


WIRING MATTERS

Autumn 07 Issue 24

MOBILE AND TRANSPORTABLE UNITS

A proposed new Section
for BS 7671:2008

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The impact of
the 17th Edition
Floor and Ceiling
Heating Systems

Changes to the
Electrical Installation
Certificate and Report Forms

In Service Inspection and
Testing of Electrical Equipment
The Insulation Test



THE IMPACT OF THE 17TH EDITION

by Geoff Cronshaw

IN THIS ARTICLE we look at the impact that some of the changes expected in BS 7671:2008, the IEE Wiring Regulations (17th Edition), will have on the design, erection and verification of electrical installations. This article is generally based on the Draft for Public Comment and therefore the actual requirements may change.

1. Section 701 Locations containing a bath or shower.

Regulation 701.411.3.3 now requires that additional protection shall be provided for all circuits of the location, by the use of one or more RCDs having the characteristics specified in Regulation 415.1.1. This is a significant change.

Previously, only fixed current using equipment (other than electric showers) located in zone 1 required 30mA RCD protection and current using equipment (other than fixed

current using equipment – such as a washing machine, if suitable for use in a bathroom, connected through a fused connection unit) in zone 3 required 30mA RCD protection.

Regulation 701.411.3.3 means that all circuits, including lighting, electric showers, heated towel rails, etc., will require 30mA RCD protection.

Another significant change is introduced by Regulation 701.512.3. This now permits 230v socket outlets to be installed in a room containing a bath or shower providing they are installed 3 m horizontally from the boundary of zone 1. This change resolves the ambiguity that existed between locations containing a bath or shower and a bedroom containing a shower.

Regulation 701.415.2 introduces a further significant change regarding supplementary equipotential bonding. The Regulation states that where the location containing a bath or shower is

in a building with a protective equipotential bonding system in accordance with Regulation 411.3.1.2, supplementary equipotential bonding may be omitted where all of the following conditions are met:

- (i) All final circuits of the location comply with the requirements for automatic disconnection according to 411.3.2, and
- (ii) All final circuits of the location have additional protection by means of an RCD in accordance 701.411.3.3, and
- (iii) All extraneous-conductive-parts of the location are effectively connected to the protective equipotential bonding according to 411.3.1.2.

2. Chapter 52 Selection and erection of wiring systems. Cables concealed in a wall or partition.

A new series of regulations has been introduced concerning cables concealed in a wall or partition. These new Regulations introduce the concept of skilled person and instructed person. They also introduce the requirement for RCD protection.

It is now required to protect cables concealed in a wall or partition (at a depth of less than 50mm) by a 30 mA RCD where the installation is not intended to be under the supervision of a skilled or instructed person if the normal methods of protection including use of cables with an earthed metallic covering, earthed conduit/trunking or mechanical protection cannot be employed.

Irrespective of the depth, a cable in a partition where the construction includes metallic parts other than fixings shall be protected by a 30mA RCD.

For example, this means (in a domestic installation) where insulated and sheathed cables are concealed in a wall at a depth of less than 50mm and have no mechanical protection, they need to be installed within the safe zones and need to be protected by a 30mA RCD.

3. Chapter 41 Protection against electric shock.

3.1 socket-outlets

Chapter 41 now requires in Regulation 411.3.3 that for the protective measure of automatic disconnection of supply for an a.c. system, additional protection by means of a 30 mA RCD shall be provided for socket-outlets with a rated current not exceeding 20A that are for use by ordinary persons. The 17th Edition defines an ordinary person as “a person who is neither a skilled person nor an instructed person”.

An exception is permitted for socket-outlets for use under the supervision of skilled or instructed persons, The 17th Edition defines a skilled person as “a person with technical knowledge or sufficient experience to enable him/her to avoid dangers which electricity may create”. An instructed person is defined as “a person adequately advised or supervised by skilled persons to enable him/her to avoid dangers which electricity may create”. Therefore this exception would apply, for example, in some commercial or industrial locations.

A further exception is permitted for a specific labelled or otherwise suitably identified socket-outlet provided for connection of a particular item of equipment. This, for example, could be a socket outlet for a freezer in a domestic kitchen.

However, the Regulations require that an RCD shall be so selected and the electrical circuits so subdivided that any protective conductor current which may be expected to occur during normal operation of the connected load(s) will be unlikely to cause unnecessary tripping of the device. For example, this could mean the installation of RCBOs instead of Split Load consumer units in a domestic installation.

This requirement is a significant change from the 16th Edition which had fewer requirements for RCD protection, for example, these were:

- supplementary protection in every circuit likely to supply portable equipment for use outdoors, and
- indirect shock protection where the earth fault loop impedance (Zs) is insufficiently low to operate a fuse or circuit-breaker within the prescribed time.

3.2 Disconnection times.

Chapter 41 now requires that final circuits not exceeding 32 A shall have a disconnection time not exceeding 0.4 seconds for a TN system with, for example, a nominal voltage to earth of 230 volts. For a TT system, this is further reduced to a 0.2 second disconnection time.

However, with regard to TT systems, a statement is included with Table 41.1, Maximum disconnection times:-

"Where disconnection is achieved by an overcurrent protective device, and the protective equipotential bonding, or main equipotential bonding, is correctly installed, the maximum disconnection times applicable to a TN system may be used."

With regard to TN systems, users of the Regulations will note that where the overcurrent protective device is a circuit-breaker, such as a device to BS EN 60898 and the earth fault loop impedance Zs is not greater than the values given in Table 41.3, the circuit will disconnect within 0.4 seconds then the requirements of the 17th Edition of BS 7671 will be met.

This reduction in disconnection time is a significant change from the 16th Edition. The current Edition requires that a circuit supplying socket-outlets, for example, shall have a 0.4 second disconnection time compared to a circuit supplying stationary equipment which must have a disconnection time not exceeding 5 s (413-02-13).

4.0 Voltage drop in consumers' installations.

Chapter 52 introduces changes in the maximum value of voltage drop permitted and makes a clear division between the requirements of an installation supplied from a public LV supply and a private LV supply.

The first two Regulations require that the voltage at the terminals of



Wiring Matters is produced by IET Services Limited, a subsidiary of The Institution of Engineering and Technology (IET), for the IET. Michael Faraday House, Six Hills Way, Stevenage, Herts, SG1 2AY, United Kingdom Tel: +44 (0)1438 313311 Fax: +44 (0)1438 313465

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IEE Wiring Matters is a quarterly publication from the Institution of Engineering and Technology (IET). The IET is not as a body responsible for the opinions expressed.

