cleaning of floors and ceilings will depend upon the environment and to a lesser degree the nature of the lighting, i.e. whether it is direct or indirect, and on the size of the room.

Indirect lighting reflecting from a ceiling is very dependent ▶

◀ upon the cleanliness of the ceiling or the surface from which the lighting is being reflected, and dirty walls will have a lesser impact on a large room than on a small room.

Lamp replacement

Three factors are particularly important when considering the frequency of lamp replacement. These are:

1. lamp survival factor, LSF (the proportion of lamps still working after a specified burning time);

2. lamp lumen maintenance factor, LLMF (the proportion of the initial light output being maintained after a specified burning time due to deterioration (ageing) of the lamp);

3. cleaning frequency.

Cleaning frequency

It is cost effective to replace lamps when carrying out routine cleaning of the luminaires. As a result, it is almost always sensible to arrange lamp replacement during routine cleaning, but perhaps not at every routine cleaning.

Power-factor correction

A poor power-factor is undesirable for a number of reasons. Power-factor correction technology is used mainly on commercial and industrial installations to restore the power factor to as close to unity as is economically viable.

Low power-factors are caused by reactive power demand of inductive loads such as induction motors and fluorescent lights. A poor power-factor reduces the effective capacity of the electrical supply, since the more reactive power that is carried the less useful power can be carried, also causes losses at transformers, and can cause excessive voltage drops in the supply network and may reduce the life expectancy of electrical equipment.

For this reason electricity tariffs encourage the user to maintain a high power-factor (nearly unity) in their electrical installation by penalising a low power-factor. There are a number of ways in which power-factor correction can be provided. The most common way that this can be achieved is by the installation of power factor correction capacitors. These can be installed in bulk at the supply position or at the point of usage on motors, for example. Persons involved in this type of work are recommended to seek advice from specialists on the most economic system for a given installation.

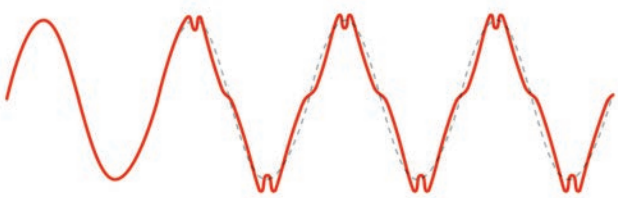
Harmonics

Harmonics are a steady-state disturbance compared with for example short-term transient overvoltages. Harmonics are generally caused by non-linear loads such as switched mode power supplies of computers and discharge lighting see Fig below. Regulations 523.6.1 and 523.6.3 of the 17th edition recognise the effect of triple harmonic currents in the neutral conductor and the need to take account of it. In electrical installations there is a particular problem in three phase circuits.

A wind generator. The pole mounted unit on the roof of the first house is a weather station which can measure wind speed and rate of solar radiation (insolation) and the dark PV tiles are integrated with the red roof tiles.

The third and other triple harmonics combine in the neutral to give a neutral current that has a magnitude equal to the sum of the third harmonic content of each phase. The heating effect of this neutral current could raise the temperature of the cable above its rated value and damage the cable.

Other harmonics can cause problems with electric motors causing the frame temperature to rise consequently reducing the life and efficiency of the motors. With the increased use of switched mode power supplies the resulting harmonic distortion is a major concern. It is therefore important to be able to measure the power quality and where harmonic distortion is found provide a solution to reduce the harmonic distortion.



Harmonics

Renewable energy

On-site renewable energy sources do not of themselves increase the efficiency to the electrical installation but reduce the overall utility network losses as the consumption of the building from the utility is reduced.

There are a wide range of microgeneration technologies including: Solar photovoltaic (PV), wind turbines, Small scale hydro and Micro CHP (Combined heat and power). Microgeneration systems such as solar PV installations should always be carried out by a trained and experienced installer. For example, where the PV panels are roof-mounted the roof must be strong enough to take their weight, especially if the panel is placed on top of existing tiles. It is also important to note that there are mandatory requirements concerning the parallel connection of generators with the supply network.

PV Installation

Section 712 of BS 7671:2008(11) is concerned with the safe installation of solar photovoltaic (PV) power supply systems. A PV system is a collection of interconnected PV cells that turn sunlight directly into electrical energy.

The risks

Modules produce electricity when exposed to daylight. This needs to be taken into account during design, installation, use and maintenance. Also, the electrical installation which incorporates a PV system has a second source of energy which needs to be isolated before starting work. A further risk involves working at height on a roof, for example together with the manual handling associated with a PV installation. Finally, PV installations require expertise in dc wiring and fault protection for d.c. side of the installation.

PV Installations require expertise in d.c. wiring and fault protection for d.c. side of the installation

Scope

Section 712 of BS 7671:2008(2011) applies to the electrical installations of PV power supply systems including systems with a.c. modules. Section 712 does not apply to PV power supply systems which are intended for standalone operation.

The Electricity Safety, Quality and Continuity (Amendment) Regulations 2006

Solar photovoltaic (PV) power supply systems are required to meet the Electricity Safety, Quality and Continuity (Amendment) Regulations 2006 (ESQCR) as they are embedded generators. These are mandatory requirements.

However, where the output does not exceed 16 A per line they are small-scale embedded generators (SSEG) and are exempted from certain of the requirements provided that:

i. the equipment should be type tested and approved by a recognised body;
ii. the consumer's installation should comply with the requirements of BS 7671;
iii. the equipment must disconnect itself from the distributor's network in the event of a network fault; and
iv. the distributor must be advised of the installation before or at the time of commissioning.

See 'Engineering Recommendations G83/1, for PV systems up to 16 A (5 kw) and G59/1', published by the Energy Networks Association (ENA) for larger systems and generators, etc. Further information can be obtained at: www.ena-eng.org.

Protection for safety General requirements

Regulation 712.410.3 requires that PV equipment on the dc side must be considered to be energised, even when the system is disconnected from the a.c. side. This is because modules produce electricity when exposed to daylight. Regulation 712.410.3.6 states that the protective measures of non-conducting location and earth-free local equipotential bonding are not permitted on the d.c. side.

Protective measures

Regulation 712.41 recognises three methods of protection:

- automatic disconnection of supply
- double or reinforced insulation
- extra-low voltage provided by SELV or PELV.

Protection against overcurrent and electromagnetic interference

Regulation 712.433, Regulation 712.434, and Regulation 712.444 are the relevant regulations.

Finally, other regulations in Section 712 of BS 7671:2008(11) include: Regulation 712.512 dealing with operational conditions and external influences, Regulation 712.513 dealing with accessibility, Regulation 712.522 dealing with wiring systems, Regulation 712.537.2.1.1 dealing with isolation, switching and control and Regulation 712.54 deals with earthing arrangements. There are also special requirements for Labelling.

