HSE GUIDANCE

CARRYING OUT ELECTRICAL TESTING AT WORK

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RISK SOLUTIONS

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Introduction

Introduction

This leaflet is aimed at people who manage or carry out electrical testing, and provides guidance on controlling risks and preventing or reducing danger arising from these activities.

Electrical testing is a critical maintenance task that ensures that key equipment and systems are operating efficiently year-round. Specifically, electrical testing may be carried out for several reasons, such as:

- Quality assurance tests on electrical components
- Diagnostic testing
- Fault finding on electrical plants
- Routine safety checks

In these situations, this guide will provide beneficial information on testing low voltage equipment, such as industrial and domestic appliance. Low voltage is defined as not exceeding 1000 volts alternating current (ac) or 1500 volts direct current (dc). Most of this equipment will be used on mains supply voltages of 230 V ac single phase or 400 V ac three phase. However, there could be internally derived voltages which are much higher, and, in some cases, above the low voltage limits; these are still covered by this guidance.

During testing, some of the voltages applied to equipment may be above the low voltage limits. These voltages are not considered dangerous if the maximum output current available from the test instrument is reliably limited to no more than 3 milliamps (mA). (Note: BS EN 50191:2000, which came into effect in 2016, limited such outputs of test equipment to 3 mA ac; test equipment manufactured to the preceding standard may only be limited to 5 mA ac.)

The Law

The main legislation relating to electrical-testing activities are:

- **Electricity at Work Regulations 1989:** Regulation 4(3) requires that work on or near an electrical system 'shall be carried out in such a manner as not to give rise, so far as is reasonably practicable, to danger'. Regulation 14 places a strict prohibition on working on or near exposed live conductors unless:
    - It is unreasonable in all circumstances for it to be dead
    - It is reasonable in all circumstances for the work to take place on or near the live conductor
    - Suitable precautions, including the provision of suitable protective equipment where necessary, have been taken to prevent injury
- **Management of Health and Safety at Work Regulations 1999:** Requires that a suitable and sufficient risk assessment is made

Risks Associated With Electrical Testing

Injury can occur when:

- Live electrical parts are exposed and can be touched
- Metalwork that is meant to be earthed becomes live at a dangerous voltage

It is more likely that this will happen during electrical testing and fault finding, when conductors at dangerous voltages are often exposed. You can minimise this risk if testing is done while the equipment is isolated from any dangerous source of supply, although this is not always possible. Take care to prevent contact with any hazardous internally produced voltages.

The most serious injuries are caused by electric shock. The effects of a shock are largely unpredictable and can easily lead to a fatal injury. However, there is also a risk of burn injuries from arcing when conductors are accidentally short-circuited. Another risk can be caused by a person reacting to an electrical injury, such as falling from an access ladder or being traumatised by the experience.

Electric shocks occur when contact with a live conductor causes sufficient current to pass through the body to cause an injury. As a rough guide, voltages exceeding 50 V ac or 120 V ripple-free dc are hazardous in a dry, unconfined, non-conductive location. These voltage values must be reduced if the location is wet or confined or conductive; so, where there is an adverse environment, those in charge of the work and those doing the work should be aware of the probable increase in injury risk.

In some equipment, such as microwave ovens, voltages of several thousand volts are used and there is a very high risk of fatal injury if the exposed conductors are touched. Currents as low as 5 mA or stored charges can also cause injury. You must take suitable precautions to prevent contact with stored charges in excess of 350 millijoule (mJ).

If the skin is pricked or cut at the point of contact, the shock current (and the seriousness of the injury) will be higher. Healthy skin may also become damaged at the time of contact, either by the burning effect of the current or by penetration from sharp-ended conductors.