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Co-operating Organisations The Institution of Engineering & Technology acknowledges the contribution made by the following organisations in the preparation of this publication: British Electrotechnical & Allied Manufacturers Association Ltd – R Lewington, P D Galbraith, M H Mullins | Department for Communities and Local Government – I Drummond | Electrical Contractors Association – D Locke, S Burchell | City & Guilds of London Institute – H R Lovegrove | Energy Networks Association – D J Start | Electrical Contractors Association of Scotland SELECT – D Millar, N McGuinness | Health & Safety Executive – K Morton | Electrical Safety Council | ERA Technology Limited – M Coates | British Cables Association – C Reed | Scottish Building Standards Agency | DTI – D Tee | CORGI – P Collins | GAMBICA – K Morris.

ISSN 1749-978-X



any fixed current-using equipment shall be greater than the lower limit corresponding to the product standard relevant to the equipment or in the absence of a standard shall not to impair the safe functioning of that equipment; this is the same as the 16th Edition requirement.

The new Regulations recognise that the voltage drop requirements will be satisfied if the voltage drop between the origin of the installation (usually the supply terminals) and a socket-outlet or the terminals of fixed current-using equipment does not exceed that stated in Appendix 12.

This Appendix gives a maximum value of 3% for lighting and 5% for other uses for a low voltage installation supplied directly from a public low voltage distribution system. This is the most common situation.

For a low voltage installation, supplied directly from a private LV supply, the appendix gives a maximum value of 6% for lighting and 8% for other uses.

This is a significant change from

the 16th Edition which permitted a maximum value of 4% voltage drop, irrespective of whether the installation was supplied from a public or private supply.

5.0 Section 702 - Swimming pools and other basins

Section 702 now includes basins of fountains, zones A, B and C in the 16th Edition are replaced by zones 0, 1 and 2 (however the actual zones remain the same) and a solution is included for the installation of 230 volt luminaires for swimming pools where there is no zone 2 (previously zone c).

The 17th Edition states that for swimming pools where there is no zone 2, lighting equipment supplied by other than a SELV source at 12 V a.c rms or 30 V ripple-free d.c. may be installed in zone 1 on a wall or on a ceiling provided that the following requirements are fulfilled:

- the circuit is protected by automatic disconnection of the supply and additional protection is provided by an RCD having the characteristics

specified in Regulation 415.1.1, and

- the height from the floor is at least 2 m above the lower limit of zone 1.

In addition, every luminaire shall have an enclosure providing Class II or equivalent insulation and providing protection against mechanical impact of medium severity.

This is a significant change from the 16th Edition which only allowed SELV luminaires in zones A and B. It is not usually practicable to provide general illumination in a swimming pool by means of SELV luminaires and therefore the solution was to install ordinary luminaires at a height greater than 2.5 m above the floor/access level. However, when refurbishing older, smaller installations, there may be insufficient headroom to install the luminaires outside zone B and it may not be practicable to illuminate an area with 12 volt SELV luminaires. The 17th Edition will provide a solution to this problem.

Section 708 Electrical installations in caravan / camping parks and similar locations - Caravan pitch electrical supply equipment - socket-outlets

Section 708 now requires that each socket-outlet shall be protected individually by a residual current device with a rated residual operating current not exceeding 30 mA. The neutral shall always be disconnected by the residual current device.

This is a significant change from the 16th Edition which required that each socket-outlet must be protected individually by an overcurrent device which may be a fuse but is more usually a circuit-breaker, and either individually or in groups of not more than three socket-outlets by a 30mA RCD.

More information.

Important: this article only considers a small number of the changes expected in the 17th Edition. For more information refer to the IET website, www.theiet.org ■



FLOOR AND CEILING HEATING SYSTEMS

by John Ware

A FLOOR OR ceiling heating system functions by warming the floor or ceiling of a room. These objects then warm the air in the room. Some systems use electric heating panels to generate heat, which is radiated into rooms, other systems are thermal storage systems. The requirements apply to the installation of electric floor and ceiling heating systems which are erected both as direct acting heating or thermal storage systems. A thermal storage system is where heat from off-peak electricity is stored in concrete or similar material.

The Risks

The risks associated with floor and ceiling heating systems are generally that of penetration of the heating element by nails, drawing pins, screws, etc., pushed through the ceiling surface. Similarly, there

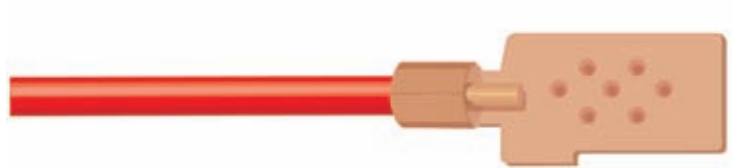


Figure 1: Crimped connection to cold tail



Figure 2: Heating cables



Figure 3: Flexible sheet heating element



Figure 4: A 30 mA RCBO being installed
[Photograph courtesy of MK Electric Ltd]

are concerns that underfloor heating installations can be damaged by carpet gripper nails, etc.

To protect the building structure and provide precautions against fire, there are requirements to avoid overheating of the floor or ceiling heating system.

Definitions

Cold tail. The interface between the fixed installation and a heating unit. See Figure 1.

Heating unit. Heating cable or flexible sheet heating element with rigidly fixed cold tails or terminal fittings which are connected to the terminal of the electrical installation

Flexible sheet heating element. Heating element consisting of sheets of electrical insulation laminated with electrical resistance material, or a base material on which electrically insulated heating wires are fixed. Figure 3.

Heating-free area. Unheated floor or ceiling area which is completely covered when placing pieces of furniture or kept free for built-in furniture. See Figure 6.

Requirements and Recommendations

The increased risks of shock or fire with such systems are recognized in BS 7671 which, in the 17th Edition, will place additional requirements, in Section 753, which supplement or modify the general requirements in Parts 1 to 6.

There are no comparable requirements in BS 7671:2001 (The Sixteenth Edition). However Guidance Note 7, Special Locations, includes recommendations in Chapter 14 for floor and ceiling heating systems.

Where a floor or ceiling heating system is installed in a bathroom, swimming pool or other basin, the requirements of

Table 1: General requirements for heating conductors and cables

Concerning	Regulation (16th)	Regulation (17th)
1 Avoidance of fire risk and mechanical damage where a heating cable passes through, or close to, a material which presents a fire hazard.	554-06-01	554.4.1
2 Avoidance of damage to a heating cable that is to be laid directly in soil, concrete or a cement screed or other material used for road and building construction. Both mechanical damage and dampness and corrosion under normal conditions of service need to be considered.	554-06-02	554.4.2
3 Heating cables to be completely embedded, not to suffer damage in the event of movement and installed in accordance with manufacturer's instructions	554-06-03	554.4.3
4 The temperature of heating cables are not to exceed specified values. Note that the 16th Edition gives specific temperatures in Table 55C while the 17th refers to the manufacturer's stated limit.	554-06-04	554.4.4

Section 601 (Section 701 in the 17th) and Section 602 (Section 702 in the 17th) will also apply.

The requirements being prepared in Section 753 will not apply to wall heating systems or to outdoor floor and ceiling heating systems.