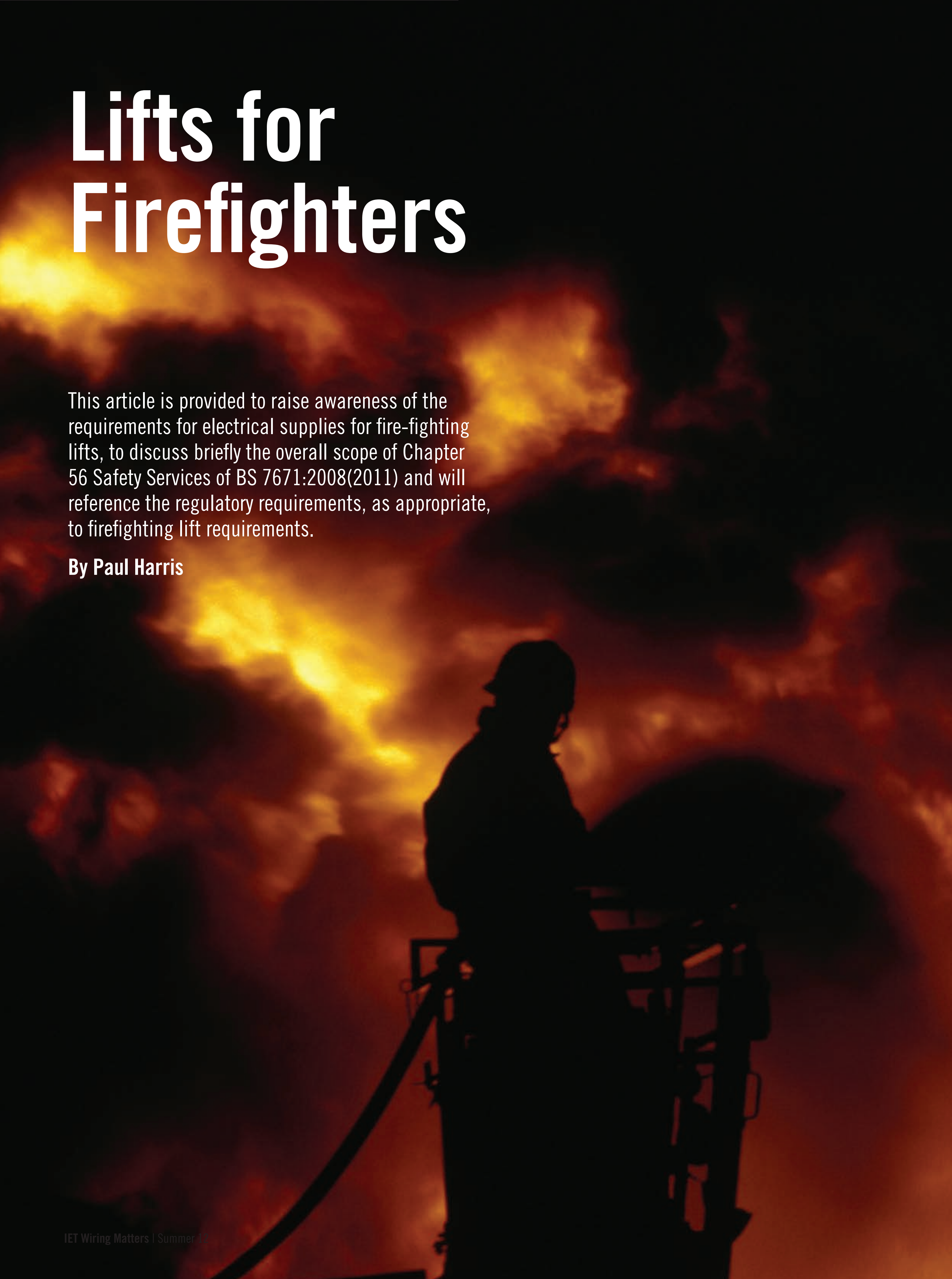
For further information refer to 'BS 7671:2008, Engineering Recommendations G83/1 and G59/1' published by the Energy Networks Association and the Department for Business, Enterprise & Regulatory Reform (BERR).

England and Wales - The Department of Communities and Local Government www.communities.gov.uk

Scotland - The Scottish Building Standards Agency www.sbsa.gov.uk

Note: It is important to consult the Building Regulations in the UK when designing electrical installations. The Building Regulations contain requirements for lighting controls etc. Please note this article is only intended as a brief overview of issues that are being considered at a very early stage and therefore may not become international standards.

Special thanks to Hager for some of the images used.



Lifts for Firefighters

This article is provided to raise awareness of the requirements for electrical supplies for fire-fighting lifts, to discuss briefly the overall scope of Chapter 56 Safety Services of BS 7671:2008(2011) and will reference the regulatory requirements, as appropriate, to firefighting lift requirements.

By Paul Harris

There appears to be a common area of misunderstanding leading to incorrectly designed supplies which result in firefighting lift installations not being fully compliant with BS 7671, in particular, Chapter 56 and the requirements for firefighters lifts contained in BS EN 81-72: Lifts for Firefighters.

When carrying out an electrical design and/or installation, it will at some point be necessary to certify compliance with BS 7671 for the entire electrical installation. This will include the certification of the safety services and, in particular, the firefighting lift supply.

Failure to design or install the supplies correctly will not only jeopardise the integrity of the Electrical Installation Certificate, it may have an effect on the persons using the firefighting lift in onerous conditions.

Chapter 56 Safety Services – BS 7671

Whilst it excludes hazardous areas, Chapter 56 covers within its scope a large number of subject areas:

- Emergency lighting
- Fire pumps
- Fire rescue service lifts
- Fire detection and alarm systems
- CO detection and alarm systems
- Fire evacuation systems
- Smoke ventilation systems
- Fire services communication systems
- Essential medical systems
- Industrial safety systems.

The subject areas addressed in the scope of Chapter 56 have many Codes of Practices and their own supporting British Standards.

Building Regulation Requirement for Firefighting Lifts

A firefighters lift is defined as: "a lift installed primarily intended for passengers use which has additional protection, controls and signals which enable it to be used under the direct control of the fire service".

The design of new buildings requires compliance with Building Regulations for England and Wales, which includes Approved Document B (Fire Safety). To meet the requirements of Building Regulations, Approved Document B (AD B), BS 9999 Code of Practice for Fire Safety in the design, management and use of buildings provide an abundance of best practice information for building designers and managers to use to discharge their responsibilities under the Building Act.

(Building Regulations vary throughout the UK, this article focuses on England and Wales. However, in Scotland ▶

