NHS National Services Scotland

Servicing and repair of medical electrical equipment

Safety during hazardous live testing

Scottish Health Technical Note

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Contents

Preface

Working with live electrical equipment presents significant hazards that demand careful attention, thorough preparation, and strict adherence to safety protocols. The importance of clear, comprehensive guidance in this area cannot be overstated. Such guidance is essential not only for safeguarding the health and well-being of personnel but also for ensuring operational continuity, minimising the risk of costly damage, and maintaining compliance with legal and regulatory standards.

Live equipment poses inherent dangers, including the risk of electric shock, arc flash incidents, burns, and even fatal electrocution. Additionally, improper handling can lead to equipment failure, fire hazards, and broader safety incidents that may affect entire facilities. These risks underscore the need for structured procedures and well-informed practices.

Effective guidance serves as a critical tool in mitigating these dangers. It provides workers with the knowledge required to identify potential hazards, implement appropriate control measures, and use personal protective equipment (PPE) correctly. It also outlines the necessary steps for planning and executing tasks safely, including lockout/ tagout procedures, risk assessments, and emergency response protocols.

By fostering a culture of safety and awareness, such guidance not only protects individuals but also contributes to a more resilient and responsible working environment. This document aims to support that goal by offering practical, actionable information for anyone involved in the operation, maintenance, or inspection of live equipment.

1. What is this guidance about?

1.1. This Scottish Health Technical Note (SHTN) contains advice on the means of achieving safety during hazardous live testing of medical electrical equipment. It provides guidance on the prevention of danger to test personnel and other persons. The guidance is based on Health and Safety Executive (HSE) guidance leaflet INDG354 (1).

2. What are the hazards?

2.1. In addition to injuries from falling objects, moving parts, pressurised systems, high and low temperatures, chemicals, ionizing and non- ionizing radiation and so on, a significant danger to people carrying out live testing of medical electrical equipment is electric shock or burns. Electric shock can lead to serious or fatal injury, either due to the current itself or from injuries sustained when a person reacts to an electric shock, for example by falling or touching another hazard. Burn injuries may result from current flowing through the body, including high frequency 'diathermy' currents, or as a result of arcing when conductors are accidentally short-circuited. Medical electrical equipment such as defibrillators may also contain dangerous levels of stored electrical energy.

What is hazardous live testing?

2.2. Any situation where contact with exposed live parts is possible should be considered hazardous. However, live parts are not considered to be hazardous if one of the following conditions, defined in British Standard (BS) EN 50191 (2), is met:

A. the voltage at frequencies above 500 hertz (Hz) do not exceed 25 volts (V) alternating current (AC) or 60V direct current (DC) and complies with the requirements for Separated Extra-Low Voltage (SELV) or for Protective Extra-Low Voltage (PELV) as defined in BS7671 (3)

B. in the case of voltages at frequencies up to 500Hz exceeding 25V AC or 60V DC, the resultant current through a non-inductive resistance of 2 kilo-ohm (kΩ) does not exceed 3 milliamps (mA) AC (root mean square (rms)) or 12mA DC

C. at frequencies above 500Hz no hazardous body currents or contact voltages occur. (Permissible body current and contact voltage values at different frequencies may be found in Table A1 of the standard)

D. the discharge energy does not exceed 350 millijoule (mJ)

How can injuries happen during testing?

2.3. Any activity where there is a risk of direct or indirect contact with exposed conductors that are live at hazardous voltages may result in an electric shock. Simultaneous contact of a part of the body with a conductor that is hazardous for example connected to the mains supply while another part of the body is in contact with a return path, such as earthed metalwork, which may result in electric current passing through the body. If the current is high enough, this will be experienced as electric shock.

2.4. The risk of electric shock is highest where:

- equipment to be repaired contains a hazardous fault for example a short circuit, fluid ingress, earth-fault, loose component or damaged insulation
- measurements or adjustments are made with normal protective covers removed
- the equipment under test (EUT) produces a hazardous output such as surgical diathermy
- there is a deliberately applied fault condition or test voltage during electrical safety tests
- the equipment for example a defibrillator contains stored energy

2.5. The risks may be further increased by:

- equipment with large areas of earthed metal - easy to touch at the same time as touching a live part
- sharp conductors or components - shock current will increase if the sharp end of a conductor penetrates the skin
- handling circuit boards which generate hazardous voltages or have stored energy for example capacitors
- inappropriate test leads - fail to provide adequate isolation from live parts
- inappropriate or incorrectly used test equipment - may expose the tester to hazardous voltages (see oscilloscopes)
- carrying out work on a ward or in a patient's home - other staff, patients or visitors (including children) are put at risk and their actions may place the tester at risk
- an electrical installation, such as in a patient's home, that is not electrically sound with regard to earthing, insulation and/ or polarity

