Types of person and the requirements of the Wiring Regulations Part 2

by Jon Elliott

In the last edition of Wiring Matters we looked at the types of person recognised by the Wiring Regulations, the skills sets that they possessed and the differences in their abilities. In this article we will consider particular requirements within BS 7671 where the type of person involved is of some significance.

BS EN 61140 Protection against electric shock.

Common aspects for installation and equipment requires that:

- *hazardous-live-parts shall not be accessible*
- *accessible conductive parts shall not be hazardous live when there is no fault or under single fault conditions*

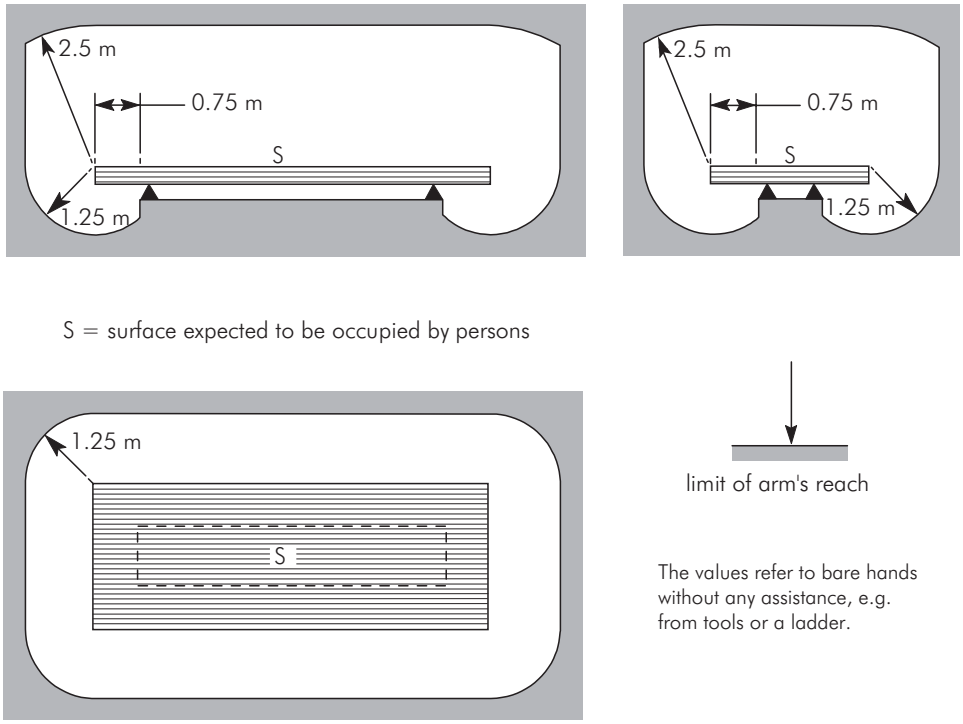
BS EN 61140 states that those protective measures providing protection under normal conditions (that is, when no faults exist) provide basic protection and those protective measures giving protection under single fault conditions provide fault protection (Section 410 refers).

The measures of protection by automatic disconnection of supply, double insulation and reinforced insulation, electrical separation to supply a single item of equipment and extra-low voltage (SELV or PELV) are generally applicable (Regulation 410.3.3).

However, in practice automatic disconnection of supply is the most commonly employed method for electrical installations while double and reinforced insulation are more frequently encountered in items of equipment rather than installations per se. Electrical separation, SELV and PELV are typically only applied to specific parts of an installation.

In any case, BS 7671:2008

Fig: 417 Arm's reach



requires the protective measures mentioned above to provide for basic and fault protection either separately or, in the case of enhanced protection from a single measure (Regulation 410.3.2 refers).

Basic protection

Measures for basic protection such as basic insulation, barriers and enclosures are generally applicable and as such may be employed in installations or parts thereof, which are accessible to ordinary persons - that is, which are accessible to anybody. However, care must be taken in the use of the measures of obstacles and placing out of reach to prevent access of persons (or indeed livestock) with live parts as both measures may be deliberately or in some cases unintentionally circumvented (Regulation 417.2). Because of this, the use of these two methods is restricted to installations, or parts thereof, which can only be accessed by skilled persons or instructed persons under the supervision of skilled persons (Regulations 410.3.5 and 417.1)

To be effective an obstacle (as defined) should prevent unintentional bodily approach to, and contact with, live parts during the normal operation and use of the equipment in question (Regulation 417.2.1). However an obstacle may be readily removable without the use of a key or tool (Regulation 417.2.2).