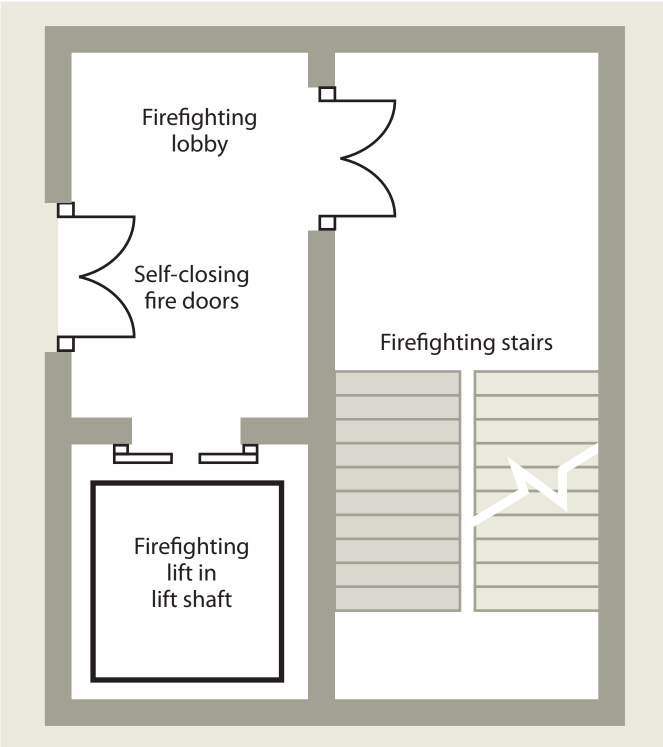


Fig 1 - Fire-fighting Shaft with Fire-fighting Lift

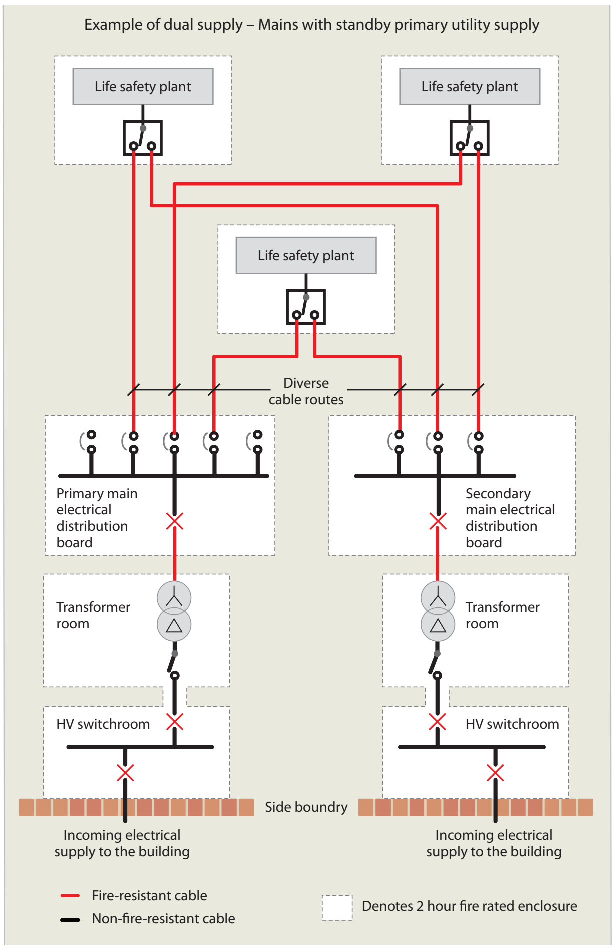


Fig 2 - Indicates a life safety arrangement utilising an alternative HV supply

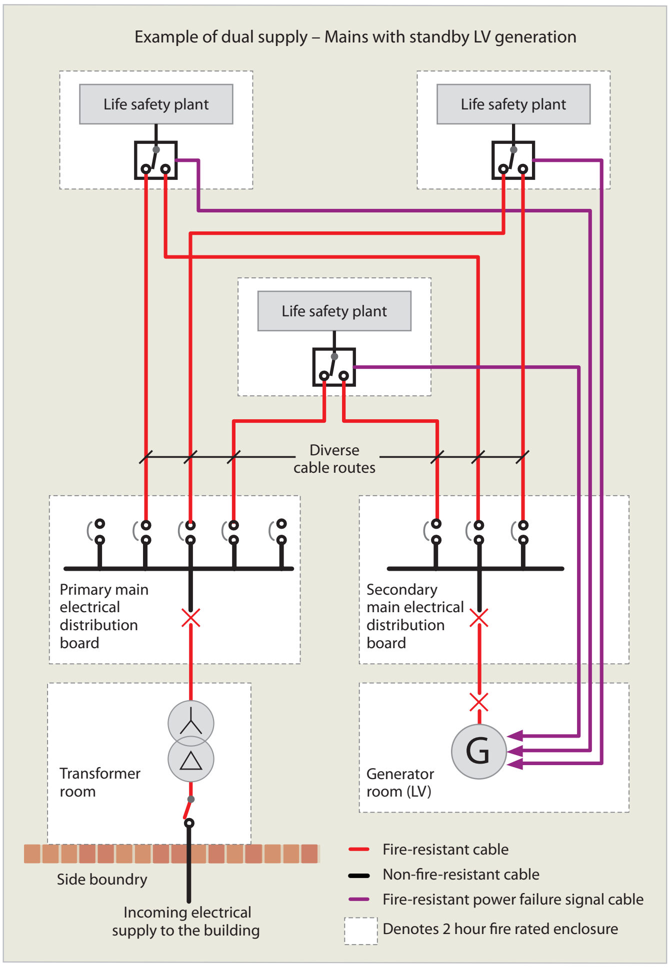


Fig 3 – Extract from BS 8519, Example of dual supply, mains with standby LV generation

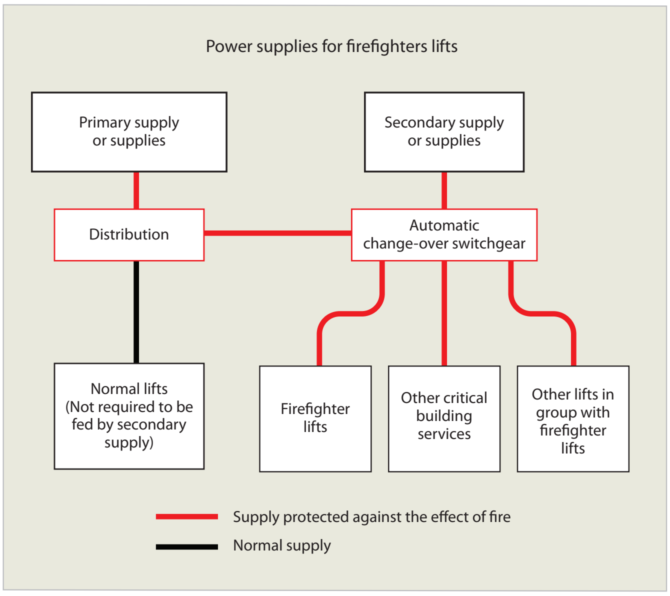


Fig 4 – Power supplies for Firefighters lifts

◀ the Building Standards are supported by Technical handbooks, www.scotland.gov.uk/Built-Environment/Building/Building-standards/ and for Northern Ireland DFP Booklet E 2005 www.dfpni.gov.uk)

Table 19 of BS 9999 sets out the provision of firefighting shafts, and details additional mitigating measures to use as the level of difficulty to access the fire increases.

The requirement for the firefighting lift(s) is set out by the Building Control Officer, Approved inspector or the Project Fire Engineer as part of method of satisfying the requirements of Approved Document B and BS 9999.

Firefighting lifts are usually required in any building or part of a building where the upper most storey is greater than 18m above floor level or where the depth of the surface of the floor of the lower most storey exceeds 10m.

Additional firefighting lifts are required where the floor area exceeds 900m^2 or the requirements for the development determine the number of lifts for firefighting purposes.

Lifts for firefighting purposes are provided to assist firefighters arriving with equipment and additional personnel to fight the fire in as short a time as possible and those lifts should not be confused with evacuation lifts.

Firefighting lifts may contain many of the same features as an evacuation lift, although it may not preclude the fire and rescue service evacuating disabled or impaired persons if necessary; Fig.1 indicates a typical firefighting shaft arrangement.