Carrying Out a Risk Assessment

You must carry out a risk assessment before testing begins to help you identify the measures to take. Consider the following when assessing the risk of injury from electrical-testing work:

- The level of voltage, charge or current
- The nature of the environment

You also need to think about the hazards that are present, who may be harmed and how, and the effectiveness of existing precautions. Bear in mind the factors in the bulleted list that follows, which might increase the risk. Some questions to ask when carrying out the risk assessment include:

- Can the work be done with the equipment dead or energised at a safe voltage or current?
- Is it absolutely necessary for someone to be working on or near equipment that is live at dangerous voltages or current levels?
- What is the maximum voltage on conductors that will be exposed during the work activity?
- Are the testers competent? Are they adequately trained and knowledgeable, or do they have sufficient experience to carry out the work without risk to themselves and others?
- If the testers are not considered fully competent, are they adequately supervised?
- Are the testers able to supervise the working area sufficiently and at all times, to prevent danger to others?
- What physical safeguards should be applied to the equipment under test to prevent injury (eg, the use of temporary or permanent screens)?
- Is the test instrumentation safe? Has it been properly maintained?
- Do you need to set up a permanent test area separate from the rest of the workplace, where equipment can be taken for testing? Do you need to set up a temporary test area around the equipment?
- Where testing is part of an ‘after sales service’, how much must be done at the customers’ premises? If testing is being done in a customer’s home, what special precautions are required to protect the tester and others?
- If the testers design, manufacture or use any special test equipment, does it meet BS EN 61010–1?7
- How big is the unit under test and how much space is required around it to undertake the testing in a safe and unconfined manner?
- Are all the other workshop employees competent enough to avoid danger if they need to approach the equipment? If not, how can you make sure they don’t approach?
- Will the equipment be left unattended while live (eg, while being ‘soak tested’)?
- Does the workbench or separate area require a warning, such as a light, to show that testing is in progress?
- Do you need additional emergency switching devices for other employees to use in order to reduce the degree of injury to testers? Can residual current devices (RCDs) be used to provide supplementary

protection? (Note that this guidance and the complementary information sheets refer to RCDs or 30 mA RCDs. See 'Residual current devices' for a more complete explanation.)

- Is it possible to reduce the number of available paths to earth in order to reduce the likelihood of a phase-to-earth shock (eg, by using barriers, screens and insulating mats)?
- Is it possible to use unreferenced supplies, like isolating transformers/batteries, to reduce the likelihood of a phase-to-earth shock?

An assessment of first-aid needs must be carried out. Due to the hazards involved in your workplace, it is likely that this will have identified the need to provide first-aiders who can give immediate help to casualties at all times. First-aiders should have had suitable training, appropriate qualifications and remain competent to perform their roles.

Make a record of the significant findings from your risk assessment: the hazards, how people might be harmed and what controls you have in place to control the risks. If you have fewer than five employees, you do not have to write your risk assessments down. However, it is useful to do this so you can review it later. You must ensure that you tell those carrying out the testing about the risks you have identified and what action they must take to control them. If you have five or more employees, you are required by law to record your risk assessment.

Managing Electrical Testing

You must provide a safe working environment and establish a safe system of work for your employees (see 'Safe systems of work'). The results of your risk assessment will help to identify the steps you need to take to do this. Employees must cooperate and take reasonable care for their own and other people's safety while they are at work. Consider the following advice for all activities involving testing.

Provide information

Before carrying out any testing, you must provide information so that all workers (including any relevant third parties, like those attending witness tests) can do the following:

- Understand that the risk of electric shock injury will still remain during the testing process, even with the use of earth-free test areas and/or isolating transformers and/or RCDs
- Fully understand the scenarios in which these electric shock injury risks can arise in a particular workplace

In addition, it is recommended that employees receive adequate first-aid training, including cardiac pulmonary resuscitation (CPR) skills.