Placing out of reach requires a designer to ensure that simultaneously accessible parts at different potentials are not placed within arm's reach (Regulation 417.3.1). Arm's reach is considered to span 1.25 m horizontally and 2.5 m vertically as shown in figure 417 of BS 7671:2008 which is reproduced above. However this does not take into account the use of ladders or work involving long conducting objects and tools and so the use of such within areas where basic protection is provided by placing live parts out of reach should the subject of serious consideration.

In the case of items of street furniture, basic protection may only be provided by placing out of reach where the item in question is situated more than 1.5 m from a low voltage overhead line unless the maintenance of said equipment is only to be carried out by skilled persons (Regulation 559.10.1).

Wherever the use of either obstacles or placing out of reach is employed it is necessary to provide the required equipment, instruction and training to allow the skilled persons and the instructed persons under their supervision to be able to work safely. As such, those parts of an installation where such measures are employed should be clearly identified by the posting of notices and measures, such as, securing with locks and permit-to-work

The following protective methods are recognised in BS 7671:

Basic protection	Fault protection
Basic insulation	Protective earthing
Barriers	Protective equipotential bonding
Enclosures	Automatic disconnection in the event of a fault
Obstacles	Automatic disconnection of supply for the primary circuit *and* connection of exposed-conductive-parts of the secondary circuit connected to the protective conductor of the primary circuit of the source
Placing out of reach	Supplementary insulation
Reinforced insulation	
	Simple separation
	Non-conducting location
	Earth-free local equipotential bonding

systems should be put in place to control access and work activities undertaken therein.

When a designer is considering the use of obstacles or placing out of reach to provide basic protection, it is strongly recommended that careful consideration be given to the statutory requirements relating to:

- system, work activities and work equipment (Regulation 4 of the Electricity at Work Regulations 1989 - EWR)
- insulation, protection and placing of conductors (Regulation 7 of EWR)
- work on or near live conductors (Regulation 14 of EWR)
- Earthing or other suitable precautions (Regulation 8 of EWR)
- working space, access and lighting (Regulation 15 of EWR), and
- persons to be competent to prevent danger and injury (Regulation 16 of EWR)

Considerable guidance in support of these regulations can be found in Memorandum of guidance on the Electricity at Work Regulations 1989 (HSR25) published by the Health and Safety Executive and available as a free download from the HSE website.

Fault protection

In the case of automatic disconnection of supply (ADS), fault protection is provided through the provision of protective earthing, protective equipotential bonding and automatic disconnection in the event of a fault including, where applicable additional protection (Regulation 411.10).

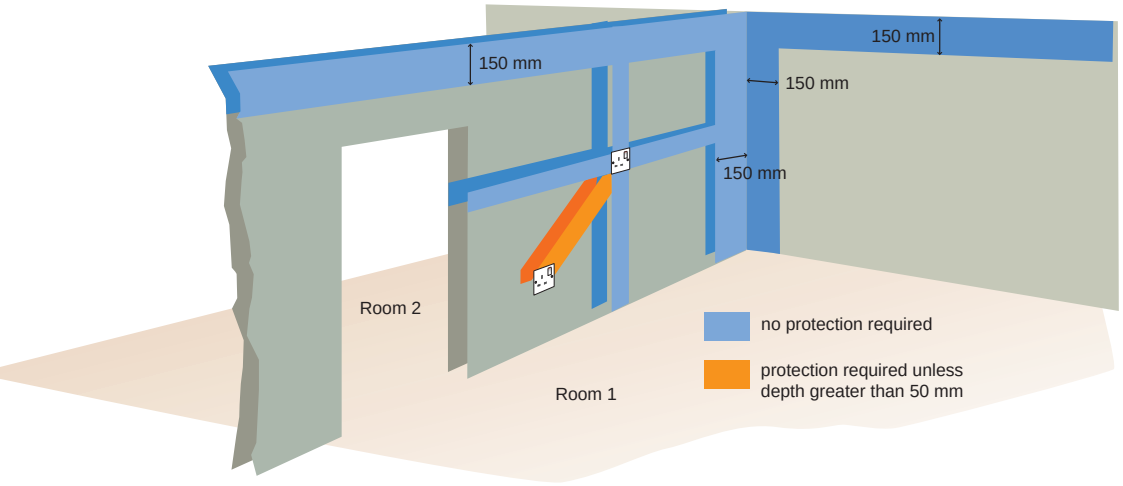
Additional protection by means of an RCD with a rated residual operating current not exceeding 30 mA and giving an operating time not exceeding 40 ms at a residual current of 5 IΔn should be provided for socket-outlets not exceeding a rating of 20 A intended for general usage by ordinary persons, and for mobile equipment of rating less than 32 A that will be used outdoors (411.3.3). A relaxation of this requirement is however permitted for socket-outlets which will be used, in for example, those industrial and commercial installations where work activities are under the effective control of skilled or instructed persons and the work activities taking place do not of themselves make RCD provision essential. This issue will be considered in further detail later in this article.

