



Isolation & Switching

GUIDANCE NOTE



IEE Wiring Regulations

BS 7671 : 2001 Requirements for Electrical Installations
Including Amd No 1 : 2002



Published by: The Institution of Electrical Engineers, Savoy Place,
LONDON, United Kingdom. WC2R 0BL.

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Issued August 1992
Reprinted May 1993, with amendments
2nd edition August 1995, incorporating BS 7671 : 1992 inc Amd No 1
3rd edition May 1999, incorporating BS 7671 : 1992 inc Amd No 2
4th edition March 2003, incorporating BS 7671 : 2001 inc Amd No 1

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ISBN 0 85296 990 2, 2003

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The Institution of Electrical Engineers acknowledges the contribution made by the following organisations in the preparation of this Guidance Note.

British Electrotechnical & Allied Manufacturers Association Ltd
R Lewington Associate IEE

British Standards Institution
W E Fancourt

City & Guilds of London Institute
H R Lovegrove IEng FIE

Electrical Contractors' Association
D Locke IEng MIIE ACIBSE

Electrical Contractors' Association of Scotland t/a SELECT
D Millar IEng MIIE MILE

The GAMBICA Association Ltd
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National Inspection Council for Electrical Installation Contracting
Office of the Deputy Prime Minister
E N King BSc CEng FCIBSE

Royal Institute of British Architects
J Reed

Safety Assessment Federation Limited
N King

Acknowledgements

References to British Standards are made with the kind permission of BSI. Complete copies can be obtained by post from:

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Preface

This Guidance Note is part of a series issued by the Wiring Regulations Policy Committee of the Institution of Electrical Engineers to simplify some of the requirements of BS 7671 : 2001 inc Amd No 1, Requirements for Electrical Installations (IEE Wiring Regulations Sixteenth Edition). Significant changes made in this 4th edition of the Guidance Note are sidelined.

Note this Guidance Note does not ensure compliance with BS 7671. It is a guide to some of the requirements of BS 7671 but users of these Guidance Notes should always consult BS 7671 to satisfy themselves of compliance.

The scope generally follows that of the Regulations and the principal Section numbers are shown on the left. The relevant Regulations and Appendices are noted in the right hand margin. Some Guidance Notes also contain material not included in BS 7671 but which was included in earlier editions of the Wiring Regulations. All of the Guidance Notes contain references to other relevant sources of information.

Electrical installations in the United Kingdom which comply with BS 7671 are likely to satisfy the relevant aspects of Statutory Regulations such as the Electricity at Work Regulations 1989, but this cannot be guaranteed. It is stressed that it is essential to establish which Statutory and other Regulations apply and to install accordingly. For example, an installation in premises subject to licensing may have requirements different from, or additional to, BS 7671, and the requirements will take precedence.

Introduction

This Guidance Note is concerned primarily with Chapter 46, Section 476 and Section 537 on Isolation and Switching design, application, selection and erection. Scope, Object and Fundamental Principles are given in Part 1 of BS 7671 and definitions of terms are given in Part 2.

Neither BS 7671 nor the Guidance Notes are design guides. It is essential to prepare a full design and specification prior to commencement or alteration of an electrical installation. Compliance with the relevant standards should be required.

The design and specification should set out the requirements and provide sufficient information to enable competent persons to carry out the installation and to commission it. The specification must include a description of how the system is to operate and all the design and operational parameters. It must provide for all the commissioning procedures that will be required and for the provision of adequate information to the user. This will be by means of an operational and maintenance manual or schedule, and 'as fitted' drawings if necessary.

514-09

It must be noted that it is a matter of contract as to which person or organisation is responsible for the production of the parts of the design, specification construction and verification of the installation and any operational information. The persons or organisations who may be concerned in the preparation of the works include:

- The Designer
- The Planning Supervisor
- The Installer (or Contractor)
- The Supplier of Electricity
- The installation Owner (Client) and/or User
- The Architect

The Fire Prevention Officer
Any Regulatory Authority
Any Licensing Authority
The Health and Safety Executive

131-01-01

In producing the design and specification advice should be sought from the installation owner and/or user as to the intended use. Often, as in a speculative building, the intended use is unknown. In such cases the specification and/or the operational manual must set out the basis of use for which the installation is suitable.

The operational manual must include a description of how the system as installed is to operate and all commissioning records. The manual should also include manufacturers' technical data for all items of electrical equipment, wiring, switchgear, accessories, etc. and any special instructions that may be needed. The Health and Safety at Work etc. Act 1974 Section 6, and the Construction (Design and Management) Regulations 1994 (the CDM Regulations) are concerned with the provision of information. Guidance on the preparation of technical manuals is given in BS 4884 (Specification for technical manuals) and BS 4940 (Recommendations for the presentation of technical information about products and services in the construction industry). The size and complexity of the installation will dictate the nature and extent of the manual.

Section 1 — The Statutory Requirements

1.1 General Appx 2

There are a number of statutory requirements that must be satisfied but foremost are the Health and Safety at Work etc Act 1974 and the Electricity at Work Regulations 1989 made under the Act. Machinery safety requirements also come under the Supply of Machinery (Safety) Regulations 1992, as amended.

1.2 Health and Safety at Work etc Act 1974

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The Health and Safety at Work etc Act 1974, Part I, Section 6, places a duty on any person who designs, manufactures, imports or supplies any article for use at work to ensure that adequate information is provided so that when put to that use, it will be safe and without foreseeable risks to health. Schedule 3 of the Consumer Protection Act 1987 extended the use to when the equipment is being set, used, cleaned or maintained.

Those with duties under the Act should include in their written instructions, manuals, etc. details of the means of isolation and other health and safety provisions provided and the need to use these when and where required.

An electrical installation may well under some circumstances be considered to be 'an article for use at work' and there is a duty on the designer and installer to provide adequate instruction and/or maintenance manuals irrespective of any contract provisions.

The responsibilities of designers, installers and users of electrical installations are summarised in this Guidance Note. However, designers, installers and users should satisfy themselves that they have met the requirements of all relevant legislation applying to their project. The Health and Safety Executive will

advise on health and safety related legislation if necessary. Health and Safety legislation continues to be introduced and updated, and users of this Guidance Note should assure themselves that they have complied with any legislation that post-dates this publication.

1.3 Electricity at Work Regulations 1989

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Of particular importance is Regulation 12 — Means for cutting off the supply and for isolation. In this Regulation, isolation means the disconnection and separation of the electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure. The word 'secure' is specifically mentioned in the Electricity at Work Regulations 1989 and requires the means of isolation to be such that it is not likely to fail, become loose, etc by the action of vibration, mechanical shock or knocks, or be accidentally or inadvertently operated. Padlocking is a widely used means, with clear labelling and warning notices (see Section 3.6 also).

The requirements of the Electricity at Work Regulations 1989 are intended to ensure the safety of persons gaining access to or working in the vicinity of normally-live parts.

The Memorandum of guidance on the Electricity at Work Regulations 1989 (Health and Safety Executive booklet HSR 25) should be carefully studied and it should be borne in mind that the Electricity at Work Regulations 1989 apply to designers, installers and users of installations alike.

BS 7671 is intended primarily for designers and installers and thus covers only the provision of isolators and the means of securing them. The user has the responsibility for ensuring that equipment is properly isolated when necessary.

In the above mentioned Memorandum (see Note 2, Regulation 12(1)(a)) it is recognised that there may be a need to switch off electrical equipment for reasons other than preventing electrical danger, but these considerations are outside the scope of the Electricity at Work Regulations 1989. BS 7671, however, takes into account injury from mechanical movement of electrically actuated equipment. Emergency switching

and switching off for mechanical maintenance are therefore included in BS 7671.