Outline requirement of BS EN 81-72

Once it has been determined that a firefighting lift is required the designer should consult the specific requirements of BS EN 81-72: Lifts for Firefighters, which is part of the BS EN 81 series of documents relating to passenger and goods lifts.

There are many requirements and restrictions placed on the lift car: the shaft design, location with respect to water, types of flooring and accessibility to the fire. However, these are usually dealt with as part of the construction/structural design of the building with input from the lift manufacturer.

This does not negate the electrical designer's need to understand the general requirements which are set out in the aforementioned standards.

There are a number of principal requirements that are in the direct control of the electrical designer. These are:

- the equipment in machinery spaces are protected from water;
- the secondary power supply is located in a fire ▶

protected area;
- the primary and secondary power supplies are separated from each other and other power supplies;
- the primary and secondary power supplies are fire protected to the same level as the lift well equipment.

Specific risks and hazards will be particular to each individual project. In addressing these, a number of other considerations need to be made and the following questions answered:

- What type of secondary supply is appropriate for this building?
- What routes are fire protected and which are likely to give suitable segregation from each other?
- Where can the lift supply changeover equipment be installed?
- What fire survival time can be used to ensure compliance?
- How does BS 8519 impact the sizing of the firefighting lift cables and overall system?

At this point any potential proposals should be checked with the requirements of BS 9999 and BS 7671 to ensure compatibility.

Electrical design requirements

Primary supply

In addressing the above points it is important to assess the primary electrical supply position. Unless the supply enters a fire-resistant switchroom directly from outside, it is likely to be affected by fire within the building.

Where the incoming supply cable passes through a basement or other occupied area to reach the meter or switchgear position, consideration should be given to how the incoming section of the electrical supply will be affected if the building is on fire.

Where required, fire segregation will be needed by either enclosing in fire-resistant materials or by routing the cable through a fire resistant duct or riser. The performance criteria for various types of fire resistant enclosures is given in BS EN 1366, which for firefighting lift supplies, requires a 120-minute fire-protection period and an additional requirement to withstand the effects of water jets at the conclusion of the period.

If the cable belongs to a utility company, fire protection or re-routing may not be possible without a specific agreement. Regardless of ownership, the size of a cable may need to be increased due to the effects of enclosing the cable in a duct or similar.

A fundamental principal of safety services, in particular firefighting lifts, is that any distribution or final circuit supplying the firefighting lift(s) shall be exclusive to the lift(s) and independent of any other main or distribution circuit feeding other circuits.

BS 7671 considers a safety source to be additional to the normal source, which is generally the public supply network. This approach differs to safety services contained in BS EN 81-72 and BS 8519 as they consider the primary supply to be of equal importance to the secondary supply.

Secondary supply

The secondary supply to the firefighting lift may be by the provision of a separate supply from an independent substation, remote from the primary supply; as indicated in Fig. 2. Where such a supply is provided it is normally at high voltage (HV). BS 9999 recognises this arrangement is usually quite difficult to obtain unless strict measures are in place to prevent the supply network becoming inappropriately interconnected through the customer's installation.

The more usual approach of providing a secondary supply is to use a generator. This is a reliable method as it does not rely on special approvals from the electricity supply company.

There is a break in supply with this system, which is due to the machine sensing loss of supply, starting the engine and then running the alternator up to synchronous speed to changeover.

This type of break is classified by BS 7671 as a medium break in Regulation 560.4.1. Care needs to be taken when selecting a generator for secondary supplies as the initial load acceptance on change-over (first step) is in the region of 60 per cent of the full-load rating.

Regulation 560.6.1 allows other sources of power, such as storage cells and primary cells, to be used as safety supplies. Due to the nature and magnitude of the firefighting lift load, these sources are not usually considered. Fig. 3, which is an extract from BS 8519 indicates a life safety arrangement utilising a generator.

Whichever solution is chosen, it is important to ensure that the primary and secondary supplies are not co-located and they are not dependent upon each other in accordance with Regulation 560.7.1, i.e. they do not share distribution circuits, protective devices or other electrical equipment.

As with the primary supply, a fire-protected enclosure is required to protect the alternative supply from the effects of fire and water jets. With a generator solution additional measures with respect to air intake and exhaust discharges have to be considered in line with Regulation 560.6.4 of BS 7671.

Changeover equipment location

In order that the supplies remain independent of each other, the changeover equipment should be sited as close to the lift drive and control equipment as possible, which would be within the fire rated construction of the firefighting shaft. This would ideally be in the same room/compartment, which by design should be free from the effects of water and allows maximum segregation of the supplies providing the level of protection called for in clause 5.7.1 of BS EN 81-72.

In addition to the protective requirements of Regulation 560.6.14 , BS 8519 requires the status of the safety service to be monitored to confirm both primary and secondary supplies are available at an appropriate location such as the fire control/command point in a building.

Fire Survival times

Regulation 560.5.2 states:

"For safety services required to operate in fire conditions, the following two conditions shall be fulfilled:

(i) An electrical safety source for safety supply shall be so selected as to maintain a supply of adequate duration, and

(ii) all equipment of safety services shall be so provided, either by construction or by erection, with protection ensuring fire resistance of adequate duration"

The fire survival time of a system is set out in BS 8519 as 60 minutes for large or complex buildings and 30 minutes for other buildings. Firefighting systems have additional requirements placed on them, with the systems installed being capable of assisting fire fighters for 60 minutes or 120 minutes depending on their role. Table 1 of BS 8519 identifies that firefighting lift supplies and their communications cabling shall have a minimum of Category 3 fire resistance. This is in line with the requirements of Regulation 560.8.2 which requires cables that control safety services are to have the same level of fire protection as the supply it is controlling.

Category 3 cables over 20 mm overall diameter meet the 120 minute survival time when tested in accordance with BS 8491, or control cables meeting ph120 classification when tested in accordance with BS EN 5020.

Selection of firefighting lift supply cables
In order to correctly size a fire resistant cable for firefighting purposes, it is important to consider the size of the fire and the amount of cable that may be potentially exposed to a fire. These factors will significantly affect the performance of a fire rated cable over those values used in normal cable sizing and volt drop calculations.

In order to meet the ▶

◀ requirements of BS 8519 and the functionality called for in Regulation 560.5.2, information within informative Annexes C and D of BS 8519 needs to be considered to ensure that equipment is able to function under the onerous conditions experienced in a fire.

In selecting a cable to supply the firefighting lift supplies, it is essential to note the requirement for a 120 minute fire rated cable. This requirement of 120 minutes restricts the number of products currently available on the market. However, it is not just a case of selecting a fire resistant cable, choices of route and which other services are to run with the firefighting lift supplies are crucial.

In addition to the usual assessment of full load operating current of the firefighting lift it is important to look at the potential exposure of the cable to fire. In taking into account any increase in impedance and, hence, volt drop, it is ideal to protect cables from the effect of heat from the fire. Where it is not practical or possible, the next approach should be to limit the length of run in any one fire compartment.