Where functional extra-low voltage is employed, it is necessary to connect the exposed-conductive-parts of the equipment so supplied to the protective conductor of the primary circuit of the source *in addition* to those protective measures required for ADS (Regulation 411.7.3)

In the case of an accessible enclosure forming part of street furniture it should only be possible to gain access to the live parts within by the use of a key or a tool, unless said enclosure is so located that only skilled or instructed persons have access (Regulation 559.10.3.1). Where isolation and switching operations on street furniture supplied from a TN supply are intended only to be carried out by, at the least, instructed persons and where the necessary precautions have been taken to prevent said equipment from being re-energised prematurely in a manner that could give rise to danger, it is acceptable for switching on-load and isolation to be achieved by removal of the distributor's fuse therein.

Cables concealed in walls

It has long been a requirement of the Wiring Regulations that where cables are concealed in walls or partitions at a depth of less than 50 mm from the



surface that they either:

- incorporate an earthed metallic covering such as armouring or sheath, or
- be enclosed in an earthed conduit, trunking or duct, or
- be otherwise protected against penetration by nails, screws and the like by the addition of mechanical protection, or
- be installed in the safe zones as shown in the diagram below (Regulation 522.6.6)

In the case of an installation not under the supervision of a skilled or instructed person the 17th Edition has introduced a requirement that an RCD having a rated residual operating current not exceeding 30 mA and meeting the conditions contained in Regulation 415.1.1 must be installed to provide additional protection where an insulated and sheathed or similar type cable is run in the safe zones without any other form of mechanical protection. A similar requirement has also been introduced for situations where such cables are installed in partitions formed in part from metallic components (Regulation 522.6.8 (v)). So, additional protection by means of an RCD as described above would be required for domestic premises. Additional protection may also be required in some commercial or industrial installations irrespective of whether they are under the supervision of a skilled or instructed person as Regulation 6 of the EAWR 1989 requires electrical equipment to be of such construction or otherwise suitably protected to prevent dasnger. This can be the provision of RCDs where the environment of use increases the risk of sustaining an electric shock. Wet working environments, such as those in kitchens, are an example of where this would apply.

RCDs and circuit-breakers

RCDs powered from an independent auxiliary source and which do not operate automatically in the event of a failure of the auxiliary source may only be used in an installation if either fault protection is still maintained in the event of loss of the auxiliary source or the installation is under the control of a skilled or instructed person and regularly inspected/tested by a person competent in such work (Regulation 531.2.6). Where an RCD can be accessed and operated by one other than a skilled or instructed person (that is, therefore, an ordinary person) it should be of a type where it is not possible to effect any changes or adjustments to the settings for its operational sensitivity or time delay thereof without the use of a key or tool (Regulation 531.2.10). A similar requirement exists relating to the modification or adjustment of the overcurrent settings of circuit-breakers (Regulation 533.1.2).

Isolators, switchgear and controlgear

Regulation 537.1.2 states that the neutral conductor in a TN-S or TN-C-S system need not be isolated and switched. Where a link is inserted in the neutral conductor, it should not be possible to remove the link without the use of a key or tool and/or it should be placed so that is accessible to skilled persons only (Regulation 537.2.2.4). Any main switch intended to be operated by ordinary persons should disconnect both poles of a single-phase supply (Regulation 537.1.4).

Where a single-phase installation having a supply rated at 100 A or less such as the majority of domestic premises is to be left under the control of ordinary persons, the switchgear and controlgear therein should either comply with the requirements given in BS EN 60439-3 *Particular requirements for low-voltage switchgear and controlgear assemblies intended to be installed in places where unskilled persons have access to their use. Distribution boards.* In the case of a consumer unit, the constituent component parts including the protective devices should comply with the relevant parts of BS EN 60439-3.

