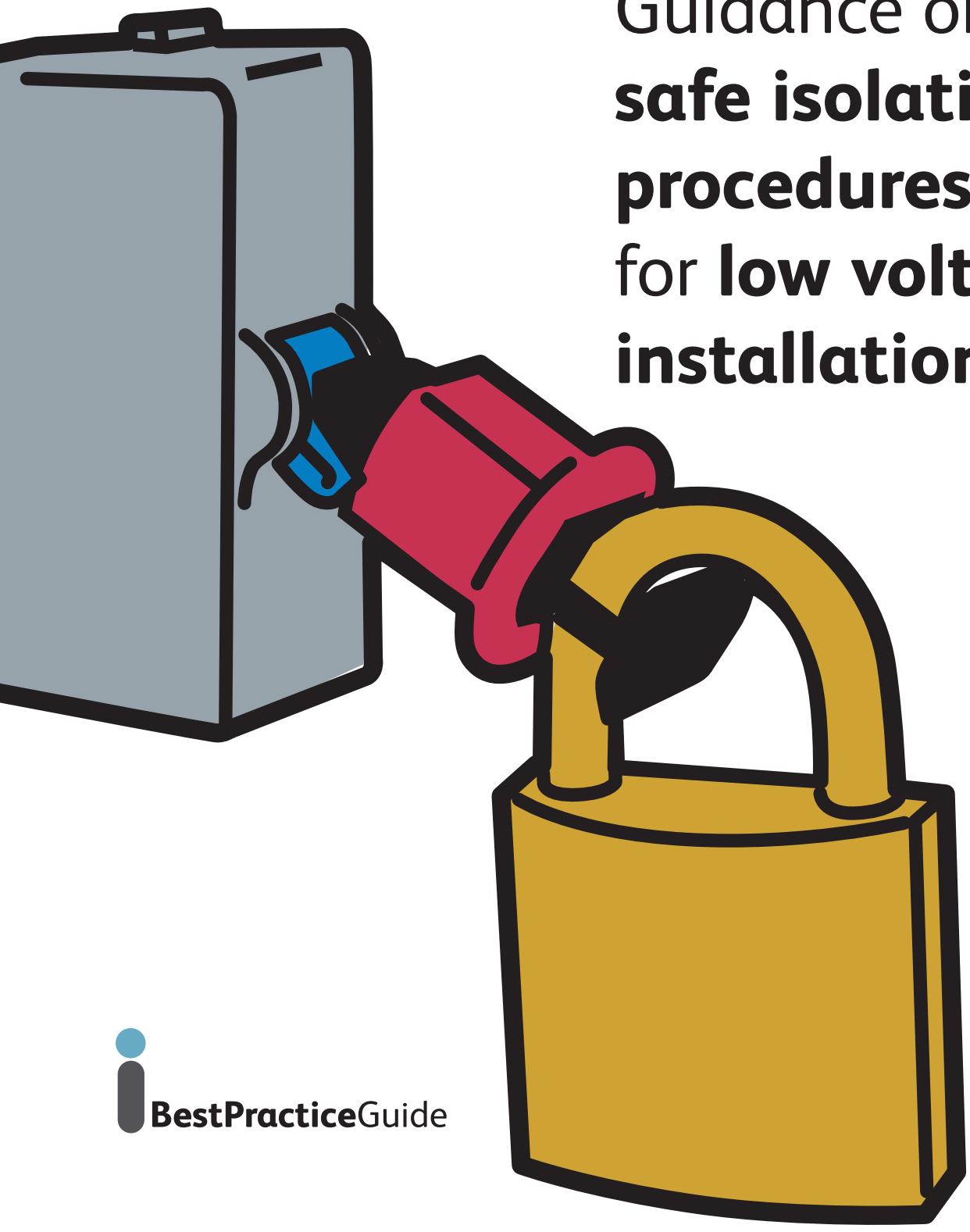
ELECTRICAL SAFETY COUNCIL

Guidance on **safe isolation procedures** for **low voltage installations**



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Guidance on **safe isolation procedures** for **low voltage installations**

This Guide has been produced in conjunction with the Health and Safety Executive (HSE). Its purpose is to provide practical guidance for employers, employees and the self-employed on safe isolation procedures to be followed when working on low voltage electrical installations.

