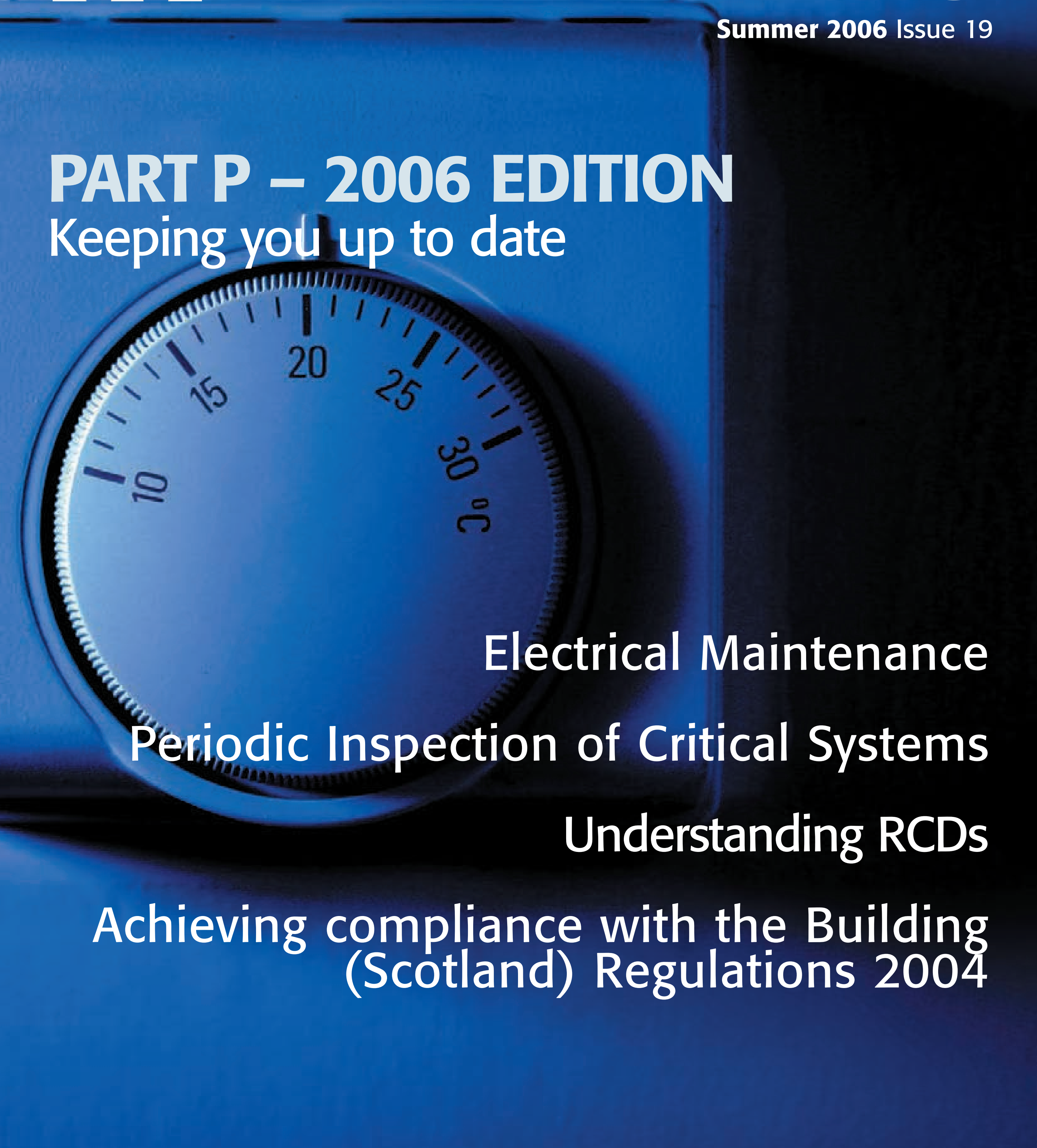
The IEE

WIRING MATTERS

Summer 2006 Issue 19

PART P – 2006 EDITION
Keeping you up to date

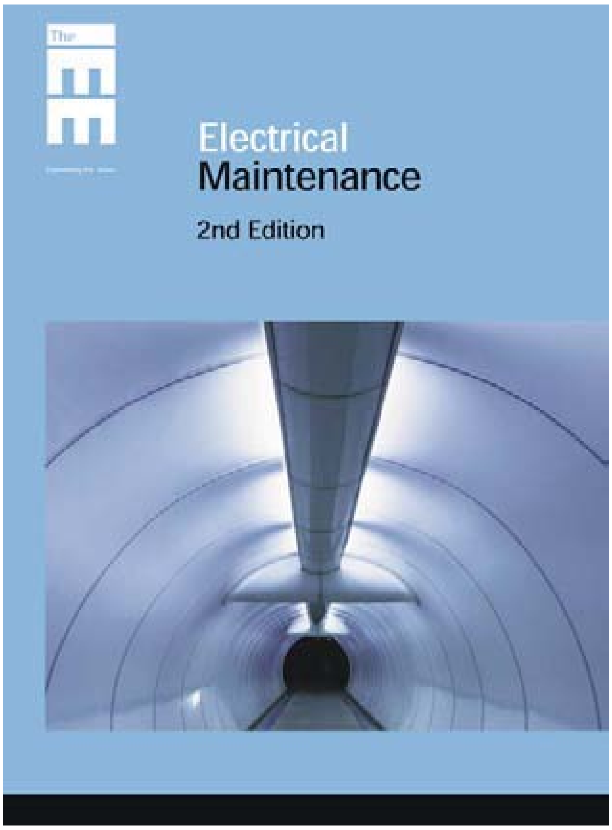


Electrical Maintenance

Periodic Inspection of Critical Systems

Understanding RCDs

Achieving compliance with the Building (Scotland) Regulations 2004



ELECTRICAL MAINTENANCE

By John Ware

THE IET's publication *Electrical Maintenance* has been completely revised and now includes up-to-date information on key areas including fire alarms, emergency lighting, risk assessment and legislation.

Why perform maintenance?
Maintenance is carried out for the following reasons:

- To prevent danger
- To reduce unit cost and to keep a facility in operation (reliability)
- To prevent pollution of the environment.

To prevent danger
Maintenance for safety may be carried out to meet common law requirements and legal requirements.

The common law requirements imply a general duty of care to other persons and their livestock, property, etc.

Legal requirements are those where there are stipulations in the legislation for maintenance. In the Electricity at Work Regulations (EWR), the requirement is phrased as follows:

'As may be necessary to prevent danger, all systems shall be maintained so as to prevent, so far as is reasonably practicable, such danger.' (Regulation 4(2)).

The requirement here is to maintain the system (including equipment) so as to prevent danger, and this may be achieved by carrying out a maintenance activity. In general, equipment cannot be kept in a safe condition without actually being maintained. Normally it is necessary to inspect and/or test a system to determine if maintenance (including repairs) is necessary. It is also likely to be necessary to monitor the effectiveness of maintenance procedures by keeping and analysing records.

To reduce unit cost and to keep a facility in operation (reliability)
The issues concern minimising business costs and maximising income.

Maintenance carried out to reduce the cost of an enterprise would include action taken to reduce or avoid:

a) The cost of failure of plant or equipment – repair costs;
b) The cost of loss of production – revenue costs;
c) The cost of loss of service – revenue and goodwill.

Cost of failure of plant or equipment – repair costs.
Decisions on the approach to be taken are rarely simple. For example, all the lamps of a street lighting installation will need to be replaced at some time or the street will end up in darkness. The decision as to whether it is cost effective to replace the lamps routinely (preventive maintenance) or when they fail (breakdown) will need to take into account the reduction in light output (if significant), the effect on traffic of frequent disturbances and the cost of attending to replace lamps. It might be decided that breakdown maintenance was appropriate for a 'B' road, while preventive lamp replacement was necessary for a motorway.

A balance needs to be achieved between the cost of the maintenance activity and the cost of the equipment.

The cost of maintaining a large motor might well be small compared with the cost of replacement, whereas the cost of replacing a single tungsten filament lamp will far outweigh the cost of the lamp. The lamp may be maintained on a breakdown basis, the motor on a routine basis.

The IET's Electrical Maintenance, 2006

Loss of production – revenue costs. In many situations the cost of the failed piece of equipment is insignificant compared with the cost of loss of output or production. In these circumstances breakdown maintenance is unlikely to be appropriate.

