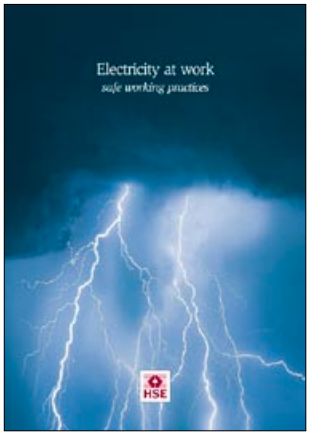
Electricity at work

Safe working practices



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This second edition of HSG85 gives guidance on the key elements that need to be considered when devising safe working practices for people who carry out work on or near electrical equipment. It includes advice that is relevant to managers and supervisors who control or influence the design, specification, selection, installation, commissioning, maintenance or operation of electrical equipment. The first edition was published in 1993 and this new version updates the guidance and provides sources of further information.

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This guidance is issued by the Health and Safety Executive. Following the guidance is not compulsory 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 as illustrating good practice.

Contents

Introduction

1 This book gives guidance on devising safe working practices for people who carry out work on or near electrical equipment. It includes advice that is relevant to managers and supervisors who control or influence the design, specification, selection, installation, commissioning, maintenance or operation of electrical equipment. Some organisations will already have industry-specific rules or guidance for safe working practices but they should ensure that all aspects addressed in this book are adequately covered. Other organisations will have no such internal guidance and will need to apply the principles contained in this book and devise safe working practices relating to their own specific circumstances and activities.

2 The *Electricity at Work Regulations 1989* (EAW Regulations)[1] apply to almost all places of work. The Memorandum of guidance on the Electricity at Work Regulations 1989[2] (the Memorandum) is intended to help duty holders meet the requirements of the Regulations. This guidance supplements the Memorandum with further advice on safe working practices. Where regulation numbers are quoted, they refer to the EAW Regulations. Regulations 17 to 28 and Schedule 1 apply specific duties in relation to mines. There are also two Approved Codes of Practice covering the use of electricity at mines and quarries that provide additional guidance relevant to those industries.[3, 4] Other legislation can also apply to electrical work and this is listed in the 'References' or 'Further reading' sections, as are all other publications referred to in the book.

Definitions

3 In this book, unless the context otherwise requires, the following words and terms have meanings as given below:

charged: the item has acquired a charge either because it is live or because it has become charged by other means such as by static or induction charging, or has retained or regained a charge due to capacitance effects even though it may be disconnected from the rest of the system;

dead: not electrically 'live' or 'charged';

designated competent person: a person appointed by the employer, preferably in writing, to undertake certain specific responsibilities and duties, which may include the issue of permits-to-work. The person must be competent by way of training and qualifications and/or experience;

disconnected: equipment (or a part of an electrical system) that is not connected to any source of electrical energy;

equipment: for this book this means 'electrical equipment' and includes anything used, intended to be used or installed for use, to generate, provide, transmit, transform, rectify, convert, conduct, distribute, control, store, measure or use electrical energy (as defined in the EAW Regulations);

high voltage: this is defined in national and international standards as being in excess of 1000 V ac or 1500 V dc. However, historically, certain precautions have been applied in the UK to systems energised at more than 650 V ac. To maintain the same degree of safety this guidance uses the term 'high voltage' where the voltage exceeds 650 V ac;

isolated: equipment (or part of an electrical system) which is disconnected and separated by a safe distance (the isolating gap) from all sources of electrical energy in such a way that the disconnection is secure, ie it cannot be re-energised accidentally or inadvertently;

live: equipment that is at a voltage by being connected to a source of electricity. This implies that, unless otherwise stated, the live parts are exposed so that they can be touched either directly or indirectly by means of some conducting object and that they are either live at a dangerous energy level or dangerous potential, ie over 50 V ac or 120 V dc in dry conditions - see BSI publication PD 6519;[5]

live work: work on or near conductors that are accessible and 'live' or 'charged'.

Hazards

4 Each year about 20 people die from electric shock or electric burns at work and about 30 die from electrical accidents in the home. Most of these accidents are preventable and this book is intended to help you avoid such accidents. Many people have had an electric shock at some time or another without lasting injury but this does not demonstrate an immunity, merely the unpredictable nature of the risk. Slightly different circumstances could have resulted in death. If the victims of electric shock do not die, they usually recover very quickly unless there are other injuries (such as burns) or consequential injuries such as strained muscles from sudden contraction during the shock or injuries from, for example, falling as a result of the shock.

5 Electric shock is not the only hazard. Where electrical arcing occurs, perhaps as a result of accidental short circuit, the heat generated can be intense and, even if it persists for only a very short time, it can cause deep-seated and slow-healing burns. Engineers and craftsmen often fail to appreciate the very real risk of injury that can arise from arcing. As a result, there are several hundred serious burn accidents each year arising from unsafe working practices. The intense ultraviolet radiation from an electric arc can also cause damage to the eyes.

6 Arcing, overheating and, in some cases, electrical leakage currents can cause fire or explosion by igniting flammable materials. This can cause death, injury and considerable financial loss.

7 Most electrical accidents occur because people are working on or near equipment that is:

- thought to be dead but which is live;
- known to be live but those involved do not have adequate training or appropriate equipment, or they have not taken adequate precautions.

Equipment

8 In general, equipment that has been properly designed, constructed, installed and maintained does not present a risk of electric shock or burn injury when properly used. BS 7671 *Requirements for electrical installations*,[6] although non-statutory, is a code of good engineering practice and makes requirements for

systems and equipment to be designed, constructed and installed so that they can be used safely. The standard mainly covers systems and equipment that operate at low voltage (up to 1000 V ac). Installations that comply with this Standard are likely to achieve conformity with the relevant parts of the EAW Regulations.

9 Some equipment, not designed to prevent injury from shock or burn, relies on the user having sufficient knowledge and experience to recognise the danger and avoid it. This equipment (including open-type switchboards and fuseboards used by electricity suppliers and steelworks etc for distribution) should be located in a secure room or area, with access available only to those who have specific authority and are competent in relation to the danger. Even then, the open-type board will need to be further protected to prevent accidental contact when competent persons are near the equipment. (See paragraph 14 for the need to insulate parts of control panels.) Regulation 14 specifies the requirements when working on or near live parts and regulation 15 and Appendix 3 of the Memorandum relate to working space, access and lighting requirements.

10 Some equipment operates at voltages that are so low that they cannot give an electric shock but, even at these extra-low voltages, an arc can occur or burns can result from overheated conductors. A good example of this is a short-circuited car battery that may cause the conductors to overheat or even explode. The following advice is also applicable to self-contained sources of electrical energy, whether the risk is from electric shock, burn or arcing.

11 Equipment should be suitable for the environment in which it is used, for example cables and equipment in heavy industries such as sheet metal works need to be protected against mechanical damage (regulation 6). Adverse environmental factors should always be considered when work is to be carried out on equipment. For example, excessively damp or humid conditions will increase the risk of injury because of a reduction in the effectiveness of insulation and may also undermine the effectiveness of devices used for isolation. Such conditions would also increase the severity should an electrical shock occur. Equipment that has corroded may not function as intended.