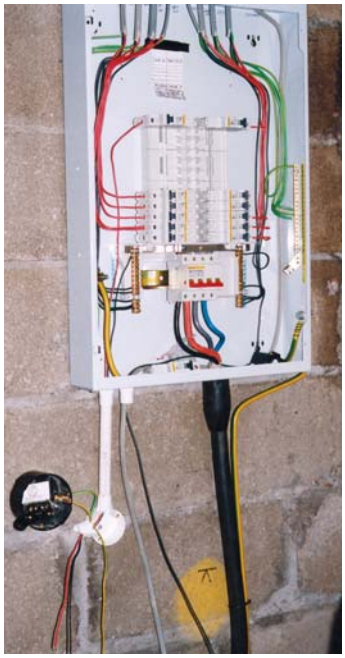
The guidance is aimed at protecting employees and other workers against serious or fatal electrical injuries. Although the principles apply generally, it is particularly relevant to circumstances where work is being carried out in the presence of other trades, and to construction sites and other places where more than one electrician is employed.

Introduction

By law, employers must ensure that all employees involved in work on electrical equipment are competent. Employees should be instructed on, and trained in, the implementation of safe systems of work. This may involve employees being issued with written rules and instructions, and having access to, and using, appropriate locking-off devices, warning/caution notices, proprietary voltage detectors and, where appropriate for the type of voltage detector being used, proving units.

Nevertheless, every year, people working on construction sites suffer electric shock and burn injuries some of which, tragically, are fatal. Electrical contractors should be aware that many of these accidents are a direct consequence of electricians not implementing safe isolation procedures on low voltage installations (ie those operating at up to 1000 V a.c.).

An example of one such fatal incident is given on the following page.

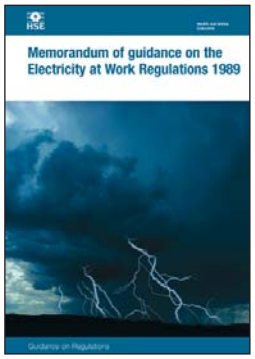


An electrician working on a new-build construction project installed the 3-phase and neutral distribution board shown in the photograph. He energized the supply to the distribution board before the circuits connected to it were complete, to provide a supply to a socket-outlet.

He was connecting the supply cables to a wall-mounted timer unit, with the phase conductor connected to the circuit-breaker at the top left hand side of the busbar assembly. The circuit-breaker had not been securely isolated and was ON as he stripped the insulation from the end of the cable. He touched the live copper conductor of the cable and was electrocuted.

The distribution board was manufactured to a high standard of safety. However, if he needed to energize the board before it was complete, he should first have replaced the cover and switched off and locked the circuit-breakers supplying unfinished or incomplete circuits. He should also have ensured that circuits were not connected into circuit-breakers until after they were complete and had been tested.

LEGISLATION



The Health and Safety at Work etc. Act 1974 sets out the general health and safety duties of employers, employees and the self-employed. *The Electricity at Work Regulations 1989*, which were made under the Act, require precautions to be taken against the risk of death or personal injury from electricity in work activities.

Duties are placed on employers to ensure, among other things, that employees engaged in such work activities on or near electrical equipment implement safe systems of work, have the technical knowledge, training or experience to carry out the work safely, and are provided with suitable tools, test equipment and personal protective equipment.

Under the *Health and Safety at Work etc Act*, employees are required to co-operate with their employer to enable the requirements of the Regulations to be met. This includes complying with any instructions given on matters such as safe systems of work. *The Electricity at Work Regulations 1989* require that employees themselves comply with the regulations.

The *Management of Health and Safety at Work Regulations 1999* require employers to make a suitable and sufficient assessment of the risks to the health and safety both of their employees and of other persons arising out of, or in connection with, the conduct of their undertakings. Where five or more persons are employed, the employer must record the significant findings of the risk assessments.

