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Electrical safety on construction sites

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This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

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CONTENTS

INTRODUCTION

1 Electricity can kill. Every year, the use of electricity on construction sites results in accidents.

2 This guidance is aimed at those responsible for planning and subsequent management, and those who control the installation and use of electrical systems and equipment on construction sites.

3 This guidance explains what to do to reduce the risk of accidents involving electricity. It includes advice on safe working practices for everyone who controls or influences the design, specification, selection, installation, commissioning, maintenance or operation of electrical systems and equipment during construction activities. Practical information is given to help understand what the requirements of the relevant legislation may mean in practice. This includes the Construction (Design and Management) Regulations 2015 (CDM 2015), Electricity at Work Regulations 1989 (EAWR 1989) and Provision and Use of Work Equipment Regulations 1998 (PUWER 1998).

4 Not all the advice in this guidance will be relevant in all circumstances. You should determine what is needed following an assessment of the risks created by the proposed work. It is important to remember that small-scale construction work is not necessarily low risk when it comes to electrical safety.

Who should read this guidance?

5 This guidance is relevant to projects of all sizes and activities, including demolition, refurbishment and new build. It provides guidance to anyone involved in planning or managing construction work or those working on a construction site. It covers:

- the installation, use and decommissioning of the temporary distribution system (designed to generate, distribute and supply electricity to plant, work equipment, site offices etc.);
- the use of electrical equipment, including portable equipment, powered by the temporary distribution system;
- the commissioning and use of the new fixed electrical system;
- the use of an existing fixed electrical installation in a building or structure undergoing modifications, together with the equipment connected to it;
- existing electrical installations in buildings or structures about to be demolished.

6 This guidance does not cover the specification or use of electrical equipment where potentially explosive atmospheres may be present. There are specific requirements for the selection and use of electrical equipment for these situations so seek competent advice. A brief introduction to the requirements of the Dangerous Substances and Explosive Atmospheres Regulations 2002 (DSEAR) is available in INDG370.[1]

7 For projects where the temporary distribution system operates at high voltage (typically 11 kV), operational safety rules for high-voltage systems will be required. These are not described here; guidance is available in HSG85 *Electricity at work: Safe working practices*.[2]

8 This guidance is divided into three parts:

- Part 1 Planning: The pre-construction phase (paragraphs 13–37)
- Part 2 Managing electrical risks: The construction phase (paragraphs 38–74)

- Part 3 Systems and equipment (paragraphs 75–87).

The References and Further reading sections at the end of this guidance identify applicable standards and other useful publications.

The meanings of the terms 'system' and 'electrical equipment' are explained in EAWR 1989 Regulation 2.[3]

Competence

9 There is a legal requirement for technical knowledge, experience or supervision for all work associated with electrical systems to prevent danger or injury (EAWR 1989 Regulation 16). Anyone working on a construction site should have the skills, knowledge, training and experience necessary to enable them to work safely.

10 A client is required to appoint a principal designer as well as a principal contractor in any project where there is, or it is reasonably foreseeable that there will be, more than one contractor working on the project (CDM 2015 Regulation 5). Anyone who makes appointments must establish that the people they appoint have the right combination of skills, experience and knowledge before appointing them.

11 Similarly, any designers or contractors seeking appointment must make sure that they have the necessary skills, knowledge and experience to identify, reduce and manage electrical risks.

12 Appointing the correct people at the right time can significantly influence how the work is carried out. When deciding whether people are competent, the following criteria are important:

- training and experience;
- knowledge of the risks involved;
- an understanding of the specific work required;
- an ability to carry it out safely.

PART 1 PLANNING: THE PRE-CONSTRUCTION PHASE

13 Decisions made before work starts can influence the health and safety of everyone involved in the work. The amount of planning needed will depend on the complexity and size of the project. Small-scale construction work is not necessarily low risk when it comes to electrical safety. Detailed guidance on CDM 2015 is available at www.hse.gov.uk/construction/cdm/2015.

14 CDM 2015 requires whoever is responsible for the initial design to:

- eliminate risks as far as reasonably practicable;
- reduce any remaining risks;
- provide information to those who need it to enable them to put in place measures to control any remaining risks.

Designers should consider the electrical risks associated with the design work they do. They must take account of any pre-construction information provided by the client, eliminate foreseeable health and safety risks, and take steps to reduce or control any risks that cannot be eliminated. They should also consider the electrical risks of work on new electrical installations and include appropriate isolation measures to enable dead working.