General Requirements

BS 7671 includes general requirements for heating conductors and cables in Regulation Group 554-06 (16th) and these will appear in 554.4 (17th). These requirements are summarized in Table 1.

Supplementary Requirements

The requirements being prepared in Section 753 will not apply to wall heating systems or to outdoor heating systems'.

1. Protection against electric shock

The protective measures of obstacles, placing out of reach, non-conducting location and earth-free local equipotential bonding are, as would be expected, not permitted. Additionally the protective measure of electrical separation is not permitted.

Where the protective measure of automatic disconnection of supply is used, as it will be in almost all cases, the floor or ceiling heating system must be protected by a 30 mA RCD.

Heating elements fall into two categories, those that have a suitable conductive covering, such as a metal sheath and those without. Where a heating element has a conductive sheath, this sheath must be connected to the protective conductor of the circuit. Where a heating element does not

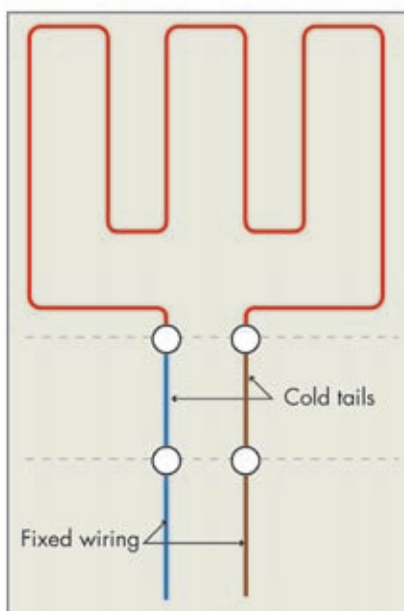


Figure 5: General arrangement



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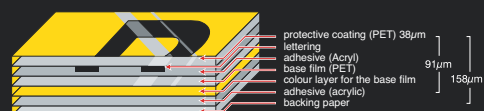
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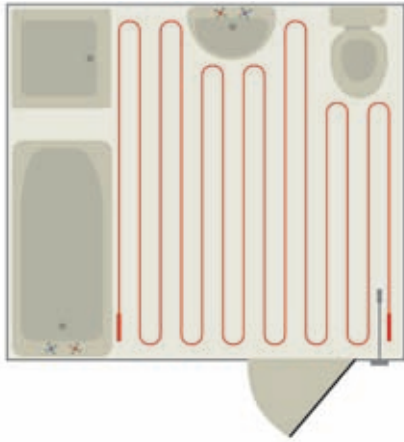


Figure 6: Heating free areas

[Illustration courtesy of Warmup Plc]

have an earthed covering or sheath, a suitable conductive covering, such as a grid with a spacing of not more than 30 mm, must be provided on site, it must be installed above the floor heating elements or below the ceiling heating elements and be connected to the protective conductor.

Heating elements can have a capacitance to earth which may result in unwanted tripping of the RCD. Limiting the rated heating power to 7.5 kW at 230 V or 13 kW at 400 V downstream of the RCD may avoid unwanted tripping.

Where a circuit supplies heating equipment of Class II construction, a 30 mA RCD must, nonetheless still be provided.

2 Protection against thermal effects

Burns. In floor areas where contact with skin or footwear is possible, the surface temperature of the floor should be limited (for example to 35 degrees C).

The temperature of heating units should not exceed 80 degrees C and this should be achieved by designing the system appropriately, installing the system appropriately or using suitable protective devices.

Connections. Heating units should be connected to the electrical installation via cold tails or suitable terminals. A heating unit must be inseparably connected to its cold tail by means such as by welding, brazing or by compression jointing techniques.

Fault conditions. Under fault conditions, a heating unit may cause higher temperatures or arcs. Measures such as installing a metal sheet close to easily ignitable parts of the building structure should be employed.

3 Selection and erection (See Figure 6)

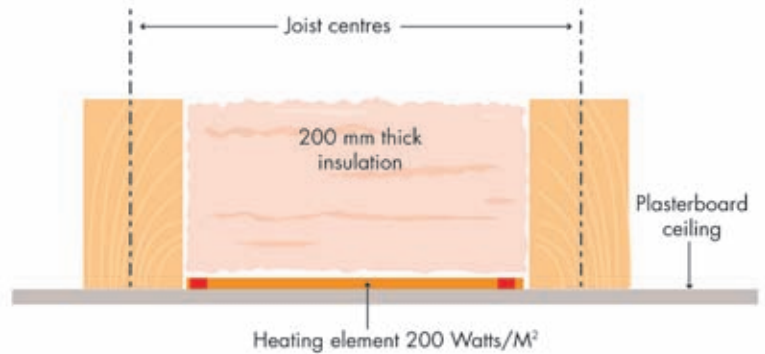


Figure 7: Cross section of ceiling heating system

[Illustration courtesy of Strada ceiling heating systems]

Flexible sheet heating elements should comply with BS EN 60335-2-96 and heating cables should comply with the BS 6351 series of standards.

4 Operational conditions and external influences

Ceiling heating units should have a degree of protection of not less than IPX1 and floor heating elements for installation in a concrete floor or similar should have a degree of protection not less than IPX7 and have suitable mechanical properties.

5 Identification and notices

The installer shall provide a plan for each heating system containing the following details:

- 1 Manufacturer and type of heating unit
- 2 Number of heating units installed
- 3 Length/area of heating units
- 4 Rated power
- 5 Surface power density
- 6 Layout of the heating units in the form of a sketch, drawing or picture
- 7 Position/depth of heating unit
- 8 Position of junction boxes
- 9 Conductors, shields and the like
- 10 Heated area
- 11 Rated voltage
- 12 Rated resistance (cold) of the heating units
- 13 Rated current of overcurrent protective devices
- 14 Rated residual operating current of RCD
- 15 The insulation resistance of the heating installation and the test voltage used
- 16 The leakage capacitance.

The plan must be fixed to or adjacent to the distribution board of the heating system.

Section 8 describes advice to be provided by the installer for the user of the installation.

6 Mutual detrimental influences

Heating units must not cross expansion joints of the building or structure.

7 Wiring systems. Heating-free areas

It may be necessary to provide areas of floor or ceiling that are unheated e.g. where fixtures to the floor or ceiling would prevent the proper emission of heat. See Figure 6. Account shall be taken of the increase in temperature and of its effect upon the cables, including cold leads (circuit wiring) and control wiring installed in heated zones.

The installer shall advise the client and all other contractors that no penetrating means such as screws, rivets, nails, etc shall be used in an area where floor or ceiling heaters are being installed.