Permanent test areas

These areas:

- Must be under the control of a responsible person
- Must have adequate space, access and lighting, including clear working space and good housekeeping arrangements
- Should be accessible during testing only to authorised employees or people working under their direct supervision—this may include an area set apart by barriers to prevent entry
- Should have warnings, as determined by your risk assessment, such as warning signs at the entrance, warning lights indicating that testing is in progress and other such lights to indicate when it is safe to enter the area (duplicate red and green lights are often used)
- Should have emergency stop push buttons or equally effective means to cut all test supplies if there is an emergency. These emergency controls should be prominently identified. (Note that the emergency controls should not remove supplies to the general lighting in the area.)
- Should, where necessary, provide first-aid information, such as displaying an electric shock poster at prominent locations, that shows emergency arrangements, especially telephone numbers

Temporary test areas

In some situations, it may not be possible to remove equipment to a permanent test area, because the equipment is too large for the test bay or is located at the customer's premises. If live testing needs to be carried out, set up a temporary test area around the equipment, and take the precautions listed above for permanent test areas. If it is not practicable to do this, make an assessment of what precautions are needed to reduce that risk to as low a level as possible.

Remember that simple ‘Go/No go’ plug-in socket testers will, in general, only provide a polarity check and an indication that an earth may be present, but not a check of its effectiveness. Further information on socket testers is available from the Electrical Safety Council.

Earth-free areas

Make a test area as earth-free as possible, in conjunction with the use of isolated supplies. To achieve this, take the following precautions:

- Use a test bench made of insulating material with shrouded legs and framework to prevent the possibility of contact with earth while testing.
- Remove all pipes, radiators, structural steelwork, metal conduits, earthed electrical appliances, metallic socket outlets, etc., from within reach of the test bench, or permanently shroud them with insulating material to prevent contact.
- Where soldering irons and task lighting are needed, they should be extra low voltage, supplied from an isolating transformer that complies with BS 6155810 in order to prevent the need for earthed metal at the test area.
- If a television or radio aerial socket is needed at the test area, it should be of isolated construction, complying with BS EN 60065.
- Provide insulating rubber matting that complies with BS EN 6111112 on the floor. Keep the rubber matting clean and dry and test it regularly. It should be large enough for the test operative to remain on it whether he or she is standing or seated during testing (note that chair legs may damage the matting).
- If electrostatic discharge wrist straps are provided, these must incorporate a suitable resistance (typically 1 Megohm or more). Using a wrist strap which directly connects the wearer to earth is not permissible. For further advice, see BS PD CLC/TR 61430–5.2:2008.13.

Supplies to equipment under test

Provide each item of equipment under test with its own test supply. These supplies should be from designated sockets or terminals provided with covers, interlocked with the supply isolator. The supplies should have suitable system protection against overload and overcurrent in the event of faults (eg, fuses). Note that:

- Where an isolating transformer is used for the supply to the equipment under test, it should comply with BS 61558 and a separate transformer should be used at every test bench. If this is not reasonably practicable, the same isolating transformer may be used for supplies to alternate benches, provided that the risk of referencing this supply to earth at any bench is properly controlled and the transformer does not then have an unacceptably high leakage current.
- The supply from the isolating transformer should be provided from a single socket outlet and clearly marked ‘only for use for making live equipment under test’. No fixed wiring should be connected to the earth terminal of the outlet socket. The face plate of the socket should be made of insulating material. There must be no unnecessarily exposed live parts on equipment under test.
- In certain circumstances, Class I equipment under test must be effectively earthed unless supplied via an isolating transformer. This will bring with it an increased risk of electric shock which may be minimised by using other precautions.

- When the equipment under test is Class I, any pre-existing earth fault must be detected and corrected before making the equipment live. In the case of the supply from an isolating transformer, failure to do this will mean that there may be a hazardous shock risk if there is simultaneous contact between the enclosure of the equipment and one or both poles of the isolated test supply.
- The integrity of the circuit protective conductor (earth) of all portable/transportable Class I equipment must be retested after all test-bench work has been completed to ensure there are no earth faults before the equipment is used again on a normal mains supply.