12 There may be a need for certified explosion-protected equipment in locations where there could be potentially explosive atmospheres, for example if there has been a leakage of flammable gas that could be ignited by an electric spark. This shows the need for careful assessment of the situation before work is carried out on or near equipment. It must be remembered that the act of working on equipment may result in removal of components and parts that provide protection for people against electric shock when the equipment is in normal use.

13 Much can be done to improve operational safety by the careful design and selection of electrical equipment. For example, switch disconnectors must have a locking off facility or other means of securing them in the OFF position to meet the requirements of regulation 12. Circuits and equipment should be installed so that all sections of the system can be isolated as necessary. Switch disconnectors should be suitably located and arranged so that circuits and equipment can be isolated without disconnecting other circuits that are required to continue in service.

14 Control panels should be designed with insulated conductors and shrouded terminals (regulation 7) so that commissioning tests, fault-finding, calibration etc can be carried out with a minimum of risk. The Engineering Equipment and Materials Users Association (EEMUA) have produced a design guide for electrical safety7 in this respect. The use of interlocking is recommended to reduce the risk of injury from contact with live parts. Equipment in which power and control circuits are segregated is preferred.

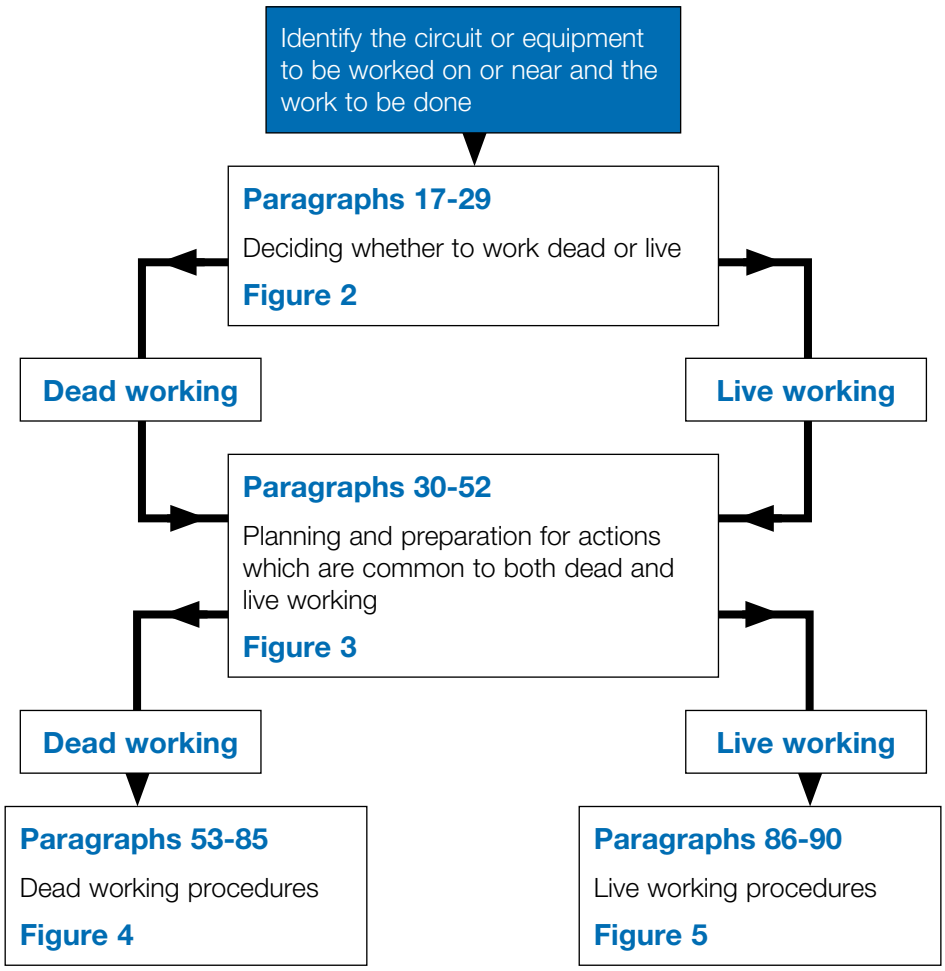
15 Sometimes live working during commissioning and fault-finding can be avoided if suitably designed equipment having in-built test facilities and diagnostic aids is provided. Regulation 15 requires that there should be adequate space, access and lighting to work safely. Temporary systems and equipment should be designed, constructed, installed and maintained to comply with the Regulations and with suitable Standards including, where appropriate, BS 7671 *Requirements for electrical installations*. The Institution of Electrical Engineers (IEE) produce a series of guidance notes that provide advice in addition to that given in BS 7671, some of which relates to electrical safety. (See 'Sources of further information' for IEE's address and telephone number.)

Assessing safe working practices

16 Figure 1 illustrates the sequence of the planning steps. The procedure can be divided into four stages as follows:

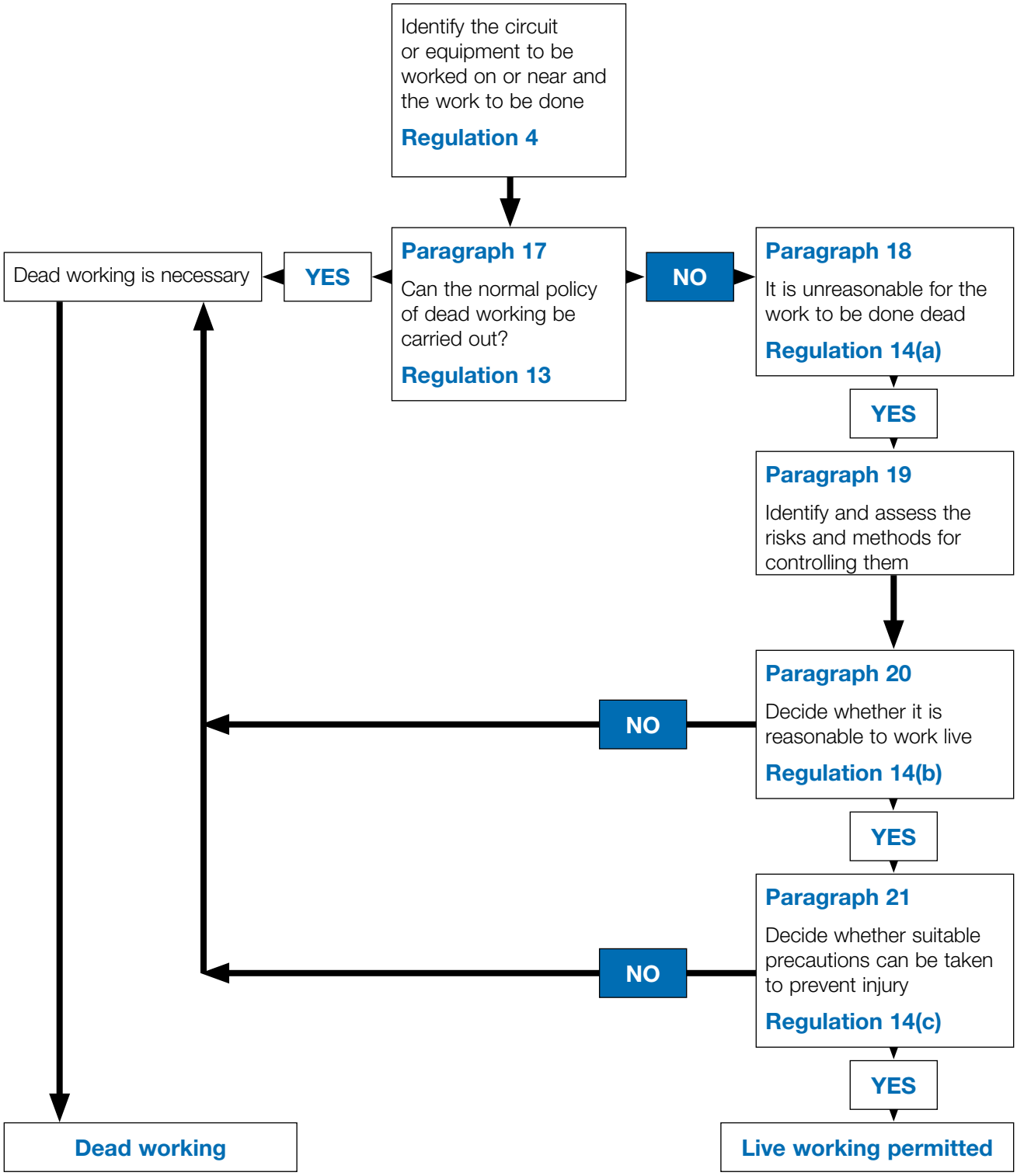
- deciding whether to work dead or work live (coloured yellow);
- planning and preparation for actions which are common to both dead and live working (coloured blue);
- procedures for working dead (coloured green);
- procedures for working live (coloured red).