Controlling the risk

2.6. The risk of electrical injury during hazardous live testing can be reduced to an acceptable level by:

- working in a designated test area, either permanent or temporary, that satisfies the principles set out in this Scottish Health Technical Note (SHTN)
- the work being carried out by competent staff using safe systems of work, including the use of appropriate tools, test equipment and personal protective equipment, based on a suitable risk assessment

2.7. The following paragraphs expand on these general principles.

Carrying out a personal risk assessment

2.8. Before starting hazardous live testing of medical electrical equipment, the tester needs to assess the risk of injury, damage to property or equipment, the effect on other people and the effectiveness of precautions or protective measures. The tester should bear in mind factors which might increase the risk, especially those given in this SHTN. When carrying out a risk assessment for electrical testing, the tester should ask himself or herself the following questions:

- are there other hazards that need to be considered, for example contact with moving parts, laser emissions, high temperatures?
- can the work be done with the equipment isolated from the electrical supply? (Repairs and replacements of faulty parts can and should be done with equipment isolated from the supply)
- can I work unimpeded and without distraction?
- is there a safer method of fault-finding or adjustment, such as software diagnostics?
- what voltage or current is likely to be present?
- are there any special electrical hazards, for example high voltage (>1kV), high frequency, and so on?
- is the right test equipment available, with leads?
- have persons not involved in testing been protected from danger?
- is it possible to carry out the work in a safer place?
- should an isolating transformer and/ or Residual Current Device (RCD) be used?
- can additional measures be employed to prevent contact with live parts?
- are there components, such as capacitors, which may retain significant charge that should be allowed to dissipate or require special arrangements for discharging?
- do I need to use eye protection or other personal protective equipment (PPE)?
- am I competent for that type of work, or am I adequately supervised?

If the risk assessment concludes that hazardous live testing must be carried out, it will be necessary to decide on the precautions to be taken against injury.

What precautions should be taken?

2.9. Where possible, the work should be done with the equipment isolated from the supply, such as connected to an isolation transformer and **not** directly to the mains supply (this is a requirement of the Electricity at Work Regulations 1989). If this is impossible or unreasonable, one or more of the following may be employed to prevent contact with exposed live parts:

- replace the equipment covers for the duration of the test

- attach and detach measuring probes only with the EUT isolated from the supply
- use temporary insulation, or modified covers, to allow access for adjustment while maintaining protection against contact with hazardous live parts
- use instruments and test leads which provide adequate protection/ isolation for the voltages measured
- prevent unauthorised people from approaching EUT by the use of signs and barriers or other appropriate access control. (This must not obstruct any escape route)

If hazardous live parts cannot be shrouded safely and reliably, work should be carried out in a test area, constructed in accordance with EN 50191 (2), and as described below.

Test Areas

2.10. A test area may be permanent, such as a room or part of a workshop, or temporary such as created around equipment at or near its point of use.

General

2.11. To ensure a safe working environment for all personnel, strict safety measures must be observed in and around workshop and test areas. These protocols are designed to minimise risk, control access, and promote awareness of potential hazards. From clear signage and physical barriers to the use of PPE, each measure plays a critical role in protecting individuals from electrical and mechanical dangers. Only trained and authorised personnel should enter designated test zones, and all staff must remain vigilant and always informed about safety procedures:

- warning signs should be placed at the entrance to the workshop and at the live test area
- the workshop should have on display an Electric Shock First Aid Guide
- all test areas should restrict access by unauthorised persons
- physical barriers may be necessary if site location, signs and monitoring by staff do not provide sufficient control over entry
- only those persons who have received adequate instruction regarding the hazards should be permitted to enter a test area
- any person working in a test area should be fully aware of the existing hazards and has a duty to take safety precautions in order to protect both themselves and others from risk. This should include using appropriate PPE
- in general, a temporary test area may require greater effort to create and make safe compared with using a permanent test area and should only be used where equipment is fixed or cannot reasonably be moved to a permanent test area