The Electricity at Work Regulations 1989 specifically require adequate maintenance, and this implies inspection of electrical systems, supplemented by testing as necessary. Regular functional testing of safety circuits such as emergency switching/stopping etc may be required — especially if they are not normally used. Comprehensive records of all inspection and tests should be made and reviewed for any trends that may arise. IEE Guidance Note 3: Inspection & Testing gives more detailed guidance on initial and periodic inspection and testing of installations.

1.4 The Electricity Safety, Quality and Continuity Regulations 2002

The prime purpose of the Electricity Safety, Quality and Continuity (ESQC) Regulations 2002 is to provide for the safety of the public and to ensure an electricity supply of adequate quality and reliability. These Regulations make reference to BS 7671. For example, under Regulation 25.(2) the consumer may have to satisfy the local distributor that the electrical installation is safe and technically sound by providing evidence that it complies with BS 7671. An Electrical Installation Certificate would normally be acceptable.

1.5 Machinery Safety Directive

The EEC Machinery Safety Directive was implemented into UK law by the Supply of Machinery (Safety) Regulations 1992 (Statutory Instrument 1992 No. 3073 made under the European Communities Act 1972).

These Regulations, amended in 1994, have specific requirements for the essential health and safety aspects of machines. The requirements are wide ranging and take into account potential dangers to operators of machinery and to other persons within a 'danger zone'. Only the requirements for isolation, switching and control are relevant to this Guidance Note.

In the Supply of Machinery (Safety) Regulations machinery is defined as:

- (i) an assembly of linked parts or components, at least one of which moves with the appropriate

actuators, control and power circuits, joined together for a specific application, in particular for the processing, treatment, moving or packaging of a material

- (ii) an assembly of machines which, in order to achieve the same end, are arranged and controlled so that they function as an integral whole, and
- (iii) interchangeable equipment modifying the function of a machine which is supplied for the purpose of being assembled with a machine or a series of different machines or with a tractor by the operator himself insofar as this equipment is not a spare part or a tool.

The Regulations do **not** apply to:

- (i) machinery specific specialist equipment listed in the Regulations, including Ships, Offshore Platforms, etc (consult the statutory instrument for specific items)
- (ii) machinery previously used in the European Community
- (iii) machinery for use outside the European economic area
- (iv) where the risks are mainly of electrical origin (such machinery is covered by the Electrical Equipment (Safety) Regulations 1994 Statutory Instrument No 3260) see Section 1.6. *Note:* These Statutory Regulations apply only to low voltage equipment up to 1 kV
- (v) where the extent that the risks are wholly or partly covered by other Directives, from the date those other Directives are implemented into United Kingdom law
- (vi) machinery first supplied in the European Community before 1 January 1993.

Machinery manufactured in conformity with specified published European standards which have also been listed in the Official Journal of the European Communities will be presumed to comply with the essential health and safety requirements of those standards, and hence the Regulations.

BS EN 60204 'Safety of Machinery: Electrical equipment of machines' is the major standard on machine electrical equipment. BS EN 292 'Safety of machinery. Basic concepts, general principles for design' and BS EN 418 'Safety of machinery. Emergency stop equipment, functional aspects. Principles for design' also give advice on emergency switching.

The principles of safety stated in the Supply of Machinery (Safety) Regulations 1992 as amended are:

- (i) machinery must be so constructed that it is fit for its function, and can be adjusted and maintained without putting persons at risk when these operations are carried out under the conditions foreseen by the manufacturer.

The aim of the measures taken must be to minimise foreseeable risks of accident throughout the intended lifetime of the machinery, including the phases of assembly and dismantling, even where risks of accident arise from foreseeable abnormal situations

- (ii) in selecting the most appropriate methods, the manufacturer must apply the following principles, *in the order given*:

- (a) eliminate or reduce risks as far as practicable by inherently safe machinery design and construction

- (b) take the necessary protection measures in relation to risks that cannot be eliminated

- (c) inform users of the residual risks due to any shortcomings of the protection measures adopted, indicate whether any particular training is required and specify any need to provide personal protection equipment

- (iii) when designing and constructing machinery, and when drafting the instructions, the manufacturer must envisage not only the normal use of the machinery but also other uses which could reasonably be foreseen.

The machinery must be designed to prevent abnormal use if such use would engender a risk.

The instructions must also draw the user's attention to ways — that experience has shown might occur — in which the machinery should not be used

- (iv) under the intended conditions of use, the discomfort, fatigue and psychological stress faced by the operator must be reduced to the minimum possible taking ergonomic principles into account
- (v) when designing and constructing machinery, the manufacturer must take account of the constraints to which the operator is subject as a result of the necessary or foreseeable use of personal protective equipment such as footwear, gloves, etc.
- (vi) machinery must be supplied with all the essential special equipment and accessories to enable it to be adjusted, maintained and used without risk.

1.6 Electrical Equipment (Safety) Regulations 1994

As noted in Section 1.5, certain machines are excluded from the Supply of Machinery (Safety) Regulations, where these have risks that are mainly of electrical origin. Such equipment is covered by the Electrical Equipment (Safety) Regulations 1994. These apply to equipment covered by the European economic area Low Voltage Directive (LVD). 'Low voltage' is defined in Part 2 of BS 7671 as not exceeding 1000 V a.c. or 1500 V d.c.

1.7 Construction (Design and Management) Regulations 1994

The Construction (Design and Management) Regulations 1994, made under the Health and Safety at Work etc Act 1974, place responsibilities on most installation owners and their professional design teams to ensure a continuous consideration of health and safety requirements during the design, construction, and throughout the life of a building, including maintenance, repair and demolition. This includes design of the electrical installation, and selection and erection of electrical equipment for health and safety in installation and general operation. The design should take into account the practicalities of installation and adequate provision of operation, access and maintenance requirements for all equipment. It is important that all who can contribute to the health and safety of a construction project, particularly clients (the installation users) and designers,

understand what they and others need to do under the Construction (Design and Management) Regulations and discharge their responsibilities accordingly.

Designers must consider the need to design in a way which avoids foreseeable risks to health and safety or reduces these risks as far as practicable so that projects they design can be constructed and maintained safely. Where risks cannot be avoided, information on them is required to be provided for inclusion in the project health and safety plan. The designer must also co-operate with others to enable all parties to comply with relevant statutory requirements and prohibitions placed on them by all statutory legislation.

1.8 Management of Health and Safety at Work Regulations 1999

These Regulations are made under the Health and Safety at Work etc Act 1974 and require employers to make (amongst other things) a "suitable and sufficient assessment of the risks to the health and safety of their employees to which they are exposed whilst they are at work", and record the results. Self-employed persons at work are deemed to be the same as employees for this purpose.

By its very nature the risk assessment must include operation of equipment and machines, and the safety of the fixed installation, and must cover the adequate provision of isolation and emergency switching and stopping devices suitable for the considered risk. It should also cover access interlocks and any other equipment safety operating provisions such as guards, etc.

The general requirement is to identify and design to reduce risks to protect against hazards and dangers.

1.9 Provision and Use of Work Equipment Regulations 1998

These Regulations are made under the Health and Safety at Work etc Act 1974 and impose health and safety requirements on the provision and use of equipment in the workplace. Work equipment is defined in the Regulations as being any machine, equipment or tool or installation used at work (whether exclusively or not).