HSE GUIDANCE

Guidance on devising safe working practices for work on electrical equipment is provided in the Health and Safety Executive (HSE) booklet entitled *Electricity at Work – Safe Working Practices* (HSG85). It provides information on isolation procedures when working on both Low Voltage (LV) and High Voltage (HV) systems.

This Best Practice Guide covers LV systems only. Extra precautions need to be taken when working with HV equipment and circuits, and reference should be made to the detailed guidance provided in HSG85 and other publications.

To comply with regulation 12 of the *Electricity at Work Regulations,* means of isolation must be provided for all electrical equipment. Circuits may be isolated in groups, provided that there is no need for other circuits in the group to remain energized when one needs to be isolated.

To comply with regulation 13 of the Electricity at Work Regulations, precautions need to be taken on equipment that has been made dead. As explained in HSG85, this includes securing the means of disconnection in the OFF position, putting a warning/caution notice or label at the point of disconnection, and proving dead at the point of work using proprietary voltage detectors.

In some circumstances, the means of isolation can be an adjacent local isolation device such as a plug and socket, switch-disconnector, circuit-breaker, fuse etc, as appropriate, which is under the direct control of the competent person carrying out the work. These devices can be used without further precautions provided there is no foreseeable risk that the supply could be re-instated by others.

To comply with regulation 14 of the *Electricity at Work Regulations,* dead working should be the normal method of carrying out work on electrical equipment or circuits. Live working should only be carried out in particular circumstances where it is unreasonable to work dead.

It is recognized that some fault finding and testing activities will require the circuit to be live. However, danger is always present when fault finding and testing is carried out on an energized circuit or equipment, and suitable precautions must be taken to prevent injury.

Commercial pressure to carry out work on or near live conductors is becoming more common in areas such as construction sites, banking and high-cost manufacturing premises, and in retail outlets operating twenty-four hours per day. Nevertheless, the requirements of the Regulations still apply in such situations, and live working should only be carried out when justified using the criteria explained in HSG85. As a reminder, regulation 14 of the *Electricity at Work Regulations* requires that:

No person shall be engaged in any work activity on or so near any live conductor (other than one suitably covered with insulating material so as to prevent danger) that danger may arise unless –

(a) it is unreasonable in all the circumstances for it to be dead; ***and***
(b) it is reasonable in ***all*** *the circumstances for him to be at work on or near it while it is live;* ***and***
(c) suitable precautions (including where necessary the provision of suitable protective equipment) are taken to prevent injury.

It should be noted that all three conditions must be met in order for work on or near live conductors to be carried out.

SITE SAFETY MANAGEMENT

It is essential from the outset that effective management and control of the system, apparatus and equipment used on site is achieved and maintained, thereby ensuring that the hazards and risks which can arise are minimised.

A suitably competent authorized person should be appointed to take responsibility for the supervision of the installation of switchgear, equipment, cables, jointing, etc. throughout the contract.

The authorized person should also have responsibility for the safe working practices of the operatives, as well as the control of appointed sub-contractors. Sub-contractors must provide appropriate method statements and risk assessments for their works.

The authorized person may delegate (in writing) his authority in total or for specific tasks and procedures to competent persons having appropriate training and competence in the performance of these tasks and procedures.

Once switchrooms and risers are made available by the main contractor for the services installation to proceed, and before installation of equipment commences, the authorized person should ensure that suitable doors with appropriate warning notices are fitted to all switchrooms and riser entrances and that heavy duty locks or padlocks, and keys are provided.

The authorized person should also ensure that access doors are locked when work is not being undertaken in these areas. Plant and materials should not be stored in electrical switchrooms or electrical risers.

Every effort should be made to avoid the energizing of any outgoing electrical distribution services until the distribution switchgear and all connected circuits are complete and have been inspected and tested.

If live services are required by others, distribution boards and circuits should only be energized following a written request from the main contractor or agent and with the agreement of the authorized person for the installation.

Once distribution circuits are energized, the safe isolation procedures explained elsewhere in this guidance must be implemented.