Permanent test areas

2.12. To reduce the risk of electric shock, hazardous live testing areas should be as earth free as possible.

Construction

2.13. To minimise the risk of electric shock and ensure a safe working environment, it is essential to eliminate or insulate any accessible metalwork within the work area. This includes using non-conductive materials for work surfaces, floor coverings, and electrical supply components. Even unearthed metal objects can pose a hazard if they encounter grounded items. By carefully controlling the materials and layout of the workspace, we can significantly reduce the potential for accidental grounding and improve overall safety:

- there should be no earthed metalwork accessible to someone in the work area
- insulating material such as wood should be used to construct the workbench and any exposed metalwork such as trunking or service pipes should be covered with an insulating shield, even if not earthed. Unearthed metalwork still presents a risk if it could be earthed inadvertently (for example by contacting an earthed object)
- cover plates for electrical supplies should be non-conducting, such as plastic
- the floor should be covered with an insulating material such as vinyl or a rubber mat to BS921 (4)
- plaster walls are acceptable. Metal shelves could provide an earth path and should be avoided

Electrical supply

2.14. To ensure safe testing conditions, all electrical supplies within the test area must be carefully managed and clearly identified. Isolated supplies should be provided via compliant isolating transformers, with outlets clearly marked and free from earth connections. Where earthed supplies are necessary, they must be RCD-protected and clearly labelled. Emergency preparedness is equally vital—an accessible emergency stop button must be installed to allow immediate disconnection of power in critical situations. These precautions are essential to protect personnel and equipment during testing operations:

- an electrical supply derived from an isolating transformer complying with BS EN 61558-2-4 (5) should be provided for the EUT. The two-wire output is taken to a mains socket outlet clearly marked ‘Isolated, earth- free, for test purposes only’. The earth terminal of this outlet must be isolated and not connected to earth.

- if socket outlets having earth-referenced supplies are required in the test area, these should be protected by an RCD with a tripping current of no more than 30mA. The RCD should be tested before each period of use. The supply outlets must be clearly labelled 'earthed supply', be non-conducting and have a protective earth connection. These outlets should be used with caution (see - Is the test area safe? and Surgical diathermy)
- an emergency stop button should be provided adjacent to the work area, so that all electrical supplies to the area (except lighting) can be interrupted by others in the event of an emergency
- additional isolated supplies from a separate isolation transformer may be required to power test equipment. Portable isolating transformers may be suitable for this purpose, but there should be no earth on the outlet from the transformer

Note 1: Oscilloscopes should not be operated earth free or isolated. See under Oscilloscopes.

Access and signage

2.15. Controlling access to live test areas is essential for maintaining a safe working environment. Physical barriers such as doors, gates, or partitions, combined with clear and visible signage, help prevent unauthorised entry and alert personnel to potential hazards. Warning signs like 'No Unauthorised Entry', 'Danger of Electric Shock', and 'High Voltage Test Area' must be prominently displayed. In some cases, illuminated warnings or the presence of personnel may serve as additional indicators that live testing is in progress. These measures are critical to ensuring safety and compliance during high-risk operations:

- access to the live test area should be restricted. Precautions may include doors, barriers or gates, combined with suitable signs. If the workshop itself, and position of the live test area within it, provides a good level of restriction of entry, the live area may require no further physical barrier
- signs should be displayed at the test area, declaring the purpose of the facility and warning of the danger. It may be considered appropriate to provide an illuminated warning which is switched on when the area is in use. However, the presence of a person working in the area may provide sufficient indication that live testing is in progress
- typical signs would include 'No Unauthorised Entry' and 'Danger of Electric Shock'. 'High Voltage Test Area' should be displayed at the test area itself

Temporary test areas

2.16. Temporary test areas should be created where hazardous live testing is to be carried out on fixed equipment or equipment which cannot reasonably be moved to a permanent test area.

Risk assessment

2.17. A risk assessment should be carried out prior to any live testing being undertaken. A personal risk assessment should be carried out in all temporary test areas prior to work commencing. A written generic risk assessment should also be completed by the healthcare organisation for areas where hazardous live testing is regularly carried out.

Signage/ barriers

2.18. In any location where hazardous live testing is taking place, signage and barriers should be put in place to ensure that members of the public and staff not involved in testing are prevented from entering the area. In certain areas where work takes place in a specific room then the doors to that room (with a sign attached to them) could form the barrier.

Lone working

2.19. Working alone on exposed or hazardous live equipment, including work by contractors, should not be done. At least one other (safety competent) person should remain in visual and audible contact throughout the period of live testing. This person should be aware of the risks and be able to recognize any dangerous conditions, actuate the emergency switch-off device and take any other appropriate action.