8 Information from the contractor for the user of the installation

A description of the heating system shall be provided by the installer of the heating system for the owner of the building upon completion of the installation or for his agent. The description should contain at least the following information:

- 1 description of the construction of the heating system, especially the installation depth from finished floor level of the floor heating units
- 2 location diagram with information concerning
 - the distribution of the heating circuits and their rated power
 - the position of the heating units in each room
 - conditions which have been taken into account when installing the heating units, e.g. heating-free areas, complementary heating zones, unheated areas for fixing, means penetrating into the floor covering
- 3 data on the control equipment used with relevant circuit diagrams and the dimensioned position of floor temperature and weather conditions sensors, if any
- 4 data on the type of heating units and their maximum operating temperature

The installer shall inform the owner that the description of the heating system includes all necessary information, e.g. for repair work. In addition, the owner shall be requested to hand over in time the instructions for use of the heating installation.

The designer/installer of the heating system shall hand over an appropriate number of instructions for use to the owner or his agent upon completion. One copy of the instructions for use shall be permanently fixed in or near each relevant distribution board.

The instructions for use shall include at least the following information:

- 1 description of the heating system and its function
- 2 operation of the heating installation in the first heating period in case of a new building, e.g. regarding drying out
- 3 operation of the control equipment for the heating system in the dwell area and the complementary heating zones as well, if any
- 4 information on the restriction on placing of furniture or similar
 - additional floor coverings, e.g. carpets with a thickness of >10 mm, may lead to higher floor temperatures which can adversely affect the performance of the heating system
 - pieces of furniture solidly covering the floor and/or built-in cupboards shall only be placed on heating-free areas
 - furniture, such as carpets, seating and rest furniture with pelmets, which in part do not solidly cover the floor may not be placed in complementary heating zones, if any
- 5 information on restrictions on placing of furniture or similar
- 6 in the case of ceiling heating systems, restrictions regarding the height of furniture. Cupboards of room height may be placed only below the area of ceiling where no heating elements are installed
- 7 dimensioned position of complementary heating zones and placing area
- 8 statement that in case of thermal floor and ceiling heating systems no fixing shall be made into the floor and ceiling respectively. Excluded from this requirement are unheated areas. Alternatives shall be given, where applicable. ■

THIS ARTICLE looks at Mobile and Transportable Units - a proposed new Section for BS 7671:2008, 17th Edition of the IEE Wiring Regulations.

Currently, there is no Part or Section of BS 7671:2001(2004) covering Mobile and Transportable Units but information on such installations can be found in IEC 60364-7-717, HD 60364-7-717 and Guidance Note 7, Special Locations.

The proposed Section 717 of BS 7671:2008 is based on the CENELEC Harmonised Document HD 60364-7-717, of which, the UK is to incorporate the technical intent of that standard.

Please note that Regulations and Sections quoted within this article are from the proposed BS 7671:2008 and may be subject to change.

The Scope of Section 717

The term 'unit' is intended to include a vehicle and/or transportable structure in which all or part of a low voltage electrical installation is contained, which is provided with a temporary supply by means of a plug and socket-outlet, for example. The units are either of the mobile type, such as self-propelled/towed vehicles, or of the transportable type, such as containers or cabins.

Examples of such units include:

- outside broadcast units as used in the entertainment industry
- medical services such as blood donor or mobile breast screening units
- advertising trucks and "roadshow" vehicles
- fire fighting appliances
- mobile workshops
- modular office buildings and construction site huts
- transportable catering units and fast food vans

It is important to note that the following are not within the scope of Section 717:

- transportable generating sets (Section 551)



MOBILE AND TRANSPORTABLE UNITS

by Mark Coles

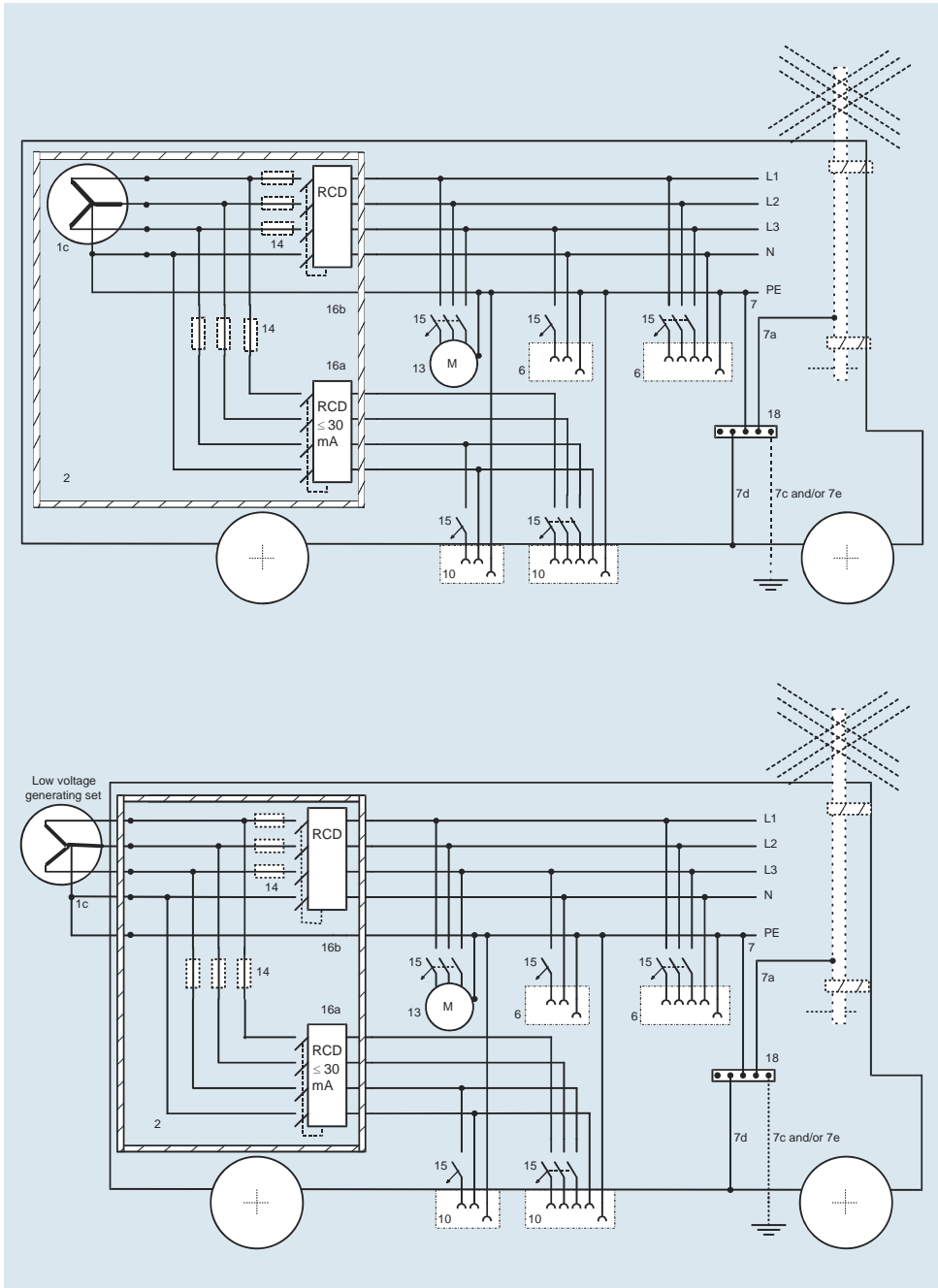
- marinas (Section 709)
- pleasure craft (IEC 60092-507)
- mobile machinery (BS EN 60204-1)
- caravans and other leisure accommodation (Section 721)

Risks

BS 7671 covers electrical installations generally and, as with all special locations, where particular risks exist, additional measures for protection are to be applied. In some instances it may be necessary to refer to other Sections of Part 7 of BS 7671, where in the case of, for example, units incorporating showers are utilised.