Information and examples in informative Annexe C of BS 8519 allow the designer to determine the approximate level of volt drop under fire conditions. Once this value has been determined it should then discussed with the equipment manufacturer to ensure that the requirements of Section 525 of BS 7671 are met. Where necessary, cable sizes should be increased to ensure function of equipment throughout the fire condition as required meeting the requirements of BS 8519 and required by Regulation 560.5.2.

In order to ensure that the requirements for firefighting lifts are met, the principal requirements have been simplified and summarised by the diagram in Informative Annexe (C) BS EN 81-72.

BS EN 81-72 Electrical Supply Requirements - Simplified

The principal issues relate to the requirement for the segregation of the supply from other circuits and fire protection to the same level as the lift shaft and segregation from the alternative supply; this is highlighted in Fig.4.

The requirements of BS 7671 cannot be overlooked when designing particular safety services. It can be seen that the Wiring Regulations provide a regulatory framework for designers and installers to work with. The individual requirements must be fully considered to achieve compliance and discharge the relevant duties in law.

In the instance of electrical supplies the specific requirements are generally set out in BS 9999, with details of solutions contained in BS EN 81-72 and BS 8519. These specific details allow regulatory compliance with BS 7671 to be achieved. This allows the designer, constructor and inspector to confirm compliance with BS 7671 on the main Electrical Installation Certificate, meeting the express and implied requirements contained within BS 7671.

This article is not aimed to be a complete and comprehensive selection guide for the installation of firefighting lift design, it is provided to create awareness of different standards and guide designers and installers towards the correct information sources. It is the responsibility of the designer to ensure they have adequately assessed all relevant risks using reasonable skill and care.■

Eur Ing Paul Harris CEng FIHEEM MIEE MCIBSE is an independent consultant for Harris Associates Ltd.

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Changes to the IET's Code of Practice for In-service Inspection and Testing of Electrical Equipment (ISITEE)

Major changes to the IETs Code of Practice are planned, to incorporate new industry requirements for in-service inspection and testing of electrical equipment.

By Richard Townsend

The Code of Practice (CoP) for In-service Inspection and Testing of Electrical Equipment (ISITEE): 3rd edition, produced by the IET, is currently undergoing a revision process to better reflect the industry and consumer requirements for the safety of electrical equipment and appliances. The main drivers for these changes have been the increased requirement for guidance from more diverse business types and a more focused approach to risk based assessing for frequency of inspections and tests.

The former will be addressed with a much broader and less restrictive scope, which currently alienates or fails to include the many new and diverse businesses that are becoming more prevalent in today's society, particularly those enterprises which deal with previously-owned goods, through either outlet shops or online selling.

The change in scope will also address the issue of hired equipment, which may form part of a long-term contract, which would not normally be included in the current scope or was unclear as to what was required.

Hired equipment covers a wide range of business types and equipment, from building site transformers to vending machines and concert visual and audio rigs. The latter has a particular requirement for inclusion due to the rigorous nature of its use. The need for clearer guidance of the responsibilities of those persons hiring equipment, of any type, was much needed and the new changes will outline the requirements for those hiring equipment of all types, for any reason.

One important development, which will have an impact on UK businesses in general, has been the publication of the Lofstedt report, which makes reference to industry 'over-compliance', not only within the electrical industry and its associated 'Portable Appliance Testing (PAT)' sector, but the whole of industry in general, covering a broad range of legislative over-compliance. From an electrical industry perspective, the Lofstedt report implied that businesses were being pressured to over comply by carrying out annual inspections and tests, when they may not have been necessary.

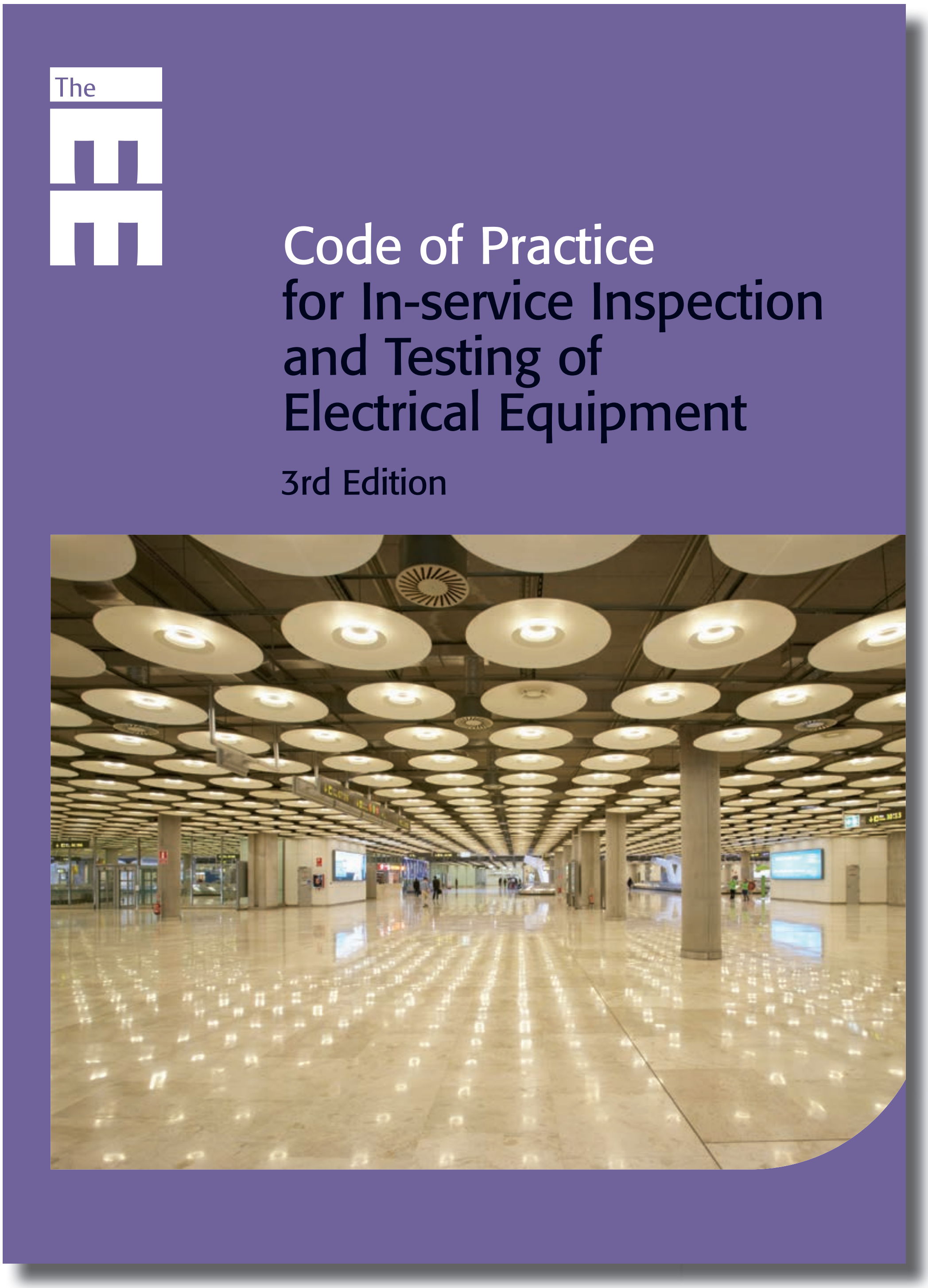
The pressure to over-comply may have come from many sources, overzealous inspection companies, a misunderstanding of the requirements or the wrongly perceived industry norm that annual testing is a requirement.