Test equipment for hazardous live testing

2.20. Equipment used for live testing should be safe for that purpose. It is preferable to use commercially manufactured equipment, designed and specified for the voltages that may be encountered during use. Purpose-built in-house test equipment should be thoroughly risk assessed by a competent team during the design and manufacture processes. Test equipment should comply with BS EN 61010-1 (6).

Probes

2.21. Probes used to access live parts are specified in GS38 (7). They have a minimal area of exposed metal at the tip. The maximum allowable dimension is 4mm with 2mm preferred. Retractable shrouds may improve safety, and finger guards should be incorporated. A fuse should be incorporated in the probe, unless adequate over-current protection is provided by the test equipment.

Oscilloscopes

2.22. Conventional oscilloscopes have their signal common referred to protective earth. Therefore, connecting a conventional oscilloscope to isolated EUT would once more reference the EUT to earth and increase the risk of electric shock. Moreover, this means that all measurements have to be made with respect to earth and this can create measurement problems. Defeating the protective earth in order to make 'floating' measurements either by disconnecting the protective earth or using an isolating transformer will allow the chassis to assume the potential of the probe earth lead. This provides a risk of electric shock and may stress the oscilloscope insulation. Manufacturers advise that defeating the protective earth is an **unsafe and dangerous practice and should never be done.**

2.23. A battery-operated isolated-input oscilloscope or an oscilloscope with high voltage differential probes would provide safer working and is recommended. **If using an oscilloscope in an earth free area it must be used on battery supply only**.

General

2.24. Battery operated test equipment with insulating case and controls are recommended for hazardous live testing. Such equipment will naturally be isolated until connected to the EUT. If the EUT is powered from an isolated supply, the whole system and working environment will be earth free. This should provide considerable risk reduction.

Special considerations

Cathode-ray tubes

2.25. Special consideration is required when testing high voltage equipment such as video monitors fitted with cathode ray tubes (CRTs). The line output transformer on such equipment may produce voltages up to 30kV. Electronics in the power supply may be directly connected to mains.

Surgical diathermy

2.26. Surgical diathermy equipment presents unique electrical risks that require careful handling during testing and maintenance. While patient-applied currents are typically high-frequency and unlikely to cause shock, they can lead to serious burns if improper connectors or leads are used. Additional hazards may arise from internal high-voltage circuits, which may not be

mitigated by isolating transformers. Furthermore, powering such devices via external isolation during servicing can interfere with built-in safety monitoring systems, potentially compromising patient safety. Understanding these risks is essential for safe and effective operation:

- the patient applied current is at a sufficiently high frequency that electrical shock would not occur, but it does present a significant risk of burns. Particular attention should therefore be paid to using appropriate test equipment, leads and connectors
- the risk of conventional phase to earth shock would usually be confined to the mains input part of the device and may be reduced by using insulation or isolating transformers. Internally generated voltages, such as supplies to power amplifiers, are likely to be present within a surgical diathermy unit and may be high voltage and referenced to the equipment chassis. An isolating transformer would provide little protection in this case but insulating material may be effective
- it should also be noted that some surgical diathermy units incorporate circuitry to monitor the isolation of the patient from earth. Powering the equipment via an external isolating transformer during maintenance may interfere with the operation/ calibration of this safety circuitry with subsequent risk to the patient

Stored energy (defibrillators)

2.27. Defibrillators and similar high-energy devices pose serious risks due to their ability to generate and store potentially lethal electrical charges. Strict safety procedures must be followed, including disconnecting power and safely discharging stored energy before accessing high-voltage components. Built-in bleed resistors should not be solely relied upon, and direct shorting of capacitors must be avoided unless using a properly designed discharge probe. These precautions apply to any equipment storing energy above 350mJ and are critical to preventing injury during maintenance or testing:

- all defibrillators, including battery-operated devices, generate and store potentially lethal charge. It is therefore essential that the manufacturer's safety advice is followed, power is disconnected and stored energy safely discharged before accessing any high voltage component
- although a bleed resistor may be incorporated into the high voltage circuit this should not be relied upon as the sole method of ensuring that stored energy has been discharged
- direct shorting across capacitor terminals (such as using a screwdriver) should be avoided whether or not a safe level of charge is measured or assumed. Shorting capacitor terminals should only be performed with a specially constructed probe with shrouded bleed resistors
- similar advice would apply to other devices where stored energy exceeds 350mJ