Figure 1 Basic flow chart for assessing safe working practices



Deciding whether to work dead or live

Figure 2 Deciding to work dead or live



Can the normal policy of dead working be carried out?

17 Work on or near live conductors should rarely be permitted (regulation 14). Many accidents to electricians, technicians and electrical engineers occur when they are working on equipment that could have been isolated. In most cases, adequate planning and work programming will allow such jobs to be carried out as the Regulations require, ie with the equipment dead. Regulation 14 requires that three conditions are met for live working to be permitted where danger may arise. It is stressed that if just one of those conditions cannot be met, live working cannot be permitted and dead working is necessary. The assessment procedure illustrates this. The conditions are:

- it is unreasonable in all the circumstances for the conductor to be dead; and
- it is reasonable in all the circumstances for the person to be at work on or near that conductor while it is live; and
- suitable precautions (including, where necessary, the provision of personal protective equipment) have been taken to prevent injury.

It is unreasonable for the work to be done dead

18 There are some circumstances where it is unreasonable to make equipment dead because of the difficulties it would cause (regulation 14(a)). For example, it may be difficult, if not impossible, to commission a complex control cabinet without having it energised at some time with parts live (but not exposed so that they may be easily touched). Also it may not be realistic to monitor the operation and performance of a control system or to trace a malfunction of such equipment with it dead, ie fault-finding. Another example is the situation of a Distribution Network Operator (DNO) (formerly known as a Regional Electricity Company (REC)) who needs to connect a new low-voltage service to an existing main, but it might be unreasonable to disconnect many other customers. In recognition of the dangers associated with live working, the DNO needs to have a very strict code of safety rules and procedures to prevent injury.

Identify and assess the risks and methods for controlling them

19 At this stage some form of risk assessment is necessary. This will usually be qualitative but it should be applied to the specific equipment to be worked on or near. The assessment indicated in this box on Figure 2 pre-empts to some extent the requirements of other boxes in Figures 3, 4 and 5, particularly those dealing with regulations 4(3), 4(4), 14(c) and 16. The person carrying out the assessment etc should have extensive knowledge and experience of the factors to consider and of the competence of the people who will be carrying out the work and of their ability to avoid danger.

Decide whether it is reasonable to work live

20 On completion of the preceding stage it is now appropriate for managers and supervisors to judge whether it is reasonable in all circumstances to work live (regulation 14(b)). The decision should not be taken lightly. At this stage the economic and operational factors should be evaluated against the risks involved before making a decision, bearing in mind that the shock or burn risks associated with working live can be very serious.

Decide whether suitable precautions can be taken to prevent injury

21 Providing the other requirements of regulation 14 have been met, live working can still only be justified if suitable precautions are taken to prevent injury arising from risks identified in the assessment (regulation 14(c)). All of the factors covered in paragraphs 22-29 should be taken into account.

22 The possibility of anyone touching parts at dangerously different potentials at the same time should be avoided by installing temporary insulation or protective barriers. This may mean putting temporary insulating screens over live parts and/or applying insulation to parts that are at earth potential. Temporary screens etc can also help to prevent the risk of accidental short circuit from tools, components, conductors etc.

23 When work is to be carried out 'near' rather than 'on' live equipment (eg near an overhead line), the essential precautions will often be directed towards ensuring that appropriate and adequate safety clearances are established and maintained. For more detailed advice, see HSE Guidance Note GS6 *Avoidance of danger from overhead electric powerlines*.[8]

24 The people doing the work must be adequately trained and experienced in the type of live work being undertaken (regulation 16). They should understand the task and be able to recognise any deterioration in the state of equipment or departures from agreed procedures. They should have the self-discipline to recognise their own limitations and should be encouraged to seek assistance with work that may be outside their area of competence.

25 There must be adequate working space and adequate lighting (regulation 15). There should be adequate headroom, no tripping hazards and no obstructions that could restrict a person's movements. Where there are exposed parts live at 400 V ac the recommended minimum clear working space should not be less than 3 ft or 915 mm measured from the live part. If there are live parts exposed on each side of the working space the minimum recommended clearance should not be less than 4 ft 6 ins or 1375 mm, although this situation should be avoided whenever possible, eg by screening.

26 Only properly insulated tools should be used (see BS EN 60900[9]). They should have insulation that is robust enough to be proof against mechanical damage (regulation 14(c)). These tools should be inspected frequently by a suitably competent person. They should be destroyed if the insulation is damaged. Test instruments should have insulated probes and fused leads (see HSE Guidance Note GS38 *Electrical test equipment for use by electricians*[10]).