15 CDM 2015 applies to electrical safety during construction. Before work starts, everyone involved in planning should, depending on the project, have considered:

- What will the power requirements be for the construction activities and how will these change as the work progresses?
- Who will design, supply, install and maintain the site's temporary electrical systems?
- Are there overhead power lines or buried cables on or near the site?
- Is there an electrical supply to the site, and can this be used to provide power for the construction work?
- Are there existing electrical services in the work areas and, if so, who will co-ordinate the requirements of the construction phase with the needs of the existing users?
- Who will be responsible for ensuring that any existing electrical services are identified and made safe, and how will this be done?
- Who will be responsible for making electrical services available to sub-contractors?
- What types of electrical equipment will be permitted on site?
- What are the environmental factors? For example:
  - What time of year will the work take place?
  - If winter, will the ground be waterlogged?
  - Will there be other work taking place that generates dust?
- How will the means for cutting off the supply and isolation be maintained? It should be in a suitable location, clearly marked and kept clear of obstructions.

16 Those preparing the design and planning the work should act on the findings to determine how, through design, they can eliminate electrical safety risks and take steps to mitigate those that remain. They should give information on how to manage residual risk to those who will go on to do the work.

Overhead power lines

17 Every year people are killed or seriously injured when the equipment they are using or holding touches an overhead power line. Those at risk include drivers of telehandlers, lorry-loader cranes, skip wagons, tipping trailers, mobile elevated work platforms (MEWPs) and people carrying long items of equipment, such as scaffold tubes and ladders.

18 The best way to prevent these incidents is to eliminate the risk in the first place by:

- arranging for the lines to be diverted before work starts;
- making dead overhead power lines when work has to take place near them; or
- avoiding the need to cross underneath overhead power lines and ensuring that all work takes place at a safe distance.

19 Even when construction work is planned to take place at a safe distance from overhead power lines, they may become accessible from scaffolding or access equipment, such as MEWPs. Clearances may also be compromised if ground levels are changed during the project. The position of the materials delivery area and site roads must be properly considered. Guidance on how to avoid danger from overhead power lines is available in GS6 *Avoiding danger from overhead power lines*.[4]

Underground services

20 The explosion and arc-flash caused by a cable strike can cause life-changing burns. Designers should investigate the likelihood of underground services being present in the work area; this is essential to ensure that they reduce or design out the risks arising from damage to underground services.

21 Designers should find information about all the relevant underground services. Utility asset drawings and information held by the client are good starting points. Once they know where the buried cables are, they can consider a design that avoids work on or near those services.

22 If the designer cannot eliminate the risk by relocating or avoiding buried cables, they must manage the risk. The publication HSG47 *Avoiding danger from underground services*[5] provides guidance. Additional information on construction work around underground services is available via the Utility Strike Avoidance Group at www.utilitystrikeavoidancegroup.org/toolkit.html.

Distribution network operators

23 Overhead power lines and buried cables that are part of the public supply system are owned by a distribution network operator (DNO) or an independent distribution network operator (IDNO). If work activities have the potential to affect their assets (including poles, pylons or stay wires), they should be informed as part of the pre-construction planning. The asset owners will provide information on safe working practices, including the distances needed to maintain safety.

24 Only the asset owner can authorise the diversion of overhead power lines or buried cables, and they will require adequate time to plan this work. To find out who the DNO is for a specific area, visit the Energy Networks Association (ENA) website at www.energynetworks.org/operating-the-networks/whos-my-network-operator or telephone 105.

25 Asset owners will, on request, provide plans identifying the location of their cables. There may be a charge for this service.

26 Although asset owners are responsible for making sure that others are not endangered by their

equipment, the responsibility for working safely in the presence of overhead power lines and buried cables falls to those managing the work.

Case study

A client wanted to build a structure on his land and identified a space close to an existing high-voltage overhead power line. The completed building would have been clear of the line but during construction a construction worker in a MEWP made contact with the line. The worker suffered serious burns and could have been electrocuted.

Safety messages

The designer should have thought about the position of the building in relation to the overhead line before deciding on the location. It may have been possible to place the structure further away from the overhead line.

The contractor should have considered whether it was possible to complete the work safely as part of the site assessment. Having made the decision to undertake the work as per the plans, they should have implemented control measures to prevent contact with the line.

27 On some industrial sites overhead power lines and buried cables may be part of the distribution system operated by the site owner. Ask the site owner for information about the location of the services and how to make them safe during the proposed work.

Existing electrical services in buildings

28 When working in an existing building, electrical services are likely to be present. At the planning stage, the designer should obtain as much information as possible about what services are there. Records may be incomplete, cables may have been installed in unexpected places, and points of isolation may be difficult to identify. It may be necessary to complete a survey if information is not available or out of date.