The following are examples of particular risks associated with mobile and transportable units:

- loss of connection to earth
- different national and local electricity distribution networks
- impracticality of establishing an equipotential zone external to the unit
- open-circuit faults of the PEN conductor of PME supplies



- shock due to high-protective-conductor currents
- vibration whilst the vehicle or trailer is in motion

Permitted types of supply to mobile and transportable units

There are a number of different types of electrical supplies permitted for mobile and transportable units.

TN-S system

TN-S systems are preferred for ease and reliability. See figure 1 and Appendix for the key to the figures.

Top, Figure 1:
Connection to a TN or TT system, with or without an earth electrode at the unit

Above, Figure 2:
Connection to a low voltage generating set located inside the unit, with or without an earth electrode

TT system

If TN-S is not available then a TT system could be utilised but it is not always easy to install a suitable earth-electrode, particularly if the anticipated time period for use of the installation at that location is short. See figure 1 and Appendix for the key to the figures.

TN-C

The use of a TN-C system is not permitted inside any unit. Regulation 8(4) of the ESQC Regulations forbids the use of combined neutral and protective conductors in a consumer's installation.

TN-C-S

TN-C-S systems should only be used where the installation is continuously under the supervision of a skilled or instructed persons and the suitability and effectiveness of the means of earthing has been confirmed before the connection is made. See figure 1 and Appendix for the key to the figures.

Low voltage generating set

The unit could also be supplied from a low-voltage generating set in accordance with Section 551 of BS 7671.

Figure 2 shows the connection to a low voltage generating set located inside the unit. Note that the generator may also be located outside the unit. An earth electrode would be necessary if the generator is providing a switched alternative to the system of distribution to the public, as Regulation 551.4.2 implies.

IT system

An IT system can be created by

utilising one of two methods.

The first is to use an isolating transformer or a low voltage generating set and incorporating an insulation monitoring device.

The second is to use a transformer providing simple separation, e.g. in accordance with BS EN 61558-1 but only in the following cases:

- a) an insulation monitoring device is installed with or without an earth electrode, providing automatic disconnection of the supply in case of a first fault between live parts and the frame of the unit.
- b) an RCD and an earth electrode are installed to provide automatic disconnection in the case of failure in the transformer which provides simple separation. Each item of equipment used outside the unit shall be protected by a separate residual current device RCD with a rated residual operating current not exceeding 30 mA having the characteristics specified in Regulation 415.1.1.

Protection against electric shock

Regulation 415.1.1 requires that additional protection by residual current protective devices with a rated residual operating current not exceeding 30 mA is necessary for all socket-outlets intended to supply current-using equipment outside the unit. An exception is permitted for socket-outlets which are supplied from circuits with protection by SELV, PELV (Section 414) or electrical separation (Section 413)

Accessible conductive parts of the unit, such as chassis, body structure or tube systems, should be interconnected and, through the protective equipotential bonding conductors in accordance with Regulation 411.3.1.2, connected to the protective conductor of the TT, IT or TN systems within the unit.

The main equipotential bonding conductor should be finely stranded, to BS 6004, Table 4B (harmonised code H07V-K), to allow for movement.

Identification and labelling

A permanent notice should be fixed to the unit in a prominent position, preferably adjacent to the supply inlet connector. The notice should state in clear and unambiguous terms the following information:

- the type of supply which may be connected to the unit
- the voltage rating of the unit
- the number of phases and their configuration
- the onboard earthing arrangement
- the maximum power requirement of the unit



Wiring systems - external

Flexible copper cables according to BS 7919 should be used (harmonised codes H07BB-F, H07RN-F, H07BN4-F). The minimum cable size used should be 2.5 mm².

The flexible cable should enter the unit by an insulating inlet in such a way as to minimize the possibility of any insulation damage or fault which might energize the exposed conductive parts of the unit. The cable sheath should be firmly gripped by the cable gland of the connector or otherwise anchored to the unit.

Wiring systems - internal

As some movement of wiring systems is inevitable, internal wiring should be of the flexible type:

- Where wiring is to be in conduit systems, then PVC insulated cable to BS 6004, Table 4B, should be used (harmonised code H07V-K).



- Where wiring is to be carried out using PVC sheathed cable then PVC/PVC cable to BS 6500 (harmonised code H0VV-F) should be used.
- Green/yellow protective bonding conductors and earthing tails should be finely stranded flexible cable to BS 6004, Table 4B (harmonised code H07V-K).

Other equipment - Plug and socket-outlets

Plugs and socket-outlets used externally to the unit should be to BS EN 60309-1, with pin configurations to BS EN 60309-2. Plug and socket-outlet enclosures connecting the unit to the supply should be of an insulating material and if mounted outside must have an Index of Protection not less than IP44*.

* The Index of Protection IP44 gives protection against ingress of moisture from water splashing from any direction and ingress of solid foreign objects of 1.0 mm and greater. For socket-outlets outside the unit (e.g. for supplies to equipment outside the unit) the degree of protection should be not Less than IP 54.



Verification

The frequency of inspection should be assessed by a competent person who is aware of the operating conditions for that vehicle. Some trucks could be static for long periods whilst others may be moved from location to location on a daily basis so it is important to assess the risks associated with different units. Minimally, the unit should be inspected and tested annually, with a Periodic Inspection Report obtained on its condition and the necessary maintenance work implemented.

A visual inspection should be carried out on the connecting cable and all plugs and socket-outlets before each and every transported use of the unit. The results of the visual inspection should be entered in a log-book as a permanent record of the condition of the electrical equipment.



Appendix

Key to diagrams - Mobile and Transportable Units

- 1a Connection of the unit to a supply through a transformer with simple separation in accordance with Regulation 717.411.6.2
- 1b Connection of the unit to a supply in which the protective measures are effective
- 1c Connection to a LV generator set in accordance with Section 551
- 2 Class II or equivalent enclosure up to the first protective device (see item 8 or 9) providing automatic disconnection of supply
- 6 Socket-outlets for use exclusively within the unit
- 7 Protective equipotential bonding in accordance with Regulation 717.411.3.1.2.1
 - 7a To an antenna pole, if any
 - 7c To a functional earth electrode, if required
 - 7d To the conductive enclosure of the unit
 - 7e To an earth electrode, for protective purposes, if required
- 8 Protective devices, if required, for overcurrent and/or for protection by disconnection of supply in case of a second fault
- 10 Socket-outlets for current-using equipment for use outside the unit
- 13 Current-using equipment used exclusively within the unit
- 14 Overcurrent protective device, if required
- 15 Overcurrent protective device (e.g. one P or PN circuit-breaker)
- 16a Residual current protective device rated with a rated residual operating current not exceeding 30 mA for protection by automatic disconnection of supply for circuits of equipment for use outside the unit
- 16b Residual current device for protection by automatic disconnection of supply
- 18 Main earthing terminal or bar

Thanks to Julian Parsons at BBC OB Resources for the images used.