Loss of service – revenue and goodwill. Customer goodwill is difficult to estimate financially, but should be considered, when determining maintenance regimes. The additional costs of early replacement, or even frequent maintenance, can be justified by customer goodwill.

To prevent pollution of the environment

Maintenance may be required to be carried out, not simply to protect people's health and safety, but also to protect the environment. This may not be cost effective, but it may be seen as a general duty of care or it may be a legislative requirement as required by the WEEE Directive, the Clean Air Act or the Environmental Protection Act and associated Regulations.

So far as is reasonably practicable

Duties in some of the Regulations of the EWR, such as Regulation 4(2) quoted previously, use the phrase 'so far is as reasonably practicable'. Where this qualifying term is absent, for example in Regulation 16 concerning competence, the regulation is said to be absolute. The meaning of 'reasonably practicable' has been well established in law. The interpretations below are given as a guide both to administrators and to persons inspecting and testing.

■ **Absolute**

If the requirement is 'absolute' the requirement must be met regardless of cost or any other consideration.

■ **Reasonably practicable**

Someone who is required to do something 'so far as is reasonably practicable' must assess, on the one hand, the magnitude of the risks of a particular work activity and, on the other hand, the costs in terms of the physical difficulty, time, trouble and expense that would be involved in taking steps to eliminate or minimise those risks. If, for example, the risks to the health and safety of a particular person are very low, and the cost or technical difficulties of taking certain steps to prevent those risks are very high, it may not be reasonably practicable to take those steps. The greater the degree of risk, the less weight that can be given to the cost of the measures needed to prevent that risk.

In the context of the EWR, where the risk is very often that of death, for example by electrocution, and where the nature of the precautions which can be taken are so often very simple and cheap, for example by locking off a main switch or circuit-breaker, the level of duty to prevent that danger approaches that of an absolute duty. ■

A new Institution from the IEE and IIE

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IEE Electrical Maintenance

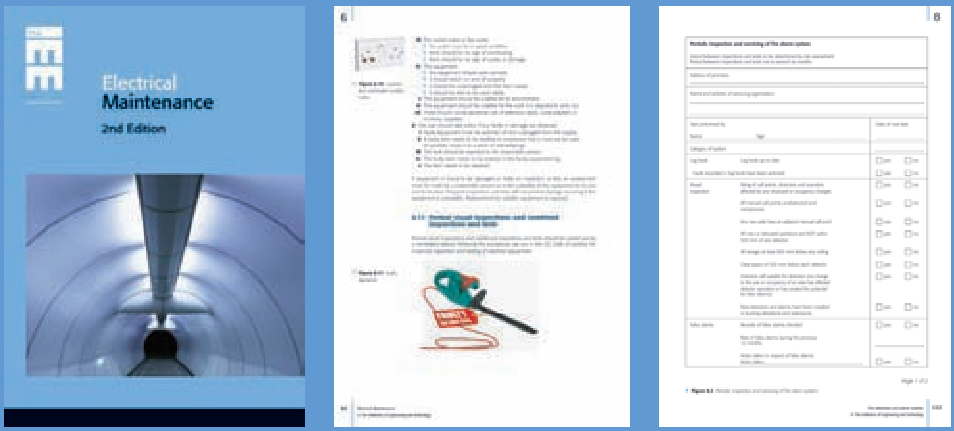
2nd Edition

REVISED AND UPDATED

The IEE's Electrical Maintenance guide has been thoroughly revised and updated.
The new edition – which has been written by IEE Engineers - has been brought up to date to reflect changes in the law and explain new concepts and working practices.

Under the Electricity at Work Regulations 1989 there is a requirement that all systems are maintained so as to prevent danger. **This guide will ensure you follow best practice** and are aware of the legal requirements.

Contents



The new edition is supported by full-colour illustrations, clear diagrams and model forms you can use at work.

The IEE

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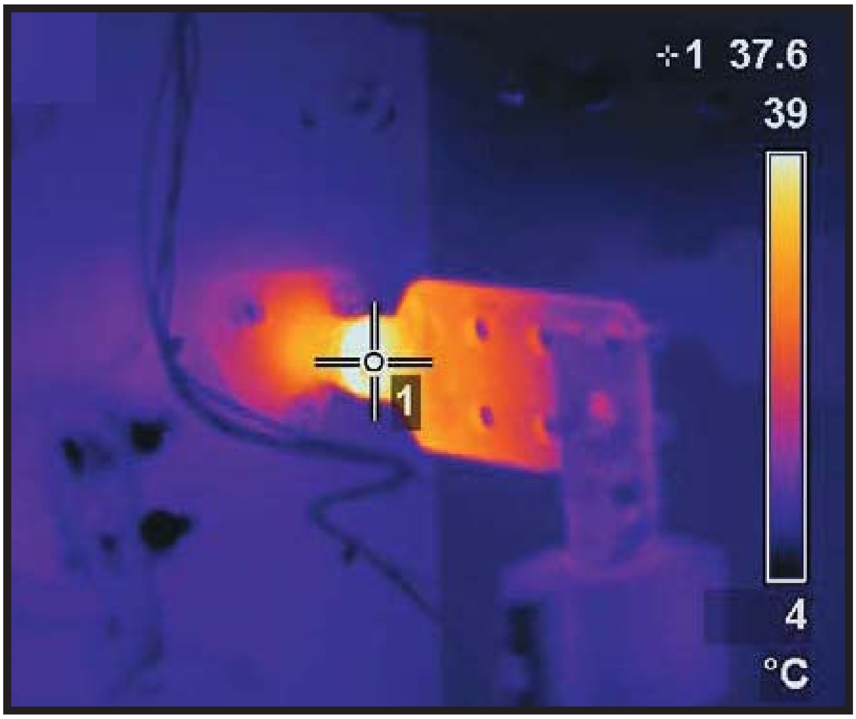


PERIODIC INSPECTION OF CRITICAL SYSTEMS

By Mark Coles

WHEN UNDERTAKING periodic inspections, contractors are often refused permission to shut down parts of an installation to carry out the required tests; the contractor duly records a limitation on the Periodic Inspection Report. The situation can go on for years and elements of an electrical installation are never assessed, which of course, does not comply with BS 7671 or the Electricity at Work Regulations 1989; electrical installations must be tested and inspected at regular intervals.

The Standards and Compliance department here at the IET is often asked if there any additional inspection methods that can be employed to ensure the continuing reliability of critical systems.

THE NEED FOR PERIODIC INSPECTIONS

Over time, electrical installations degrade due to a number of factors; loading, overheating, environment, mechanical damage, wear and tear, poor maintenance, etc. It is therefore important that any deficiencies in the installation are found and corrected as soon as possible.

The law

The law requires that electrical installations are maintained and kept in a safe condition. The following extract from the Electricity at Work Regulations 1989, Regulation 4, places a duty on employers to provide safe systems for their workers:

Regulation 4 of the Electricity at Work Regulations 1989

Systems, work activities and protective equipment
*(1) All **systems** shall at all times be of such construction as to prevent, so far as is reasonably practicable, **danger**.*

*(2)As may be necessary to prevent **danger**, all **systems** shall be maintained so as to prevent, so far as is reasonably practicable, such **danger**.*

*(4) Any equipment provided under these Regulations for the purpose of protecting persons at work on or near **electrical equipment** shall be suitable for the use for which it is provided, be maintained in a condition suitable for that use, and be properly used.*

Competency

The law requires that the operation, maintenance and testing of electrical systems and equipment should be carried out only by those persons who are competent for the particular class of work. The use of people who are properly trained and competent to work on live equipment safely is a legal requirement.

The following extract from the Electricity at Work Regulations 1989, Regulation 16, defines competency:

Regulation 16 of the Electricity at Work Regulations 1989

Persons to be competent to prevent danger and injury
*No person shall be engaged in any work activity where technical knowledge or experience is necessary to prevent **danger** or, where appropriate, injury, unless he possesses such knowledge or experience, or is under such degree of supervision as may be appropriate*

having regard to the nature of the work.

The requirements of BS 7671

One of the essential requirements of BS 7671 is stated in Regulation 130-01-01. This Regulation sets the scene for Chapter 13, Fundamental Principles. The requirements of Chapter 13 are intended to provide for the safety of persons, livestock and property against dangers and damage which may arise in the reasonable use of electrical installations. Risk of injury may result from shock currents, excessive temperatures likely to cause burns, fires, other injurious effects and explosion.

It is therefore a requirement to select the correct equipment and install in a suitable manner for the particular application. It is also a requirement that such installations be periodically inspected and tested to ensure ongoing safety.