The IET's CoP for In-Service Inspection and Testing of Electrical Equipment (ISITEE), has always emphasised that the frequency of inspections and testing should be reviewed on a regular basis in order to effectively asses the risk of use of any appliance, or piece of equipment, and in so doing extend or reduce any subsequent frequencies of inspection or testing, as may be necessary.

Taking into consideration the Lofstedt report and the confusion associated with the frequency of inspection and testing, the CoP for ISITEE update will give clearer guidance and far more emphasis will be placed on the need for on-going risk assessments to more accurately set effective frequencies of inspection and testing, where necessary. In many cases the frequency of inspection and testing has the potential to be extended to respectively long periods without any detriment to the user or the equipment.

The new CoP ISITEE guidance on risk based assessments is being developed by an industry stakeholder peer group which includes the HSE and is seen as a positive step forward.

The HSE has also updated their documentation in order to give further guidance on in-service appliance testing in light of the outcomes of the Lofstedt report. These new documents, INDG231 and INDG236, the latter being a combination of the old INDG236 and INDG237, both of which are available as free downloads from the HSE website www.HSE.gov.uk .



The new CoP ISITEE represents a considerable improvement upon an already, well respected, industry leading document. The many changes and alterations will enable both building managers and inspectors to understand their obligations and make a more informed decision on the level of inspections and testing required at an individual location. This will help to reduce the costs associated with over compliance in the whole of the UK workplace.

Other expected changes to the CoP for ISITEE may include:

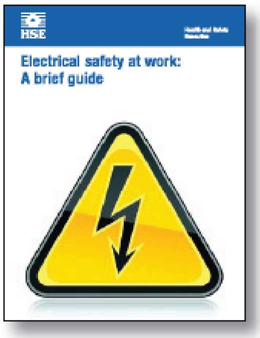
- Removal of non-associated tests, such as microwave leakage and manufacturers production tests
- Increased and additional definition clarity
- Additional equipment types
- Additional information on legislation and residence types
- Clearer guidance on types of residences and the requirements for landlords

The IET's 4th edition of the Code of Practice for In-Service Inspection and Testing of Electrical Equipment is expected to be published in November of this year with advance purchase orders being possible in mid-August from the IET's website www.theiet.org/electrical.

Health and Safety Executive

Electrical safety and you

A brief guide



This is a web-friendly version of leaflet INDG231(rev1), published 04/12

Introduction

Electricity can kill or severely injure people and cause damage to property. Every year many accidents at work involving electric shock or burns are reported to the Health and Safety Executive (HSE). Most of the fatal incidents are caused by contact with overhead power lines.

Even non-fatal shocks can cause severe and permanent injury. For example, shocks from faulty equipment may lead to falls from ladders, scaffolds or other work platforms.

Those using or working with electricity may not be the only ones at risk – poor electrical installations and faulty electrical appliances can lead to fire, which may also cause death or injury to others. Most of these accidents can be avoided by careful planning and straightforward precautions.

This leaflet provides some basic measures to help you control the risks from your use of electricity at work. Further guidance for particular industries or subjects can be found on HSE's website (www.hse.gov.uk).

What are the hazards?

The main hazards are:

- contact with live parts causing shock and burns – normal mains voltage, 230 volts AC, can kill;
- faults which could cause fire; and
- fire or explosion where electricity could be the source of ignition in a potentially flammable or explosive atmosphere.

Assessing the risk

Your health and safety risk assessment should take into account the risks associated with electricity. It will help you decide what action you need to take to use and maintain your electrical installations and equipment and also how often maintenance is needed. See HSE's website for further guidance (www.hse.gov.uk/risk).

The risk of injury from electricity is strongly linked to where and how it is used. The risks are greatest in harsh conditions, for example:

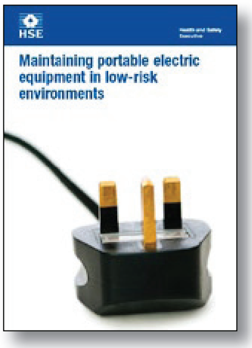
- in wet surroundings – unsuitable equipment can easily become live and can make its surroundings live;
- outdoors – equipment may not only become wet but may be at greater risk of damage; and
- in cramped spaces with a lot of earthed metalwork such as inside a tank – if an electrical fault developed it could be very difficult to avoid a shock.

The updated HSE publication INDG231: Electrical safety and you, which recognises the recent changes made to INDG236. http://www.hse.gov.uk/pubns/indg231.htm

HSE

Health and Safety Executive

Maintaining portable electric equipment in low-risk environments



This is a web-friendly version of leaflet INDG236(rev2), published 04/12

Introduction

This leaflet explains the simple and sensible precautions that need to be taken to prevent danger from portable or movable electrical equipment in low-risk environments, such as offices, shops, some parts of hotels and residential care homes.

It also provides examples of this sort of equipment to help you decide what you need to do to maintain portable appliances in your workplace.

What does the law say?

You must maintain electrical equipment if it can cause danger, but the law* does not say how you must do this or how often. You should decide the level of maintenance needed according to the risk of an item becoming faulty, and how the equipment is constructed. You should consider:

- the increased risk if the equipment isn't used correctly, isn't suitable for the job, or is used in a harsh environment; and
- if the item is not double insulated, for example some kettles are earthed but some pieces of hand-held equipment, such as hairdryers, are usually double insulated. See page 4 for more information on earthed equipment and double insulated equipment.

This includes any electrical equipment your employees use at work, whether it is their own or supplied by you. You have a joint responsibility to maintain any equipment used by your employees that is either leased (eg a photocopier) or provided by a contractor (but not equipment both provided and used by a contractor).

You will need to check periodically if any work needs doing. How you do this depends on the type of equipment.

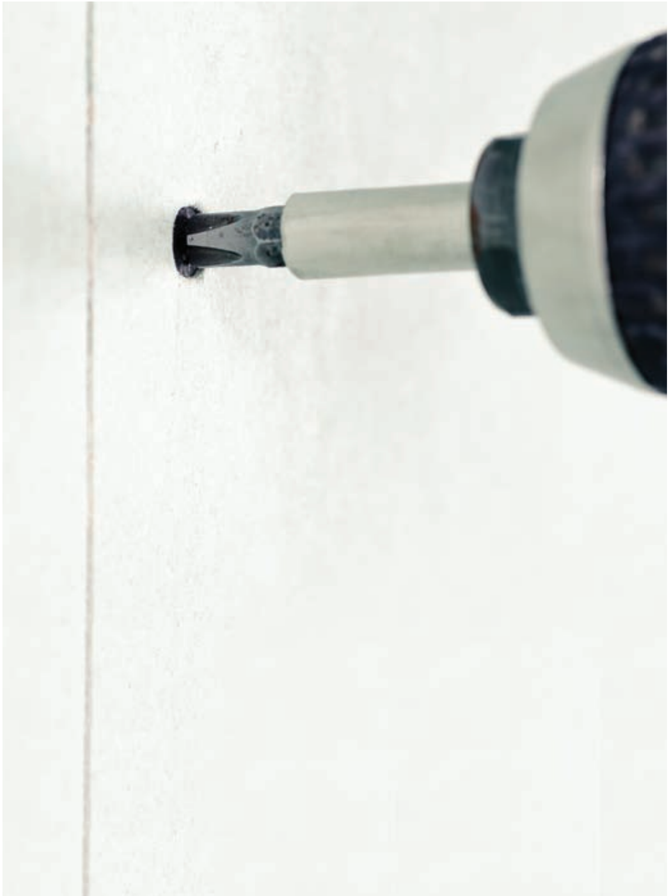
Not every electrical item needs a portable appliance test (PAT)
In some cases, a simple user check and visual inspection is enough, eg checking for loose cables or signs of fire damage and, if possible, checking inside the plug for internal damage, bare wires and the correct fuse.