CHANGES TO THE ELECTRICAL INSTALLATION CERTIFICATE AND REPORT FORMS

by Jonathan Elliott

SCHEDULE OF INSPECTIONS	
<p>Methods of protection against electric shock</p> <p>Both basic and fault protection:</p> <input type="checkbox"/> (i) SELV <input type="checkbox"/> (ii) PELV <input type="checkbox"/> (iii) Double insulation <input type="checkbox"/> (iv) Reinforced insulation <p>Basic protection:</p> <input type="checkbox"/> (i) Insulation of live parts <input type="checkbox"/> (ii) Barriers or enclosures <input type="checkbox"/> (iii) Obstacles <input type="checkbox"/> (iv) Placing out of reach <p>Fault protection:</p> <p>(i) Automatic disconnection of supply:</p> <input type="checkbox"/> Presence of earthing conductor <input type="checkbox"/> Presence of circuit protective conductors <input type="checkbox"/> Presence of protective bonding conductors <input type="checkbox"/> Presence of supplementary bonding conductors <input type="checkbox"/> Presence of earthing arrangements for combined protective and functional purposes <input type="checkbox"/> Presence of adequate arrangements for alternative source(s), where applicable <input type="checkbox"/> FELV <input type="checkbox"/> Choice and setting of protective and monitoring devices (for fault and/or overcurrent protection) <p>(ii) Non-conducting location:</p> <input type="checkbox"/> Absence of protective conductors <p>(iii) Earth-free equipotential bonding:</p> <input type="checkbox"/> Presence of earth-free equipotential bonding <p>(iv) Electrical Separation:</p> <input type="checkbox"/> Provided for one item of current-using equipment <input type="checkbox"/> Provided for more than one item of current-using equipment <p>Additional protection:</p> <input type="checkbox"/> Presence of residual current device(s) <input type="checkbox"/> Presence of supplementary bonding conductors	<p>Prevention of mutual detrimental influence</p> <input type="checkbox"/> (a) Proximity of non-electrical services and other influences <input type="checkbox"/> (b) Segregation of Band I and Band II circuits or use of Band II insulation <input type="checkbox"/> (c) Segregation of safety circuits. <p>Identification</p> <input type="checkbox"/> (a) Presence of diagrams, instructions, circuit charts and similar information <input type="checkbox"/> (b) Presence of danger notices and other warning notices <input type="checkbox"/> (c) Labeling of protective devices, switches and terminals <input type="checkbox"/> (d) Identification of conductors <p>Cables and conductors</p> <input type="checkbox"/> Selection of conductors for current-carrying capacity and voltage drop <input type="checkbox"/> Erection methods <input type="checkbox"/> Routing of cables in prescribed zones <input type="checkbox"/> Cables incorporating earthed armour or sheath, or run within an earthed wiring system, or otherwise adequately protected against nails, screws and the like <input type="checkbox"/> Additional protection provided by 30 mA RCD for cables in concealed walls (where required in premises not under the supervision of a skilled or instructed person) <input type="checkbox"/> Connection of conductors <input type="checkbox"/> Presence of fire barriers, suitable seals and protection against thermal effects <p>General</p> <input type="checkbox"/> Presence and correct location of appropriate devices for isolation and switching <input type="checkbox"/> Adequacy of access to switchgear and other equipment <input type="checkbox"/> Particular protective measures for special installations and locations <input type="checkbox"/> Connection of single-pole devices for protection or switching in-line conductors only <input type="checkbox"/> Correct connection of accessories and equipment <input type="checkbox"/> Presence of undervoltage protective devices <input type="checkbox"/> Selection of equipment and protective measures appropriate to external influences <input type="checkbox"/> Selection of appropriate functional switching devices
<p>Inspected by _____ Date _____</p> <p>NOTES:</p> <p>✓ to indicate an inspection has been carried out and the result is satisfactory X to indicate an inspection has been carried out and the result is not satisfactory (applicable for a periodic inspection only) N/A to indicate that the inspection is not applicable to a particular item LMT to indicate that, exceptionally, a limitation agreed with the person ordering the work prevented the inspection being carried out. (applicable for a periodic inspection only)</p>	

IN THE COURSE of producing the new edition of BS 7671 (the IEE Wiring Regulations 17th Edition) a number of changes have been made to the chapters covering initial verification; periodic inspection & testing; and certification & reporting and to Appendix 6 (Model forms for certification and reporting). This article explains the reasoning behind these changes and highlights the principal differences between the 16th and 17th Edition requirements.

Alignment with International and European conventions

The 17th Edition of the Wiring Regulations (BS 7671) is currently under production and is due to be released in January 2008 and will come into effect on 1st July 2008. The new version of BS 7671 has been produced including the changes necessary to maintain technical alignment with IEC (International) and CENELEC (European) harmonization documents. In the case of the requirements within Part 6 of the new edition relating to initial verification, periodic inspection & testing, and certification and reporting these have been based on Harmonization Document HD 384.6.61 S2; 2003 but with reference having been made to the more recent HD 60364-6 Part 6: 2007 - Verification and to Part 7 as it appeared in the 16th Edition of BS 7671.

The Chapter and numbering system

This brings us to the first difference between the 16th and 17th Editions. In the 16th Edition Part 7 covered the various aspects of inspection and testing. In the 17th Edition, inspection and testing is covered by Part 6, so aligning with the numbering in the European base standard - a practice that has been adopted throughout the rest of the 17th Edition wherever possible.

So, in the 17th Edition:

- for Initial verification refer to Chapter 61
 - for Periodic Inspection refer to Chapter 62
 - for Certification and reporting refer to Chapter 63
- The model forms for certification and reporting remain in Appendix 6.

The numbering of Parts, Chapters and Sections throughout the 17th Edition has been changed to fall in line with the systems employed by the International Electrotechnical Commission (IEC) and CENELEC as much as is practically possible. However, although different, the system should be sufficiently familiar to users of the wiring regulations to not present difficulties. By way of an example, in the 16th Edition, section 712 covered Inspection, with Regulation 712-01-03 being a summary of items to be checked during installation. In the 17th Edition the equivalent section is numbered 611 and Regulation is numbered 611.3.