Chapter 73 of BS 7671, Periodic Inspection and Testing, states that, where required, periodic inspection and testing of every electrical installation shall be carried out to determine whether the installation is in a satisfactory condition for continued service.

The frequency of periodic inspection and testing should be determined by taking into account the type of installation, the use and operation, the frequency and quality of maintenance and the external influences to which it is subjected.

Table 3.2 of The IEE publication Guidance Note 3 – Inspection and Testing provides guidance on the frequency of formal inspections of electrical installations as well as the routine checks.

The formal inspections should be carried out in accordance with Chapter 73 of BS 7671. This requires an inspection comprising careful scrutiny of the installation, carried out without dismantling or with partial dismantling as required, together with the appropriate tests of Chapter 71.

THE PERIODIC INSPECTION

In smaller installations, such as those in domestic properties, the periodic inspection is a relatively straight-forward process. The installation would be under the control of the inspector and they may shut down parts or all of the installation at will to undertake the relevant tests. On larger installations, this is not so easy.

Consider an electrical installation in a hospital or a bank. The duty holder has refused the contractor permission to shut down parts of the installation for patient welfare, safety or for security reasons. The contractor would then make reference to this situation on the Periodic Inspection Report (see figs 1 & 2 below). Installations that have such critical loads, like hospitals and banks, cannot afford supply failure. Failure of a piece of distribution equipment or a distribution cable, for example, which causes an interruption of supply, could be extremely dangerous as well as financially disastrous for the organisation.

The irony is that those circuits for which permission to isolate is refused are those which require the most scrutiny to ensure that they do not fail...

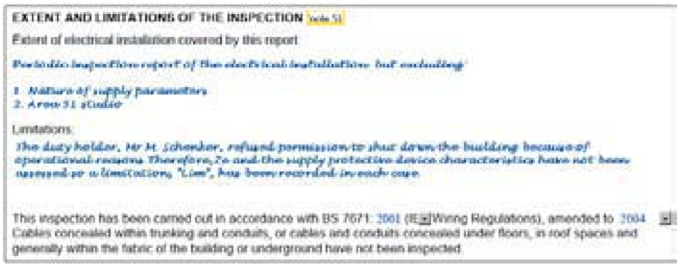
The contractor cannot insist on shut down to assess the installation but the duty holder still has a duty of care to ensure that their systems are safe. To comply with BS 7671 and the Electricity at Work Regulations 1989, the Duty holder must make available all parts of the installation for periodic inspection.

Problems and hidden dangers

Visual inspections of electrical installations will pick up most common problems, e.g. if the method of installation is unsuitable for the environment in which it is located, mechanical damage due to impact or abrasion will generally be obvious and any problems associated with wear and tear, such as loose screws or covers, will be clearly apparent.

If elements of the installation are not inspected, problems may therefore go undetected.

Loose terminals, located within an enclosure, can cause overheating in conductors and equipment. The heating effect is due to an increase in



EXTENT AND LIMITATIONS OF THE INSPECTION

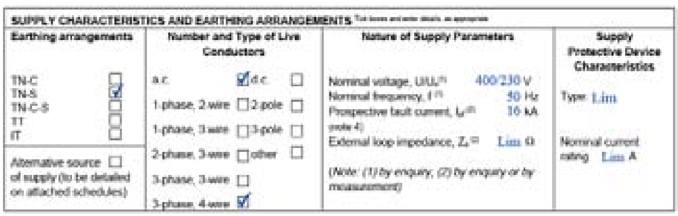
Extent of electrical installation covered by this report

Limitations:

This inspection has been carried out in accordance with BS 7671: 2001 (IEE Wiring Regulations), amended to 2004

Cables concealed within trunking and conduits, or cables and conduits concealed under floors, in roof spaces and generally within the fabric of the building or underground have not been inspected

Fig 1: Extent and limitations of the inspection – extract from page 1 of the model form Periodic Inspection Report for an Electrical Installation



SUPPLY CHARACTERISTICS AND EARTHING ARRANGEMENTS

Earthing arrangements	Number and Type of Live Conductors	Nature of Supply Parameters	Supply Protective Device Characteristics
TN-C, TN-S ✓, TN-C-S, TT, IT	a.c. ✓ d.c.; 1-phase, 2-wire; 2-pole; 1-phase, 3-wire; 3-pole; 2-phase, 3-wire; other; 3-phase, 3-wire; 3-phase, 4-wire ✓	Nominal voltage, U/U₀ (1) 400/230 V; Nominal frequency, f (1) 50 Hz; Prospective fault current, Ipf (2) 16 kA (note 4); External loop impedance, Ze (2) Lim Ω; (Note: (1) by enquiry, (2) by enquiry or by measurement)	Type: Lim; Nominal current rating Lim A
Alternative source of supply (to be detailed on attached schedules)			

Fig 2: Supply characteristics and earthing arrangements – extract from page 2 of the model form Periodic Inspection Report for an Electrical Installation

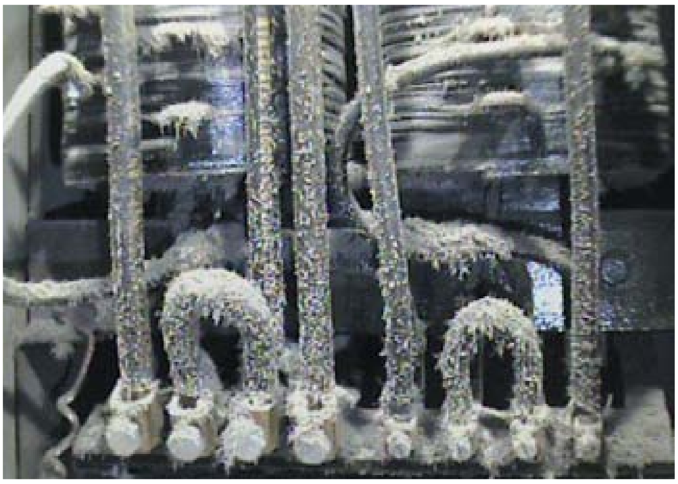


Fig 3: Accumulation of dust on terminations

Fig 4: Accumulation of dust in equipment

resistance across the joint; as heat rises, the insulation can fail which could cause an arc or even an explosion in some cases.

Arcing is an electrical discharge that begins at full intensity and can end just as abruptly. A path to earth develops as the insulation breaks down and high temperatures are reached very quickly.

A build-up of dust and debris, undetected over time, can cause arcs, tracking, short circuits and faults within equipment. Clearly, this is a major fire hazard.

Tracking is a problem that will build in intensity; like arcing, it will develop a path to Earth and accelerate the deterioration of insulation. Tracking is visually evident by carbon residue or 'tracks'.

There are other problems found in electrical installations, which a general periodic inspection would not necessarily discover. Mechanical vibration, for example, is a problem that can only be detected when the equipment is energised and running. Generally, the source of the vibration can be related to a number of issues including contactor or relay chatter, transformer delaminating, loose fixings or worn parts on equipment.

Overloaded circuits can also cause overheating in conductors and equipment.

Harmonics

Harmonics are generated when a load draws a non-linear current from a sinusoidal supply. Switch-mode power supplies, used extensively in computer and IT equipment, or variable frequency drives (VFDs), used to control electric motors, for example, can distort the voltage and current waveforms; high 3rd order harmonic current is typical for switch-mode power supplies. 3rd, in addition to other triple, harmonics combine in the neutral conductor and create a neutral current that has a magnitude equal to the sum of the third harmonic content of each phase. The heating effect of this increased neutral current can have an influence on the temperature at which a cable operates, particularly where multicore cables are used. The tables of current-carrying capacity, as shown in Appendix 4 of BS 7671, assume that at full load the neutral current will be zero and will therefore not contribute to the heating effect of the cable. In reality, the resultant neutral conductor current can be well above the current-carrying capacity for the cable.

This can be extremely dangerous as neutral conductors, which are not fuse or MCB protected, can overheat.

OTHER METHODS OF ASSESSMENT

New technologies, such as Infrared Thermography and Ultrasonic Testing, are methods which allow for the assessment of energised electrical installations. The technology provides for early detection of problems and potential catastrophic failure of the equipment and associated components but should not be used as a replacement for regular programmed periodic inspections.

Infrared Thermography

Infrared Thermography is based on the principle that all materials emit electromagnetic radiation which can be detected by an infrared camera.