29 Making electrical services safe by isolating or disconnecting supplies in the work area is the safest thing to do before work starts. These terms are defined as follows:

- 'Isolating' means the disconnection and separation of equipment from all sources of supply in such a way that the disconnection and separation are secure. Isolations are usually made secure by applying a lock to an appropriate isolating device. **Switching off is not isolating because it is not secure.**
- 'Disconnecting' means disconnection from the supply so that the equipment ceases to be part of the electrical system and cannot be accidentally re-energised.

Circuits must be proven dead before work starts. Detailed guidance is available in the Working Dead section of HSG85 *Electricity at work: Safe working practices*.

30 Isolations and disconnections must be managed. It is important that everyone understands what is safe to work on and what is not.

Temporary distribution systems

31 It is important to think about the need for electrical power to support construction activities before work starts. For smaller sites the power requirements may be very simple, but whatever the scale or complexity, the electrical system must be safe.

What is a temporary distribution system?

A temporary distribution system comprises the electrical services used to distribute and supply electricity to plant, work equipment, site offices etc. on the site.

32 Separating the site's electricity supplies from the existing building services is recommended. A temporary distribution system has a number of practical benefits:

- the system is under the control of people doing the work;
- only the equipment needed for the construction work needs to remain live;
- a reduced low-voltage (110 V AC) system can be used (existing services are likely to be at mains voltage);
- the temporary distribution system can be selected for the conditions on site (eg weather, temperature, impact);
- maintenance can be limited to the temporary distribution system, avoiding the requirement to inspect and test all of the building services.

33 When designing a temporary distribution system, consider the following:

- the supply capacity;
- the distribution voltage – high voltage, low voltage (230 V AC single-phase, 400 V AC three-phase) and reduced low voltage (110 V AC centre-tapped earth);
- the arrangements for earthing and protection against electric shock;
- the cable routeing;
- who will provide the system;
- who will maintain the system;
- who will commission and decommission the system.

Case study

A demolition contractor was hired to demolish buildings, including an electrical switch room. The site owner told the contractor that the electrical equipment was dead. As a precaution, one of the two men sent to remove the electrical switchgear threw a crowbar into the equipment before touching it. In the explosion that resulted, both were burned, one seriously. The photograph shows the electrical distribution system before and after the explosion.

Safety messages

Verbal assurances that electrical equipment is dead are never acceptable. When equipment has been isolated or disconnected, it must be proven dead before work starts.

Electrical distribution system before and after explosion

Only someone who understands what they are doing and uses proper test equipment should prove dead.

If isolations are undertaken by others, you should get confirmation that the isolations have been completed.

Figure 1 Main site intake point for a new-build construction site

Figure 2 Site supply arrangements for a small refurbishment site

34 A competent electrical contractor should be used to design, supply, install and maintain a temporary distribution system. Specific guidance on the requirements for temporary distribution systems for construction sites and the types of equipment to be used is provided in BS 7375 *Distribution of electricity on construction and demolition sites*.[6] An example of a temporary main electrical intake point for a new-build project is shown in Figure 1.

35 For a small refurbishment project, the temporary distribution system may consist of a consumer unit mounted on a backboard, along with residual current device (RCD) protected 230 V AC sockets. The sockets can be used for battery chargers and to supply 110 V AC transformers that will provide power to the site, as illustrated in Figure 2.

36 The choice of distribution voltage is important. It impacts the safety of everyone working on site. A practical way to reduce the likelihood of receiving a fatal shock from electrical equipment is to reduce the supply voltage to the lowest value necessary. The following approach mitigates risk at source and provides protection for all:

- battery-operated tools are the safest and their use removes the requirement for extension cables and leads;
- reduced low-voltage systems (110 V AC) can be used elsewhere for lighting and power tools.

37 The use of battery-operated equipment introduces the requirement for battery charging. Battery chargers generally require a mains voltage supply. For a small site, this can be provided by RCD-protected socket outlets as described in paragraph 35. For larger sites, specific charging stations may be provided, as shown in Figure 3.

Figure 3 A secure, lockable battery charging point

PART 2 MANAGING ELECTRICAL RISKS: THE CONSTRUCTION PHASE

38 Every construction project requires a construction phase plan (CPP). It must set out the arrangements for securing health and safety risks during the construction phase of the project. Once drawn up, the document should help communicate significant risks, site rules, and health and safety arrangements to other people involved in the construction phase. It should be easy to understand and as simple as possible.