Before any final circuit (i.e. lighting, power, etc.) is energized, it should be checked that the wiring system within the area has been completed and that equipment, including luminaires and accessories connected to the circuit, have been fitted and that all enclosures are in place. This check should also ensure that earthing arrangements and protective conductors including equipotential bonding are in place, and that the final circuit is tested as far as practicable.

If the circuit in question is energized for the testing and commissioning of equipment or a system, it must be switched OFF, isolated, and locked until completion of the work, unless stated otherwise on a written instruction and agreed with the authorized person.

When live services are provided prior to final commissioning, warning/caution notices should be displayed on each item of live switchgear, plant and along cable routes that pass through the work areas in exposed positions. This is particularly important where switchgear and cables are exposed to damage that may be caused by other trades or the environmental conditions.

Persons or trades entering completed and energized areas, working under instructions from the main contractor or client agent, must be made aware of the extent of the live services within the respective areas by the electrical contractor, main contractor or client's agent, whichever is the designated Duty Holder.

SAFE ISOLATION PRACTICE

A fundamental principle of safe isolation practice is that the point of isolation should be under the control of the person who is carrying out the work on the isolated conductors. This may be achieved by using one of the methods described below.

For work on LV electrical equipment or circuits, it is important to ensure that the correct point of isolation is identified, an appropriate means of isolation is used, and the supply cannot inadvertently be reinstated while the work is in progress.

Warning/caution notices should also be applied at the point(s) of isolation, and the conductors must be proved to be dead at the point of work before they are touched.

The means of isolation can be an adjacent local isolation device such as a plug and socket, switch-disconnector, circuit-breaker, fuse etc, as appropriate, that is under the direct control of the competent person carrying out the work. This requires the person carrying out the work to be able to see the means of isolation at all times in order to be able to prevent anyone interfering with it. In such circumstances, a local isolation device can be used without further precautions provided there is no foreseeable risk that the supply could be reinstated by others.

When there is no such local means of isolation or where there is a risk of reinstatement of the supply, the circuit or equipment to be worked on should be securely isolated by one of the methods described below.

- *Isolation using a main switch or distribution board (DB) switch-disconnector*

Isolation of equipment or circuits using the main switch or DB switch-disconnector is the **preferred** method. The point of isolation should be locked off using a unique key or combination retained by the person carrying out the work.

Courtesy of Reece Safety Products Ltd

In the case of multiple isolations on a DB, a multi-lock hasp can be used to prevent access to a main isolator until such time that all persons working on a system have completed their work and removed their padlocks from the hasp.

If locking-off facilities are not provided on the relevant switch then a locked DB door or locked switch-room door is acceptable provided the key or combination is unique, and is retained by the person doing the work.

Again, multi-lock hasps can be used to control multiple isolations, although a key box or similar system may be needed to retain and control access to the main door key.

Where it is intended that more than one person will be working on circuits supplied from a DB, (i.e. multiple isolations) and a multi-lock hasp cannot be used to secure the main point of isolation, individual isolation of each circuit by one or more of the methods shown below is recommended, to prevent inadvertent reinstatement of the supply.

The principle is that each person carrying out such work should have control of their own point(s) of isolation and not rely on others to prevent deliberate or inadvertent energization.

- *Isolation of individual circuits*

Where it is not practicable to isolate a distribution board, individual circuits supplied from it can be isolated by one of the methods described below, depending on the type of protective device used.

However, the overriding advice is to avoid energizing any outgoing electrical distribution services, preferably until the distribution switchgear and all connected circuits are complete and have been inspected, and the relevant tests carried out.

If any items required to carry out the procedures recommended below are not manufactured for the DB in question or cannot be obtained through retail/trade outlets, it is acceptable to disconnect the circuit from the DB as long as the disconnected conductors are made safe so as to prevent inadvertent contact with live parts (such as by being insulated and coiled). Suitable labelling of the disconnected conductors is important to prevent the supply being reinstated, particularly if other electricians are present.