In these Regulations, Regulations 14 to 18 cover controls and control systems, Regulation 19 details isolation requirements and Regulation 21 requires the provision of suitable and sufficient lighting for safe operation and working. Regulations 5, 6 and 22 concern equipment maintenance.

Section 2 — Definitions and Principles

2.1 General 46 476 537

BS 7671 (the IEE Wiring Regulations) recognises four distinct types of isolation and switching:

- (i) isolation
- (ii) switching off for mechanical maintenance
- (iii) emergency switching
- (iv) functional switching.

Each type has specific requirements and a clear understanding of the meanings of the four types is essential. Devices can fulfil more than one function, but the device selected must fulfil the specific requirements for all the functions needed. Detailed guidance on requirements is given in the following sections, but a brief outline is given below.

530-01-03
537-01-01

Regulation 511-01-01 includes the requirement that every item of equipment used in an electrical installation shall comply with the relevant requirements of the applicable British or Harmonised Standard appropriate to the intended use of the equipment.

511-01-01

BS EN 60947 'Specification for low voltage switchgear and controlgear' has seven parts and historically has, through those parts which cover specific products, been accepted as the standard for isolation and switching. Requirements within these parts are set down for the isolation function and include performance, indication and marking. There are, however, other product standards which satisfy the requirements for isolation as listed in Regulation 537-02-02.

537-02-02

BS EN 60073 : 1993 'Specification for coding of indicating devices and actuators by colours and supplementary means' provides details and rules for colours, shapes and positions of indicating devices and actuators.

Functional switching devices are mainly covered by:

- BS EN 60669-1 : 2000 and BS 3676 : Part 1 : 2000
Switches for household and similar fixed electrical installations : General requirements
- BS 5518 : 1977 (1999) Specification for electronic variable control switches (dimmer switches) for tungsten filament lighting
- BS 1363 : 13A Plugs, socket-outlets and adaptors
- BS EN 60309-2 : 1999 Plugs, socket-outlets and couplers for industrial purposes
- BS 5733 : 1995 Specification for general requirements for electrical accessories.

However, there are several systems — such as electronic lighting control by Building Management Systems — that have no specific British Standard. In such installations the components themselves should still be to the relevant standards, and the installation must comply with BS 7671 and the Electricity at Work Regulations 1989.

Where equipment to be used is not covered by a British Standard or Harmonised Standard or is used outside the scope of its standard, the designer or other person responsible for specifying the installation must confirm that the equipment provides at least the same degree of safety as that afforded by compliance with the Wiring Regulations. The designer or others responsible may be liable to prosecution if an accident is found to have been caused by inappropriately selected equipment.

511-01-02

Specific legislation must also be complied with. This may include specific duties or requirements and overrides any other requirements or standards.

2.2 Isolation 461

The definition given in BS 7671 is 'A function intended to cut off for reasons of safety the supply from all, or a discrete section, of the installation by separating the installation or section from every source of electrical energy'.

Part 2

This is the definition given in the IEC International Electrotechnical Vocabulary (IEV: 826-08-01). It differs, however, from the definition given in the Electricity at Work Regulations 1989 (Regulation 12) in which isolation is defined to mean 'The disconnection and separation of the electrical equipment from every source of electrical energy in such a way that this disconnection and separation is secure'. While there is no mention in the BS 7671 definition of the need for securing the isolating device this is required by Regulation 476-02-02 in situations where the isolator is remote from the equipment that has to be isolated. This requirement is specific in the Electricity at Work Regulations 1989 and therefore must be taken into consideration.

476-02-02

The purpose of isolation is to enable persons to safely carry out work on, or in the vicinity of, normally live parts. This requirement is specific in the Electricity at Work Regulations 1989 and must be complied with where necessary to prevent electrical danger. Danger here means risk of death or personal injury from electric shock, electric burn, electrical explosion or arcing, or from fire or explosion initiated by electrical energy.

131-14

2.3 Switching off for mechanical maintenance 462

No definition is provided for switching off for mechanical maintenance in BS 7671, but the term 'Mechanical maintenance' is defined as 'The replacement, refurbishment or cleaning of lamps and non-electrical parts of equipment, plant and machinery'.

Part 2

The purpose of the measure is to prevent physical injury, but not electric shock or burns as mechanical maintenance should not involve work upon, or access to, normally live parts. There is no reference to this operation in the Electricity at Work Regulations 1989 but particular attention is drawn to the requirements of Regulations 14 and 16 in respect of working on or near live parts. Switching off for mechanical maintenance should also be considered if access to machinery or equipment may involve access to normally moving parts. Isolation of supplies to machinery or equipment may be more appropriate in some situations to provide a sufficient degree of physical safety.

2.4	Emergency switching 463	<p>The definition given in BS 7671 is 'An operation intended to remove, as quickly as possible, danger, which may have occurred unexpectedly'.</p> <p>The danger may be electrical or mechanical in nature.</p>	<p>Part 2</p>
2.5	Emergency stopping 463	<p>The definition given in BS 7671 is 'Emergency switching intended to stop an operation'.</p> <p>This definition introduces a further requirement over and above emergency switching so that, in addition to cutting off the supply of electrical energy, operations are stopped in a safe manner.</p> <p>In some circumstances the measure may involve the de-energising of devices such as electromagnetic brakes which are held-off during normal operation, or the energisation of electrodynamic braking circuits.</p> <p>BS EN 418 : 1992 'Safety of machinery. Emergency stop equipment, functional aspects. Principles for design' gives guidance on the principles for the design of emergency stop equipment. Regulation 16 of the Provision and Use of Work Equipment Regulations 1998 provides specific requirements for machine emergency stop controls.</p> <p>BS EN 60204-1 : 1993 'Safety of machinery. Electrical equipment of machines. Specification for general requirements' contains general requirements.</p> <p>BS EN 60947-5-5 : 1998 contains requirements for 'Electrical emergency stop devices with mechanical latching function'.</p>	<p>Part 2</p> <p>463-01-05</p> <p>537-04-02</p>
2.6	Functional switching 464	<p>The definition given in BS 7671 is 'An operation intended to switch ON or OFF or vary the supply of electrical energy to all or part of an installation for normal operating purposes'.</p> <p>BS 7671 is mainly concerned with safety aspects of electrical installations and only deals with functional switching generally in Section 464.</p> <p>However, BS 7671 implicitly recognises that some functional devices may be used for switching off for mechanical maintenance purposes provided that they</p>	<p>Part 2</p> <p>537-05</p>

meet the relevant requirements of BS 7671 for this operation and of other relevant British Standards.

2.7 Category of utilization

BS EN 60947-1 defines standard utilization categories which allow for conditions of service use and the switching duty to be expected. Switching heavy currents or highly inductive loads places more strain on the switching device than the switching of light currents or non-inductive loads.

The utilization category of equipment defines the intended application and is specified in the relevant product standard; it is characterised by one or more of the following service conditions:

- current(s), expressed as multiple(s) of the rated operational current
- voltage(s), expressed as multiple(s) of the rated operational voltage
- power factor or time constant
- short-circuit performance
- selectivity
- other service conditions, as applicable.

Examples of utilization categories for low voltage switchgear and controlgear are given in Table 2.1.

2.8 Summary of principles

It is emphasised that both the Electricity at Work Regulations 1989 and BS 7671 require that a means of isolation must *a/ways* be provided for an installation, even in situations where a particular installation may be such that neither switching off for mechanical maintenance nor emergency switching is required. Functional switching is always necessary.