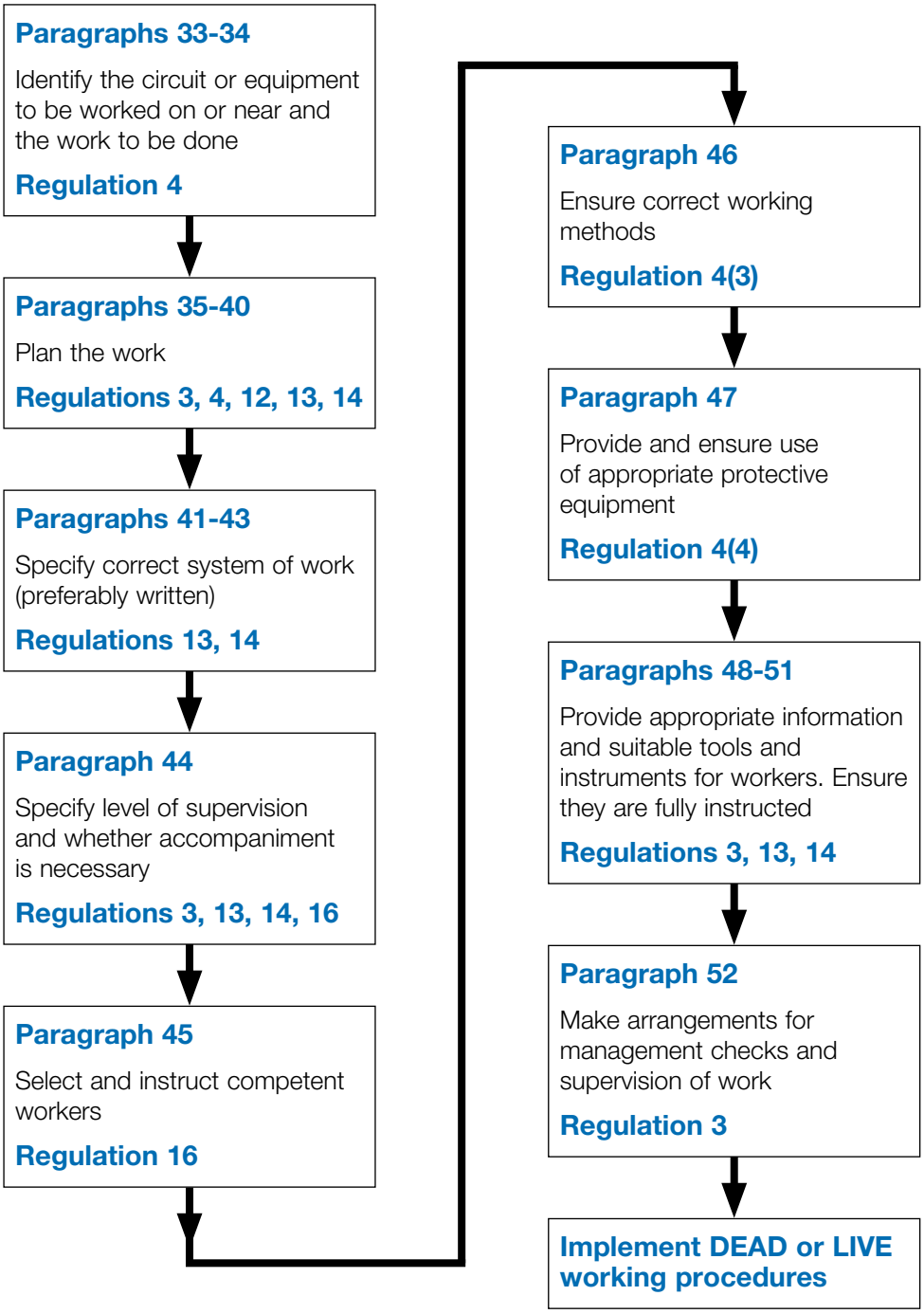
27 Protective clothing and equipment should be provided and used as required by regulation 4(4) where this would reduce the risk of contact with live parts or earth. For example, a cable joiner will need insulating gloves and insulating rubber matting to BS 921.[11] Such equipment should be inspected frequently by a person who is competent to assess its condition.

28 Horizontal surfaces and projections inside control cabinets etc should not be used for temporary storage of tools and other equipment.

29 Experience has shown that rapid action can save life in the event of electric shock. A person working on live parts should normally be accompanied by someone who is in a safe position, who has the necessary competence to avoid injury, who can help by disconnecting the supply and who can render first aid or obtain assistance in the event of an emergency.

Actions common to both dead and live working

Figure 3 Planning and preparation for actions which are common to both dead and live working



Actions for managers and supervisors

30 Both managers and supervisors should be involved at the first stage since this is where, in most cases, major responsibility for safe working practices lies. In some cases management and supervision may be carried out by the same person and there may be cases where the worker has to carry out these two functions. There may be some routine jobs covered by a management policy, but the details may not be discussed before each job is done. Where a business employs a contractor, the division of responsibilities requires careful definition, in advance of the work being done.

31 The supervision of electrical work must be appropriate to the danger and the technical knowledge or experience of the people doing the work (regulation 16). Supervisors should be knowledgeable about the general principles of electrical safety and their duties and responsibilities should be defined in writing by their employers. The supervisor should discuss the intended work with the participants, ensuring that they clearly understand the precautions that are to be taken.

32 If there is more than one group at work, the supervisor should co-ordinate the activities of the various groups and there should be a recognised procedure for referring any problems that may arise to the supervisor. Everyone involved should also be clear about what is to be done if something goes wrong. It is essential that for group activities one person should be given overall supervisory responsibility and everyone involved should know who that person is.

Identify the circuit or equipment to be worked on or near and the work that needs to be done

33 Much time and trouble can be saved by carrying out these actions in advance of the work being done. Factors that may affect the safe system of work should also be taken into account. In many cases actual physical identification will be necessary and this may be aided by the use of appropriate drawings, diagrams and other written information. The features of equipment mentioned in paragraphs 8 to 15 should be taken into account.

34 When the equipment and work to be done has been identified, it is necessary to decide whether to work dead or work live, although it must be stressed that working dead should be the norm because the three conditions which have to be met to permit working live, as set out in regulation 14, are very strict. This procedure is discussed in more detail in paragraphs 17 to 29. Irrespective of whether it has been decided to work dead or live, the common steps in paragraphs 35 to 52 should always be followed.

Plan the work

35 Many electrical accidents are due to failure to plan ahead. Safe working practices rely on clearly thought-out systems of work, carried through by adequately competent and trained personnel who are self-disciplined and aware of their own limitations. Recklessness with electricity can lead to injury, death and criminal charges.

36 To plan and execute electrical work safely, there should be adequate information available about the electrical system and the work to be done. In the case of a newly constructed electrical system (or newly installed equipment), there should be drawings and schedules relating to the design and these should have been updated, if necessary, by the people carrying out the installation.

37 Records in the form of drawings and/or schedules should be kept for all but the most basic of installations. In the case of old installations where records may be poor, some measures should be taken to improve the records for the installation. Such measures would involve a combination of surveying, testing and labelling of the installation. However, when checking records before working on an installation it is unwise to rely solely on one source of information, eg a label. All equipment should be labelled as necessary for it, and its function, to be properly identified.

38 Planning should include the management, supervision and execution of the work and should lead to a formal system of work, as is discussed further in paragraphs 41-43. It is necessary to plan work, even for seemingly simple jobs, both in advance and while the work progresses. Planning is most important since it requires a disciplined way of thinking by the person in charge of the work and demands that five important factors are considered:

- the work to be done;
- the hazards of the system or equipment to be worked on;
- the people doing the work and the level of supervision necessary;
- the precautions to be taken; and
- the system of work to be employed.

39 A job may have been planned but the nature of the work may change as the job progresses. When planning work properly it should be recognised that some decisions may not be possible until part-way through the job, eg a testing job may turn into a fault-finding situation. The plan should recognise this and cover the possibilities. The worker should then be in a position to recognise the changed circumstances and that it may be necessary to stop and review the situation with the person in charge of the work.