It should be remembered that work carried out inside a live DB, such as disconnecting a circuit for isolation, is classed as live working when there is access to exposed live conductors. In this case, the appropriate precautions should be taken as described in HSG85 with respect to Regulation 14 of the *Electricity at Work Regulations.*

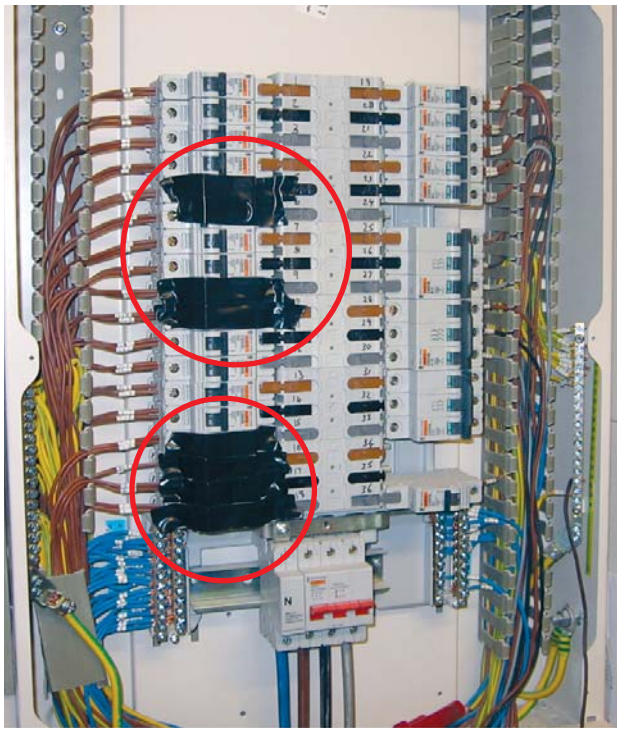
i. Isolation of individual circuits protected by circuit-breakers

Courtesy of Reece Safety Products Ltd

Where circuit-breakers are used, the relevant device should be locked-off using an appropriate locking-off device with a padlock which can only be opened by a unique key or combination. The key or combination should be retained by the person carrying out the work.

Courtesy of Reece Safety Products Ltd

The practice of placing insulating tape over a circuit-breaker to prevent inadvertent switch-on is **not** a safe means of isolation.



Courtesy of HSE

Note: Some DBs are manufactured with 'slider switches' to disconnect the circuit from the live side of the circuit-breaker. These devices should not be used as a means of isolation for circuits, as they do not meet the requirements for isolation and the wrong switch could easily be operated on completion of the work.

ii. Isolation of individual circuits protected by fuses

Where fuses are used, the simple removal of the fuse is an acceptable means of isolation. Where removal of the fuse exposes live terminals that can be touched, the incoming supply to the fuse will need to be isolated.

To prevent the fuse being replaced by others, the fuse should be retained by the person carrying out the work, and a lockable fuse insert with a padlock should be fitted as above.

A warning/caution notice should also be used to deter inadvertent replacement of a spare fuse.

In addition, it is recommended that the enclosure is locked to prevent access as stated above under *'Isolation using a main switch or distribution board (DB) switch-disconnector'*.

Note: In TT systems, the incoming neutral conductor cannot reliably be regarded as being at earth potential. This means that for TT supplies, a multi-pole switching device which disconnects the phase and neutral conductors must be used as the means of isolation. For similar reasons, in IT systems, all poles of the supply must be disconnected. In these circumstances, single-pole isolation, such as by fuses or single-pole circuit-breakers, is not acceptable.

- Temporary disconnection of incoming supply

For some types of work on existing installations, such as the replacement of main switchgear, consumer units etc., it is necessary for the distributor's service fuse(s) to be withdrawn in order to disconnect the incoming supply for the purpose of isolation.

Legally, service fuses can be withdrawn only by the distributor, or by those they have expressly authorized to carry out such work.

ELECTRICAL PERMITS-TO-WORK

An electrical permit-to-work must be used for work on HV systems that have been made dead, and can be useful in certain situations for LV work. These permits are primarily a statement that a circuit or item of equipment is isolated and safe to work on. They must not be used for live working as this can cause confusion. Details on the use of these permits, including an example form, are given in HSG85.