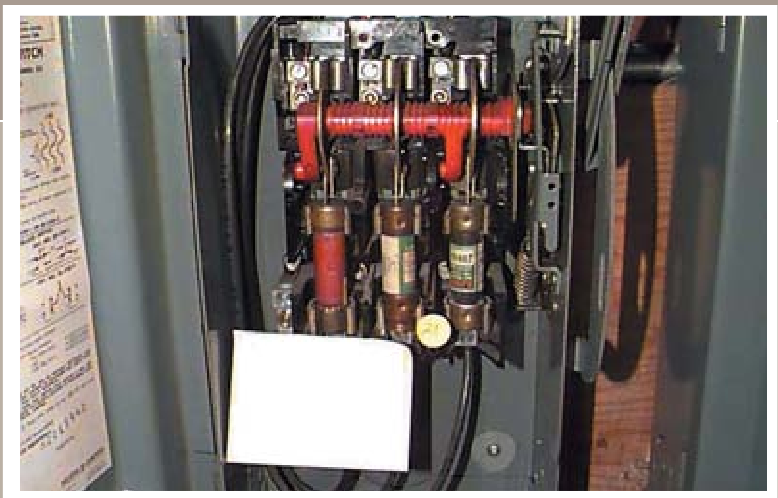


Fig 5: Positive image of an item of switchgear

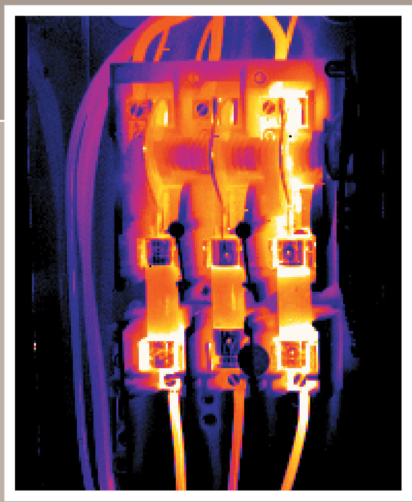


Fig 6: Infrared image

The amount of radiated energy detected is translated into temperature information based on the laws of quantum physics. All materials above the hypothetical temperature of absolute zero, (-273.15ºC, 0 kelvin) will emit this energy.

In electrical installations, heating effects are created and generated as a result of numerous factors including cyclical-load operations, insufficient cross-sectional area of conductors, types of loads and system deterioration.

A common point of failure, related to heating in electrical applications, is at the terminations of conductors. In many cases this is due to an increase in the resistance of that joint or connection which is directly related to the thermal energy that can be identified.

The following images show how infrared technology can be used as an inspection and diagnostic tool.

Figs 1 and 2 show an item of switchgear; fig 1 is the positive image of the equipment, fig 2 is the infrared image. Note that darker areas of the infrared image are cooler; whiter areas are warmer. It can therefore be seen from fig 2 that parts of the equipment are hotter than others; these areas are terminations and/or contacts and the increase in temperature will be due to an increased resistance across the joint.

Fig 7 shows the positive image of an MCB in a distribution board; fig 8 shows the infrared image.

As can be seen from fig 8, one circuit is operating at a far higher temperature than others within the same distribution board.

Note that raised temperatures on one or even a number of circuits may not be a cause for concern; some circuits are designed to operate up to 70ºC, others may even be designed to operate up to 90ºC. Problems occur where a particular element of a circuit is far hotter than the remainder and these 'hotspots' can deteriorate very rapidly.

An increase in resistance not only creates heat at connections and joints, which is the simple Ohm's Law relationship but also fatigues the apparatus reducing useful service life and increases the risk of fire. The increased resistance will cause an increase in power loss at the termination, which in turn increases energy costs; again the increase in emission of thermal radiation will be detected by the infrared camera.

Ultrasonic Testing

The National Aeronautics and Space Administration (NASA) in the USA developed ultrasonic technology in the 1970s as a tool for analysis procedures on the Space Shuttle programme. Ultrasonic frequencies are those that are found between the ranges of 20kHz to 100kHz; the average range for human hearing is between 20Hz and 16kHz. Some emissions related to electrical issues can be in the ultrasonic frequency range and will therefore be beyond our hearing capabilities. The ultrasound technology detects the ionisation of air as it produces turbulence in electrical applications, particularly in systems below 1000 volts.

The main concerns are arcing, tracking, contactor or relay chatter and mechanical vibration.

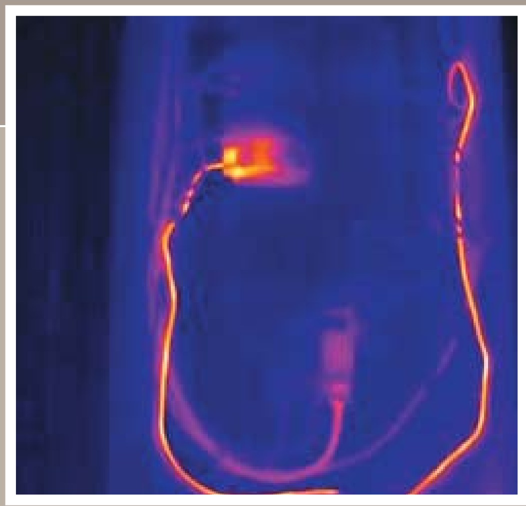


Fig 7: **Positive image of an MCB in a distribution board**

Fig 8: **Infrared image**

The advantage of using this technology is that it may be employed where sight and access are restricted. Ultrasonic emissions generated in electrical equipment can escape through any opening in the enclosure, such as a door seal, cooling vent or seams around integral components; the emissions are detected by probe.

Additionally, problems associated with sealed or liquid-filled equipment can be identified by employing a contact probe. In this configuration, the probe becomes a wave-guide for sound and channels any emission that exists internally within the equipment into the probe. The unit will process the signal and demodulate it into a sound audible to human hearing. Once electronically recorded, the frequency content can be analysed using application software.

All electrical anomalies can be identified as they have a unique spectral 'signature'. By comparing recordings with known samples, software can isolate the type of anomaly, identify the source and gauge its severity relatively accurately. These can be either in the FFT (Fast Fourier Transform) frequency analysis, the time series domain, or both for proper interpretation.

PRESENTING THE FINDINGS

Early discussions will establish exactly what the client requires from the inspection. The client should be made aware that the use of infrared and ultrasonic technology to assess an electrical installation is not a replacement for an on-going periodic inspection and testing regime and it does not provide the information as required in the model Periodic Inspection Report form, as Appendix 6 of BS 7671.

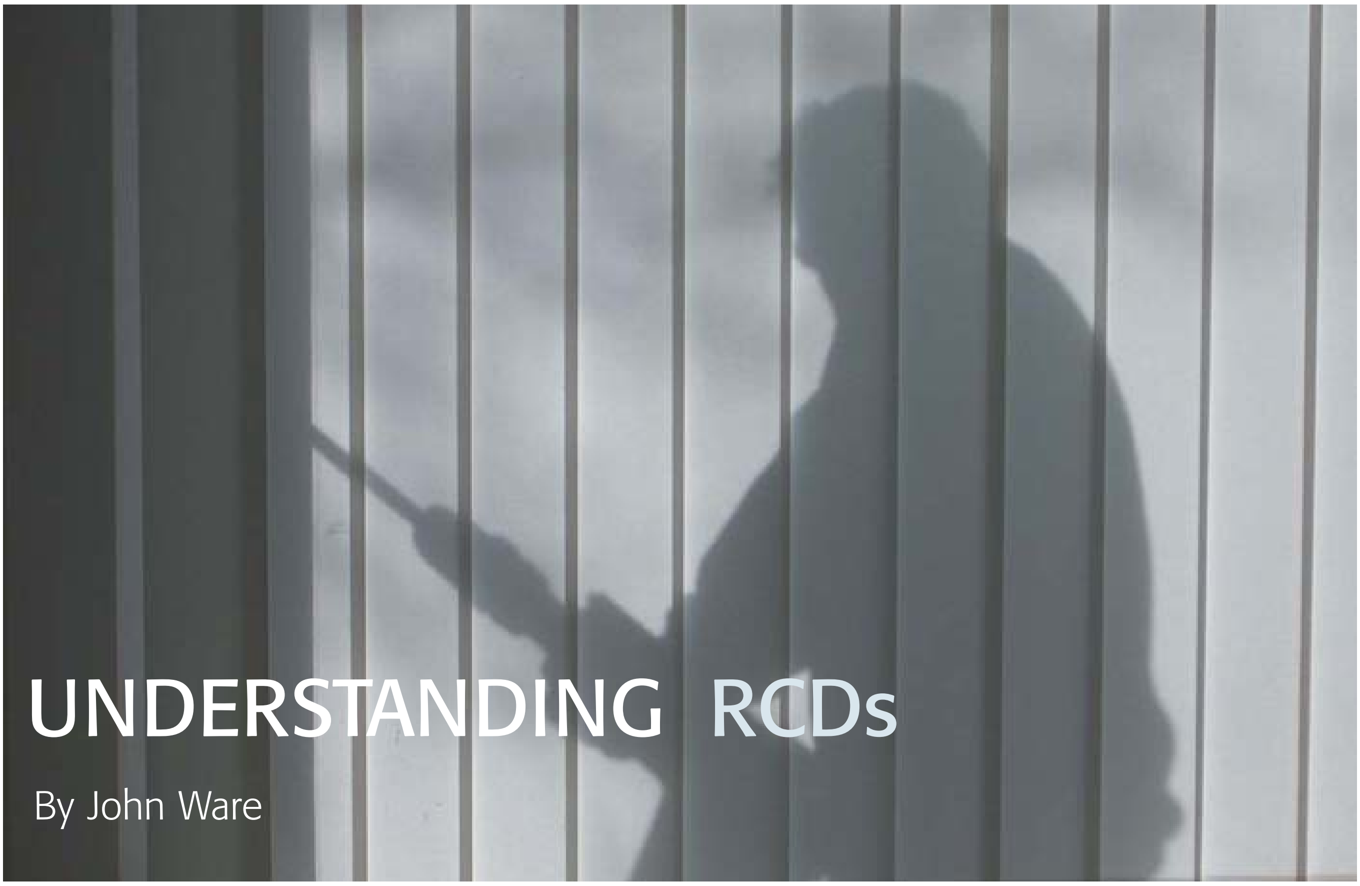
However, contractors may use the model Periodic Inspection Report form, where pertinent, augmented by the findings from infrared and ultrasonic inspections. Software packages will enable the results to be interpreted and presented in an efficient manner.