Insulation monitoring devices

It is a requirement in installations supplied from an IT system that an Insulation monitoring device (IMD) is installed to continuously monitor the insulation resistance of the complete system including and extending beyond the secondary side of the source of supply (Regulation 538.1.1) to indicate when a first fault occurs between a live part and an exposed-conductive-part or between a live part and Earth (Regulation 411.6.3.1). Where such devices are located in positions accessible by ordinary persons - that is persons who are neither skilled nor instructed - the IMD should be so designed or installed such that the use of a key, tool or password is required before changes can be made to operational settings (Regulation 538.1.3).

Storage batteries and safety sources

Storage batteries are commonplace in most industrial and commercial installations either to provide a back-up supply as is the case with fire and security alarm systems, emergency lighting and uninterruptible power supply (UPS) systems or to provide a source of supply independent of that derived from the public distribution network to supply, for example, compressors designed to run standby generation up to speed in the event of supply failure. Batteries may present a shock risk and flammable gases may be released in normal use. In both cases ordinary persons may not be aware of the risks that may exist. As a result batteries forming part of an installation should be so placed that they are only accessible to skilled or instructed persons (Regulation 551.8.1).

A safety source for a safety service, whatever its nature (Regulation 560.6.2), and

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

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

any associated switchgear and controlgear (Regulation 560.7.5) should also be in a location only accessible to skilled or instructed persons.

Fault protective measures subject to supervisory restrictions

Moving away from protection by ADS, Regulation 410.3.6 permits non-conducting location, earth-free local equipotential bonding and electrical separation for the supply to more than one item of current using equipment to provide fault protection but only where the installation, or more realistically, that part thereof protected by such measures, remains under the supervision and effective control of skilled or instructed persons (Section 418).

The protective measure of non-conducting location is very seldom used within the United Kingdom but a summary of the requirements relating to its use is given below:

- It should not be possible under normal operating conditions for persons to be able to make simultaneous contact between
  - two exposed-conductive-parts, or
  - an exposed-conductive part and an extraneous-conductive part

  where such parts can be at different potentials (Regulation 418.1.2)
- no protective conductors should extend into the location so protected (Regulation 418.1.3)
- exposed and extraneous-conductive parts are deemed to be adequately separated through
  - the relative spacing between them being not less than 2.5 m or 1.25 m if placed beyond arm's reach
  - the placing of obstacles between exposed and extraneous-conductive parts
  - the insulation, whether inherent or applied, of extraneous-conductive parts (non-conducting location 418.4)
- the resistance of insulating walls and floors within the location when tested in accordance with the requirements of Regulation 612.5.1 should not exceed the values given in Appendix 13 appropriate to the particular test method employed (non-conducting location - Regulation 418.1.5)

All of the above requirements need to be present for the measure to be effective. This is why it is so important that effective control and supervision of the location so protected is maintained. If inadequately supervised, the measure can be rendered ineffective and therefore potentially dangerous by the introduction of class I items of mobile equipment or indeed extraneous-conductive parts. Moreover, persons placed in control of a location so protected will need to ensure that excessive humidity does not reduce the insulation resistance of the floors and walls of the location beyond acceptable levels (Regulation 418.1.6).

The responsible person must also ensure that no potentials which might give rise to danger are allowed to appear beyond the location from within (Regulation 418.1.7)

Protection by earth-free local equipotential bonding is a fault protection measure which can only realistically be applied to a particular area or location within the greater installation. In order for this protective measure to be effective all exposed and extraneous-conductive parts within the location must be electrically separate from earth or other potentials being introduced from outside (Regulation 418.2.3) and, if simultaneously accessible, be connected together by local protective bonding conductors (Regulation 418.2.2). The accessible floor surface within such a location may be constructed of non-conducting materials or from a conductive floor connected to the local earth-free bonding within the location and wholly insulated from Earth.

A particular risk of shock can exist at the point where persons pass into the earth-free protected area from the greater, earthed, installation and so effective supervision at this point must be maintained to ensure that precautions such as insulating mats or floor panels at the point of transition are not removed and remain in a serviceable condition (Regulation 418.2.4). Other potential risks arising from persons unfamiliar with the method of protection being employed are that during the course of alterations, additions, maintenance or repair work a connection to earth is introduced into the location or that portable and/or handheld tools or equipment having exposed conductive parts are used in the location whilst connected to the earthed supply within the "normal" installation. In the hope of preventing this from occurring it is a requirement that the warning notice reproduced above (Regulation 514. 13.2) is posted at any and all points of entry to the location protected by earth-free local equipotential bonding (Regulation 418.2.5).