Dialysis Equipment

2.28. When fluids are present, the criteria for what constitutes hazardous live testing changes significantly due to the increased risk of electric shock and fluid ingress. Dialysis equipment, which often involves conductive fluids, presents unique challenges:

- **Fluid Ingress Hazards**:
  - fluid ingress into electrical components can cause short circuits, earth faults, or unexpected energisation of conductive surfaces
  - equipment must be inspected for signs of leakage or moisture before testing
  - live testing should not be conducted if fluid ingress is suspected or confirmed
- **Earth Faults and Conductive Paths**:
  - dialysis machines often have large areas of earthed metalwork and fluid pathways that can create unintended conductive paths
  - a fault in the protective or functional earth can result in shock hazards, even when using isolating transformers
  - earth continuity and insulation resistance must be verified before energising the equipment
- **Stored Energy Risks**:
  - some dialysis machines may contain capacitors or batteries that store energy
  - stored energy above 350mJ is considered hazardous
  - use shrouded discharge probes - never short capacitors directly
- **Test Area Requirements**:
  - testing should be done in a designated test area with:
    - insulated flooring (such as rubber matting to BS921)
    - no accessible earthed metalwork
    - isolated electrical supply via compliant isolating transformers
    - clear signage and restricted access
- **Personal Risk Assessment**:
  - before testing, assess:
    - whether fluid contact could occur during testing
    - if insulation barriers are adequate
    - whether PPE (gloves, eye protection) is suitable for both electrical and fluid hazards
    - if test leads and probes are rated for use in moist environments
- **Precautions for Live Testing**:
  - never test alone - a second competent person must be present
  - use battery-operated test equipment with insulated cases

- attach/ detach probes only when equipment is isolated
- temporary insulation or modified covers should be used to prevent contact with live parts

Earth faults

2.29. Ensuring electrical safety during equipment testing is critical to protecting personnel and maintaining operational integrity. A fault in the protective or functional earth of the EUT can pose serious hazards, including electric shock—even when using isolating transformers. To mitigate these risks, it is essential to verify earth continuity and insulation resistance before energizing the equipment. Furthermore, comprehensive safety testing must be conducted prior to returning the equipment to service, ensuring it meets all required standards and safeguards:

- a fault in any protective or functional earth on the EUT may render the device hazardous to the tester. Even when the supply is from an isolating transformer, there may be a risk of shock in the event of simultaneous contact between the enclosure of the equipment and a pole of the isolated test supply
- it is recommended that earth continuity and insulation resistance between phase/ neutral and earth is checked before making the equipment live
- the equipment should be safety tested before being returned to service

Soak testing

2.30. All risks, including fire and electrical hazards, should be carefully considered before leaving equipment unattended. Equipment should not be left with hazardous live parts exposed or readily accessible.

Remote connections/ control

2.31. When equipment is controlled from a remote location, for example a control panel in another room, then a permit system such as a ‘Sanction- for-Test’ may provide a significant reduction in risk. Locking of controls and formal equipment handover may also be appropriate.

Is the test area safe?

2.32. It has to be clearly understood by the tester that an isolating transformer does not prevent an electric shock should contact be made with both phase conductors simultaneously.

2.33. Using earth-free isolated supplies for both the EUT and the test equipment may present less risk of shock than working with all systems earthed. However, hazardous voltages may be produced between different parts of the system, which are not obvious, and which are consequently more dangerous than in an earthed system. For example, there is a risk of shock between the equipment enclosure and the isolated supply if the EUT has an earth fault.

2.34. RCDs provide supplementary protection only. They do not prevent electric shock but limit the duration of phase to earth shocks. to reduce harm. As with isolation transformers they do not prevent a phase to neutral shock should the tester come into contact with both conductors.

Note 2: RCD do not provide reliable safety protection in an earth-free area.

Checking the live testing area

Flooring

2.35. Insulated matting should be inspected for damage and tested by an appropriate (flash) test annually as part of a planned system of maintenance.

Isolating transformers

2.36. Unless continuously monitored by a Line Isolation Monitor, the transformer should be checked on a regular basis to ensure that it provides isolation from earth. Insulation between the secondary windings and earth should be measured.

RCDs

2.37. Portable RCDs should be checked before use by pressing the test button. Fixed RCDs should be checked weekly and all RCDs tested annually using an RCD tester to measure speed of operation and tripping current.

External contractors

Competency

2.38. Healthcare organisations should be sure that any engineers who attend on site where hazardous live testing is required are competent to work on the type of equipment and competent in general electrical safety. This may be confirmed in advance at the time of tendering for equipment or when agreeing service contracts.