611. Inspection - Goodbye Direct and Indirect contact. Hello Basic and Fault protection

Chapter 41 (Protection against electric shock) now refers to basic protection, which is protection under normal conditions (previously referred to as protection against direct contact), and fault protection, which is protection under fault conditions (previously referred to as protection against indirect contact).

This change has had significant implications for those items required to be inspected in Regulation 611.3 and hence in the model form for the Schedule of Inspections given in Appendix 6. A summary of the differences are given in table 1.

612. Testing – Changes to minimum acceptable values of insulation resistance and requirement to check phase sequence.

In the most part the requirements for electrical tests remain unchanged from those of the 16th Edition. However, the minimum acceptable values for insulation resistance when measured at a distribution board or consumer unit with all final circuits connected but with current using equipment disconnected have been raised as shown in the comparison in table 2.

With reference to the table 2, it should be noted that in all cases the applied test voltages remain unchanged.

Also of interest is the inclusion of a note which advises that more stringent requirements for minimum insulation resistance are applicable to the wiring of fire alarm systems in buildings, referring to the reader to BS 5839 part 1 as a source of further information (see BS 5839-1: 2002, Clause 38 *Inspection and testing of wiring*).

In the 17th Edition, Regulation 612.12 makes a new requirement that verification of phase sequence is carried out in multiphase circuits. Although not specifically stated in the 16th Edition, it would have been necessary to carry out this verification where appropriate previously and as such this change will have no appreciable impact on persons carrying out the initial verification of installations.

16th Edition		17th Edition	
Measures providing protection against both direct and indirect contact	<ul style="list-style-type: none"> • SELV • Limitation of discharge of energy 	Measures providing both basic and fault protection	<ul style="list-style-type: none"> • SELV • PELV • Double insulation • Reinforced insulation
Measures providing protection against direct contact	<ul style="list-style-type: none"> • Insulation of live parts • Barriers or enclosures • Obstacles • Placing out of reach 	Measures providing basic protection	<ul style="list-style-type: none"> • Insulation of live parts • Barriers or enclosures • Obstacles • Placing out of reach
Protection against indirect contact	<ul style="list-style-type: none"> • EEBADS • Class II equipment or equivalent insulation • Non-conducting location • Earth-free local equipotential bonding • Electrical separation 	Measures providing fault protection	<ul style="list-style-type: none"> • Automatic disconnection of supply • Non-conducting location • Earth-free equipotential bonding • Electrical separation

Table 1

Circuit nominal voltage (V)	Minimum insulation resistance (M Ω)	
	16th Edition	17th Edition
SELV and PELV	0.25	≥ 0.5
Up to and including 500 V with the exception of SELV and PELV above	0.5	≥ 1.0
Above 500 V	1.0	≥ 1.0

Table 2

Voltage drop

Regulation 612.14 states that voltage drop may be evaluated by measurement of circuit impedance when necessary to verify compliance with the requirements of section 525 (voltage drop in consumer's installations).

Requirements for test instruments

There have been no changes made in relation to the specification for test instruments. If they were suitable for 16th Edition requirements, they remain suitable for use under 17th Edition requirements so long as they remain in a serviceable condition.

The new Model forms

As mentioned previously, it has been necessary to make a number of changes to the Model forms, in particular the Schedule of

Inspections. The new schedule of inspections is reproduced below for reference and to aid familiarisation. Those parts of the schedule that have been subject to significant change are highlighted.

Please note that PDF versions of the forms to accompany the 17th Edition will be available as a free download on the IET website www.theiet.org/technical from mid-January 2008 under *Forms for electrical contractors*. ■

The content of this article is based on the current Committee draft of BS 7671 and may be subject to change.

IN SERVICE INSPECTION AND TESTING OF ELECTRICAL EQUIPMENT

THE INSULATION TEST

by John Ware

Electrical equipment must be maintained so as to prevent danger. The IEE's Code of Practice for In-Service Inspection and Testing recommends that maintenance of electrical equipment is carried out in four stages: Visual inspection, Test to verify earth continuity, Test to verify insulation, and Functional test. In this article we discuss the insulation test.



Safety

Electrical testing must be performed by a person who is competent to perform the test without putting themselves or others at risk, who is able to use the test equipment safely and who knows how to interpret the results obtained. Refer to the HSE's publication HSR25 *Memorandum of guidance on the Electricity at Work Regulations 1989*. This person should be

capable of inspecting the equipment and, where necessary, dismantling it to check the cable connections. Care should always be exercised when conducting tests.

Inappropriate tests can damage equipment. Appliances should not be touched whilst carrying out insulation resistance tests as exposed metalwork may reach the test voltage which, whilst not dangerous, could be uncomfortable and risk causing injury by involuntary movement. It is important to ensure that the connections between the test instrument and the equipment under test are properly made. A poor earth connection, particularly for appliances with relatively high protective conductor current, may cause a perceived 'electric shock' from the appliance frame which whilst not dangerous, could be uncomfortable and risk causing injury by involuntary movement.

Sequence of testing

The sequence of inspection and testing of electrical equipment such as a portable appliance should always be

- 1 Visual inspection
- 2 Earth continuity test, for Class I equipment

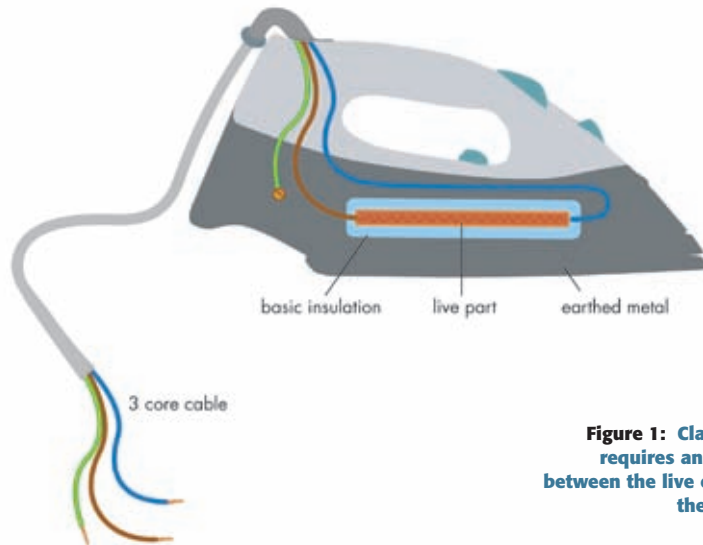


Figure 1: Class I equipment requires an insulation test between the live conductors and the earthed metal

- 3 Insulation resistance test, if appropriate
- 4 Protective conductor current and/or touch current test or substitute/alternative leakage test, if appropriate and
- 5 Functional test.