Risk assessment: Test equipment and electricity supplies

All measures used to control the risk of electric shock should follow the hierarchy given below:

- Eliminate the risk (eg, by working with the equipment dead); or, if you can't eliminate the risk
- Minimise the risk by using a safer voltage or current;
- Control as many of the risks as possible by hardware methods;
- Control all other foreseeable risks by the use of safe systems of work. These must be made known to and fully understood by all staff involved, regularly monitored, and recorded in written form (for reference as well as to allow them to be refined or amended as and when needed)
- Use competent workers who must possess the necessary level of technical knowledge and experience (or be supervised by a competent person) to prevent risk of injury (see 'Competence of testers').

If the hardware precautions resulting from the risk assessment identify the use of isolating transformers as the source of supply to mains-powered test equipment, then you should provide these transformers. They should be separate from the equipment under test. An instrument shelf should be provided for that equipment.

Some of the risks associated with the use of test equipment can be reduced, but not eliminated, by placing all test equipment on an insulated shelf immediately above the test bench. This will reduce the chance of simultaneous contact between the test equipment and the equipment under test.

When the hardware precautions resulting from the risk assessment do not include the provision of isolated supplies to the mains-powered test equipment, all supplies to test equipment should be protected by 30 mA RCDs. Note that for supplies over 16 A to equipment under test, or where the equipment under test has a high leakage current, it may not be practicable to use an RCD because of nuisance tripping. For further advice, see BS 7671 (Chapter 54, clause 543.7).14.

Setting Up Safe Test Areas

By setting up a controlled test area, you can ensure that anyone not involved with electrical testing is kept free from risk. This can be done by setting up a controlled test area, such as:

- A designated room built as a test area with special protection features and fitted with secure doors (possibly interlocked, depending on the degree of risk) to prevent unauthorised access
- An area set aside in a workshop with some form of a permanent barrier as a boundary to prevent unauthorised access
- A work bench which might be designed as a test bench or used for repairs and testing;
- A designated work position in, or at the end of, a production line
- A temporary area setup around equipment using purpose-built barriers as demarcation
- An area around fixed equipment, such as switchgear or control gear, where skilled people are carrying out repairs, fault-finding or testing during maintenance work.

In workshops where all employees have been adequately trained and instructed in safety practices and all unauthorised personnel are effectively excluded, local demarcation of the workbench or work area where testing is done may not be needed. Make sure all employees are aware that those carrying out testing should not be distracted by others who are not involved with the test in progress.

Protecting the People Doing the Testing

You must put effective measures in place to protect the people doing the testing, in order to prevent them from coming into accidental contact with dangerous exposed conductors. This might be either a single-hand contact with a source of energy which has one of its supply conductors connected to earth, or another area of conducting surface.

Class I equipment is in this category because the mains at source are earth-referenced; so is electronic equipment where a large metal surface (or chassis) is connected to the source. There is also a risk of injury from sources of supply which are not earth-referenced and where accidental simultaneous contact with both poles of the supply is possible.

Methods of reducing the risk of a shock from simultaneous contact with conductors include:

- Using interlocked test enclosures in which the unit under test is contained
- Using temporary insulation
- Replacing covers which need not be removed for the purposes of the test (eg, once supply connections have been made)
- Creating an area which is as earth free as practicable
- Using isolating transformers connected to the mains supply
- Using 30 mA RCDs

The following sections provide more detail about each of these protective measures.

Safe voltages and currents

It may be possible to test the equipment by energising it with non-hazardous voltages and current levels. Always consider this the first option before deciding to use dangerous voltages and current levels.

Interlocked enclosures

These can vary in size from a small bench-mounted box with an interlocked, hinged lid to a large enclosure (large enough for people to enter) equipped with access gates which are secured by interlocks. It is important to make sure that the safety performance of the interlocking system is comparable to that of a switching device used for isolation purposes. The use of a trapped key (key exchange) system interlocked with the access and the isolator can help. In general, interlocking using the control system alone is not acceptable; the power supply should be isolated by the interlock system.