Responsibilities

2.39. The healthcare organisation is responsible for electrical safety within its premises.

2.40. Senior staff within each department are responsible for ensuring that anyone working within their department who is likely to conduct hazardous live testing is aware of these guidelines and has been cleared as having the necessary level of competence/ supervision.

2.41. Senior staff will also be responsible for ensuring that temporary test areas in their department are adequately controlled. This may include barriers and warning signs as well as the co-operation of departmental staff. Service contractors and healthcare employees involved in hazardous live testing will therefore be required to abide by these guidelines, including the prohibition on lone working.

Training and competency of test technicians

2.42. All personnel who are required to carry out hazardous live testing should be instructed in safety requirements, safety rules and local instructions applicable to their work, and records of that training should be maintained.

2.43. Competence to undertake hazardous live testing should be formally assessed by the Technical Manager or Supervisor and only those deemed to be adequately skilled or instructed should be permitted to work in hazardous live testing areas. It should be noted that qualifications or experience alone do not constitute competency. A competent person is someone who possesses, as appropriate to the nature of the work to be undertaken, adequate education, training and practical skills, and who is able to prevent danger or, where appropriate, injury, and has been formally appointed in writing by their Technical Manager, and who accepts a safety document for defined work.

2.44. In addition to having the basic electrical/ electronic qualifications for carrying out this type of work, staff must be able to demonstrate that they understand and are able to implement unsupervised the precautions described in this SHTN. In particular, they must:

- understand the equipment on which they are required to carry out the hazardous live testing and the risks that will arise during the testing activity
- understand how to undertake a risk assessment for the work, identifying the hazards, risks and risk control measures
- understand the precautionary techniques that can be taken to prevent injury, including when to use isolated or earth-referenced supplies in the test area
- understand and be able to implement the safe working procedures necessary to reduce the risks to an acceptable level, including the use of appropriate tools, test equipment and personal protection equipment
- know the bounds of their competence and when they should not undertake hazardous live testing

Hazardous live testing safety checklist

- Risk Assessment
  - assess potential hazards including electrical, mechanical, and environmental risks
  - determine if equipment can be isolated before testing
  - verify availability of appropriate test equipment and PPE
  - ensure presence of a second competent person during testing
- Test Area Setup
  - use designated test areas with insulated flooring and no accessible earthed metalwork
  - install isolating transformers and emergency stop buttons
  - display warning signs and restrict access with barriers
  - inspect and test insulated matting annually
- Equipment Safety
  - use test equipment compliant with BS EN 61010-1
  - ensure probes meet GS38 standards with minimal exposed metal
  - avoid defeating protective earth on oscilloscopes
  - must use battery-operated oscilloscopes
- Personnel Requirements
  - only trained and competent personnel may perform hazardous live testing
  - maintain records of training and competency assessments

  - supervisors must formally appoint competent staff
  - contractors must be verified for competency before work
- Special Equipment Considerations
  - safely discharge stored energy in defibrillators using proper probes
  - avoid testing dialysis machines if fluid ingress is suspected
  - verify earth continuity and insulation resistance before energising
  - use appropriate test leads and PPE for moist environments

References

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2. **British Standard (BS) EN 50191:2001 Erection and operation of electrical test equipment**
3. **BS 7671 IET Wiring Regulations** (latest edition)
4. **BS EN 61111:2009 Specification**. Rubber mats for electrical purposes.
5. **BS EN 61558-2-4:2005, Amendment 1:2009** - Safety of power transformers, power supply units and similar. Particular requirements for isolating transformers for general use.
6. **BS EN 61010-1: 2010 Amendment 1:2019** Safety requirements for electrical equipment for measurement, control and laboratory use.
7. **Electrical test equipment for use by electricians GS38** HSE Books 2015 ISBN 0 7176 0845 XI

Abbreviations

AC:	alternating current
BS:	British Standard
CRT:	Cathode-Ray Tubes
DC:	direct current
EUT:	Equipment Under Test
HSE:	Health and Safety Executive
Hz:	Hertz
mA:	milliamps
mJ:	millijoule
PELV:	Protective Extra-Low Voltage
PPE:	Personal Protective Equipment
RCD:	Residual Current Device
RMS:	Root Mean Square
SELV:	Separated Extra-Low Voltage
SHTN:	Scottish Health Technical Note
V:	Volt
kΩ:	Kilo-ohm