460-01-02

TABLE 2.1
Examples of utilization categories for low voltage
switchgear and controlgear

Nature of current	Category	Typical applications
a.c.	AC-1 AC-2 AC-3 AC-4 AC-5a AC-5b AC-6a AC-6b AC-7a AC-7b AC-8a AC-8b AC-12 AC-13 AC-14 AC-15 AC-20 AC-21 AC-22 AC-23	Non-inductive or slightly inductive loads, resistance furnaces. Slip-ring motors: starting, switching off. Squirrel-cage motors: starting, switching off motors during running. Squirrel-cage motors: starting, plugging ¹⁾ , inching ²⁾ . Switching of electric discharge lamp control. Switching of incandescent lamps. Switching of transformers. Switching of capacitor banks. Slightly inductive loads in household appliances and similar applications. Motor loads for household applications. Hermetic refrigerant compressor motor control with manual resetting of overload releases. Hermetic refrigerant compressor motor control with automatic resetting of overload releases. Control of resistive loads and solid state loads with isolation by optocouplers. Control of solid state loads with transformer isolation. Control of small electromagnetic loads. Control of a.c. electromagnetic loads. Connecting and disconnecting under no-load conditions. Switching of resistive loads, including moderate overloads. Switching of mixed resistive and inductive loads, including moderate overloads. Switching of motor loads or other highly inductive loads.
a.c. and d.c.	A B	Protection of circuits, with no rated short time withstand current. Protection of circuits, with a rated short time withstand current.
d.c.	DC-1 DC-3 DC-5 DC-6 DC-12 DC-13 DC-14 DC-20 DC-21 DC-22 DC-23	Non-inductive or slightly inductive loads, resistance furnaces. Shunt-motors, starting, plugging ¹⁾ , inching ²⁾ , dynamic braking of motors. Series-motors, starting, plugging ¹⁾ , inching ²⁾ , dynamic braking of motors. Switching of incandescent lamps. Control of resistive loads and solid state loads with isolation by optocouplers. Control of d.c. electromagnets. Control of d.c. electromagnetic loads having economy resistors in circuit. Connecting and disconnecting under no-load conditions. Switching of resistive loads, including moderate overloads. Switching of mixed resistive and inductive loads, including moderate overloads (e.g. shunt motors). Switching of highly inductive loads (e.g. series motors).
<p>1) By plugging is understood as stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running.</p> <p>2) By inching (jogging) is understood as energising a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.</p>		

From BS EN 60947-1: 1999

Note:

Further utilisation categories are specified for particular devices in the various parts of the BS EN 60947 series.

Whether or not switching off for mechanical maintenance, emergency switching and/or emergency stopping are required should be the subject of the earliest consideration by the installation designer. The designer has to bear in mind the purpose of the installation, operational requirements and the intended use, and the specific legislation requirements. In that consideration the designer must take account of the capability of operating and maintenance staff and maintenance systems as regards the devices used. The designer may well find it necessary to seek very detailed advice from the owner or user of the installation as to its intended operation and use (see Sections 1.5 and 1.7).

341-01-01

There is a general requirement that all electrical equipment, and the term includes isolating and switching devices, shall be arranged to facilitate operation, inspection and maintenance and access to connections. Devices shall also be suitable for their environment (see Guidance Note 1: Selection & Erection).

513-01-01

512-06-01

When siting devices for isolation and switching, the designer should bear in mind the possibility that the designed ease of accessibility may not be maintained when the installation is in use. The attention of the user of the installation should be drawn to this point. There is a need to ensure that at all times there is adequate operating and working space at all switchboards (Electricity at Work Regulation 15 and Appendix 3). Designers and installers must make appropriate arrangements when designing and siting switchgear and controlgear. The requirements of legislation —especially the Electricity at Work Regulations 1989 — must be complied with.

The specific Regulations for isolation and switching are mainly contained in Parts 4 and 5 of BS 7671, and may be found by reference to Table 2, but Regulations 314-01-01 and 341-01-01 are also relevant. Additional or different specific requirements may be applicable in the special locations of Part 6.

For generating sets incorporated into an installation, particular requirements are included in Section 551.

TABLE 2.2 Relevant Regulations in BS 7671

Subject	Protective Measures	Application of Protective Measures	Selection and Erection of Equipment
Isolation and switching — General	131-13, 131-14 and 460-01-01 to 460-01-06	476-01-01 to 476-01-03	537-01-01
Isolation	461-01-01 to 461-01-05	476-02-01 to 476-02-04 482-02-08	537-02-01 to 537-02-10
Switching off for mechanical maintenance	462-01-01 to 462-01-03	Covered in 476-01-01	537-03-01 to 537-03-05
Emergency switching	463-01-01 to 463-01-05	476-03-01 to 476-03-03	537-04-01 to 537-04-05
Functional switching	464-01-01 to 464-02-01	476-01-02 553-04-01	537-05-01 to 537-05-05
Other requirements for switching for safety		476-03-04 to 476-03-07	537-04-06

2.9 Definitions of equipment related terms

Product standards as listed in Regulation 537-02-02 provide, in addition to those in BS 7671, further definitions of equipment related terms based on the International Electrotechnical Vocabulary IEC 60050 (IEV). Some are reproduced below for information:

[537-02-02](#)

- (i) *breaking current* (of a switching device or a fuse)

The current in a pole of a switching device or in a fuse at the instant of initiation of the arc during a breaking process.

Note: For a.c. the current is expressed as the symmetrical rms value of the a.c. component.

(ii) *breaking capacity* (of a switching device or a fuse)

A value of prospective breaking current that a switching device or a fuse is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.

Notes:

1. The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.
2. For a.c., the current is expressed as the symmetrical rms value of the a.c. component.

(iii) *fuse combination unit*

A combination of a mechanical switching device and one or more fuses in a composite unit, assembled by the manufacturer or in accordance with his instructions

(iv) *making capacity* (of a switching device)

A value of prospective current that a switching device is capable of making at a stated voltage under prescribed conditions of use and behaviour.

Note: The voltage to be stated and the conditions to be prescribed are dealt with in the relevant product standard.

(v) *rated value*

A quantity value assigned, generally by the manufacturer, for a specified operating condition of a component, device or equipment

(vi) *rating*

The set of rated values and operating conditions

(vii) *rated short-circuit making capacity*

The rated short-circuit making capacity of an equipment is the value of short-circuit making capacity assigned to that equipment by the manufacturer for the rated operational voltage, at rated frequency, and at a specific power factor for a.c. or time constant for d.c. It is expressed as

the maximum prospective peak current, under prescribed conditions

(viii) *rated short-circuit breaking capacity*

The rated short-circuit breaking capacity of an equipment is the value of short-circuit breaking capacity assigned to that equipment by the manufacturer for the rated operational voltage, at rated frequency, and at a specified power factor for a.c. or time constant for d.c.. It is expressed as the value of the prospective breaking current (rms value of the a.c. component in the case of a.c.) under prescribed conditions

(ix) *service short-circuit capacity*

The service short-circuit capacity is the maximum level of fault current operation after which further service is assumed without loss of performance

(x) *switch disconnecter*

A switch which, in the open position, satisfies the isolation requirements specified for a disconnecter

(xi) *short-circuit breaking capacity*

A breaking capacity for which prescribed conditions include a short-circuit at the terminals of the switching device

(xii) *short-circuit making capacity*

A making capacity for which prescribed conditions include a short-circuit at the terminals of the switching device

(xiii) *utilization category (of a switching device or a fuse)*

A combination of specified requirements related to the conditions in which the switching device or the fuse fulfils its purpose, selected to represent a characteristic group of practical applications (see Section 2.7).

