# Low voltage electrical supplies for equipment on construction sites

OBJECTIVE

**A range of supplies are permitted for socket-outlets and equipment on construction sites. This article summarises the requirements and recommendations for the use of low voltage supplies in such locations. This article follows on from articles in the previous issue of *Connections* that looked at the environmental factors on construction sites and the use of low voltage to supply electrical equipment on-site. You may find it helpful to refer those articles when reading this one. An article describing the requirements for reduced low voltage (RLV) supplies appears elsewhere in this edition and may also be of interest.**

## Introduction

Notes 1 and 2 of Regulation 704.410.3.10 of *BS 7671* express a strong preference for the use of reduced low voltage (RLV) for the supply to portable hand lamps for general use, portable hand tools and local lighting up to 2 kW, and SELV systems for portable hand-lamps for use in confined or damp locations.

However, it will still be necessary to provide low voltage supplies for higher current demand loads, such as:

- site buildings (offices, drying rooms, canteens and the like)
- the RLV transformers distributed around site
- large items of current-using equipment, such as cranes, lifts and hoists
- fixed floodlighting.

1 *BS 7375: 2010 Distribution of electricity on construction and demolition sites – Code of practice*
2 *BS EN 50525-2-21: 2011 Electric cables – Low voltage energy cables of rated voltages up to and including 450/750 V ($U_o$/U) Part 2-21: Cables for general applications – Flexible cables with cross-linked elastomeric insulation*
3 *BS 5467: 2016 Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1000 V and 1900/3300 V for fixed installations. Specification*

When low voltage equipment is used on construction sites, precautions must be taken to reduce the risk to an acceptable level.

## Protection against shock

The following basic protection measures may **not** be used on a construction site:

- obstacles
- placing out of reach (704.410.3.5).

Additionally, the use of the protective measures of non-conducting location, earth-free local equipotential bonding or electrical separation for the supply of more than one item of current-using equipment is not permitted on construction sites (704.410.3.6). This is because these measures may be employed only where an installation or part of an installation is under the control of skilled persons, or of instructed persons acting under the supervision of skilled persons (410.3.5 and 410.3.6). This is not the case on a construction site, where electrical equipment will be used by unskilled persons (*ordinary persons*, as defined in Part 2 of *BS 7671*).

Where the protective measure automatic disconnection of supply is used, an RCD of rated residual current not exceeding 30 mA must be installed to provide additional protection for every circuit supplying:

- a socket-outlet having a rated current not exceeding 32 A, or
- hand-held electrical equipment of rated current not exceeding 32 A (704.410.3.10).

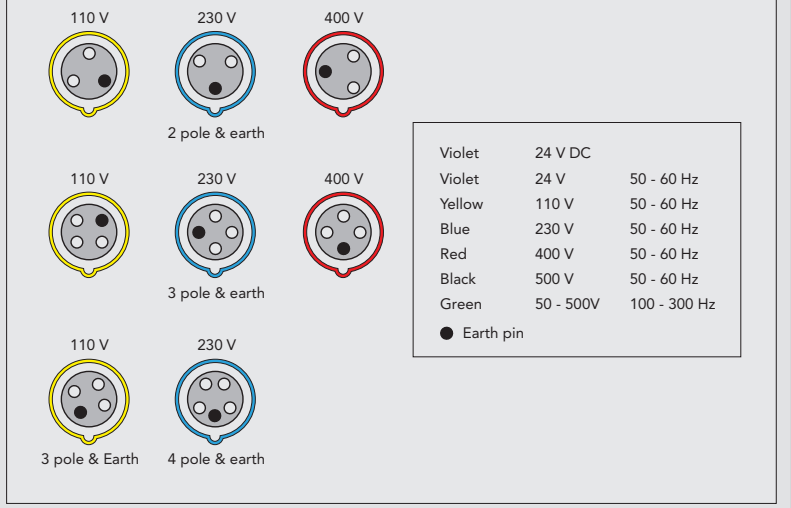
Any low voltage circuit supplying one or more socket-outlets having a rated current exceeding 32 A must be provided with an RCD of rated residual current not exceeding 500 mA to give automatic disconnection within the following times, as appropriate to the type of earthing

system of which the electrical installation forms a part (704.411.3.2.1):
- 5 seconds – TN system (411.3.2.3)
- 1 second – TT system (411.3.2.4).