40 Some electrical accidents occur during fault-finding after a plant breakdown, when pressure for continued operation or production could result in electricians taking risks. To anticipate this, a plan should be established for proper fault-finding procedures that are always implemented during breakdown maintenance.

Specify correct system of work

41 There should be a system of rules and procedures wherever electrical work is to be carried out. These should be in written form so that everybody involved is made aware of them. The amount of detail depends on the circumstances; the simplest form may be a brief policy statement (perhaps reflecting a policy of always switching off, working dead and never working on live equipment) backed up by a set of simple instructions to reflect that policy. Where there are extensive or complex electrical systems this will be reflected in the safety rules, which should embody a methodical approach so that the safety principles involved can be clearly understood and avoid ambiguity.

42 Safety rules should set out the principles and general practices clearly and in a format that is compact enough for the people involved to carry around with them. Detailed procedures for safe working on particular items of equipment, or under particular circumstances, should be the subject of separate documents, which should be readily available when required (even in out-of-hours emergencies). This book does not contain a sample set of safety rules because they should be devised to reflect, among other things, the relevant organisation, personnel and working environment. However, guidance can be obtained from three British Standards – BS 6423,[12] BS 6626[13] and BS 6867.[14]

43 If something totally unforeseen occurs during the working procedure, there should be a review of the work. Even a properly trained, competent worker may not always be aware of what to do when things go wrong. The worker should have been trained to recognise that there may be a need to change to a new system of work. It will normally be necessary for the worker to know how to refer a changed situation to the correct people, by communicating both up and down the management structure in the organisation.

Specify level of supervision and whether accompaniment is necessary

44 The system of work (paragraphs 41-43) will give an indication of the level of supervision required. An important factor to consider at this stage is the amount of training and experience workers have had to do the specific jobs. There will be a greater need for supervision when working live as opposed to working dead. The need for accompaniment is also greater for live work, although it may still be necessary for some cases of working dead, especially if there are adjacent live parts. See also paragraphs 29 and 90.

Select and instruct competent workers

45 It is important to remember that the degree of competence of individual workers should be judged against the specific type of work to be done and related to their knowledge, training and experience. The instructions should also be specific to each job and in many cases will require emphasis on and elaboration of the safe system of work. Where workers are expected to carry out a broad range of work, which may involve additional responsibilities, additional training should be given. The need for training to make a person competent is very important. Even the most highly qualified people may not be competent to carry out specific types of work without suitable training. It is usually necessary to accompany people during training.

Ensure correct working methods

46 Workers should understand the correct working methods, again related to the specific work in hand. It is necessary for the people doing the work to be aware of the limits of the work they are to do and the constraints put upon them in how they carry out the work. This includes knowing how to deal with any contingencies that may arise.

Provide and ensure use of appropriate protective equipment

47 It is an absolute requirement of regulation 4(4) that any protective equipment provided for people at work on or near electrical equipment must meet the following three requirements, these duties being placed on managers, supervisors and workers as necessary. It must be:

- suitable for the use for which it is provided;
- maintained in a condition suitable for that use; and
- used properly.

Provide information, tools and instruments and ensure workers are fully instructed

48 If a job has been planned properly, the worker will be supplied with and will use correct and appropriate information, tools, instruments, safety equipment and instructions. Appropriate information includes drawings and diagrams of the equipment or circuit, as well as manufacturer's and installer's information and instructions. Appropriate tools may include suitably insulated tools which have been maintained in good condition and which have been regularly inspected and tested.

49 Before working on equipment made dead (regulation 13), the conductors should be proved dead. The instrument to do this should be properly constructed to protect against electric shock and designed to prevent short circuits occurring during use. Adequate insulation and fusing or energy limitation are essential. Proprietary voltage detectors should be used. It will be necessary to test the instrument before and after use. This may be done by means of a proving unit with a low power output. If live circuits are used to prove instruments, adequate precautions against electric shock and short circuits should be taken (see paragraphs 18 and 21-29).

50 Training in the correct use of voltage detectors is essential to avoid risk in the event of unexpected use on a live conductor. Where underground cables cannot be positively identified at the point of work, it may be necessary to spike the cable using a properly designed, cartridge-operated spiking gun. For low voltages, detectors, such as two-pole voltage detectors, proprietary test lamps, or voltmeters with insulated probes and fused leads can be used (see HSE Guidance Note GS38 *Electrical test equipment for use by electricians*). The use of multimeters, which can be set to the wrong function, is not recommended for proving dead. All instruments used for checking circuits should be maintained and inspected frequently.

51 This is usually the stage at which the worker is about to approach the equipment or circuit to be worked on, or to start switching operations, so a final check that the worker understands the system of work and work to be done should be made. If there is more than one worker, the understanding of the team leader should be checked and the team members should understand that only the work given them by the team leader should be undertaken. On no account should team members carry out work on their own initiative.

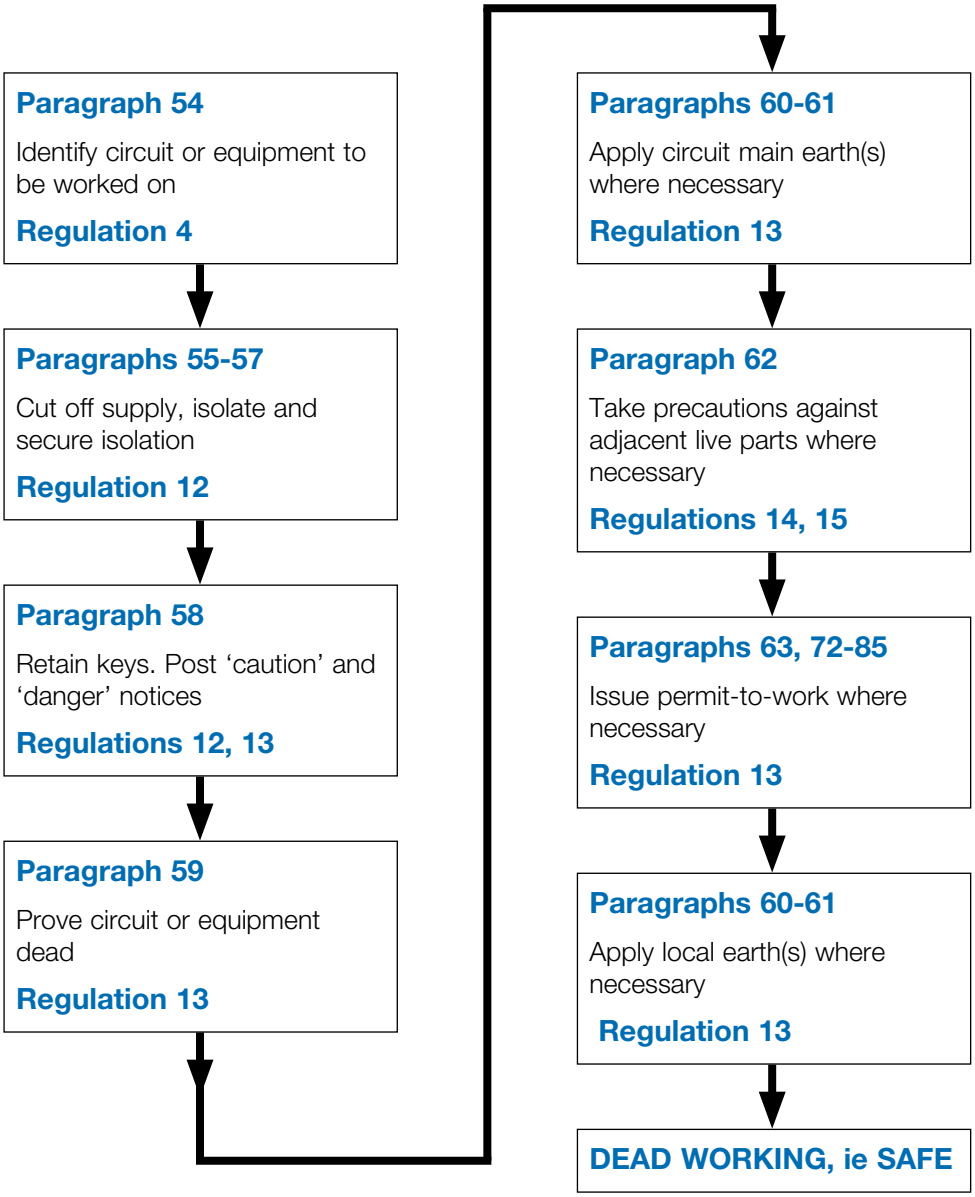
Make arrangements for management checks and supervision of work