Note: The specified requirements may concern e.g. the values of making capacities (if applicable), breaking capacities and other

characteristics, the associated circuits and the relevant conditions of use and behaviour.

2.10 Warning notices and labels

Adequate notices, labels and instructions must be provided to ensure safe and proper operation of the electrical installation - both normally and in an emergency. BS 7671 makes specific requirements for labels and notices for isolation and switching, and these are listed in Table 2.3.

461-01-03
461-01-05
514-11-01

There is also a need for temporary warning labels to inform people when equipment has been shut down, e.g. for maintenance, or when circuits have been isolated. Such signs must be clearly and prominently displayed as inadvertent operation of equipment would be dangerous. However, signs are only a supplement to the proper securing arrangements for isolating devices - with padlocks if necessary (see 3.3 and 3.4).

Fig 2.1: The use of labels and locks

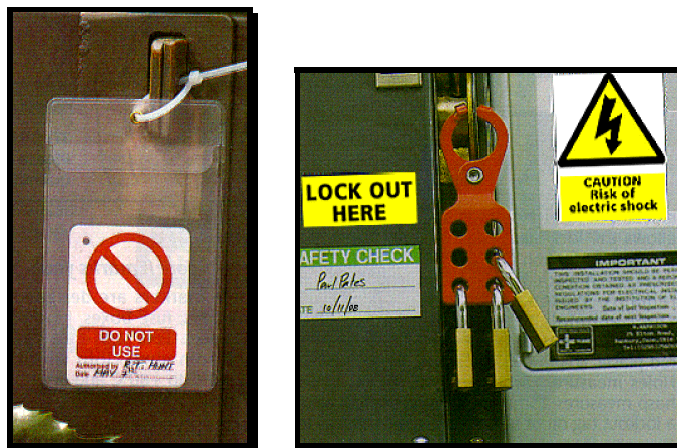
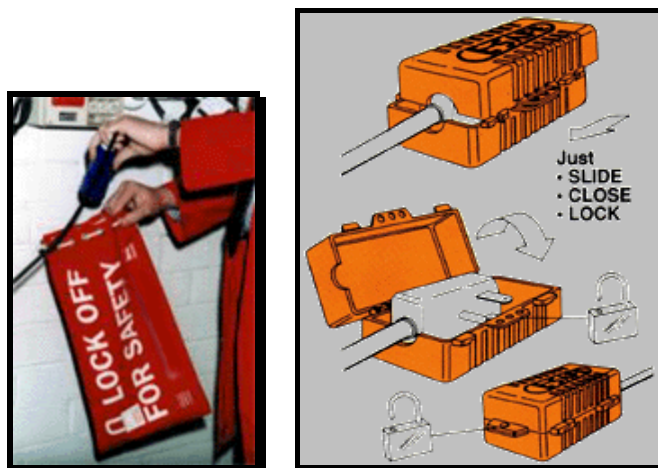


Fig 2.2: Lock-out bags and boxes

Lock-out bags and boxes may be used to enclose electrical plugs to prevent accidental reconnection



Labels and warning notices should be of a size and type suitable for the location and installed in such a way that they are unlikely to be painted over or easily removed or defaced. Labels etc should be permanently fixed by suitable screws or rivets, taking care not to damage equipment, invalidate IP ratings or block vents. Stick-on labels should only be used where heat or damp is not expected.

The fundamental principle for isolation is that effective means suitably placed for ready operation shall be provided so that all voltages may be cut off from every installation, from every circuit thereof from all equipment, as may be necessary to prevent or remove danger.

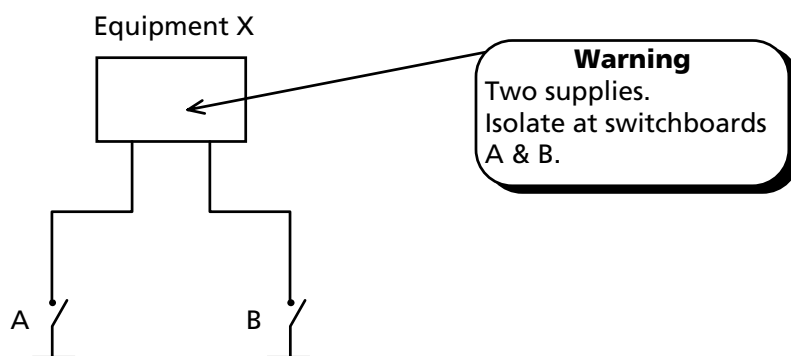
131-14-01

Some items of equipment have live parts that are not capable of being isolated or switched by a single device and in such cases durable warning notices are required. The word 'capable', in terms of the regulations for warning notices, means capable with the switchgear as fitted.

514-11-01

There are situations when equipment is supplied from separate sources e.g. a.c. three-phase from one source and d.c. power source from another. The regulations require that in such circumstances (see Figure 2.3) durable warning notices be permanently fixed in such a position that any person before gaining access to live parts will be warned of the need to use the appropriate isolating devices, unless an interlocking arrangement is provided so that all the circuits concerned are isolated before access is gained. This arrangement is uncomplicated.

Fig 2.3: Label for equipment with two supplies



Circumstances also arise with equipment supplied from a single source only, where the switch mounted on or adjacent to the equipment switches off, say, the power supply but maintains supplies to auxiliary functions as shown in Figure 2.4. It is most important that durable warning notices are permanently fixed in such a position that persons before gaining access to live parts are warned of the need to use the appropriate isolating devices.

Fig 2.4: Label where switch does not isolate equipment

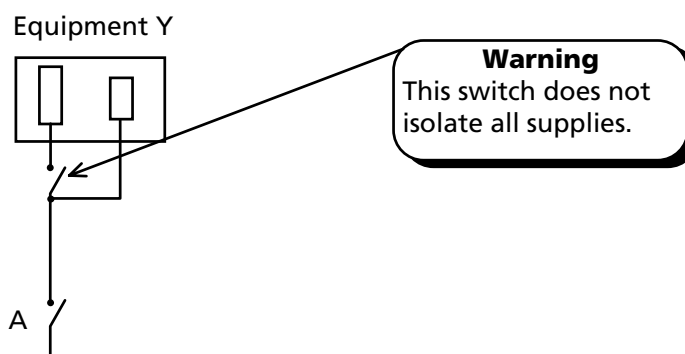


TABLE 2.3 Warning notices and identification labels required by BS 7671 : 2001 in connection with isolation and switching

Notice, label or identification	Regulation
Isolation of installation supplied from more than one source	460-01-02
Live parts not capable of being isolated by a single device	461-01-03 514-11-01
Isolating device and its installation or circuit (if not obvious)	461-01-05 537-02-09
Switching device for mechanical maintenance (indication of operation)	462-01-02 537-03-02
Areas reserved for skilled or instructed persons	471-13-03
Fireman's switch	476-03-07 537-04-06
Purpose of switchgear and controlgear (if not obvious)	514-01-01
Diagrams, charts etc for installation information	514-09-01
Switchgear and controlgear for safety services	563-01-05

Section 3 — Detailed Requirements — Isolation

3.1 General 130

'Isolation' is usually combined in a term with 'Switching' (see Chapter 46 and Section 476 of BS 7671) but it must be understood that the term switching applies to the general operation and functional control of an installation or machine. A switching device is not necessarily suitable for isolation, or vice versa.

476-01-01

Devices suitable for isolation should be marked with the isolation symbol. Figure 3.1.1 shows the general symbol which may incorporate other details associated with the type of device, such as a circuit-breaker, see Figure 3.1.2.