In certain circumstances, there may be the potential for a stored charge to occur, like from the use of capacitors. In these circumstances, the supply to the equipment under test should be earthed, preferably automatically, before entry is made. If it is not possible to earth the equipment automatically, it should be manually earthed by the use of a suitably insulated earthing tool. Where automatic earthing is used, it is essential to also use a manual earthing device before making contact with any parts that have previously been made live.

Where large enclosures are used, you must make sure people cannot be inside the enclosure while there is danger from the equipment being tested.

Temporary insulation

Where there is risk from simultaneous contact with hazardous conductors, do not assume employees will be able to avoid accidental contact. Consider using temporary insulation which may be in the form of purpose-made screens or insulating sheets or shrouding (rigid or flexible). However, there may be a practical limit on using screens when testing compact electronic assemblies.

Earth-free areas

It is difficult to achieve a true earth-free area, as you need to make sure floors and walls will not conduct current which can cause shock injury. So, suitable insulating materials, including mats, are needed to construct an earth-free area. These parts will then have to be tested at regular intervals to demonstrate that their insulation properties are being maintained.

An area which is as earth free as practicable can be more easily created, but you need to carry out a thorough risk assessment to ensure that the testers will not make accidental contact with any earthed conductors. Enclose items such as heating and water pipes and radiators, or situate the test area to prevent simultaneous contact by the tester with the item under test and the earthed item. Earth-free areas should have the minimum of exposure of conductive parts. A 30 mA RCD could be used as supplementary protection. Earth-free areas are often used in conjunction with isolating transformers.

Where it is not possible to make an area earth free because the test equipment and/or the equipment under test needs to be earthed, it is still possible to reduce the extent of the accessible earthed metalwork.

Isolating transformers

Isolating transformers connected in the test supply will prevent the risk of electric shock if a person touches a single live conductor of the isolated supply while in contact with an earthed conductor.

It should be clearly understood, however, that an isolating transformer cannot prevent an electric shock if someone makes contact simultaneously with both conductors of the supply on the secondary side of the transformer, unless the output voltage is below 50 V ac (120 V dc) in dry conditions and 16 V ac (35 V dc) in wet conditions. Test the integrity of the isolation from earth regularly, or install earth fault-monitoring devices, to ensure that dangerous earth faults are detected.

Residual current devices (RCDs)

These are supplementary protection devices which do not prevent an electric shock, but are able to limit the duration of some shocks by being able to cause rapid disconnection of the electricity supply if there is a relatively low current flowing to earth, such as what may occur during an electric shock. They are, therefore, able to provide a much higher level of protection against the risk of a severe electric shock than what could be provided from an unprotected source.

An RCD required to minimise the risk of personal injury should have a rated tripping current of no more than 30 mA and should not have an adjustable time delay.

Although the 30 mA versions are often used, those with lower rated tripping currents (typically, 10 mA or below) are readily available and may be used to provide additional protection where nuisance tripping is not a problem.

Where personal safety depends, in part, on the operation of an RCD, the RCD must be tested using the built-in test facility at appropriate intervals (eg, portable RCDs before each use, fixed RCDs weekly). Also, all RCDs should be tested at least annually using an RCD tester, which will check the tripping current and the speed of operation.

Choosing Test Equipment

Where possible, test equipment should be of a proprietary design. In this case, the manufacturer should have taken an account of its safety performance during use. Where applicable, test equipment should be manufactured to BS EN 61010.

Purpose-built test equipment must be designed and constructed to the same standards of safety as proprietary equipment. Where equipment is mains-powered, it must be safe to use as a piece of electrical equipment in its own right. In addition, the arrangements for connecting it to the equipment under test must be safe.

Insulation test instruments can generate high voltages at their output, and some have the option to limit the output current to a safe level. Since 2001, test equipment constructed to BS EN 61010 has the output current limited to 3 mA; older test equipment may be limited to 5 mA. If accidental contact with the output conductors occurs, the risk of injury will be minimised if these current levels are not exceeded. If higher current levels are necessary, put special precautions in place to prevent injury. These include using test probes fitted with control switches, or using interlocked enclosures to prevent access to the dangerous parts, and restricting the testing work to authorised people. Most insulation-testing can be done within the safe current limits specified above.