Such methods are over and above the requirements of BS 7671 but, nevertheless, the technology will be a valuable maintenance and diagnostic tool to some organisations.

FURTHER INFORMATION

The model form Periodic Inspection Report for an Electrical Installation, in addition to model forms of the Electrical Installation Certificate and the Minor Electrical Installation Works Certificate may be downloaded free of charge from the IET's website, at www.theiet.org/technical and select the option Forms for electrical contractors.

Thanks to TEGG for the images used



UNDERSTANDING RCDs

By John Ware

This article is based on information from 'The RCD Handbook, The BEAMA Installation Guide to the Selection and Application of Residual Current Devices'

IN THIS ARTICLE we discuss Residual Current Device (RCD) operation, which can occur due to electrical faults both downstream and upstream of the device. An RCD, when correctly selected and installed, can provide protection against electric shock due to indirect contact. RCDs are also used to provide supplementary protection against direct contact and protection against thermal effects. Operation of an RCD can occur due to a downstream fault such as a crossed neutral on a split-load board, high protective current or an upstream effect such as mains-borne disturbances.

1. Indirect contact. An RCD may be used to provide protection against

Faults existing downstream of the RCD

1	Faults existing downstream of the RCD	Indirect contact
2		Direct contact
3		Incorrect application
4		No discrimination between series-connected RCDs
5		Loose connection
6		Crossed neutral on split load board
7		Neutral to Earth fault
8		Nails and picture hooks
9		High protective conductor current
10		Mineral insulated cables
11		Moisture ingress
12		Double pole switching
13	Faults existing upstream of the RCD	Loose connections
14		Mains-borne disturbance including lightning strike
15		Site machinery or plant and installed services
16		Overhead lines

electric shock due to indirect contact in an installation in accordance with the requirements of Regulation 413-02-16 (for a TN system) or Regulation 413-02-20 (for a TT system) of BS 7671.

2. Direct contact. An RCD may be used to provide supplementary protection against direct contact in accordance with the requirements of Regulation 412-06 of BS 7671.

3. Incorrect application. An RCD must be correctly selected and erected for the particular application. For example, protecting an entire installation using a single high-sensitivity RCD can, in many cases, lead to unwanted tripping, particularly in industrial environments where inductive loads will cause greater transient overvoltages and where longer cable runs will result in larger values of capacitance to earth.

4. No discrimination between series-connected RCDs. A fault downstream of two series-connected RCDs may result in operation of either device. Fig 1 illustrates two RCDs connected in series. A fault downstream of the second device will be ‘seen’ by both devices. Inconvenience may result if the upstream device operates. Discrimination, where required, must be ensured by means such as selecting a time-delayed device for the upstream device (Refer to Regulation 531-02-09).

5. Loose connections. A loose connection downstream of an RCD may cause it to operate due to transient voltages or capacitive effects. Every connection must be properly constructed (Regulation 133-01-04) of durable electrical continuity and adequate mechanical strength (526-01-01), correctly selected (526-02) enclosed (526-03) and accessible, where required (526-04).