52 Regulation 3(1) requires that employers comply with the Regulations in so far as they relate to matters within their control, and regulation 3(2) places similar duties on employees. The only effective way of management knowing that the Regulations are being complied with is by carrying out regular checks of the work. Sometimes, some or all of these checks may be delegated to the supervisor of the work. Even in organisations with effective, written safety rules and safe systems of work, regular and systematic management checks of the work are necessary. This is particularly important if the work is being done in the field, on another occupier's premises or by peripatetic workers.

Working dead

53 While it is not always possible to rigidly follow a set procedure in every situation, the following sequence is recommended as a guide.

Figure 4 Dead working procedures



Identification

54 Adequate information should be supplied for this step as mentioned in paragraphs 33-34. For most circuits and equipment correct labelling is important, but it should never be assumed that labelling is correct and that work can be started without having first proved that the equipment or circuit is dead. In some special cases, eg underground cables, cable-locating techniques using specialised instruments may be necessary and it may also be necessary to identify the cable both before and after switching operations and cable spiking.

Disconnection

55 Disconnect the equipment from every source of electrical energy before working on, or near, any part which has been live or is likely to be live (regulation 12). To ensure safety after disconnection the procedure in paragraphs 56-62 should be followed.

Secure isolation

56 To ensure adequate isolation, the disconnecting device should have an isolating gap sufficient for the voltage levels present or likely to occur. Make sure that any switch disconnector or other means of disconnection is secure (regulation 13). Switches should preferably be locked in the OFF position using a 'safety' lock, ie a lock having a unique key. If a plug has been withdrawn, make sure that it cannot be reconnected to the electrical supply while work is taking place on the circuits or apparatus. If a fuse is removed, make sure that it or a similar one cannot be reinserted by taking it away or by locking the box or enclosure until work is completed.

57 Some manufacturers produce insulating blanks that can be inserted in an empty fuseway and are capable of being locked. This prevents inadvertent insertion of a fuse while the associated circuit is being worked on. If reliance is placed on locking off where a number of people are working, the use of a multiple locking hasp attachment may be appropriate to ensure that all the locks are removed before the equipment can be re-energised.

Post notices

58 Put a notice or label at the place of disconnection so everyone else knows that work is being done. A good system is to use a 'caution' notice to indicate that someone is working on the apparatus and may be injured if it is re-energised. This should be supplemented by 'danger' notices adjacent to the place of work indicating nearby apparatus that is still energised. Notices or labels should be easily understandable to anyone in the area. It is also important to remove labels or notices when they no longer apply so that the system does not fall into disrepute. It is often useful for the 'caution' and 'danger' notices to have a space for the name of the person working or in charge and for the date. All keys should be retained in a secure place.

Proving dead

59 Having isolated the circuit or equipment, check at the point of work that the parts to be worked on or near really are dead, even if the isolation has been achieved automatically through an interlocking system. If it is a three-phase system or equipment with more than one supply, prove that all supply conductors are dead. The device used for proving dead should itself be proved immediately before and after testing. See paragraphs 49-50 for information on suitable devices.

Earthing

60 To ensure that the risk to personnel is minimised, even if the above precautions fail, it is preferable that all the conductors are earthed using properly designed earthing devices or earthing leads, usually applied to all points where the circuit or equipment is isolated from the supply. Additional local earths at the point of work may also be necessary if this is remote from the point of isolation, but these should be applied only after proving dead at the point of work. This procedure is essential

for high-voltage apparatus (see paragraphs 66-67) and stored energy equipment (eg capacitors). The earthing conductors and their connections should be suitable for the energy that may flow in the event of a failure of the above precautions.

61 Earthing low-voltage equipment is particularly desirable if there is a risk of re-energisation, eg from a generator under someone else's control (regulation 13). In other low-voltage equipment, however, it may be physically impractical to apply earths, or the risk of short circuit from introducing an earth near adjacent live parts may outweigh the benefit of earthing the apparatus being worked on.

Adjacent parts

62 When the circuit or equipment to be worked on has been made dead or where the work is non-electrical, it may still be necessary to protect against inadvertent contact with other live parts nearby (regulation 14). This should preferably be done by erecting physical barriers and/or the use of temporary insulation. The requirements of regulation 15 regarding adequate working space, access and lighting should also be met.

Additional procedures

63 On the high-voltage systems (and often on high-energy systems) a permit-to-work should be issued but only after all the actions described in paragraphs 54-62 have been carried out. (See paragraphs 72-85 for more information on permit-to-work systems.)

Extra precautions for high-voltage work

64 The following paragraphs (relating to regulations 12 and 13) apply particularly to equipment and circuits operating at high voltage. However, there are many installations where the same procedures should be used at lower voltages, for example if the available short-circuit power is such as to give rise to a risk of serious burn injuries. Conversely, there are a few exceptional circumstances where high voltages will not give rise to danger, for example if the maximum possible current is reliably limited to a safe level (see PD 6519 Parts 1 and 2).

65 High-voltage equipment should be designed and installed so that it is not necessary to work on exposed live parts. However, allowance has to be made for carrying out potential checks or tests, and also for observation from safe distances such as when phasing out.

66 Because high voltages can arc across an air gap, it is not necessary to touch live voltage parts to suffer a shock or burns. The procedure outlined in paragraphs 54-63 should be strictly applied. The isolation should be by means of a device that has a safe isolating gap between live parts and those that have been made dead for work to be carried out (see relevant British Standards). Earthing of conductors at the point of disconnection of the supply is essential and additional earths may be necessary at the place of work.