Fig 3.1.1: The general isolation symbol

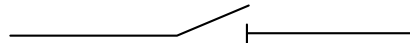


Fig 3.1.2: The symbol for a circuit breaker suitable for isolation



The general isolation symbol, or its variants, depending on the specific device, should be marked by manufacturers on all devices that comply with BS EN 60947-3 for the isolation function.

The terms 'Isolator' and 'Disconnecter' are defined as being the same in Part 2 of BS 7671. 'Disconnecter' is the internationally used term, although for convenience and traditional usage the term isolator is used in this Guidance Note.

<p>Any device that can meet the requirements for isolation can be used as an isolator — with suitable operating capabilities, but it must be of an adequate rating for the load. If, however, a device is not suitable for operation on load it must be identified as such, and secured against inadvertent and unauthorised operation (see Sections 2.7 and 3.4 for 'off-load' isolators).</p>	<p>460-01-01 537-02-01 537-02-02</p>
<p>Regulation 537-02-08 requires that a means of isolation shall preferably be provided by a multi-pole switching device which disconnects all poles of the relevant supply, but single-pole devices situated adjacent to each other are not excluded. Where single-pole devices are utilised, adequate warning notices must be provided. Fuses and links should not be selected solely for the purpose of providing isolation, but if they have been selected for some other reason, e.g. fuses to provide overcurrent protection, then consideration can be given to their suitability for isolation.</p>	<p>537-02-08 514-11-01</p>
<p>Regulation 460-01-01 requires that a means shall be provided for non-automatic isolation and switching to prevent or remove hazards associated with the electrical installation or electrically powered equipment and machines.</p>	<p>460-01-01 476-01-01</p>
<p>BS 7671 Chapter 13 — Fundamental Principles, contains a number of requirements relating to isolation and switching.</p>	
<p>Regulation 131-14-01 gives the fundamental requirements for isolation. Where the electricity supplier, usually a Regional Electricity Company, provides at the origin switchgear or fusegear such as their cut-out or a switch, and if they agree to its use for isolation, then it is not necessary to provide other means of isolation before the main switch. However, in these circumstances isolation at the origin can only be carried out by the electricity company, or by arrangement with them. A switch at the origin will still be required. If there are a number of separate installations or systems such as 'off peak' systems or certain fire alarm supplies, a number of separate switches may be necessary, together with adequate labelling.</p>	<p>131-14-01 476-01-01 460-01-02</p>

Some supply companies (RECs) now provide a double-pole switch after their meter for a domestic consumer's connection. If the switch does not interrupt both live conductors of a single-phase supply it cannot be considered for isolation of a domestic or similar installation. It may be necessary to enquire from the supplier if their switch fulfils the requirements for an isolator.

476-01-03

Regulation 131-13-01 prohibits the insertion of a single-pole fuse, switch or circuit-breaker in the neutral or any protective conductor.

131-13-01

Regulation 131-14-02, a fundamental principle, requires every fixed electric motor to be provided with an efficient means of switching off - readily accessible, easily operated, and so placed as to prevent danger. This is an emergency switching and mechanical maintenance requirement.

131-14-02

**3.2 Isolation,
basic
requirements
460
537**

The definition of an isolator as given in Part 2 of BS 7671 indicates that it is a mechanical switching device which, for reasons of safety, provides in the open position an isolating distance in accordance with specified requirements in BS 1363-4, BS 3676, BS EN 60669-2-4, BS EN 60898, BS EN 60947-2, BS EN 60947-3, BS EN 61008-1 or BS EN 61009-1

Part 2

537-02-02

Where an isolator is provided which is only suitable for operation as an off-load device, it must be ensured that only electrically skilled persons have access to and are permitted to operate it. The device must be capable of being secured to prevent inadvertent or unauthorised operation. Adequate labelling for operating instructions should be provided (see also Section 3.4 and Table 2.3).

537-02-07

An isolating switch (or switch disconnecter), in addition to being suitable for isolation is, however, capable of making, carrying and breaking currents under normal circuit conditions for functional operation. These may also include specified overload conditions and it may also carry, for a specified time, currents under abnormal conditions such as in the case of a fault.

As stated in Regulation 460-01-03 protective conductors are not to be isolated or switched, because their integrity is fundamental to many of the measures for protection against electric shock and therefore they must not be disconnected. An exception is allowed in Regulation 460-01-05 for the operational switching of protective conductors where an installation is supplied from more than one source of energy such as mains or a generator, but the integrity of the protective conductor is still to be maintained at all material times.	460-01-03 460-01-05
The principal purpose of Regulation 460-01-05 is the avoidance of excessive circulating (third harmonic) currents and parallel connections of the supply neutral to earth. If one of the sources is the public distribution system the supplier, a Regional Electricity Company, must be consulted and agree the earthing arrangements.	460-01-05
Devices which are suitable for the purpose of isolation include:	537-02
<ul style="list-style-type: none"> (i) isolators (disconnectors), isolating switches (switch disconnectors), circuit-breakers (including RCDs) as listed in Regulation 537-02-02 (ii) plugs and socket-outlets, luminaire couplers and luminaire supporting couplers (iii) withdrawable fuses and disconnectable links. 	537-02-02
Provision must be made to ensure that the person working is at all times able to prevent the inadvertent reclosure of the means of isolation.	461-01-02 476-02-02 537-02-07
The requirements of Chapter 34 of BS 7671 for maintainability should also be considered and isolation arranged to provide for safe and convenient maintenance.	341-01-01

3.3 Location and identification of isolating devices
461
514

The position of an isolating device at a particular location in the installation demands careful assessment by the designer.

Although it is desirable to have a single means of isolation and switching for a whole installation, some services may require to be separately isolated e.g. fire alarms, sprinklers, security systems etc.

On larger installations with more than a single source of supply it is not practicable to have a single main switch. The size of the installation and the need for security of supply dictate the best arrangement. Where there is more than one such device at the origin of the installation, or more than one supply is provided, clear and unambiguous identification is crucially important.

460-01-02

Regulation 19 of the Provision and Use of Work Equipment Regulations 1998 and Regulation 12 of the Electricity at Work Regulations 1989 require that where appropriate, and to prevent danger, *suitable* means shall be provided to isolate equipment and machinery from all sources of supply. This must include control systems, even at extra-low voltage, as well as power supplies. The isolation devices must be able to be secured against inadvertent operation and clearly labelled if their use is not obvious.

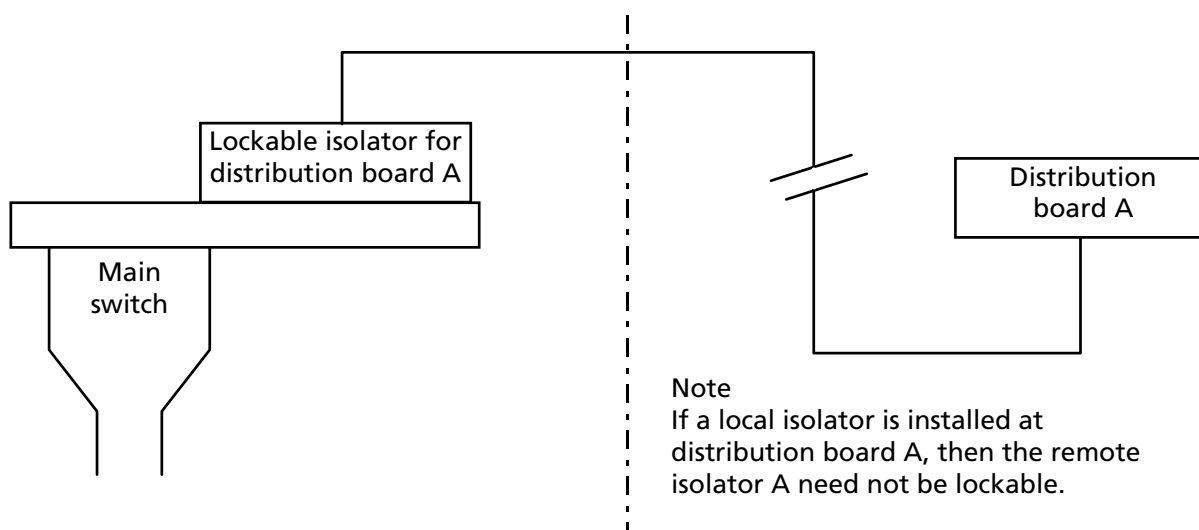
461-01-05

The means of isolation must be suitably placed for ready operation to enable its convenient and proper use but it does not necessarily have to be local to the equipment. If not local it must be properly identified and able to be properly secured in the off position, preferably by locking.