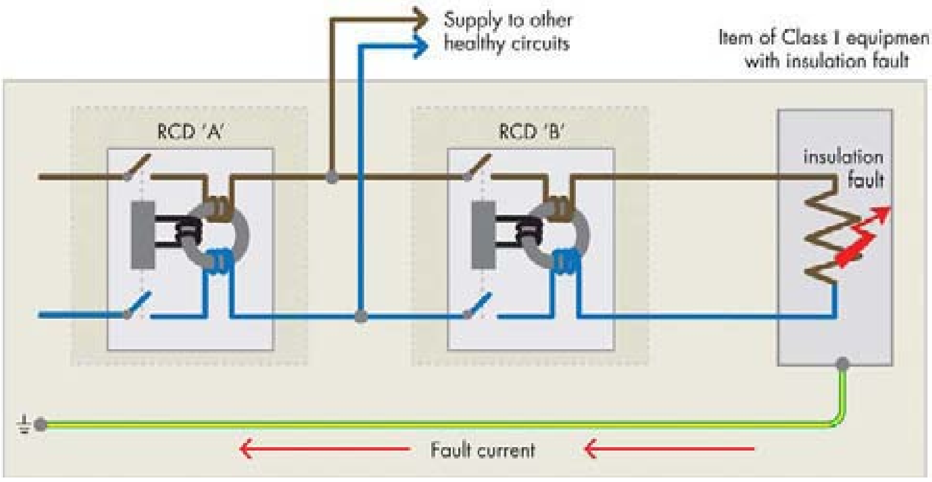


Fig 1: Series-connected RCDs

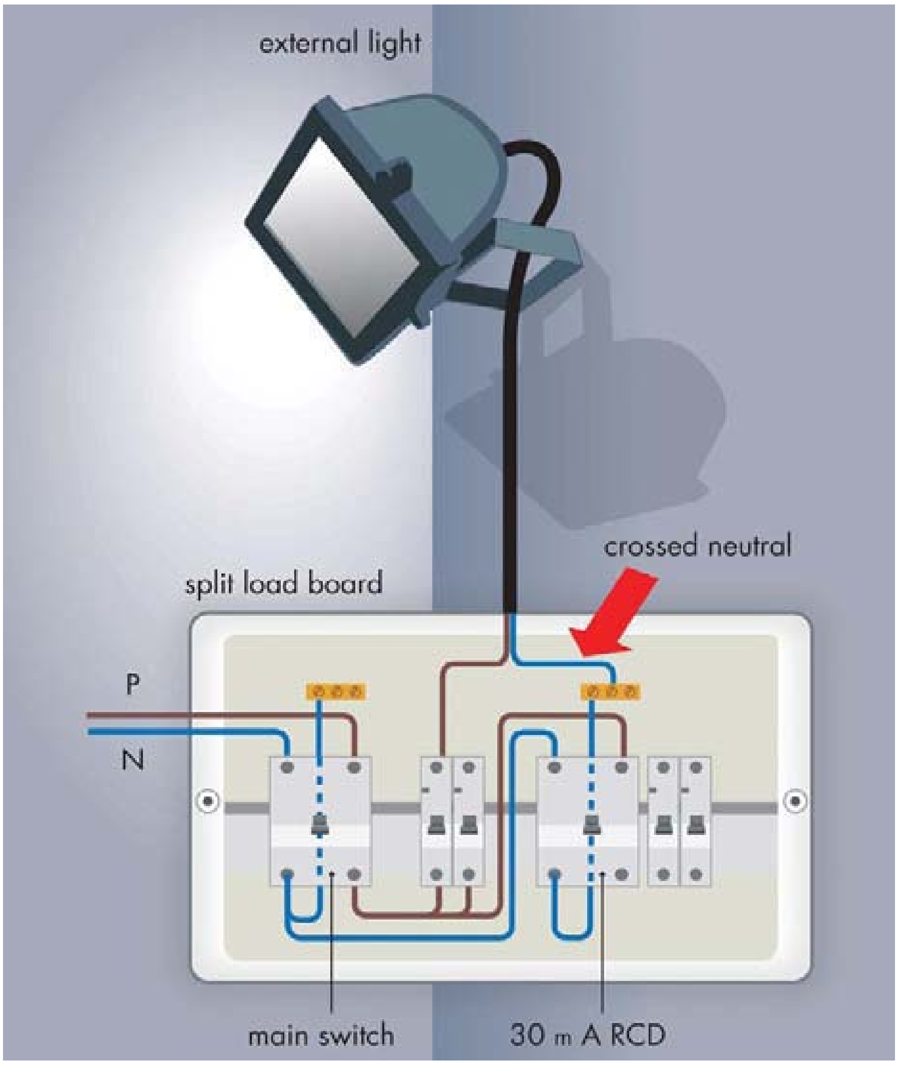


Fig 2: Crossed neutral on a split-load board

6. Crossed neutral on split load distribution board or consumer unit. In the diagram, fig 2, the external lighting circuit has been incorrectly connected. The miniature circuit-breaker supplying the circuit is connected to the non RCD-protected side of the split-load board but the neutral conductor for the circuit has been inadvertently connected downstream of the RCD. As soon as the outside light is energized, the RCD will 'see' a large imbalance and will operate. The neutral must be taken from the same final circuit, never from another circuit as has happened in this example. Circuits must be kept separate (Regulation 314-01-04). In this example a 'borrowed neutral' situation exists presenting a potential shock risk for an electrician attempting to troubleshoot the problem.

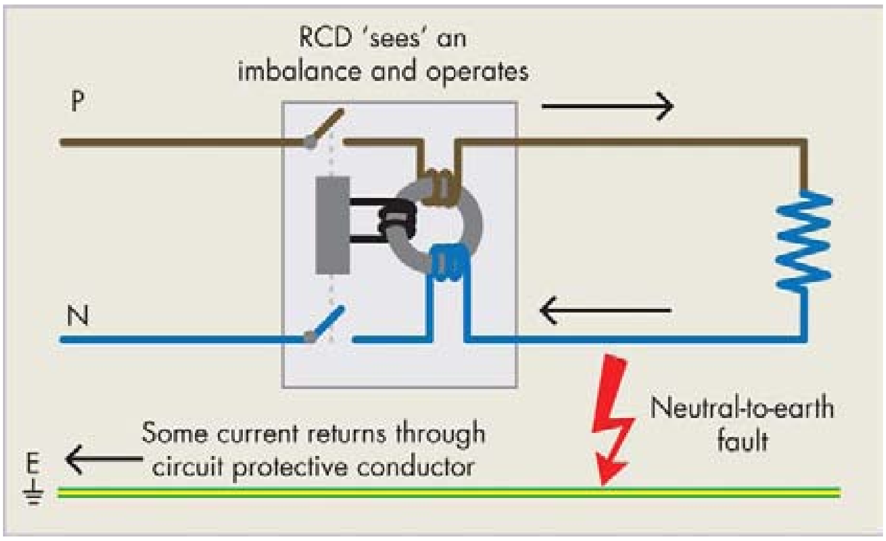


Fig 3: Neutral-to-Earth fault

7. Neutral-to-Earth fault. A neutral-to-earth fault or inadvertent connection of neutral to earth downstream of an RCD will probably result in the device operating as part of the neutral current will flow in the circuit protective conductor resulting in the RCD 'seeing' an imbalance (see fig 3, above). A neutral-to-earth fault can be caused by:

- A neutral conductor touching an earthed mounting box or earthed metal conduit
- Reversed neutral and earth connections at an accessory or item of current-using equipment
- Withdrawal of a fuse or switching off a circuit-breaker in a final circuit resulting in an RCD tripping as the neutral is normally not interrupted.

The most effective way of testing for earth faults in the wiring or equipment is by measuring the insulation resistance as described in Section 713-04 of BS 7671.

8. Nails and picture hooks, screws and power drills. A floorboard nail driven between the neutral and earth conductors creates a neutral to earth fault which is likely to cause an upstream RCD to trip. The fault can be located by insulation testing. The damaged cable must be replaced and either relocated to avoid further damage or protected. Requirements to protect cables from impact and penetration are given in Regulation 522-06 of BS 7671.

9. High protective conductor current. Equipment such as variable speed drives, computer equipment and high frequency luminaires often incorporate filters that cause a certain amount of earth leakage or protective conductor current. Protective conductor current levels below the operating current of the RCD cannot be ignored. The RCD sensitivity is effectively increased and becomes the difference between the RCD trip current and the standing protective conductor current. For example, an RCD with a rated residual operating current of 30mA will have a typical trip current of 22mA. If the standing protective conductor current due to computer equipment is 10mA it will only take an earth fault current of 12mA to operate the RCD. This could lead to unwanted tripping.

The electrical contractor can obtain an approximate measurement of protective conductor current by using a sensitive clamp-on a.c. milliammeter encircling the phase and neutral conductors. The instrument 'sees' the same current that an RCD would see at the same point in the installation.

The RCD selected to provide protection must be selected to take account of protective conductor currents, or, alternatively, the circuits must be subdivided so that any protective conductor current likely to occur during normal operation of the connected load is unlikely to cause unnecessary tripping of the device (Regulation 531-02-04).

10. Mineral insulated cables. Mineral insulated cables can absorb moisture if not correctly terminated resulting in reduced insulation which may cause an RCD to trip as a certain amount of outgoing phase current will return through the MI cable sheath causing the RCD to see an imbalance. Insulation testing should identify the problem.

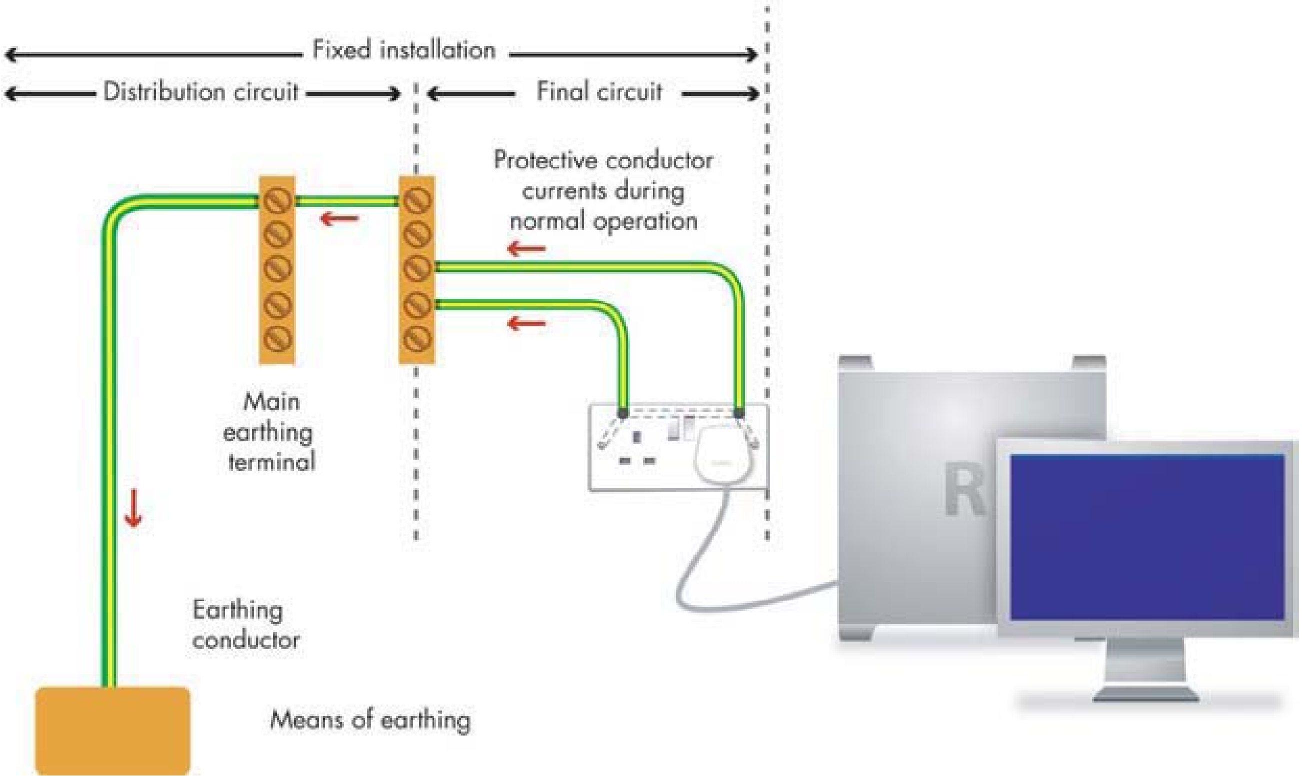


Fig 4: Protective conductor current caused by computer equipment.