39 A template CPP for small projects is available on the HSE website.[7] A free-to-download smartphone app, the CDM Wizard,[8] is also available from the Construction Industry Training Board (CITB) website.

Overhead power lines

40 If overhead power lines are known to be near the construction area, the CPP must set out specific measures for managing the risks. You should implement the control measures identified in the CPP. Guidance is available in GS6 *Avoiding danger from overhead power lines*.

41 Deliveries to site need to be planned. ENA has produced safety guidance about work that may take place near overhead power lines.[9]

Underground cables

42 Underground cables identified during the planning phase are likely to have been based on DNO plans and site records. They may not be accurate so a survey should be completed to identify the actual position of the cables.

43 Anyone using equipment for detecting cables should be trained and competent to use the equipment. Using the equipment incorrectly can give a false reassurance that an area is safe to dig. Cable avoidance tools (CATs) are straightforward to use but training is needed to enable them to be used effectively. They should be used with a signal generator, often called a 'Genny'. Further information on detecting devices and locators is available in HSG47 *Avoiding danger from underground services*.

44 The position of the services should be marked on the ground. The markings should be durable, and their meaning clear to those who will rely on them for safety.

45 If there is risk of contact with a buried cable, its position should be confirmed by exposing the cable before the work takes place. Trial holes may be needed to confirm the service and depth. Safe digging techniques must be used. Guidance can be found in HSG47.

46 Not all electrical services will be shown on plans. For example, the underground cables that supply power to lighting columns, illuminated signs and entry barriers may not appear on plans. Looking for items such as these near a planned excavation can help to identify where cables cross the work area.

47 When cables have been identified and located, their positions should be marked on drawings for future reference. This information should be in the CDM health and safety file for future use by the client. If the asset owner can be identified, they should be

informed of any significant deviations from the information they provided.

Existing electrical services in buildings

48 Where construction work is taking place in a building where electrical services are already present, you must take action to avoid danger from those services. Any decisions made about disconnection or isolation of electrical services must be communicated to contractors and implemented on site.

49 The law requires that work activities of any sort, either directly or indirectly associated with an electrical system, must (so far as is reasonably practicable) be undertaken in a way that does not give rise to danger (EAWR 1989 Regulation 4(3)).

50 There are many construction activities that could have an impact on electrical safety on site. You should identify what electrical systems are present, what can be isolated, and where the points of isolation are. You should be aware that records may be incomplete; cables may have been installed in unexpected places, and points of isolation may be difficult to identify.

Case study

A worker at a building under partial refurbishment was electrocuted when they touched a damaged cable in the ceiling void. The cable was powering the building's internal lighting. This cable was not identified during the planning process.

Safety messages

Electrical services are likely to be present in roof spaces, above suspended ceilings, and in underfloor voids. They can be hidden from view so damaged cables and broken electrical equipment are not obvious.

Electricity supplies should be made dead and proved dead before work commences, and the method of isolation should prevent inadvertent or deliberate re-energisation of the electrical system.

51 Non-contact voltage indicators can be useful for checking whether any live cables and accessories are present before work starts. You should not rely on non-contact devices for proving that equipment is dead, but they may tell you if it is live.

Isolation procedures

52 It is a legal requirement to take adequate precautions to prevent electrical equipment that has been made dead from becoming live while work is being carried out (EAWR 1989 Regulation 13).

53 Suitable isolation procedures are needed when safety depends on making sure that electrical systems have been made dead, proven dead and secured against re-energisation.

54 Placing tape over a circuit breaker to prevent inadvertent switch on, as shown in Figure 4a, is not an adequate means of securing an isolation. Such unsafe practice does not comply with EAWR 1989. Figure 4b shows a lock-off device in use on a circuit breaker. Personal locks with safety notices, suitable for a wide range of isolating devices, are readily available and inexpensive.

55 Guidance on the management and implementation of isolation procedures and more general guidance on safe systems of work for electrical work activities can be found in HSG85 *Electricity at work: Safe working practices*.