WARNING/CAUTION NOTICES

Example of a warning notice

In **all** instances where there is **any** risk that the supply could be reinstated, an appropriate warning/caution notice should be placed at the point of isolation.

For DBs with 'multiple isolations', a single suitably worded notice on each DB, such as the example shown below, would suffice:

CAUTION

THIS DISTRIBUTION BOARD HAS A NUMBER OF CIRCUITS THAT ARE SEPARATELY ISOLATED. CARE SHOULD BE TAKEN WHEN REINSTATING THE SUPPLY TO AN INDIVIDUAL CIRCUIT THAT IT HAS BEEN CORRECTLY IDENTIFIED.

PROVING DEAD ISOLATED EQUIPMENT OR CIRCUITS

It is important to ensure that the correct point of isolation is identified before proving dead.

Following isolation of equipment or circuits and **before** starting work it should be **proved** that the parts to be worked on and those nearby, are dead. It should **never be assumed** that equipment is dead because a particular isolation device has been placed in the OFF position.

Typical devices for proving dead

The procedure for proving dead should be by use of a proprietary test lamp or two-pole voltage detector as recommended in HSE Guidance Note GS38, *Electrical test equipment for use by electricians*. Non-contact voltage indicators (voltage sticks) and multimeters should not be used.

The test instrument should be proved to be working on a known live source or proprietary proving unit before and after use. All conductors of the circuit, including the neutral, should be tested and proved dead.

Electricians who regularly work on installations that have been energized should be equipped with devices for proving that conductors are dead.

Electricians who may occasionally work on installations that have been energized should have ready access to devices for proving conductors dead.

ADDITIONAL PRECAUTIONS

New installations

New installations can be a particular hazard as some of the circuits or equipment may require to be modified after the installation has been energized.

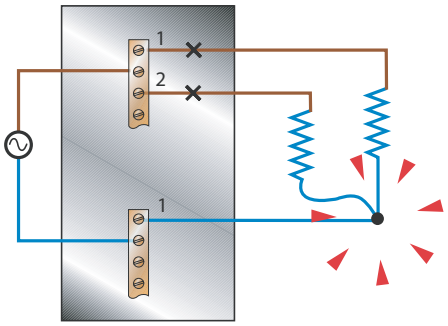
It is therefore important that every protective device is **correctly** identified at each distribution board before any energizing takes place, and safe isolation procedures, such as locking-off circuit-breakers as described above, are adopted, particularly where a number of electricians are working on the same installation.

Alterations and additions

Alterations and additions to existing installations can also be particularly hazardous. Records including circuit identification may not be available, or may be inadequate or incorrect. It is therefore particularly important to ensure that circuits to be worked on have been correctly identified for isolation purposes.

Neutral conductors

Care should be taken when working on neutral conductors of circuits. The practice of 'borrowing' neutrals, i.e. making use of the neutral of one circuit for use on another circuit, is not permitted by BS 7671. This dangerous practice, however, may still be encountered.



Lighting and control circuits are the most common examples where this practice is found. In these circumstances, the neutral conductor can become live when the conductor is disconnected, if a load is connected to that circuit.

It is also difficult to identify specific neutral conductors in 'bunches' of single-core cables, such as where enclosed in trunking or conduit, and care should be taken when severing such cables that the correct conductor has been identified.

If doubt exists, live working measures, such as the use of eye protection, electricians' insulating gloves, insulated tools etc, should be employed until the circuit has been proved dead.

Protective conductors

Protective conductors of circuits with high protective conductor currents are effectively live, and should be treated with caution.

Significant protective conductor currents can be present in both power and lighting circuits.

Proving dead unused or unidentified cables

Where there is uncertainty regarding isolation when removing unidentified cables or proving an 'unused' cable to be dead, particularly where insufficient conductor is exposed to enable the use of test probes, those conductors should be assumed to be live until positively proven to be dead and any work carried out on them should employ live working practices until the conductors are proved dead.