The connecting leads of test equipment must be of a design that provides adequate protection from electric shock. The only exception to this is when test lead connections are inside an interlocked enclosure and are connected to and disconnected from the equipment under test, while the source of supply is isolated and measures are taken to ensure that any stored energy is dissipated. In this case, the connecting lead conductors become an extension of the conductors being tested and present the same risk of injury.

Test instruments

This section applies mainly to oscilloscopes but can sometimes apply to other instruments, like signal generators.

Hazardous voltages may arise on the enclosures of Class I (earthed) oscilloscopes, or, in some cases, on certain types of double-insulated, Class II oscilloscopes. The hazardous voltages may arise from the voltages being measured on the equipment under test, or, in some cases, from the breakdown of the insulation of the oscilloscope itself. The measurement problems arise because most oscilloscopes have the ‘signal common’ terminals connected to the oscilloscope’s chassis and its enclosure and connectors.

In a Class I oscilloscope, these parts are connected to the supply protective conductor. This means that all measurements must be made to earth which limits the measurements that can be made by the oscilloscope. A technique has been developed to ‘float’ the oscilloscope (ie, remove the connection to the supply protective conductor) which then allows the oscilloscope’s enclosure to float above earth potential (which could be at high voltages for some types of measurement) with obvious possible shock risks. Operation of an oscilloscope with the protective conductor removed means that it is no longer protected against internal insulation breakdown. Another disadvantage with this situation is that it will then be necessary to attempt to create an earth-free area. Such use also defeats the equipment manufacturer’s primary protection concept for Class I protection and should be discouraged.

A number of methods have been developed to allow floating measurements to be made more safely. One method is to supply the oscilloscope via an isolation transformer, so removing the earth reference in the supply and allowing floating measurements. The advantage of this method is that an earth-free area is not required, but the disadvantage is that the oscilloscope is not protected against internal insulation breakdown to the chassis. (The oscilloscope’s internal insulation could be overstressed if high-voltage measurements are being taken.)

A second method is to use a proprietary isolation monitor (sometimes called a line isolation monitor or an earth (ground) isolation monitor) in the supply to the oscilloscope. While this allows the oscilloscope to operate with its protective conductor disconnected, the monitor continuously checks the voltage between the oscilloscope's enclosure and the supply earth. If the oscilloscope's enclosure reaches a hazardous voltage, the monitor removes the mains supply to the oscilloscope and usually reconnects the supply protective conductor. A typical operational setting for a monitor would be about 30 V RMS. The oscilloscope would still be protected against internal insulation breakdown.

The disadvantage is that it can only be used to measure low-level signals because the oscilloscope's internal insulation could otherwise be overstressed.

In recent years, developments have led to various devices that can be used in an oscilloscope's measuring probes which allow the Class I oscilloscope to be earthed to the mains supply, but which isolate the measured voltages to prevent them from appearing on the oscilloscope's enclosure. Modern proprietary devices use various techniques to achieve isolation (like opto-isolators) and typically allow measurements to be made ranging from millivolts to thousands of volts. Bearing in mind the risks involved, such isolators should be regarded as being reasonably practicable safeguards. The isolation devices come in several forms and may have slightly different names, according to the manufacturer. Some of the common names for these devices are: isolation amplifiers, differential amplifiers and isolation probes. Correct selection of device, according to the measurements to be made, is important. The user should seek the manufacturer's advice.

Some manufacturers now offer oscilloscopes with isolated inputs (ie, where the measured inputs are isolated from each other and from the oscilloscope's chassis), up to reasonably high voltage levels (typically 850 V peak ac and dc). Consider using these as well as all-insulated, Class II oscilloscopes. Battery-operated oscilloscopes which can be used up to reasonably high-voltage measurement levels are available. These are not referenced to earth.