Generally, where it is not feasible to achieve a required disconnection time in the event of a fault to a protective conductor or to Earth for a final circuit covered by Regulation 411.3.2 using an overcurrent device, or the use of an RCD is not appropriate, the methods described in Section 419 may be applied (411.3.2.5). However, to do so is not permitted for circuits supplying one or more socket-outlets with a rated current exceeding 32 A on a construction site (704.411.3.2.1).

A protective multiple earth (PME) earthing facility should not be used to provide the means of earthing for a construction or demolition site installation unless all extraneous-conductive-parts are reliably connected to the main earthing terminal (704.411.3.1). However, Clause 6.5.4.1 of *BS 7375*[1] advises that a PME earthing facility cannot normally be used as it is not practicable to ensure that all extraneous-conductive-parts, either existing or added during construction, will be adequately bonded at all times.

**Fig 1** Examples of plugs to *BS EN 60309 2*




## Wiring systems

Flexible cable complying with H07RN-F (*BS EN 50525-2-21*[2]) type or equivalent heavy duty flexible cable should be used for low voltage applications (704.522.8.11).

Clause 6.7.2 of *BS 7375* recommends that all fixed cables and wiring of the general installation operating at a voltage to earth exceeding 63.5 V:
- incorporate an earthed armour or metal sheath or both, suitable for use as a protective conductor, which should be continuous and effectively earthed, and
- non-flexible armoured cables should conform to *BS 5467*[3] or *BS 6724*[4].

Additionally, this clause recommends that in the case of flexible or trailing cables, any earthed armour and/or metal sheath should be in addition to the earth core in the cable and should not be used as the protective conductor.

Clause 6.7.3 of *BS 7375* recommends that any flexible cables used should:
- conform to *BS 6708*[5]
- be suitable for correct anchoring and termination in the accessories or other equipment
- have a minimum conductor cross-sectional area of 1.5 mm$^2$
- have a current rating not less than that of the associated protective device.

Clause 6.7.1 of that standard specifies that the protective conductor in any cable should have a cross sectional area of not less than that of the largest associated circuit (meaning live) conductor.

## Plugs and socket-outlets

All plugs and socket-outlets, and indeed cable couplers and cable connectors, of current rating exceeding 16 A should meet the requirements of *BS EN 60909-2*[6] (704.511.1). Unless specified otherwise in that standard, the requirements of *BS EN 60309-1*[7] are also applicable.

Accessories to *BS EN 60309-2* are non-interchangeable with respect to their current and voltage ratings.

For current rating, this is achieved by differences in physical dimensions; the higher the current rating, the larger the accessory.

Non-interchangeability for voltage rating is achieved by the relationship between the earth pins/socket tubes and the keyway(s) to physically prevent incorrect insertion of items of the same current rating but different voltage rating. The position of the earthing contact or keyway is typically identified by reference to a 12-hour clock-face analogy, as described in Clause 7.1 of *BS EN 60309-2*.

For example, an accessory designed for a voltage of 400 V should have its keyway situated in the 9 o'clock (9 h) position. If its current rating was 16 A it would be identified by one of the following designations on the product:

16 A – 9 h/400 V~

or

16 – 9 h/400~

or

$$16 - \frac{9h}{400\sim}$$

4 *BS 6724: 2016 Electric cables. Thermosetting insulated, armoured cables of rated voltages of 600/1 000 V and 1 900/3 300 V for fixed installations, having low emission of smoke and corrosive gases when affected by fire. Specification*

5 *BS 6708: 1998 Flexible cables for use at mines and quarries*

6 *BS EN 60309-2:1999+A2:2012 Plugs, socket-outlets and couplers for industrial purposes. Dimensional interchangeability requirements for pin and contact-tube accessories*

7 *BS EN 60309-1:1999+A2:2012 Plugs, socket-outlets and couplers for industrial purposes. General requirements*

**Table 1 Colour coding for operating voltage applicable to accessories to *BS EN 60309-1***

| | |
|---|---|
| 20 to 25 | Violet |
| 40 to 50 | White |
| 100 to 130 | Yellow |
| 200 to 250 | Blue |
| 380 to 480 | Red |
| 500 to 1 000 | Black |

Clause 7.7 of *BS EN 60309-1* states that the operating voltage of accessories may be indicated by colour. In the case of low voltage, the colours seen in Table 1 are applicable.