131-14-01
476-02-02

537-02-09

Fig 3.2 Remote lockable isolator



In the HSE Memorandum of guidance on the Electricity at Work Regulations 1989 *suitable* is also considered to apply to the location of the isolation device, on the grounds that if the device is not easily

accessible it will not be properly used. The accessibility is also related to the expected frequency of use in that if it is to be used frequently it should be readily accessible (and local to the equipment). Accessibility can also change during the course of time as access ways through a building may be revised and doors sealed etc. In such situations an isolator will need to be relocated to a more practical and suitable position.

In the case of a machine supplied through a plug and socket-outlet which is accessible for withdrawal of the plug, provision of the plug and socket-outlet for isolation may be sufficient.

[537-02-10](#)

BS 7671 Regulations 461-01-03, 461-01-05 and 537-02-09 cover the identification of isolators, and further reference to the provision of warning notices required is contained in Section 2.10 of this Guidance Note and Regulation 514-11-01.

[461-01-03](#)

[461-01-05](#)

[537-02-09](#)

[514-11-01](#)

3.4 Securing the means of isolation

476
537

Regulation 461-01-02 requires that once the installation or part of it is isolated, it is not re-energised without the knowledge of those working on or near the isolated live parts. Therefore, in choosing the precautions to be used, it is necessary to consider the probability of someone seeking to re-energise the system. This demands the most careful attention of the designer, particularly where industrial or commercial installations are concerned. The safety requirements of the Electricity at Work Regulations need to be ensured and the associated HSE Memorandum of guidance gives useful advice.

[461-01-02](#)

[476-02-02](#)

In general, Regulation 461-01-02 may be met by the provision of a locking device on each isolating device. However, where only skilled persons can gain access to the devices it may be possible to rely on one or more of the following:

[461-01-02](#)

- (i) notices
- (ii) devices preventing switch operation which may be removed only by a deliberate act e.g. spring clips
- (iii) devices such as covers, which prevent operation and require the use of a tool to remove them.

Locking attachments to secure some cbs in the open position are available from manufacturers. These require the use of a tool for removal, or can accommodate a padlock.

If the installation has a lockable switchroom accessible only to skilled or instructed persons, the access and keys to that switchroom must be under the control of a responsible person. When more than one job — each requiring isolation of separate parts of the installation — is being undertaken at the same time, rigorous control procedures and 'Permits to Work' may be necessary (see Section 3.9).

The use of fuses and links for the purpose of isolation involves similar considerations. The distribution board in which they are contained must be capable of being secured, particularly as this will usually be remote from the equipment. The use of fuses and links should be restricted to skilled or instructed persons to avoid any risks associated with their being withdrawn or replaced on load. All fuses and links removed for the purpose of isolation must be secured and not left in the distribution board. Coloured fuseway blanking pieces are available and may be utilised for warning. Distribution boards from which protective devices are removed for the purpose of isolation must be locked or otherwise secured. In domestic premises there may be the risk of someone interfering with the consumer unit while an electrician is working in another part of the house.

537-02-07

A particular danger may arise in older single-phase installations where double-pole fuseboards may still be found. Special care is necessary to ensure that the correct phase fuse is removed and isolation should be proved by the use of an approved voltage detector. Unless this is done, there is a risk that only the neutral fuse is removed, leaving the circuit live. Double-pole fuseboards were common in single-phase and neutral installations which would now be of a considerable age, often greater than the expected life of such installations, and a re-wire would be advisable for such installations where they are found. The owner of the installation should be informed and matters noted on any Certificate or Report issued. Double-pole fuseboards may also be found in certain specialist installations.

Certain isolation devices are suitable for off-load operation only and BS EN 60947-3 : 1999 Clause 5.2 requires this limitation of devices with lower utilization categories (AC-20A, AC-20B, DC-20A and DC-20B) to be clearly indicated by marking the isolator 'Do not open under load' unless the device is interlocked to prevent such opening (see Section 2.7). BS 7671 Regulation 537-02-07 requires such devices to be secured against inadvertent and unauthorised operation.

537-02-07

For machinery (see BS EN 60204-1), an isolator must be capable of being locked where it is not possible, from any of the points of access, to check that the supply remains cut off. After the supply is cut off, it must be possible to dissipate normally any energy remaining or stored in the circuits of the machinery without risk to exposed persons. As an exception to the above requirements, certain circuits may remain connected to their supply sources in order, for example, to hold parts, protect information, light interiors, etc. In this case, special steps must be taken to ensure operator safety.

3.5 Isolation at the origin of the installation
460
461

The main switch or circuit-breaker required by Regulation 460-01-02 is a means of isolation and switching for the whole installation.

460-01-02

The requirements of this regulation and the associated regulations are illustrated in the following drawings.

460-01-04
461-01-01

Additional provision must be made in those systems where there are standby generators or uninterruptible power supplies. Further details on the operation of standby supplies are given in HSE guidance material, Electricity Association Engineering Recommendation G85/1 — Recommendations for the connection of embedded generating plant to the Regional Electricity Companies' distribution systems and guidance material (Engineering Technical Report No 113 — Notes of guidance for the protection of private generating sets up to 5 MW for operation in parallel with Electricity Boards' distribution networks).

551-06-01
460-01-02

Regulation 476-01-03 specifically requires the interruption of both the phase and neutral conductors by the main isolating switch at the origin of a supply to a household (domestic) or

551-07-04
476-01-03

similar installation which is intended for operation by an electrically unskilled person, regardless of the type of supply system. In Appendix 5 of BS 7671 the coding of IEC 364-3 would identify this as BA1 — an ordinary person. In TN-S or TN-C-S systems, involving only skilled or instructed persons (BA5 or BA4), the neutral conductor need not be isolated or switched where it can reliably be regarded as being at earth potential. Supplies which are provided in accordance with the Electricity Safety, Quality and Continuity Regulations 2002 are considered to have the supply neutral conductor (PEN or N) connected with earth by a suitably low resistance. However, separate provision must be made for disconnecting the neutral conductor. This is usually a bolted link or accessible joint.