It is good practice to include an RCD with a rated tripping current of, at most, 30 mA in the power supplies to Class I instruments, soldering irons and any other mains-powered equipment. If isolation transformers are used to supply power to fixed socket outlets as part of a distribution system for test supplies, the sockets should be of a different type to standard sockets, or of the polarised type, to make sure they are only used for the purpose intended.

Ensuring Safe Systems of Work

Details of safe systems of work for testing activities should, wherever it is reasonably practicable to do so, be documented. To produce a workable system, all personnel should be involved in preparing the safe systems of work. The completed documents, which will need to be reviewed from time to time, should be made readily available to employees.

Where testing is confined to diagnostic testing on electrical distribution systems and equipment (eg, switchgear), by electrically competent persons, the contents of the written documents should cover the essential safe working practices. They may not need to cover the inherent background knowledge of such a competent person (this will, of course, depend on the experience of the competent person).

Test personnel employees who work in customers' premises might have to work under different rules, as compared to working at a factory-based test facility. This means that there may need to be two sets of rules. Take this into account when producing the safe system of work. The contents of the written safe systems of work should include, at a minimum, details of:

- Who is authorised to undertake testing, and, where appropriate, how to access a test area and who should not enter the area
- Where temporary test areas are constructed and how this is to be done
- Rules for isolating equipment and how the isolation is secured
- The correct use of additional protection measures, such as flexible insulation, that have to be applied to the equipment under test while its covers are removed. If it is considered necessary to apply the insulation and remove covers while the equipment is live, this risk should also be assessed.
- What form of power supply to use to energise the equipment under test, particularly where using the wrong method would compromise safety
- What is expected of test personnel regarding the inspection of test equipment before use, and how to report defects
- The correct use of any warning devices that form part of the safety system at designated test areas
- Instructions about what action to take in an emergency situation
- Procedures to follow when the testing is undertaken by a contractor (see 'Competence of testers')

Training

All personnel involved in testing should be given specific safety training that is relevant to the work they are doing. Appropriate training or instruction must also be given to anyone who may attempt to enter test areas and approach test benches.

You are likely to need to provide new training whenever any of the following changes take place:

- Product design, layout and installation
- Production or working methods
- Test methods and instruments
- Test personnel and others who may be affected

Competence of testers

Ensure people working on electrical equipment or systems are 'competent' for the task.

Being competent means having suitable training, skills and knowledge for the task in order to prevent injury to yourself and others.

In small businesses, skilled electricians or technicians are sometimes employed to look after the day-to-day operation of the electrical systems. If such people are involved in setting up testing arrangements, make sure that they are aware of all aspects of safety relating to testing. Specialist competent advice may be needed to make sure that the testing procedure is safe.

When setting up a testing area, it is important that everyone, and in particular those who are electrically unskilled or inexperienced, are protected from electrical danger at all times. Appropriate precautions will also need to be taken to prevent people who have electrical knowledge and skills from being injured. Remember that even a skilled person can make accidental contact with dangerous electrical conductors if he or she is not protected. Do not rely on someone's personal electrical competence as his or her main protective measure.

Review precautions regularly, as part of your risk assessment process, to make sure they are being followed and are still appropriate for the work being done. As part of this safety review, give employees sufficient instruction and training on how the safe working procedures have been amended. This is especially important where there is a change in the design of the products being tested which is relevant to how the protection concepts are applied.

Designs should be reviewed, implementing any necessary changes to safety procedures after discussions with the test personnel. A safety review must be carried out when changes are made that may affect testing work, such as changes in production methods, supply arrangements, test methods and instruments, or when personnel changes are made.

Where testing is done by a contractor, safe working arrangements must be discussed and agreed upon before the work starts, preferably at the contract discussion stage. This enables everyone concerned to know who is doing what and who is responsible for what, so the work can be done safely and without risk to the contractor's employees, the site employees and others who might be affected. In particular, the person who is responsible for the safe isolation and state of the equipment should be identified and agreed upon.