Persons performing testing should be aware that it may not be possible to perform some of the tests prescribed by the IEE's Code of Practice for In-Service Inspection and Testing of Electrical Equipment, for example, in this particular case, electrical equipment should not be subjected to test voltages and currents that would result in damage. Some electrical test devices apply tests which are inappropriate and may even damage equipment containing electronic circuits, possibly causing degradation to safety. In particular, whilst the Code of Practice includes insulation resistance tests, equipment should not normally be subjected to dielectric strength testing (also known as flash testing or hi-pot testing) because this may damage insulation and may also indirectly damage low voltage electronic circuits unless appropriate precautions are taken.

Insulation resistance testing may be substituted by a protective conductor

current/touch current measurement where insulation resistance testing is not appropriate due to the possibility of the item of equipment being damaged by the test voltage.

Alternatively insulation resistance testing may be inappropriate because of voltage limiting devices in the equipment under test or the fact that the equipment under test has an electronic switch which requires mains power to close the switch.

An insulation test should be carried out before any powered tests as it may detect a potentially dangerous insulation failure. Only then should other tests such as a protective conductor or touch current be performed, if appropriate.

The insulation resistance test

Insulation resistance is normally measured by applying a test voltage of 500 V d.c. and recording the resistance measured. This test, a so-called 'hard test', may not always be suitable as it may damage IT equipment or other equipment containing electronic components and the protective conductor/touch current measurement test, a so-called 'soft' test, or substitute/alternative leakage current test, or insulation resistance test at a reduced voltage, such as

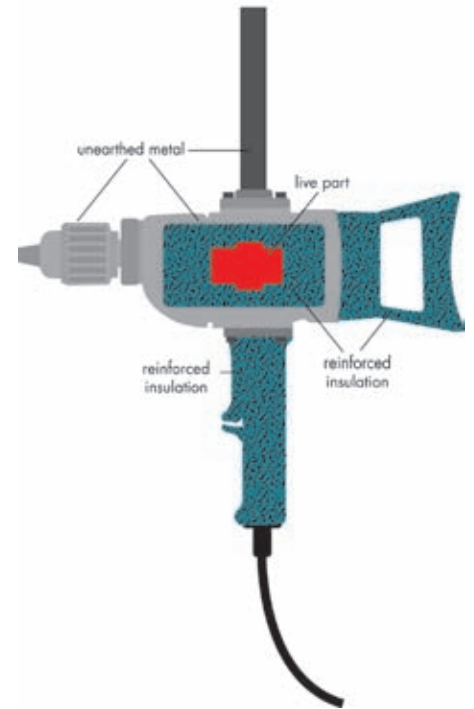


Figure 2: The drill, a Class II appliance, should have an insulation test made between the conductors and the unearthed metal

250 V d.c. may be a more appropriate alternative. The 500 V d.c. insulation test should not be applied to IT (information technology) equipment, unless such equipment complies with the requirements of BS EN 60950: *Specification for safety of information technology equipment including electrical business equipment*. Equipment not constructed to this standard may be damaged by the 500 V d.c. applied during the insulation test.

The live conductors (phase and neutral) should be connected together for the insulation test. This is best achieved either by using special test equipment or by using a special test socket with the phase and neutral connected together. Equipment is not to be returned to service with any phase-neutral connections still in place. It is therefore recommended that the functional test is carried out last.

Before the test, the suitability of

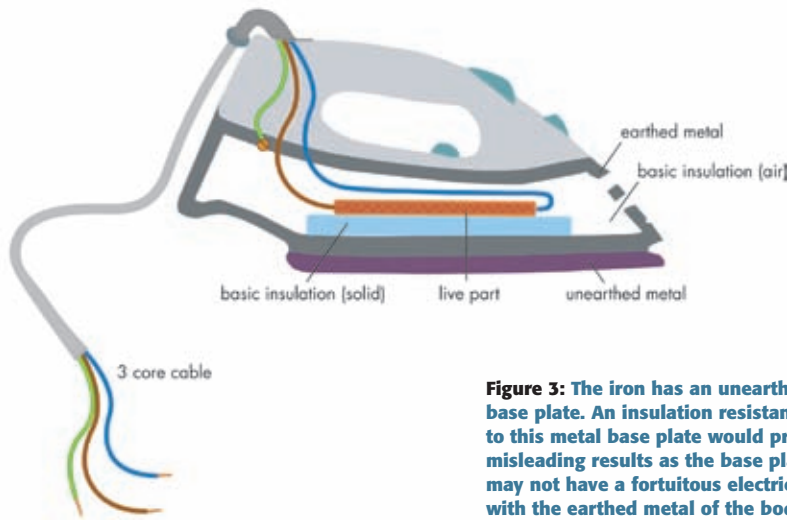


Figure 3: The iron has an unearthed metal base plate. An insulation resistance test made to this metal base plate would probably give misleading results as the base plate may or may not have a fortuitous electrical connection with the earthed metal of the body of the iron

Appliance Class	Minimum insulation resistance
Class I heating and cooking equipment with a rating ≥ 3 kW	0.3 megohm
All other Class I equipment	1.0 megohm
Class II equipment	2.0 megohms
Class III equipment	250 kilohm

Table 1: Insulation resistance readings

fuses in the equipment to be tested should be checked and power switches put in the 'on' position. All covers should be in place. The test is carried out between live conductors, i.e. phase and neutral, connected together and the body of the appliance.

The applied test voltage should be approximately 500 V d.c. The test instrument should be capable of maintaining this test voltage with a load resistance of 0.5 megohm. Insulation resistance readings obtained should be not less than the values shown in Table 1 above.

When testing insulation resistance on a Class II appliance the test probe should be connected to any metal parts or suspect joints in the enclosure where conductive material may have accumulated. This may require multiple tests.

Heating and cooking appliances. Certain heating and cooking appliances may be unable to meet the insulation resistance

requirements above, such as where metal sheathed mineral-insulated heating elements are used. It may be necessary in some cases to switch on the appliance for a period of time to drive off absorbed moisture before commencing testing. Additionally the touch current measurement test may be carried out.

Three-phase equipment. For 3-phase equipment, all three phases and neutral (if applicable) are to be linked together whilst making this test.

Equipment with filter networks. Some equipment may have filter networks or transient suppression devices which could cause the insulation resistance to be less than specified. The manufacturer or supplier is to be consulted in these cases as to the acceptable value of measured insulation resistance. A protective conductor and/or touch current test should be performed in addition to the insulation test. ■

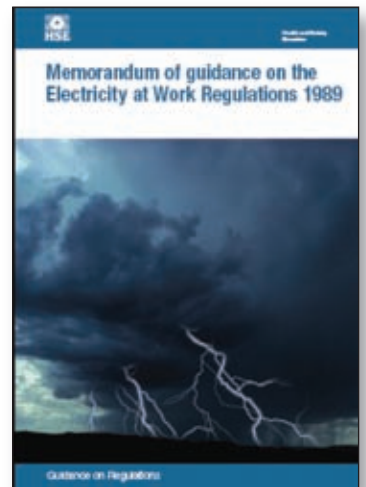


Figure 4: Performing In Service Inspection and Testing? These three publications will help.