Other equipment, eg a floor cleaner or kettle, may need a portable appliance test, but not necessarily every year.

* *Electricity at Work Regulations 1989*

Extract from The HSE's new publication INDG236: Maintaining portable electrical equipment in low-risk environments. http://www.hse.gov.uk/pubns/indg236.htm

Inadequate testing leads to unlawful killing verdict



The coroner at the inquest into the death of 22-year-old mother Emma Shaw asks whether anything can be done to avoid similar tragedies.

In December 2007, Emma Shaw, a 22-year old mother, was electrocuted in the airing cupboard of her flat in the West Midlands.

At an inquest into Miss Shaw's death, the jury heard how the tragedy resulted from a plasterboard fixing screw being driven into a concealed cable when the flat was being built the previous year, causing the metallic frame of the partition to become 'live' when the electrical installation was energised.

The damage to the cable had not been detected because insulation resistance tests had not been carried out properly on the wiring, the jury was told.

The fault had remained undetected until water from a leak in a hot water cylinder came into contact with the metal partition. This caused water on the airing cupboard floor also to become 'live', which led to the electrocution when Miss Shaw attempted to turn off the water stop cock when in contact with the water. As the flat was on the first floor, no RCD protection had been provided.

Her son, then aged 23 months, had been shut in the living room while his mother went to tend to the leak.

Last December, after listening to two weeks of evidence, the inquest jury found that the initial testing of the electrical installation in the flat by the installing contractor, Anchor Electrical and Building Services Ltd of Staffordshire, was "not carried out to a professional standard, if at all".

Evidence at the inquest revealed that when the electrics were installed, a series of errors were made. These included an unqualified electrician's mate testing and approving the wiring in the flat. The inquest heard that four safety documents that the mate had filled out, and which were checked by the company's supervisor, also had a number of errors in them.

The jury said that there had been a "failure by the company to assess the capabilities of their workforce and constantly monitor their development" and a "failure to comply with their health and safety standards". They concluded that Miss Shaw had been unlawfully killed.

Following the verdict of unlawful killing, the Health and Safety Executive confirmed that new evidence would be passed to the Crown Prosecution Service, which had previously said that there was insufficient evidence to successfully prosecute anyone.

The Coroner told the inquest that he would use coroner's rules to write to the NICEIC and other relevant bodies, asking if anything can be done to curb the practice of electricians signing safety certificates based solely on information reported to them by others.

Thanks to the ESC SwitchedOn Issue 24 Spring 2012, p13 for this update.

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The Institution prepares regulations for the safety of electrical installations for buildings, the IET 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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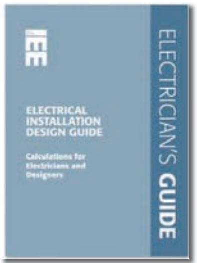

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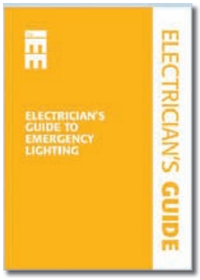

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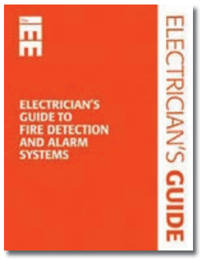

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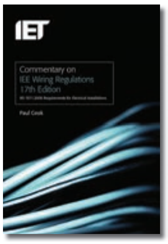

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Requirements for Electrical Installations

P. Cook

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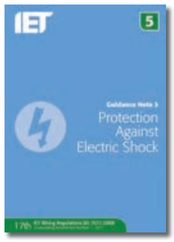

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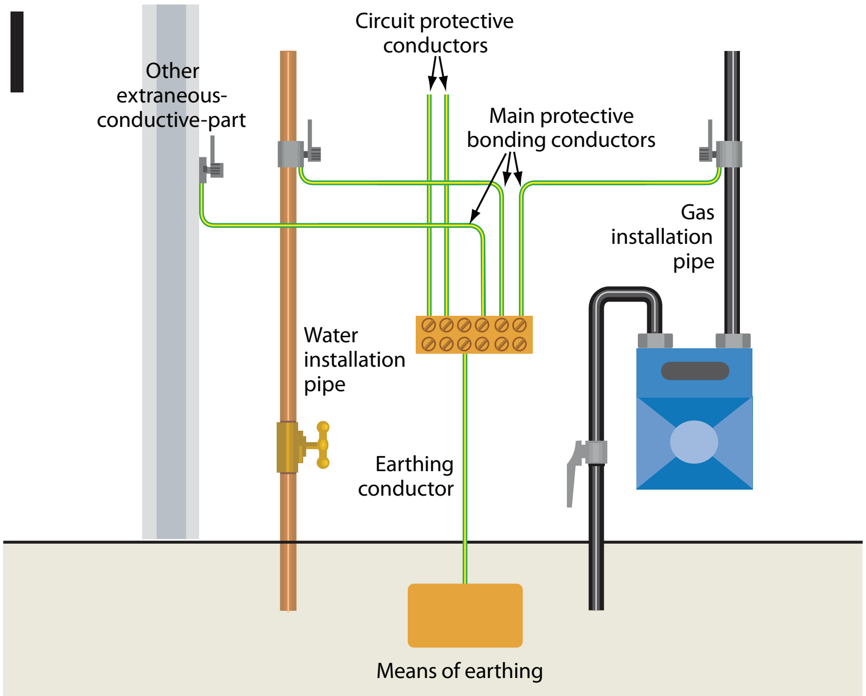
Protective Equipotential Bonding

Regulation 411.1 states that automatic disconnection of supply is a protective measure in which basic protection is provided by basic insulation of live parts or by barriers or enclosures and fault protection is provided by protective earthing, **protective equipotential bonding** and automatic disconnection in case of a fault



Typical protective conductor arrangement

By Geoff Cronshaw

There are four protective measures generally permitted by BS 7671:2008 (2011), given in Regulation 410.3.3: (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).

A note at the end of this Regulation acknowledges that, in electrical installations, the most commonly used protective measure is automatic disconnection of supply.

Regulation 411.1 states that automatic disconnection of supply is a protective measure in which basic protection is provided by basic insulation of live parts or by barriers or enclosures and fault protection is provided by protective earthing, **protective equipotential bonding** and automatic disconnection in case of a fault.