The use of a supply from a TN system can introduce an earth into the location via the earthed neutral conductor. As a result the supply to a location where earth-free local equipotential bonding is used as a protective measure is most likely to be taken from a source employing electrical separation.

Electrical separation for the supply to more than one item of equipment is a protective measure so arranged that a single fault or first fault should not present a risk of electric shock occurring. However as the presence of such a fault is unlikely to be detected in normal use a potentially dangerous situation could arise if further faults were to occur. As a result it is a requirement for the separated circuit to be so arranged as to minimise the risk of damage or insulation failure occurring (Regulation 418.3.3).

All exposed-conductive parts associated with the separated circuit are required to be connected together by non-earthed, insulated protective bonding conductors and no connection should be made from the exposed-conductive parts so bonded to the protective conductor, exposed-conductive parts of other circuits, or any extraneous-conductive parts within the location (Regulation 418.3.4) and the protective conductor contact of socket-outlets are to be connected to the bonded exposed-conductive parts (Regulation 418.3.5).
Again it can be seen that effective supervision must be provided to ensure that the above requirements are not deliberately or accidentally defeated rendering the method of protection ineffective.

Special installations and locations
To be included in Part 7 of BS 7671 a location or type of installation should present an increased risk of shock to persons (or livestock) either by its nature or from how it is used. To illustrate this, a construction site is a harsh environment for an electrical installation, and the likelihood of damage occurring to wiring systems and equipment is, relatively speaking, high. As a result, special measures are required to ensure that the installation is sufficiently robust. In the case of a swimming pool the increased risk of shock is as a direct result of factors such as the lack of dry (and therefore insulating) footwear and clothing and the significantly reduced resistance of skin when wet. A number of installations or locations covered by Part 7 are subject to specific requirements related to the types of person recognised by BS 7671.

Where extra-low voltage transformers are employed in an electrical installation forming part of an exhibition, show or stand falling within the scope of Section 711, the transformers should be so placed that they are not within arm's reach of members of the public (that is, ordinary persons as defined) and such that they can be accessed to facilitate testing and maintenance by skilled persons competent in such work (Regulation 711.55.6).

Some types of mobile and transportable unit are capable of being connected to a wide range of potential supplies. However hazardous situations may arise from loss of continuity of the connection to the source of earth, an open circuit on a PEN conductor (as defined) resulting in a diverted neutral current or if the unit contains much electronic equipment a potentially harmful functional current being present on earthed metalwork. As a result, regulation 717.411.4 states that:

- a suitably skilled or instructed person has confirmed the suitability of the means of earthing prior to connection , and that
- a mobile or transportable unit may only connected to a supply derived from a TN-C-S system where the unit remains under continuous supervision by a skilled or instructed person whilst in use, it being their responsibility to confirm the effectiveness of the means of earthing for the unit whilst it is in use.

Where safety isolating transformers are employed in a temporary installation within a fairground, amusement park or circus they should be mounted out of arm's reach or failing that, installed such that they are only accessible to skilled or instructed persons. Moreover, there should be adequate means of access to permit inspection, testing and maintenance (Regulation 740.55.5) and with the exception of those items intended for operation by ordinary persons, all switchgear and controlgear should be placed inside enclosures which can only be opened by the use of a key or a tool (Regulation 740.51).

Inspection and testing
In the case of most types electrical installation there is no statutory requirement to carry out inspection and testing periodically. It is, however, a commonly adopted practice seen as a means of meeting the maintenance obligations given in, for example, the Electricity at Work Regulations 1989 (Regulation 4) and the Housing Act 1985 (Section 11). BS 7671 is in the most part concerned with the design, installation, and initial inspection and testing of new installations but Chapter 62 contains a number of requirements relating to periodic inspection and testing. Regulation 622.2 states that periodic inspection and testing is not required where an installation is under an effective management system operated by skilled persons covering its maintenance. However, and as has been mentioned previously, the persons responsible may be held accountable in the event of an incident occurring. As such, appropriate records must be kept of the maintenance activities undertaken.

Useful reading
Guidance Note 2 – Isolation and switching. Published by the IET
Guidance Note 5 – Protection against shock. Published by the IET
HSR 25 – Memorandum of guidance on the Electricity at Work Regulations 1989. Published by the HSE
HSG 85 – Electricity at work.