Figure 4a An example of bad practice – tape covering circuit breaker

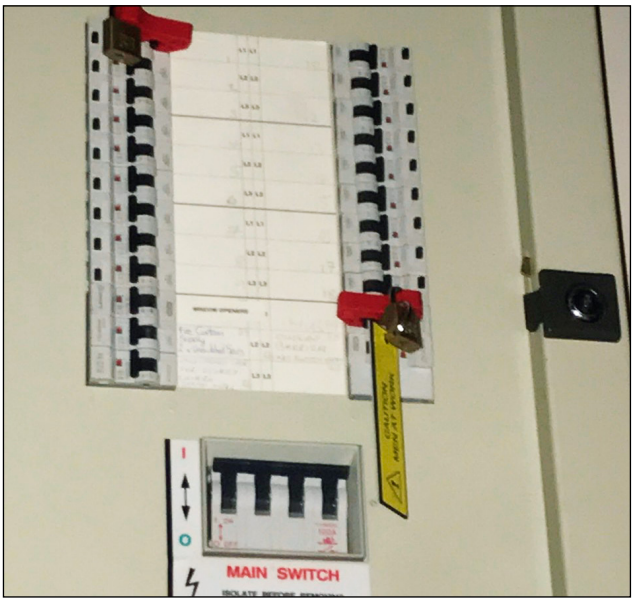


Figure 4b An example of good practice – use of a circuit breaker locking device

Temporary electrical distribution systems

56 Temporary electrical distribution systems may be needed on construction sites. Their temporary status does not mean that lower standards are acceptable as these systems are likely to be subjected to harsh conditions. Even the smallest systems require effective management and control.

57 Only competent persons should install or modify temporary electrical distribution systems, and management systems should be in place for ensuring appropriate maintenance and repair. Test records should be kept. For low-voltage installations, the safety requirements are set out in BS 7671 *Requirements for electrical installations*.[10] For more complex systems, guidance can be found in BS 7375 *Distribution of electricity on construction and demolition sites.*

58 You should use electrical equipment appropriate for a construction site environment (see Part 3 of this guidance). Figure 5 shows examples of 110 V AC distribution points provided for use on a new-build site.

59 When on site:

- take damaged equipment out of use;
- do not use twin and earth cables as extension cables;
- do not use standard 230 V AC accessories such as 13 A socket outlets on the site unless they are of a suitable type, protected from the environment, and protected from shock by an RCD;
- protect cabling against mechanical damage;
- position cables where they are unlikely to become a tripping hazard or subject to damage; see Figure 6.

Figure 5 Examples of temporary distribution equipment appropriate for a construction site

Figure 6 Cabling fixed at height eliminating the need for extension leads and trailing cables

Earthing the site's supply

60 The correct earthing arrangement for a temporary distribution system is essential for electrical safety on site. Use competent people who understand what needs to be done, and can inspect and test a system once installed to verify that it is safe to use.

61 DNOs frequently use protective multiple earthing (PME) arrangements on their low-voltage distribution networks. A PME arrangement may not be suitable for a construction site, and in this situation, either a different supply arrangement will be needed from the DNO (a TN-S supply system) or earth electrodes can be used to provide a local earth connection (a TT earth system). A DNO may refuse to provide a connection unless an effective earth is provided.

Maintenance and inspection

62 It is a legal requirement that electrical installations and equipment are maintained, so far as is reasonably practicable, so that they are safe (EAWR 1989 Regulation 4(2)). You must ensure that the electrical systems and equipment used on site are maintained in a way that is appropriate for the equipment and the risks present on site.

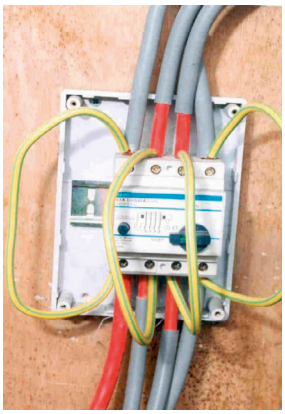
63 Regular inspection is important to identify electrical systems and equipment that may have become damaged and it is good practice to keep records of testing and maintenance.

64 If circuit breakers, fuses or RCDs repeatedly trip, there is likely to be something wrong and the fault should be investigated by a competent person. Never bypass or disable RCDs to stop nuisance tripping.

Case study

A supply to a temporary site office was installed using a flat-twin and earth cable. The cable was not mechanically protected and was damaged when a jack-leg for the office cabin was lowered onto it. The damage caused the RCD protecting the site's supply to trip intermittently. Someone frustrated by the supply going off bypassed the RCD by fitting wires coloured green and yellow (as shown in the photograph); this rendered the RCD useless.

A worker received a fatal electric shock when he touched the metal door frame of the cabin. The subsequent investigation identified that a live core within the damaged cable had come into contact with the cabin jack-leg, making the frame of the cabin live at mains voltage.



The RCD as found during the HSE investigation

Safety messages

Never bypass devices provided for safety.

A competent person should have investigated the reason for the RCD tripping.

A flat-twin and earth cable should not have been used for a site's supply. A competent person would not have used this type of cable for this type of supply.