67 The system of locking OFF while work is in progress should use safety locks which have unique keys so that the apparatus cannot be inadvertently re-energised. The keys should be retained in a key safe or other suitable place available only to the person in charge of the activity. The precautions should be backed up with a disciplined documentation system; the permit-to-work is an established system that has proved to work well in practice and is detailed in paragraphs 72-85.

68 There are some situations where additional procedures will be necessary to cover adequately shift changes or work extending over long periods. It may also be necessary to have special rules or procedures for particular items of equipment and for particular working practices such as testing (eg it may be necessary to remove earths to facilitate testing under a clearly defined sanction-to-test procedure).

69 Precautions must be taken to prevent people approaching dangerously close to high-voltage conductors. This will normally mean that any work on high-voltage equipment is undertaken only after all the precautions set out in paragraphs 64-68 have been taken. There are, however, some special situations where, by the use of appropriate tools, apparatus and precautions, work on live, high-voltage conductors may be permissible while the people involved are at a safe distance. Two examples are work on overhead conductors by DNOs or work on railways using long, specially designed, insulated tools.

70 A more recent development is live, hands-on working on both electricity transmission and distribution overhead conductors. For this latter work, special vehicles, work equipment, tools, clothing etc, together with exacting working methods, are necessary to ensure safe working. For all the special situations referred to, work procedures need to be specially devised and a very high degree of training and discipline are essential for everyone involved. These special situations are not within the scope of this document.

71 Similar procedures may also be necessary if high-voltage apparatus is to be tested. In every case, the objective is to prevent anyone coming near to live, high-voltage conductors and the procedure should reflect this.

Permits-to-work

72 A typical example of a permit-to-work form is given in Appendix 1. Further information is available in BS 6626 and BS 6867. An electrical permit-to-work is primarily a statement that a circuit or item of equipment is safe to work on. A permit should never be issued on equipment that is still live. The information given in the permit should be precise, detailed and accurate. It should state which equipment etc has been made safe, the steps by which this safety has been achieved and exactly what work is to be done.

73 In no circumstances should anyone be allowed to work on equipment that is not specified in the permit as having been made safe. This restriction should be understood to apply to everyone in the premises, including directors and senior staff. No one is too important to comply with safety rules and no one should do any work that is not specified in the permit.

74 If it is found that a programme of work must be changed, no variation of any kind should be introduced until after the existing permit has been cancelled and a new one issued. The only person who has the authority to agree the change in programme and issue the new permit-to-work is either the person who issued the original permit or the person nominated by management to take over the responsibility, eg at the end of a shift or during absence on leave.

75 A permit-to-work should be issued by only a designated competent person (see paragraph 3) who is deemed to be so by means of technical knowledge and/or experience and who is familiar with the system and equipment. The person should be authorised, in writing, by the employer to issue permits relating to specified equipment or systems. Before issuing the permit, this person should work out, in detail and in writing, what the various steps are to disconnect, isolate, prove

dead, lock OFF and earth the equipment, post warning notices and identify the equipment to be worked on and adjacent equipment which will still be live.

76 The permit-to-work should state clearly:

- the person the permit is addressed to, ie the leader of the group or working party, who will be present throughout the work;
- the exact equipment which has been made dead and its precise location;
- the points of isolation;
- where the conductors are earthed;
- where warning notices are posted and special safety locks fitted;
- the nature of the work to be carried out;
- the presence of any other source of hazard, with cross-reference to other relevant permits;
- further precautions to be taken during the course of the work.

77 In most cases it is preferable to include a diagram on, or attached to, the permit confirming the above information and showing the zone for work.

78 It is strongly recommended that the permit is issued at the place where the work is being done. The designated competent person issuing the permit should explain the work and agree the accuracy and completeness of the details with the person doing the work before they both sign the permit. The person issuing the permit should be sure that all necessary action has been taken to make the equipment safe. As a general rule, a personal inspection should be made but in geographically very large undertakings, such as the electricity supply industry, it may occasionally be necessary to make an exception to this.

79 In cases where some degree of divided responsibility may arise, for instance between the DNO and the duty holder at the customer's premises, the permit-to-work form should be countersigned by a person nominated in the joint ownership schedule and by the duty holder for the premises. Another example is where contractors may need to work on an occupier's system or equipment. In this case the duty holder at the premises needs to take particular care to define responsibilities, in advance of the work being done and any permit-to-work being issued, to ensure that there is no confusion over divided responsibilities.

80 The person who accepts the permit (ie the person who is in immediate charge of the operation) becomes, from that moment, responsible for ensuring that all the specified safety precautions are adhered to, that only permitted work is done and that this is confined to the area defined in the permit. If the permit is issued to the leader of a group, the leader accepts responsibility for people in the group.

81 If the person issuing the permit will also be doing the work, it is strongly recommended that another person should make an independent check of the precautions taken. The person doing the work should then issue a permit to himself/herself. This routine helps to ensure that the full safety procedure is applied. The self-discipline is vitally important.

82 The recipient of a permit-to-work should keep it for reference while the work is in progress and to prevent inadvertent cancellation and re-energisation of the equipment.

83 When the work is complete, whoever the permit clearance was issued to should sign it to declare that any additional earths and tools have been removed and people in the group have been withdrawn and instructed not to approach the equipment again. The person clearing the permit should also indicate whether or not the equipment is fit for service. The permit is then returned, preferably to the

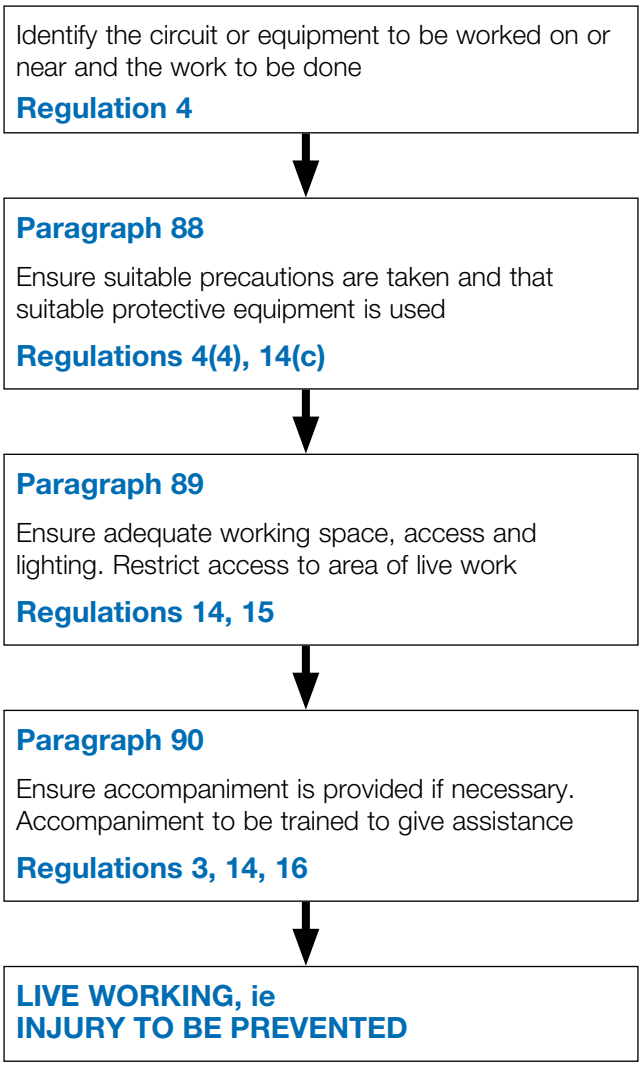
designated competent person who originally issued it, for cancellation before the equipment is re-energised.