11. Moisture ingress can cause reduced insulation resulting in RCD operation. Reduced insulation can result from wet plaster, condensation or water entry into accessories. Similarly some appliances may exhibit reduced insulation causing RCD operation. Certain installed services such as heating elements in cookers can have reduced insulation when cold; the insulation increasing when hot. Manufacturer's instructions should be consulted.

12. Double-pole switching. Double-pole switching within the fixed wiring is known to trip an RCD when switching off or on due to capacitive effects. Changing over from double-pole to single-pole switching can overcome the problem, where such replacement is permissible and safe.

Faults existing upstream of the RCD

13. A loose connection upstream of the RCD such as at the main switch or at the busbar connections can cause the device to operate.

14. Mains-borne disturbances such as spikes, voltage surges and dips, a lightning strike and the operation of distribution network switchgear and protective devices combined with capacitance to earth within the installation can cause unwanted RCD operation. A filter may be of assistance.

15. Site machinery or plant and installed services can cause mains-borne interference. Motors such as lift motors, control gear for discharge lighting and transformer inrush currents can cause unwanted RCD operation. Although significant transients can arise within an installation they would normally only occur under fault conditions. They might, however, travel to other installations where they could cause unwanted tripping of an RCD.

16. Overhead lines. Unwanted tripping may occur more frequently in an installation supplied by overhead lines compared to one supplied by an underground concentric cable. An underground concentric cable is, by its very nature, a good attenuator of transient overvoltages. Spurious tripping may be avoided by installing a filter upstream of the RCD at the origin of the installation.

PART P – 2006 EDITION

By Jon Elliott

Part P has changed
The original Approved Document P Electrical Safety came into effect on 1 January 2005. Its purpose, as with all other Approved Documents was to provide practical guidance for some of the more common building situations.

Part P of Schedule 1 to the Building Regulations (England and Wales) has been amended in an attempt to provide greater clarity of the requirement and to make enforcement more proportionate to the risk. To reflect these amendments, a new version of Approved Document P has been issued by the Department for Communities and Local Government (formerly the Office of the Deputy Prime Minister). This came into effect on Thursday 6th April 2006 and may be obtained from the ODPM website (www.odpm.gov.uk/electricalsafety)

What are the changes?
In the 2005 version, there were two requirements, P1 (Design, installation, inspection and testing) and P2 (Provision of information). The new version contains only one requirement, P1 (Design and Installation), which is reproduced overleaf.

Requirement P1, now entitled 'Design and installation' no longer refers to inspection and testing. However, this does not mean that inspection and testing is no longer required. Section 1 (Design, installation, inspection and testing, and provision of information) of the new Approved Document P states in sub-section 1.7 that; *Electrical installations should be inspected and tested as necessary and appropriate during and at the end of installation, before they are taken into service, to verify that they are safe to use, maintain, alter and comply with Part P of the Building*

Regulations and with other relevant Parts of the building Regulations.

The importance of certification is stressed in sub-sections 1.8 to 1.11.

Requirement P1 now also refers to the need to protect persons *operating, maintaining or altering* the installations. This wording originally appeared in P2, which has now been deleted. The provision of sufficient information requirement has been removed. However, sub-section 1.33 of the new Approved Document P states that *Sufficient information should be left with the occupant to ensure that persons wishing to operate, maintain or alter an installation can do so with reasonable safety*. Sub-section 1.34 reinforces the need to meet the requirements of BS 7671 regarding provision of information such as electrical installation certificates, labels, operating instructions, log books and in the case of larger more complex installations detailed plans.

New circuits are notifiable

The provision of new circuits remains a notifiable activity, as does the extension of existing circuits if the work is in a special location, or associated with a special installation.

Limits on application

Changes have been made to the limits on application for the purposes of clarification. It is now stated that Part P applies to electrical installations *in or attached to a dwelling.*

Attached buildings

It should be noted that it is now clearly stated in the additional notes to Table 1 (work that need not be notified to building control bodies) and Table 2 (special locations and installations) that conservatories and attached garages are not special locations and work in such structures is only notifiable if it involves the installation of a new circuit, or if the supply for the location is taken from a kitchen or special location.

It would also be necessary to notify if a circuit is extended from it into a special location, as would be the case for example, if a socket-outlet was provided outdoors, or if a supply was taken to lights in the garden.

What about external wall lights and A/C units?

This brings us to another of the clarifications provided in the 2006 edition. Installation work involving the fitting of items such as air-conditioning units, wall lights or radon ventilation fans to an exterior wall is only notifiable if electrical connections are made outside of the building and not directly within the enclosure of the item of equipment. To clarify, installation of a wall light where the connections were made immediately behind the fitting would not be notifiable, but if connections were made inside an external joint box and then to a fitting the work would be notifiable. Similarly wiring directly to an air-conditioning unit would not require notification, but if the air-conditioning unit were supplied via a separate externally mounted isolator, notification would be required.

Where a new circuit is installed or where such items are supplied from an existing circuit involving work in a kitchen or special location or associated with a special installation notification would be necessary.

Requirement	Limits on application
PART P ELECTRICAL SAFETY Design and installation P1. Reasonable provision shall be made in the design and installation of electrical installations in order to protect persons operating, maintaining or altering the installations from fire or injury.	The requirements of this Part apply only to electrical installations that are intended to operate at low or extra-low voltage and are: (a) in or attached to a dwelling; (b) in the common parts of a building serving one or more dwellings, but excluding power supplies to lifts; (c) in a building that receives its electricity from a source located within or shared with a dwelling; and (d) in a garden or in or on land associated with a building where the electricity is from a source located within or shared with a dwelling.

In the garden
Outdoor lighting, except for lights fixed on exterior walls of a dwelling as described above, and provision of power to the garden are classed as special installations. As such, these are notifiable activities.

The installation of garden lighting consisting of CE-marked prefabricated components linked by plug and socket connectors is not notifiable provided that the final connection to the fixed wiring, if in a kitchen or special location, is made to an existing connection unit or socket-outlet.

Provision of a socket-outlet to the exterior of the property remains notifiable.

Connection to an existing outlet or isolator
It is not necessary to notify building control if connecting items such as electrically operated garage doors and gates to an existing isolator. It is also not necessary to notify if connecting / reconnecting / replacing items such as showers or cookers to an existing circuit.

Earthing and bonding
One of the most marked changes to have been made to Approved Document P is that installing or upgrading main or supplementary equipotential bonding is no longer a notifiable work activity. In the 2005 edition it was necessary to notify if such work took place in a kitchen or special location.

The situation is not so clear in the case of installing or upgrading main earthing.

Consumer unit change is not considered like-for-like replacement
Part P, as amended permits the like-for-like replacement of items without the need to notify building control locally. However, it is made clear that this does not apply to the replacement of consumer units, which is a notifiable activity.

Central heating control wiring
The provision of new central heating control wiring is notifiable regardless of the location of the cabling and even where the wiring does not extend into the kitchen or a special location such as a bathroom.

Persons carrying out notifiable work
The 2005 edition contained guidance on inspection and testing requirements for work undertaken by a contractor, who was a *competent person* registered with an *electrical self-certification scheme authorised by the Secretary of State*, or a DIY worker. It did not cover in detail the requirements when work was carried out by electrically competent but unregistered persons.

This was not helpful to those persons who either worked as electrical contractors in the commercial / industrial sector, only occasionally carrying out domestic installation work and the substantial number of electrically competent persons no longer carrying out installation work on a day-to-day basis, but who nonetheless remain competent.

This issue has been addressed somewhat in the 2006 edition, which now refers specifically to the *installer not registered with a Part P competent person self-certification scheme but qualified to complete BS 7671 installation certificates*.

This clarification should help to reduce the workload of Building Control departments in meeting their duty to verify that electrical installation work in domestic premises is safe and in accordance with Building Regulations requirements.

