

## **Guidance notes for the installation of electrical supply in mobile trailers for breast screening**

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B Mansfield, CP Lawinski

*Withdrawn November 2021  
Please refer to local estates departments  
for guidance*

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# 1. INTRODUCTION

## 1.1 Purpose of this document

This document is designed to provide guidance to mammography superintendent radiographers, radiography managers, and other NHS staff involved the movement and operation of mobile trailers for breast screening.

The information included is intended to provide advice that will enable individuals to make all requisite electrical and mechanical provisions for a mobile trailer site, and to connect and operate the trailer safely.

## 1.2 Electrical safety issues in mammography

The NHS Breast Screening Programme (NHSBSP) has produced a wide range of advisory documents and guidance notes for the purchase, use, and testing of mammography x-ray equipment. This report supplements previous advice, contained in *Guidance on the electrical and safety testing of mammographic x-ray equipment* (NHSBSP Occasional Report 03/01). It replaces *Guidance notes for the installation of electrical supply for NHSBSP mammography trailers* (NHSBSP Equipment Report 05/03).

The requirements contained in MHRA document TRS 89, *Technical requirements for the supply and installation of equipment for diagnostic imaging and radiotherapy* (1989) have been revised and updated in the *Medical Electrical Installation Guidance Notes* (MEIGaN), versions 1.0 and 2.0. The MEIGaN documents provide guidance on the electrical and mechanical aspects of providing and testing both new and relocated x-ray and mammography x-ray equipment, including details pertaining to transportable diagnostic and treatment rooms.

## 1.3 Earthing of mobile trailers for breast screening

Following recommendations in the latest version of MEIGaN, additional earthing requirements for mobile trailers are addressed in these guidance notes.

## 1.4 Provision of a new connection box

Attention is also drawn to the requirement in Department of Health document HTM 06-01 (Electrical Services Health Technical Memorandum 06-01: Electrical services supply and distribution, *Part A: Design considerations*) regarding the need for a monitored earth on the supply/connection cable to the mobile trailer when providing a new connection box.

## 2. PRE-INSTALLATION REQUIREMENTS

Although the x-ray equipment may be regarded as the most important part of the installation, the pre-installation requirements for the area in which the x-ray equipment is to be installed are also important. As any room that houses x-ray equipment must meet certain requirements, and a pre-installation assessment should be undertaken in order to facilitate installation of the x-ray equipment.

The following provisions should be considered for the x-ray room. However, not all of these provisions may be necessary for every installation (depending on the design of the installation and the type of x-ray equipment).

- An adequate power supply, sufficient to meet the demands of the imaging equipment, must be available (the specifications for the necessary supply must be obtained from the equipment supplier or manufacturer).
- A supply cable with the correct size and number of conductors must be provided. For a single-phase system a three core, double insulated cable must be used. A three-phase system will require a five core, double insulated cable.
- The line resistance must be adequate to meet the design specification of the x-ray equipment. For single-phase systems, total line resistance is measured from phase to neutral. For three-phase systems the resistance is measured between phases.
- The electrical system must be designed for a TN-S system. (This still applies where the trailer has an onboard generator).
- Trailers that connect to the electrical mains supply, but also have an onboard generator and/or an external generator, must be fitted with an isolator that will ensure that only one system can operate at any time.
- An isolator for the main x-ray equipment is required ('Emergency Off'). This must be located in a position that is accessible to a person standing in the usual operator position, which will normally be in the control area. Additional 'Emergency Off' devices may also be provided.
- If the unit uses a three-phase supply, an electromagnetic contactor must be used. A single-phase unit may use a mechanical isolator. Solid State switching must not be used for the isolator in either case.
- The isolator must be capable of being locked in the 'OFF' position, in order to prevent the unit from being energised in the event of a fault.
- An earth reference bar (ERB) must be located adjacent to the main isolator. All earth connections and equipotential bonding must be connected to this point. The ERB must be located in a position that enables connection of an earth-bonding meter for test purposes.

- In addition to the electrical earths, all accessible conductive surfaces must be connected to the ERB. These include the chassis of the trailer, the bodywork, and any internal metal trim. Plumbing and water supplies should also be earthed to the ERB.
- All electrical trunking and conduits must be of adequate size to carry the amount of wiring provided, and must be continuous, taking wiring from one location to another.
- Tri-rated cable shall be used for all installed wiring, in order to reduce the risk of failure due to vibration.
- Radiation warning lights must be provided adjacent to the door(s) to the x-ray room, as required by the local Radiation Protection Advisor (RPA).
- An adequate number of 230 volt, 13 amp sockets must be provided to support all portable equipment, servicing needs, and the other normal requirements of an x-ray room. Extension mains leads must not be used.
- The final ring circuit, the 13 amp fused connection units, and the room lighting must be on the same phase as the x-ray equipment.
- A residual-current device (RCD), conforming to the specification provided by the equipment manufacturer, must be installed in a position accessible to the operator. A label must be fixed close to the RCD bearing the following wording: *'Test the RCD by pressing the TEST button every time that the unit is first connected to a site'*.