Electrical distribution systems

65 You should arrange for an electrically skilled person to undertake inspection and testing of the electrical distribution system every 3 months (12 months for site offices). You will need to keep this under review, depending on the site conditions and what is found.

66 BS 7671 *Requirements for electrical installations* provides guidance on inspection and testing to determine whether an electrical distribution system is safe for continued use. It also sets out a reporting format for recording the results of inspection and testing, and a method for prioritising the risks associated with any defects found.

Portable tools and equipment

67 The term 'portable' is used to cover equipment that is portable, mobile or transportable. The risks from portable electrical equipment may have been reduced by specifying the use of battery-powered tools or reduced low-voltage (110 V AC) equipment. You must ensure that contractors are aware of this requirement and only bring appropriate tools to site.

68 For some tasks, 230 V AC portable tools may be the only option available. Additional precautions are needed because of the potential severity of injury from this type of equipment and its associated leads and plugs if they become faulty or damaged. Use RCDs suitable for providing protection against electric shock, and check their operation daily using the test button.

69 All portable tools being used on site should be maintained so that they are safe. Guidance on how to maintain portable electrical equipment can be found in HSG107 *Maintaining portable electrical equipment*.[11] This document provides initial maintenance intervals for different types of electrical equipment. The frequency of inspection and testing should be proportionate to the risks identified on site.

Case study

A ground worker was sent to repair a damaged foul-water pipe. He was given a mains (230 V AC) powered sump pump by his employer. By using several extension leads he was able get a power supply from an adjacent factory unit. The pump stopped working and the excavation started to fill with water. The worker received a fatal electric shock when he took hold of the pump to investigate why it had stopped. There was no RCD fitted to the supply or included within the extension cables.

Safety message

No consideration had been given to electrical safety. The pump had not been inspected and tested before it was provided for use. Petrol-driven or 110 V AC pumps are readily available. Mains-powered equipment and the cabling must always be RCD-protected.

70 Effective maintenance of portable electrical equipment can be achieved by a combination of 'user checks', 'formal visual inspections' and 'combined inspection and testing'. Further information can be found in HSG107. Anyone who uses portable electrical tools and equipment can complete the user checks. They are a visual inspection to identify:

- damage to the supply cable (apart from light scuffing), including fraying or cuts;
- damage to the plug or connector; for example, the casing is cracked or the pins are bent;
- inadequate joints, including taped joints in the cable;
- effective securing of the outer sheath of the cord or flex where it enters the plug or equipment. You should not be able to see the coloured insulation of the internal cable cores;
- whether the equipment has been subjected to conditions for which it is not suitable; for example, it is wet or excessively contaminated;
- damage to the external casing of the equipment.

71 You should ensure that defective tools or equipment are taken out of use. Extension cables are one of the most common types of equipment found to be damaged.

72 The repair of most portable electrical equipment requires specialist knowledge and expertise if the faulty or damaged equipment is to be restored to the necessary safe condition. It may be more appropriate to replace items rather than repair them.

Commissioning permanent installations

73 This section deals with the permanent fixed installation of electricity systems in the building or structure under construction. As parts of the permanent electrical installation are completed, they may be progressively commissioned and brought into use. There will be a transition from the temporary distribution system to the electrical systems in the building. Circuits and accessories that were dead may now be live or capable of being made live. The risks will change, and management systems should change to control the risk.

74 There may be pressure to make parts of the electrical installation available before the installation is fully completed. Do not make any part of an electrical system live until it has been confirmed that it is safe to energise that part. If energisation is required, it is essential that you formally manage this because once it becomes possible to make equipment live, safety depends on the management and control of safe isolation procedures.

Case study

An electrician working on a new-build construction project installed the distribution board. He energised the supply to provide electricity to a socket outlet before the circuits connected to it were complete.

He was connecting the supply cables to a timer unit, with the line conductor connected to the circuit breaker. 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.

Safety message

To energise the board before it was complete, the electrician should have first replaced the cover to prevent access to any live parts, then switched off and locked the circuit breakers supplying the unfinished or incomplete circuits.

PART 3 SYSTEMS AND EQUIPMENT

Equipment for use on construction sites

75 Electrical equipment suitable for use where it is likely to be exposed to dust or water will have an IP rating. This is a classification system that identifies the type of environment that equipment is suitable for. Equipment intended for use on construction sites will typically be of a more robust construction. The equipment selected should have an IP rating suitable for its location and proposed use.

76 Where there is a fixed supply to the site, the supply equipment should be installed in an enclosure that protects it against the weather, from damage, and prevents interference. The means of turning off the site's supply should always be accessible, and an appropriate system should be in place to ensure that it is maintained.