The DIYer
When electrical installation work is carried out by persons who are not qualified to complete the appropriate BS 7671 requirements for inspection, testing, verification and certification the relevant local authority Building Control department must be informed prior to carrying out any notifiable work and a fee will be charged.

Building Control must then decide to what extent it will be necessary to inspect and test the electrical work in order to verify that the work is safe and complies with all the relevant requirements of the Building Regulations.

Building Control may choose to carry out the inspection and testing themselves, or they may engage a competent electrical contractor (an approved inspector) to carry out the verification work on their behalf.

In either of the cases mentioned, an Electrical Installation Certificate may not be issued. If verification of the work is carried out by local authority Building Control, they will issue a Building Regulations Completion Certificate. If the verification was undertaken by a private Approved Inspector a Final Certificate will be issued.

It is stated clearly in sub-section 1.28 that *Unregistered installers should not themselves arrange for a third party to carry out final inspection and testing. The third party – not having supervised the work from the outset – would not be in a position to verify that the installation work complied fully with BS 7671: 2001 requirements. An electrical installation*

certificate can be issued only by the installer responsible for the installation work.

The competent person not registered with a self-certification scheme

Electricians and other electrically competent persons, who can demonstrate to the satisfaction of the relevant building control officers that they are competent to correctly inspect, test and certify their installation work in accordance with BS 7671 requirements should provide the relevant electrical certification to accompany the work that they have carried out.

However, they will still be required to notify building control prior to starting work. The building control body must then decide to what degree it will be necessary for them to verify the installation work prior to their issuing the building regulation completion certificate (or final certificate if the function is carried out by a private Approved Inspector).

It will be the responsibility of the building control bodies either independently or collectively to decide upon what benchmark levels of experience and qualifications to expect electrically competent persons to possess. However, it is highly likely to be similar to the requirements laid down by the providers of registered competent person self-certification schemes. It is also likely to be based on an assessment of the standard of the electrical certification that is submitted.

The Building (Local Authority Charges) Regulations 1998 requires local authorities to produce their own schemes, in order for them to recover the cost of carrying out their prescribed building control functions. This offers the real prospect of building control bodies introducing a lower fee in situations where the provision of reliable electrical certification from a competent, albeit non-registered contractor reduces their costs as they no longer need to incur the costs associated with providing an electrical inspector to certify the electrical work.

It is highly likely, however, that building control will need to verify that the electrical installation work has not had a detrimental effect on the installation with respect to other requirements of the building regulations. This will probably take the form of an inspection at the 'first fix' stage. As such, a fee will still be charged.

Registered competent installers

Although the use of a competent but unregistered contractor may result in a lower Building Control fee being charged where work is notified, contractors who regularly carry out electrical installation work in or around domestic premises will still find it more cost-effective to be registered with one of the self-certification schemes.

Being a registered Part P competent person has the benefit of the contractor not being required to notify Building Control locally prior to carrying out notifiable electrical installation work.

Details of all the competent person self-certification schemes may be obtained from the website of the Department for Communities and Local Government (formerly the Office of the Deputy Prime Minister) at www.odpm.gov.uk/electricalsafety.

ACHIEVING COMPLIANCE WITH THE BUILDING (SCOTLAND) REGULATIONS 2004 USING BS 7671: 2001(2004)

By Geoff Cronshaw

THIS IS THE SECOND of two articles on the Building (Scotland) Regulations 2004 and gives an overview of the new system of building standards and certification, the role of the Scottish Building Standards Agency, the various technical handbooks and the warrant system, etc.

THE SCOTTISH BUILDING STANDARDS AGENCY

The Scottish Building Standards Agency (SBSA) was set up in June 2004 as an Executive Agency of the Scottish Executive to undertake the national functions related to the new building standards system set out in the Building (Scotland) Act 2003.

The SBSA website lists the functions of the Agency as:

- to write the building regulations and associated guidance,
- to provide views to help verifiers make decisions,
- to grant relaxations to the building standards in exceptional cases,
- to maintain a Register of Approved Certifiers of Design and Approved Certifiers of Construction,
- to monitor and audit the Certification System,
- to monitor and audit the performance of Verifiers,
- to verify Crown buildings.

LOCAL AUTHORITIES

Under the Building (Scotland) Act 2003, local authorities are appointed as Verifiers of the building standard system. The building standards department of a local authority carries out this role, together with enforcement of the system where regulations are not met.

Building Standards surveyors verify that work proposed complies with the Building (Scotland) Regulations 2004 prior to granting a building warrant and also make reasonable enquiry in respect of works carried out to determine compliance, prior to accepting a Completion Certificate for a project.

BUILDING STANDARDS AND BUILDING WARRANTS

The present Building (Scotland) Regulations 2004 came into force on 1 May 2005. Building standards apply to almost all building, and where work is proposed a building warrant will normally be required.

A Building Warrant is the legal permission to carry out building work, convert or demolish a building in an agreed manner. It is an offence to start work without a building warrant where one is required. This responsibility lies primarily with the relevant person, who is normally the owner, occupier or developer of the building.

Exempt buildings, services, fittings and equipment are listed in Regulation 3 schedule 1 of the Building (Scotland) Regulations 2004.

Regulation 5 schedule 3 of the Building (Scotland) Regulations 2004 gives details of building work, including the provision of services, fittings and equipment, that do not require a warrant. Although a warrant is not required, the work must comply with building regulations. This can be a complex area and persons involved in electrical work may often need to make enquiry to determine if a building warrant is required. General information and publications, together with specialised guidance on electrical installations is available in the documents section of the Scottish Building Standards Agency website: www.sbsa.gov.uk . Advice can also be sought from local authority Verifiers.

The SBSA Technical Handbooks provide guidance on compliance with the 64 mandatory functional standards included under the Building (Scotland) Regulations 2004.

THE NEW CERTIFICATION SYSTEM

The new building standards system introduces an optional system of certification of design or construction by individuals who have the necessary skills and experience. Approved Certifiers are members of schemes that are approved by Scottish Ministers and operated by Scheme Providers. This permits qualified and experienced building professionals or tradesmen to be responsible for ensuring compliance with building regulations, within a framework approved by the SBSA.

Therefore, there are two routes to achieving compliance with the Building (Scotland) Regulations 2004 – Non-certificated route, and the Certificated route.

Using the non-certificated route, a building warrant applicant submits the complete design with the building warrant application to the Verifier (local authority). The Verifier checks the design and will grant a building warrant once they are satisfied the proposals meet building regulations. The applicant can then proceed with the work and must advise the Verifier when work commences. This allows the Verifier to make checks whilst the work is in progress. Once the work is complete the applicant submits a Completion Certificate for acceptance by the Verifier. This will be accepted if, after reasonable enquiry, works are found to comply with the building warrant and with the building regulations.

The certificated route is relevant to work that requires a building warrant and there are two stages – design and construction.

Design

Aspects of design may be certified as complying with Building Regulations when submitting the building warrant application, by a certificate from an Approved Certifier of Design. Such aspects are not checked by the Verifier, provided a valid certificate is issued. At present, the certification of design route is available for design of structural elements of a building (standards 1.1 & 1.2 of the building standards). Use of an Approved Certifier of Design offers a discount on the building warrant fee.

Construction

Aspects of works on site can also be certified, this time by an Approved Certifier of Construction. This is the route that both NICEIC and SELECT offer through their appointments as providers of the Scheme for Certification of Construction (Electrical Installations to BS 7671).

Where this route is taken, the applicant submits a 'notice of intention to certify construction' to the Verifier prior to the commencement of work. Works covered by a certificate are not inspected on site by the Verifier as part of the duty to make reasonable enquiry. Instead, the Certifier of Construction carries out appropriate inspection and testing during the work and on completion issues a certificate of construction. This is submitted with the completion certificate and offers a small refund on the warrant fee.

Certificates of Construction or Design may only be issued by an Approved Certifier who has suitable qualifications, experience and understanding of the matter certified. The persons signing the certificate must be registered to do so and this is recorded on the SBSA Certification Register.

Under the certificated route, the Certifier of Construction or Design must also be or be employed or contracted by, an Approved Body forming part of a scheme approved by Scottish Ministers and operated by a Scheme Provider, who is appointed and audited by the Scottish Building Standards Agency.

MORE INFORMATION

More information is available from the scheme operators SELECT www.select.org.uk and the NICEIC www.niceic.com. In addition further information is available from Scottish Building Standards Agency website: www.sbsa.gov.uk.