84 To reduce the scope for misunderstanding when work is suspended, it is always preferable that the original permit is cancelled and a new one is issued when required. The suspension of permits-to-work is not generally recommended. Where, however, the practice is essential it will be necessary to have a written procedure to ensure that tools and additional local earths are withdrawn and everyone is aware that the permit has been suspended.

85 Any permit-to-work system should also have an additional procedure for monitoring (audit) to ensure that the safety rules are followed and the documents are completed accurately. The monitoring should preferably be carried out by someone with managerial responsibilities, who is not involved in the day-to-day issuing of permits and should be random and ongoing so that bad habits and inaccuracies can be identified and eliminated quickly.

Working live

Figure 5 Live working procedures



86 For the purposes of this guidance live working is generally restricted to:

- work on live, high-voltage equipment that is, for all practical purposes, limited to diagnostic testing (apart from certain specialised work by DNOs);
- work on live, low-voltage conductors that is for all practical industrial purposes limited to diagnostic testing, eg voltage measurement (apart from certain specialised work by DNOs);
- work near live, low- or high-voltage conductors that requires the rigorous precautions described in this guidance.

87 While it is not always possible to follow rigidly a set procedure to cover all situations, the following criteria should be met.

Take precautions and use protective equipment

88 The requirements of regulation 4(4) and regulation 14(c) have to be met and these have already been mentioned in paragraphs 22-29. The use of suitably insulated tools has been covered in paragraphs 26 and 48. Instruments and voltage detectors have been covered in paragraphs 49 and 50 and further information can be found in HSE Guidance Note GS38 *Electrical test equipment for use by electricians*. Some of the precautions necessary for live, high-voltage work have been covered in paragraphs 69-71. Advice on work near overhead lines is given in Guidance Note GS6 and on avoiding danger from underground cables in guidance booklet HSG47 *Avoiding danger from underground services*.[15]

Provide adequate working space, access and lighting and restrict other access

89 The requirements of regulation 15 are mentioned in paragraph 25 and Appendix 3 of the Memorandum should be referred to for more detailed information on working space. Further details on lighting at work can be found in guidance booklet HSG38 *Lighting at work*.[16] When working live, it is important to prevent non-authorised personnel from encroaching on the area of live work. To ensure control of the area, it is often necessary to provide some form of effective enclosures or barriers to prevent access to the live work area by people not involved with the work. Warning notices should be fixed to the enclosures or barriers.

Accompaniment

90 This is often necessary for working live, especially if an accompanying person can substantially contribute towards the implementation of safe working practice. If the risk is one of electric shock, evidence shows that prompt first aid is a significant factor in survival. The accompanying person should be trained to recognise danger, how to switch off and, if necessary, to give assistance in the event of an emergency. Help can also be given in restricting access to non-authorised personnel. In addition, a less experienced worker may need to be supervised to enable the work to be carried out safely.

Appendix 1:

Typical example of a permit-to-work

1 Issue:

To _____ in charge of this work.

I hereby declare that the following high-voltage apparatus in the area specified is dead, isolated from all live conductors and is connected to earth:

_____
_____
_____

Treat all other apparatus and areas as dangerous

The apparatus is efficiently connected to EARTH at the following points:

_____
_____
_____

The points of isolation are:

_____
_____
_____

CAUTION NOTICES have been posted at the following points:

_____
_____
_____

SAFETY LOCKS have been fitted at the following points:

_____
_____
_____

The following work is to be carried out:

_____
_____
_____

Diagram

Signed _____ Time _____ Date _____

Permit-to-work (front)

2 Receipt:

I accept responsibility for carrying out the work on the apparatus detailed on this permit-to-work and no attempt will be made by me or by people under my charge to work on any other apparatus or in any other area.

Signed _____ Time _____ Date _____

Note: After signing the receipt, this permit-to-work should be retained by the person in charge at the place where the work is being carried out until work is complete and the clearance section is signed.

3 Clearance

The work for which this permit-to-work was issued is now suspended*/completed* and all people under my charge have been withdrawn and warned that it is no longer safe to work on the apparatus detailed on this permit-to-work.

All work equipment, tools, test instruments etc have been removed.

Additional earths have been removed.

*Delete words not applicable and where appropriate state:

The work is complete*/incomplete* as follows:

_____

_____

_____

Signed _____ Time _____ Date _____

4 Cancellation

This permit-to-work is cancelled.

Signed _____ Time _____ Date _____

Permit-to-work (back)

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DD IEC/TS 60479-1:2005 *Effects of current on human beings and livestock. General aspects* British Standards Institution

6 BS 7671:2001 *Requirements for electrical installations. IEE Wiring Regulations. Sixteenth edition* British Standards Institution Available from the Institution of Electrical Engineers (IEE)

7 *A design guide for the electrical safety of instruments, instrument/control panels and control systems* Engineering Equipment and Materials Users Association (EEMUA) 1994 ISBN 0 85931 080 9

8 *Avoidance of danger from overhead electric powerlines* General Guidance Note GS6 (Third edition) HSE Books 1997 ISBN 978 0 7176 1348 9

9 BS EN 60900:2004 *Liveworking. Hand tools for use up to 1000 V ac and 1500 V dc* British Standards Institution

10 *Electrical test equipment for use by electricians* General Guidance Note GS38 (Third edition) HSE Books 1995 ISBN 978 0 7176 0845 4

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Further reading

HSE publications

Management of health and safety at work. Management of Health and Safety at Work Regulations 1999. Approved Code of Practice and guidance L21 (Second edition) HSE Books 2000 ISBN 978 0 7176 2488 1

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Personal protective equipment at work. Personal Protective Equipment at Work Regulations 1992 (as amended). Guidance on Regulations L25 HSE Books 2005 ISBN 978 0 7176 6139 8

Electrical safety on construction sites HSG141 HSE Books 1995 ISBN 978 0 7176 1000 6

Electrical safety at places of entertainment General Guidance Note GS50 (Second editon) HSE Books 1997 ISBN 978 0 7176 1387 8

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Selection and use of electric handlamps Plant and Machinery Guidance Note PM38 (Second edition) HSE Books 1992 ISBN 978 0 11 886360 5

Electrical safety in arc welding HSG118 HSE Books 1994 ISBN 978 0 7176 0704 4

British Standards

BS EN 50281 Parts 1, 2 and 3 *Electrical apparatus for use in the presence of combustible dust* British Standards Institution

BS EN 60079 Parts 10, 14, 17, 19 *Electrical apparatus for explosive gas atmospheres* British Standards Institution

BS EN 60903:2003 *Liveworking. Gloves of insulating material* British Standards Institution

BS 7375:1996 *Code of practice for distribution of electricity on construction and building sites* British Standards Institution

Further information

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Michael Faraday House, Stevenage, Herts SG1 2AY
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