Cables

77 Fixed distribution cables, such as those to welfare cabins, offices and large items of power-using equipment, including cranes and construction lifts, should have a metal sheath or armour that is earthed.

78 If other types of fixed wiring cables are used for power distribution, mechanical protection such as conduit and/or trunking may be needed. Non-flexible cables (such as twin and earth) are likely to need mechanical protection and are not suitable for extension leads or direct connection to portable equipment.

79 Position cables where they are not likely to be damaged:

- If cables cross a roadway, place them in ducts with a cable marker at each end. If the roadway is used by vehicles, the ducts should be at least 0.5 m below the surface.
- If cables have to be suspended across roads, catenary wires are likely to be needed, with 5.8 m or greater clearance underneath.

Within buildings, select cables that comply with the requirements for fire safety. Where cables are routed through or over escape routes, use cable supports that are not liable to premature collapse in the event of fire.

80 Use the correct materials to carry out cable repairs and joints in order to achieve the degree of insulation, tensile and crushing strengths, conductivity and accessibility required. Use an enclosed junction box to joint fixed wiring cables. For repairs or joints in flexible cables, use proprietary joints and cable connectors as 'home-made joints' are not usually satisfactory. In most cases the quality of such joints can only be assessed by dismantling the cable – a process that destroys the joints.

Generators

81 It may be necessary to use a generator (or generators) to provide or supplement the electrical supply to a site. Electrical systems powered by generators need to be suitably designed, installed and maintained. Engage competent people to make sure that the installation is safe for use.

82 You should not set up or use generators in enclosed spaces because of the hazards of carbon monoxide generation. Take appropriate precautions for the storage of fuel and during refuelling.

Small, single-phase generators

83 Small, single-phase generators are useful for remote tasks where battery-powered tools may not be appropriate. A reduced low-voltage supply (110 V AC) and/or double-insulated (Class II) equipment is recommended. Placing the generator close to the point of work will remove the need for extension cables, minimising the risk of cable damage.

84 When the generator is used as described above, there may be no requirement for it to be earthed and RCD protection may not be necessary.

85 If earthed (Class I) equipment (which requires an earth connection for safety) is being used, only one item of equipment should be connected to the generator. If more than one item of Class I equipment is used, each circuit will need RCD protection.

86 The terms 'earthed (Class I) equipment' and 'double-insulated (Class II) equipment' are explained below.

Earthed (Class I) equipment

This equipment relies on the metallic (exposed conducting) parts of the equipment being effectively earthed. If this earth connection is lost, there is a possibility of the exterior of the equipment becoming live, with a potentially fatal result. Anyone touching live metal will be in contact with electricity.

Double-insulated (Class II) equipment

This equipment (which includes double-insulated equipment) is constructed with high-integrity insulation and does not have or need an earth connection to maintain safety. If you cannot see the symbol shown here on the right (a square within a square), you should assume that the electrical equipment is a Class I appliance.

Larger generators

87 Larger generators, often three-phase, may provide power to an entire site and are likely to supply more than one item of equipment. These generators should be earthed and the outgoing circuits should be RCD-protected. Correct earthing is essential to ensure that the protective devices will operate in the event of a fault.

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1 *Controlling fire and explosion risks in the workplace. A brief guide to the Dangerous Substances and Explosive Atmospheres Regulations 2002* INDG370 HSE 2013 https://www.hse.gov.uk/pubns/indg370.htm.

2 *Electricity at work: Safe working practices* HSG85 HSE 2013 https://www.hse.gov.uk/pubns/books/hsg85.htm.

3 *The Electricity at Work Regulations 1989* HSR25 HSE 2015 https://www.hse.gov.uk/pubns/books/hsr25.htm.

4 *Avoiding danger from overhead power lines* GS6 HSE 2013 https://www.hse.gov.uk/pubns/gs6.htm.

5 *Avoiding danger from underground services* HSG47 HSE 2014 https://www.hse.gov.uk/pubns/books/hsg47.htm.

6 BS 7375:2010 *Distribution of electricity on construction and demolition sites. Code of practice* British Standards Institution.

7 *Construction phase plan (CDM 2015) What you need to know as a busy builder* CIS80 HSE 2013 https://www.hse.gov.uk/pubns/cis80.pdf.

8 *CDM Wizard* CITB 2015 https://www.citb.co.uk/about-citb/partnerships-and-initiatives/construction-design-and-management-cdm-regulations/cdm-wizard-app/.