This colour-coding system is often also applied to the outer sheath of flexible cables, although there is no requirement for this.

## Assemblies for construction sites (ACS)

Any assembly for the distribution of electricity on a construction or demolition site should meet the requirements of *BS EN 61439-4*[8] (704.511.1).

A device should be provided to isolate the supply to the installation of the construction site (704.537.2). Clause 7.1.2 of *BS 7375* recommends that this, and other devices to provide isolation within the installation, are of multi-pole type, which break all circuit (live) conductors (including the neutral conductor) simultaneously. A note to this clause explains that this is because equipment for construction sites may be re-used on various sites during its operational life, and in some cases the site installation will form part of a TT system.

While Regulation 704.537.2 also requires the means of isolation for the installation to be securable in the OFF position, Clause 7.1.2 states that any means of isolation other than a plug and socket-outlet or cable coupler should be provided with a facility for securing it in the OFF position while the load circuit is being worked on.

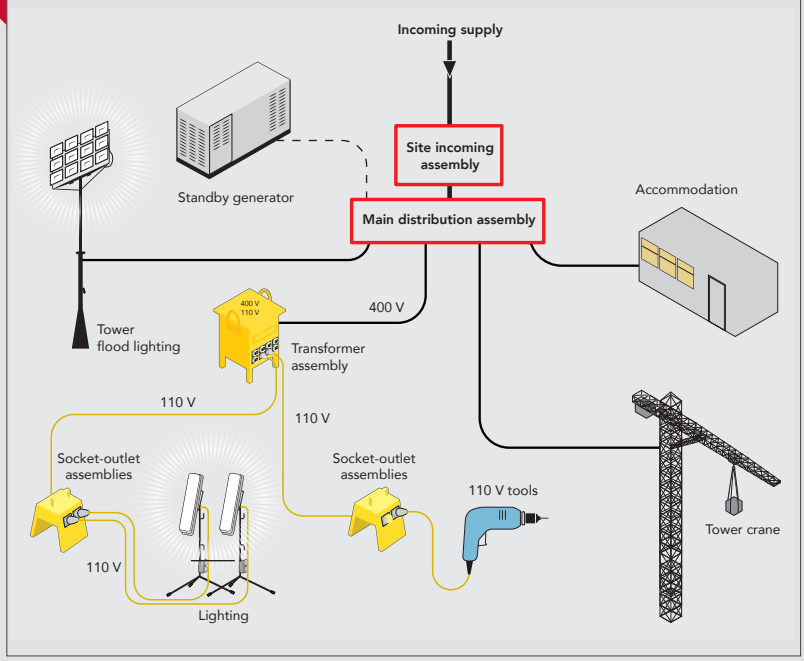
The design of the site electrical installation needs to ensure, among other things, that distribution equipment such as ACSs are supplied with appropriate sized conductors and located at relevant points of utilisation before site work commences and as the work progresses, to minimise values of earth fault loop impedance and permit connection of moveable and/or portable equipment without excessive length of trailing cables.

An example of a construction site electrical installation is shown in Fig 2.

Consideration should be given to the length of cable runs within the site supply system. Excessively long runs might result in earth fault loop impedance values in excess of those permitted by Section 411 in order to cause operation of the overcurrent protective device(s) in the ACS.

Where excessive values of earth fault loop impedance are obtained an appropriate RCD may be used to satisfy the fault protection requirements of *BS 7671* (411.4.204 for TN system and 411.5.3 for TT system).

**Fig 2** Example of a construction site electrical installation (Note: the blue lines are shown to represent cables connecting equipment, their colour does not denote any particular voltage)




## Conclusion

It will be necessary to provide a low voltage electrical supply for some equipment on a construction site. Where this is the case, it is essential that these supplies are able to withstand the ambient conditions presented by such an environment to ensure that the installation may be used safely.

It is therefore important that all relevant requirements relating to the installation of such supplies on a construction site are met. This will require reference to a number of British Standards, in particular *BS 7671*, *BS 7375* and *BS EN 61439-4*.

Further guidance may also be found in HSG150 Health and Safety in Construction, downloadable as a free copy from www.hse.gov.uk/pubns/books/hsg150.htm.

8 *BS EN 61439-4: 2013 Low-voltage switchgear and controlgear assemblies. Particular requirements for assemblies for construction sites (ACS)*