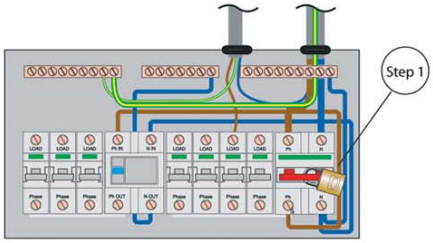
Clamp meters can be used as a means of identifying cables by testing for current flow in the conductors.

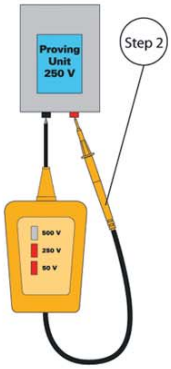
Non-contact voltage indicators (voltage sticks) can also be useful in these situations to test for voltage where cables without a metallic sheath are to be identified. If the non-contact indicator shows a cable to be live, it may be assumed to be so. However, if it does not, the cable may not be assumed to be dead.

Once insulation is removed using live working practices to reveal the underlying conductors, contact voltage detectors should be used as the means of proving dead.

SHORT GUIDE TO SAFE ISOLATION PROCEDURE

GUIDE TO ISOLATION PROCEDURE





Step 1
Check it is safe and acceptable (with the occupier/user) to isolate. If the isolator is an off-load device, remove the load. Open the means of isolation for the circuit(s) to be isolated and secure the isolating device in the open position with a lock or other suitable means.

Step 2
Prove the correct operation of a suitable voltage detection instrument, see note (v), against a known voltage source, such as that illustrated.

Steps 3 and 4 are shown overleaf

Notes (also see notes overleaf)

(i) This guide gives information on safe working procedures for the isolation of the supply of electrical energy to electrical equipment.

(ii) The example illustrated shows the minimum steps required to isolate the final circuits supplied by a single-phase consumer unit. The consumer unit includes an isolator and circuit-breakers.

(iii) When circuits are protected by fuses enclosed in a distribution board, remote isolation of the supply to the distribution board may be required.

(iv) *HSG85 Electricity at work safe working practices* gives detailed guidance on devising safe working practices for people who carry out work on or near electrical equipment.

(v) Guidance on voltage detection instruments is given in *HSE Guidance Note GS 38 – Electrical test equipment for use by electricians.*

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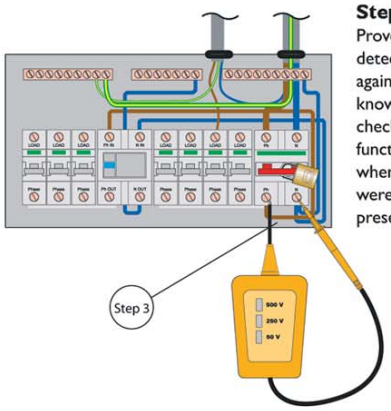
GUIDE TO ISOLATION PROCEDURE (continued)

Step 3
(steps 1 and 2 are shown overleaf)
Using a voltage detection instrument, check that there is no dangerous voltage present on any circuit conductor to be worked on. It is important to confirm that conductors are **not** energized, for example, due to a wiring fault. Check terminal voltages between: (i) earth and phase, (ii) neutral and phase (as shown) and (iii) earth and neutral.

Notes:
a. In practice the equipment being worked on is likely to be remote from the consumer unit, for example, a socket-outlet located remotely from the means of isolation. In this case it is necessary to check that all the socket-outlet contact terminals are **dead**.
b. When checking for a voltage between an earth terminal and live (including neutral) terminals, the test probe should make contact with the earth terminal first, to reduce the risk of the remaining probe becoming live.



Step 4
Prove the voltage detection instrument again against the known source to check that it was functioning correctly when the circuit(s) were tested for the presence of voltage.

NOTES (also see notes overleaf)

1 The *Electricity at Work Regulations 1989* require precautions to be taken against the risk of death or personal injury from electricity in work activities. Regulation 12 requires that, where necessary to prevent **danger**: a suitable means is available for cutting off the supply of electrical energy to any electrical equipment, and isolation of any electrical equipment.

2 The Health and Safety Executive booklet *HSR25 - Memorandum of guidance on the Electricity at Work Regulations 1989* is intended to help duty holders meet the requirements of the Regulations.

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