9 *Look out – Look up! A guide to the safe use of mechanical plant in the vicinity of electrical overhead lines* Energy Networks Association 2018 https://www.energynetworks.org/industry-hub/resource-library/mechanical-plant-safety-advice.pdf.

10 BS 7671:2018 *Requirements for electrical installations*. BSI 2018 British Standards Institution.

11 *Maintaining portable electrical equipment* HSE 2013 HSG107 https://www.hse.gov.uk/pubns/books/hsg107.htm.

FURTHER READING

HSE publications

Electrical safety and you: A brief guide INDG231(REV1) HSE 2012 www.hse.gov.uk/pubns/indg231.pdf.

Electrical test equipment for use on low voltage electrical systems GS38 HSE 2015 (fourth edition) www.hse.gov.uk/pubns/priced/gs38.pdf.

Managing contractors. A guide for employers (second edition) HSG159 HSE 2011 https://www.hse.gov.uk/pubns/books/hsg159.htm.

Managing health and safety in construction. Construction (Design and Management) Regulations 2015. Guidance on Regulations L153 HSE 2015 www.hse.gov.uk/pubns/books/l153.htm.

Safe use of work equipment. Provision and Use of Work Equipment Regulations 1998. Approved Code of Practice and guidance (fourth edition) L22 HSE 2014 https://www.hse.gov.uk/pubns/books/l22.htm.

Industry guidance

Best Practice Guide 2 (Issue 3) – Guidance on the management of electrical safety and safe isolation procedures for low voltage installations Electrical Safety First 2015 https://www.electricalsafetyfirst.org.uk/media/1201/best-practice-guide-2-issue-3.pdf.

Best Practice Guide 8 (Issue 2) – Selection and use of plug-in socket-outlet test devices Electrical Safety First 2015 https://www.electricalsafetyfirst.org.uk/media/1205/best-practice-guide-8-issue-2.pdf.

Additional information regarding CDM is available from the CITB website at https://www.citb.co.uk/about-citb/partnerships-and-initiatives/construction-design-and-management-regulations-2015/about-cdm/.

British Standards

BS 7430:2011+A1:2015 *Code of practice for protective earthing of electrical installations* British Standards Institution.

BS EN 60529:1992 *Degrees of protection provided by enclosures (IP code)* British Standards Institution.

BS EN 50525-2-11:2011 *Electric cables. Low voltage energy cables of rated voltages up to and including 450/750 V (U0/U) Cables for general applications. Flexible cables with thermoplastic PVC insulation* British Standards Institution.

BS 6004:2012 *Electric cables – PVC insulated and PVC sheathed cables for voltages up to and including 300/500 V, for electric power and lighting* British Standards Institution.

BS EN 61439-4:2013 *Low-voltage switchgear and control gear assemblies. Particular requirements for assemblies for construction sites (ACS)* BSI 2013 (under review) British Standards Institution.

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

BS 7071:1992 *Specification for portable residual current devices* British Standards Institution.

BS 7288:2016 *Specification for residual current devices with or without overcurrent protection for socket-outlets for household and similar uses* British Standards Institution.

BS IEC 1008-2-2:1990 *Specification for residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCCBs). Applicability of the general rules to RCCBs functionally dependent on line voltage* British Standards Institution.

BS 4363:1998+A1:2013 *Specification for distribution assemblies for reduced low voltage electricity supplies for construction and building sites* British Standards Institution.

FURTHER INFORMATION

For information about health and safety, or to report inconsistencies or inaccuracies in this guidance, visit www.hse.gov.uk. You can view HSE guidance online and order priced publications from the website. HSE priced publications are also available from bookshops.

This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory, unless specifically stated, and you are free to take other action. But if you do follow the guidance, you will normally be doing enough to comply with the law. Health and safety inspectors seek to secure compliance with the law and may refer to this guidance.

Electrical safety on construction sites

Electricity can kill. Every year, the use of electricity on construction sites results in accidents. People suffer electric shocks and burns which can cause serious, sometimes fatal, injuries.

Construction sites present a challenging environment for managing electrical safety because:

- work may be undertaken outdoors in all weathers;
- frequent movement of plant, tools and materials increases the likelihood of damage to equipment;
- existing, new and temporary electrical installations may all be present.

This second edition contains updated guidance on the precautions to take to reduce the risk of accidents involving electricity on construction sites for anyone planning, arranging or supervising construction work. The guidance is divided into three parts:

- Part 1 Planning: The pre-construction phase
- Part 2 Managing electrical risks: The construction phase
- Part 3 Systems and equipment.

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