The electrical supply for single phase equipment must be on the same phase as the 13 amp final ring circuit and the lighting circuit. This avoids a 415 volt difference in potential between the x-ray equipment and other electrical equipment in the room.

Checking the electrical provision and x-ray equipment is the responsibility of the equipment supplier or the independent equipment inspection tester. The Trust (or the owner of the trailer and equipment) has a responsibility under the Health and Safety at Work Act to satisfy themselves that the equipment is safe for use, both for the operator and the patient. If the equipment supplier cannot provide an adequate report for both the equipment and the room's electrical supplies, with full test results, it may be necessary to employ the services of an independent inspector. An electrical safety check must also form part of the trailer's annual inspection.



### 3. DESIGN OF THE ELECTRICAL CONNECTION BOX FOR MOBILE TRAILERS

The following guidance and design advice relates to connection boxes for mobile trailers.

- The electrical connection box for the mobile trailer must be as close as possible to the parked position of the trailer when in use.
- The location and height of the connection box should be such that it is readily accessible to the operator.
- The electrical supply cable running from the main distribution board (DB) that provides the trailer with its electrical supply must take the shortest route to the connection box, in order to keep the cable length to a minimum. The distance/length of the cable run will affect the final cross-sectional area (CSA) of the cable to be installed.
- The design of the connection box must allow for an isolator that can switch between single or three-phase power, depending on the electrical supply.
- The isolator and other fittings in the connection box must be designed to meet relevant standards (Index of Protection (IP) code IP44 (Splash Proof) or higher).
- An RCD with test and reset buttons is required.
- An Industrial/Commando type socket outlet (BS EN 60309-2) must be provided. This must match the trailers supply cable and plug.
- An ERB for connecting all earth wires must be provided.
- The enclosure must be earthed to the main earth cable from the main DB.
- A supplementary earth connection must be installed in the enclosure (POAG - ID6 socket). A supplementary earth cable (6 mm earth cable fitted with POAG - KB16 plugs) must also be provided and must be connected to both the trailer and the connection box before the supply cable to the trailer is connected.
- Should the connection box be required to provide a water supply for the trailer, a barrier must be installed to prevent water from transferring into the electrical part of the box.
- The water supply must have a non-return valve and a control valve in the connection box to open and close the water flow. The water supply pipe must be protected against frost.

- The connection box must have an access hole for the trailer supply cable. The access hole will normally be located on the underside of the connection box, and must be of sufficient size to allow the industrial/commando connection plug to be passed through it. A lockable, hinged plate with a cable cut-out is also required.
- A further access hole will be required if a water supply hose is to be connected to the trailer. A lockable, hinged plate with a hosepipe cut-out is recommended.
- The front of the connection box should be able to open fully, allowing operator access. The door must be capable of being securely locked to prevent tampering and for security purposes.
- The connection box should be constructed of a hard-wearing material, preferably metal, for durability, to withstand poor weather conditions, and to protect against vandalism.
- The connection box, and the electrical items inside, will all require adequate labelling to identify their function and to warn users of the maximum voltages present.
- When installing a new connection box, attention is drawn to Department of Health document HTM 06-01 (Electrical services Health Technical Memorandum 06-01: Electrical services supply and distribution *Part A: design considerations*), paragraph 16.73. This states that '**Designers and stakeholders should ensure that the final supply/connection cable to any mobile unit includes a monitored earth as described in BS 4444.**' Conformity with this guidance is only possible where a supplementary earth connection to the mobile trailer is provided.

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## 4. DESIGN OF THE ELECTRICAL PROVISION

Whether it is located on a trailer or on a static site, mammography x-ray equipment has the same electrical requirements. However, in trailers, the following additional issues need to be considered:

- The CSA of the supply cable must be calculated, taking into account the mains impedance at the connection point on the main DB, and the length of cable required to reach the trailer connection box.
- The trailer connection box must be IP44 code (Splash Proof) compliant. It must be provided with test and re-set buttons, an isolator and a miniature circuit breaker (MCB) with a minimum rating of 63 amps.
- A 63-amp Industrial/Commando (BS EN 60309-2) socket outlet will be required for connection of the electrical supply cable to the trailer (the number of pins must match the trailer supply cable).
- The electrical supply cable between the connection box and the trailer must be of the CSA and length specified by the equipment supplier, to prevent excessive voltage drop due to high mains impedance.
- The supply cable can be manufactured with plugs at both ends (male and female, as appropriate), so that, in the event of a failure, the complete cable can be disconnected and a replacement cable plugged in. A spare cable can be ordered with the trailer and stored in a suitable location on board. The mains cable is not intended to withstand vehicular traffic and where vehicular traffic is unavoidable, cable protectors must be used.
- A three core supply cable is required for a single-phase unit. A three-phase unit will require a five core cable
- The electricity supplier may require a power consumption meter to be fitted. This should be installed in the trailer connection box.
- The electrical supply cable should be connected to a DB inside the trailer. The DB should be located in a lockable cupboard, accessible to the operator.
- The DB provides electrical supplies to all of the electrical services in the trailer, and should be provided with MCBs for each of the following circuits:
  - The x-ray equipment
  - The 13 amp final ring circuit and lighting
  - The heating and air conditioning
  - The security lighting and alarm system.