Main protective equipotential bonding

The purpose of earthing the exposed-conductive-parts of an installation is to ensure that, in the event of a fault (line conductor to an exposed-conductive-part), sufficient fault current flows to operate the disconnection device (fuse, circuit-breaker, RCD). Earthing exposed-conductive-parts also reduces the touch voltage (Ut) between these and extraneous-conductive-parts during a fault. The purpose of protective equipotential bonding is to further reduce the touch voltage between exposed-conductive-parts and extraneous-conductive-parts in the event of:

i. a fault on the installation

ii. an open circuit PEN conductor in a PME supply.

Regulation 411.3.1.2 requires main equipotential bonding to be carried out, however its importance is often underestimated.

The effect of applying main protective equipotential bonding is most noticeable in TT systems. Consider Figure 1 below (extract from IET GN 5).

The touch voltage in the event of a fault with main protective bonding installed is given by:

$$U_t = I_f (R_2)$$

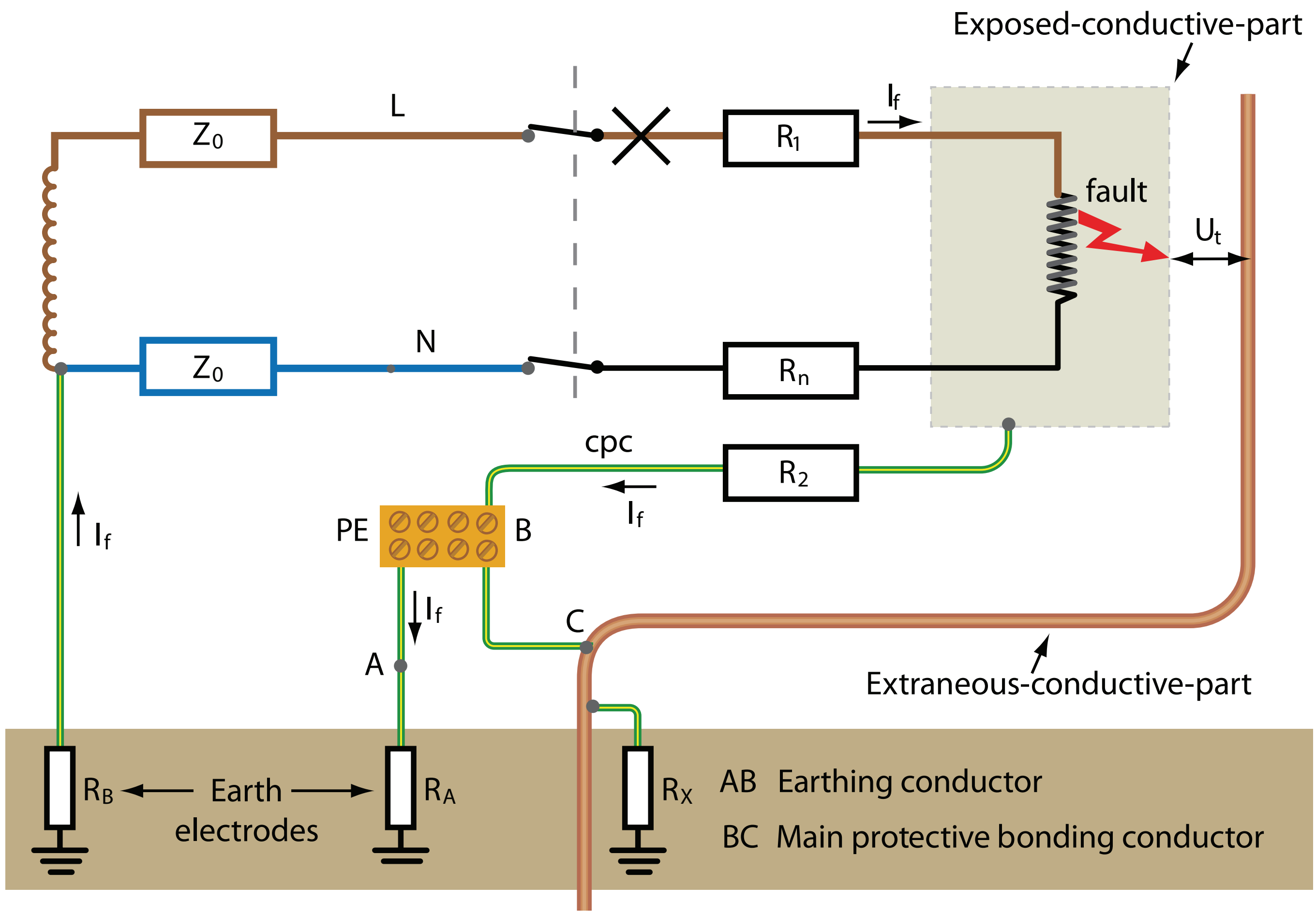
The touch voltage (within the installation) in the event of a fault with no main protective bonding is given by:

$$U_t = I_f (R_2 + R_A)$$

If is given by:

$$I_f = \frac{U_0}{R_2 + R_1 + R_A + R_B}$$

Assume $U_0 = 230$ V, $R_B = 20$ Ω, $R_A = 100$ Ω, $R_1 = 0.5$ Ω, $R_2 = 0.5$ Ω ▶



Then

$$I_f = \frac{230}{0.5 + 0.5 + 100 + 20}$$

= 230/121 = 1.9 A,

giving U_t with no bonding = 191 V

and U_t with bonding = 0.95 V

Installation of main equipotential bonding conductors

IET Guidance recommends that main equipotential bonding conductors should be kept as short as practicable and be routed to minimise the likelihood of damage or disturbance to them.

The connections to gas, water and other services entering the premises must be made as near as practicable to the point of entry of each service, on the consumer's side of any insulating section or insert at that point or any meter.

Any substantial extraneous conductive part which enters the premises at a point remote from the main earthing terminal or bar must also be bonded to this terminal or bar.

Extraneous-conductive-parts should preferably be bonded using individual main equipotential bonding conductors. Alternatively, two or more such parts may share a main equipotential bonding conductor, but where this arrangement is employed the conductor should be continuous, i.e. disconnection of the conductor from one extraneous-conductive-part must not interfere with or endanger the security of the bonding of the other part(s).

Regulation 544.1.1 and Table 54.8 of BS 7671:2008(2011) gives sizing requirements for main equipotential bonding conductors. However, it is recommended that the electricity distributor or supplier should be asked to confirm their agreement to the proposed size(s) it is intended to install.

BS 951 earthing and bonding warning label

Regulation 514.13.1(ii) requires a permanent label to be fixed at or near the point of connection of every main equipotential bonding conductor to an extraneous-conductive-part. ■

Further information
BS 7671:2008(2011)
IET Guidance Notes 5 and 8.

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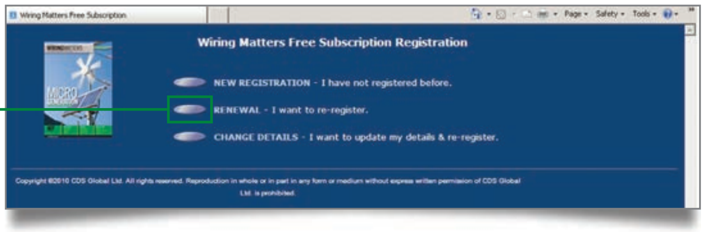

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