- The power supply must be available 24 hours per day, 7 days per week, in order to provide a consistent environment (heating/cooling) for the x-ray equipment and imaging facilities. This is particularly important for digital imaging systems, where the detector may require specific environmental conditions to prevent possible damage (this information should be obtained from the supplier or manufacturer of the digital imaging system).
- In the x-ray room, a main equipment isolator must be located in the control area. An ERB must be located in a separate box adjacent to the isolator.
- Where the trailer has a three-phase electrical supply, it is important to ensure that all single-phase devices are supplied from the same phase (this applies to those that are fed from the x-ray unit as well as those that are supplied directly from the electrical mains supply).
- In the x-ray room, the x-ray equipment, 13 amp final ring circuit, and lighting circuit must be compatible.
- A POAG-ID6 socket should be installed in an accessible position outside of the trailer for the connection of the supplementary earth cable. The socket should be electrically connected to the chassis of the trailer. A spare supplementary earth cable of suitable length, fitted with a POAG-KBT6 plug, should be obtained and stored in a suitable location on board.

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## 5. EARTHING OF MOBILE TRAILERS FOR BREAST SCREENING

The section of MEIGaN that covers the earthing of transportable diagnostic and treatment rooms states that a low impedance earth from the mains supply or from the generator must be provided via the mains cable. In the interest of safety, **all** trailers, both new and existing, should have a supplementary, high-flexibility earth cable, which must run in parallel with the supply cable in order to minimise any hazard should there be a fault on the mains cable, plugs, sockets, etc. The supplementary cable must be connected to both the trailer and the connection box before the supply cable is plugged in. Therefore, a suitable earth cable and suitable connection points on the trailer and on the electrical connection box are required.

Earth rods, i.e. metal rods inserted into the ground to connect a cable to ground potential, must not be used.

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## 6. STAND-ALONE MOBILE TRAILERS WITH A BUILT-IN ELECTRICAL GENERATOR

A mobile trailer that is designed to be free-standing, and that receives power from a built-in generator, does not need to be earthed. Earth rods or earthing plates should not be used. However, where the stand-alone unit is connected via a data cable to a fixed installation, a supplementary earth must be run between the vehicle and the docking station.

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## 7. STAND-ALONE MOBILE TRAILERS WITH AN EXTERNAL ELECTRICAL GENERATOR

A mobile trailer powered by the type of external generator that may be towed behind the vehicle should be earthed to the generator by means of an earth conductor. This should form part of the electrical supply cable. In a single-phase unit, the supply cable should be a three core, double insulated cable. In the case of a three-phase system, a five core, double insulated cable should be used.

Neither the mobile trailer nor the generator needs to be earthed by any other means than the interconnecting cable. The connection between the external generator and the mobile trailer should be made before the generator is started.

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## 8. FREQUENCY OF TESTING

Mobile trailers should be tested for electrical safety when new, and repeat checks should be made on an annual basis. This interval is more frequent than that for fixed x-ray installations and takes into account the movement of the trailer, which creates the potential for wiring to become dislodged, damaged, etc. It is also recommended that electrical connection points are checked annually for electrical safety, since they are exposed to the elements and to potential tampering, etc.

As long as trailers and connection boxes have passed their annual tests, a full electrical safety inspection is not required every time the trailer is moved. However, whenever the transportable room is moved to a new location, the continuity and quality of the earth should be tested once the supplementary earth cable has been connected.

The annual testing of the connection box should include an earth loop test. This involves using a test meter to measure the resistance between earth and neutral in the supply. For a unit fused at 63A, resistance should be less than 0.2 ohms. Where the connection box is on premises that are not owned by the Trust or the NHS, this test is the responsibility of the owner or operator of the mobile trailer.

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## APPENDIX 1: GLOSSARY AND EXPLANATORY NOTES

BS EN 60309-2	Industrial or Commando-type plug and socket outlet.
Control area	The area behind the radiation-protective screen in the x-ray room. Exposures are initiated and controlled from here.
CSA	Cross-sectional area (size of cable).
DB	Electrical distribution board containing circuit fuses.
ERB	Earth Reference Bar.
Final ring circuit	230 volt, 13 amp socket outlets.
Fused connection unit	230 volt, 13 amp spur outlets for fixed equipment.
Index of Protection (IP) code	Providing a degree of protection, for example IP44 provides Splash Proof protection.
MCB	Miniature circuit breaker (fuse).
RCD	Residual current device, an isolator designed to operate automatically in high earth leakage current conditions.
Single phase power supply	Neutral and earth at 230 volts.
Three phase power supply	Neutral and earth at 415 volts.
TN-S system	Separate neutral and earth throughout the system.

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