460-01-04

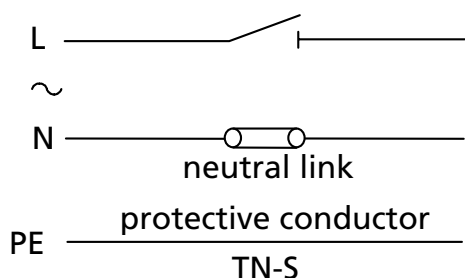
460-01-06

Fig 3.3 Single-phase systems, isolation at the origin of the installation

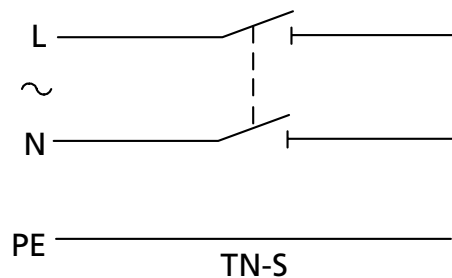
Arrangement at origin for skilled and instructed persons only

Arrangement at origin for ordinary & skilled persons. Ordinary persons are not electrically competent.

(a)

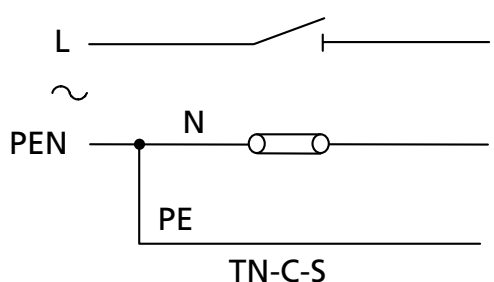


(b)

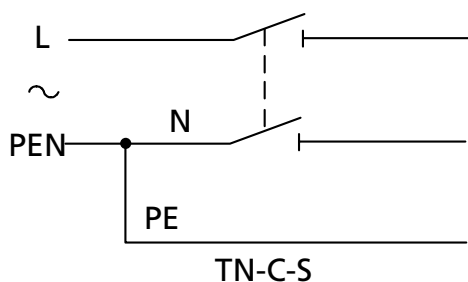


460-01-04
476-01-03

(c)

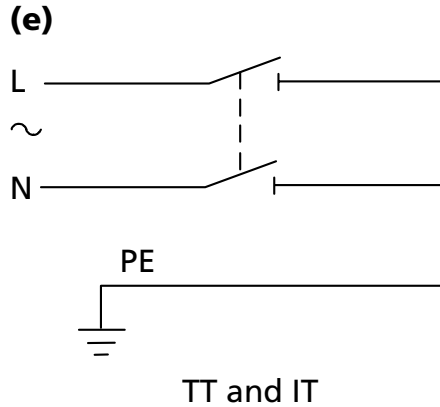


(d)



460-01-03
460-01-04
476-01-03

There is no difference in arrangement for TT and IT systems between skilled or instructed persons and ordinary persons. Ordinary persons are not electrically competent.



460-01-04

Fig 3.4 d.c. systems isolation at the origin of the installation

All poles are to be provided with a means of isolation .

460-01-02

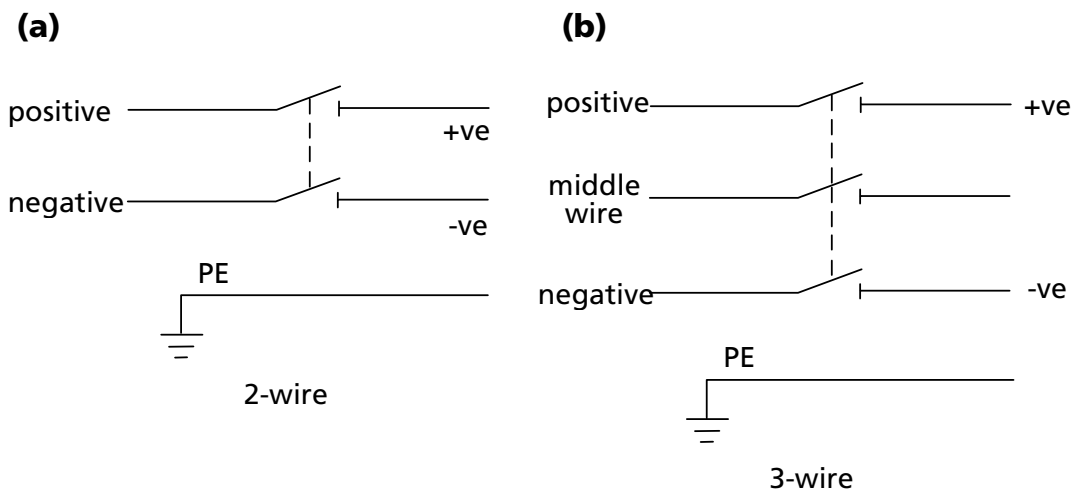
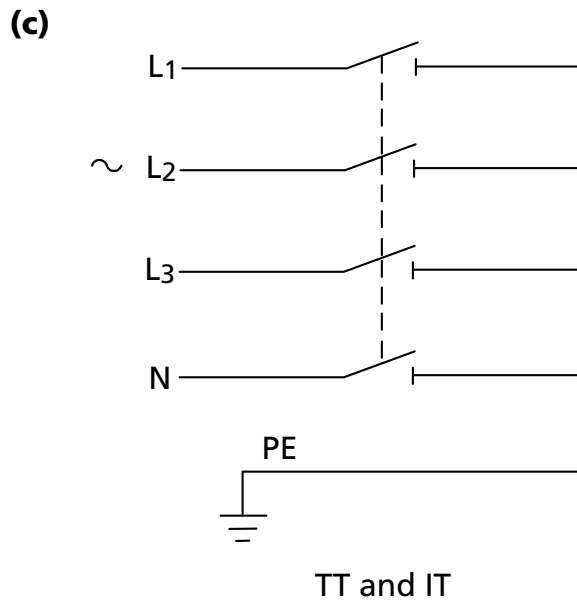
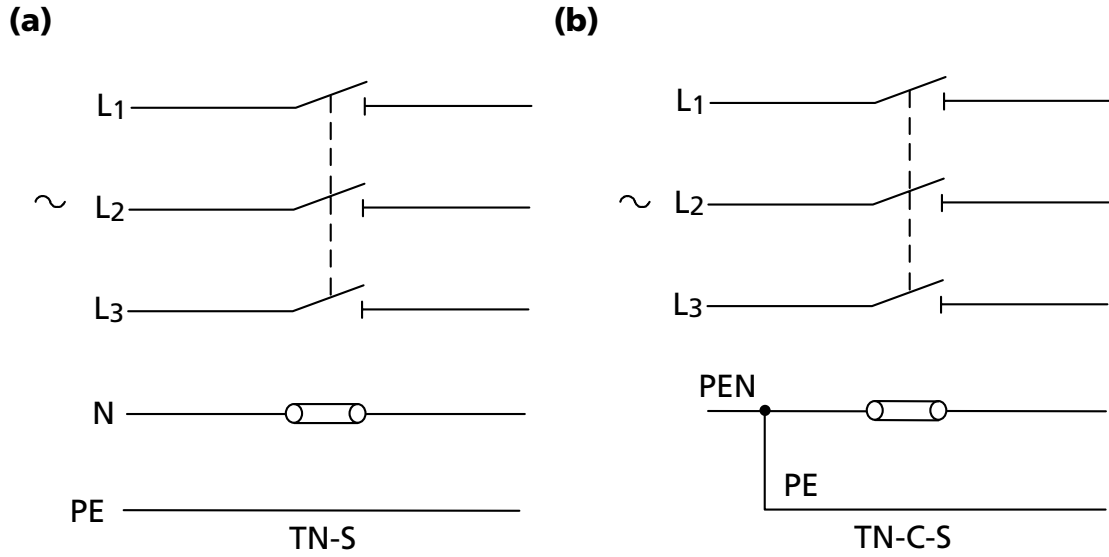


Fig 3.5 Three-phase systems, isolation at the origin of the installation

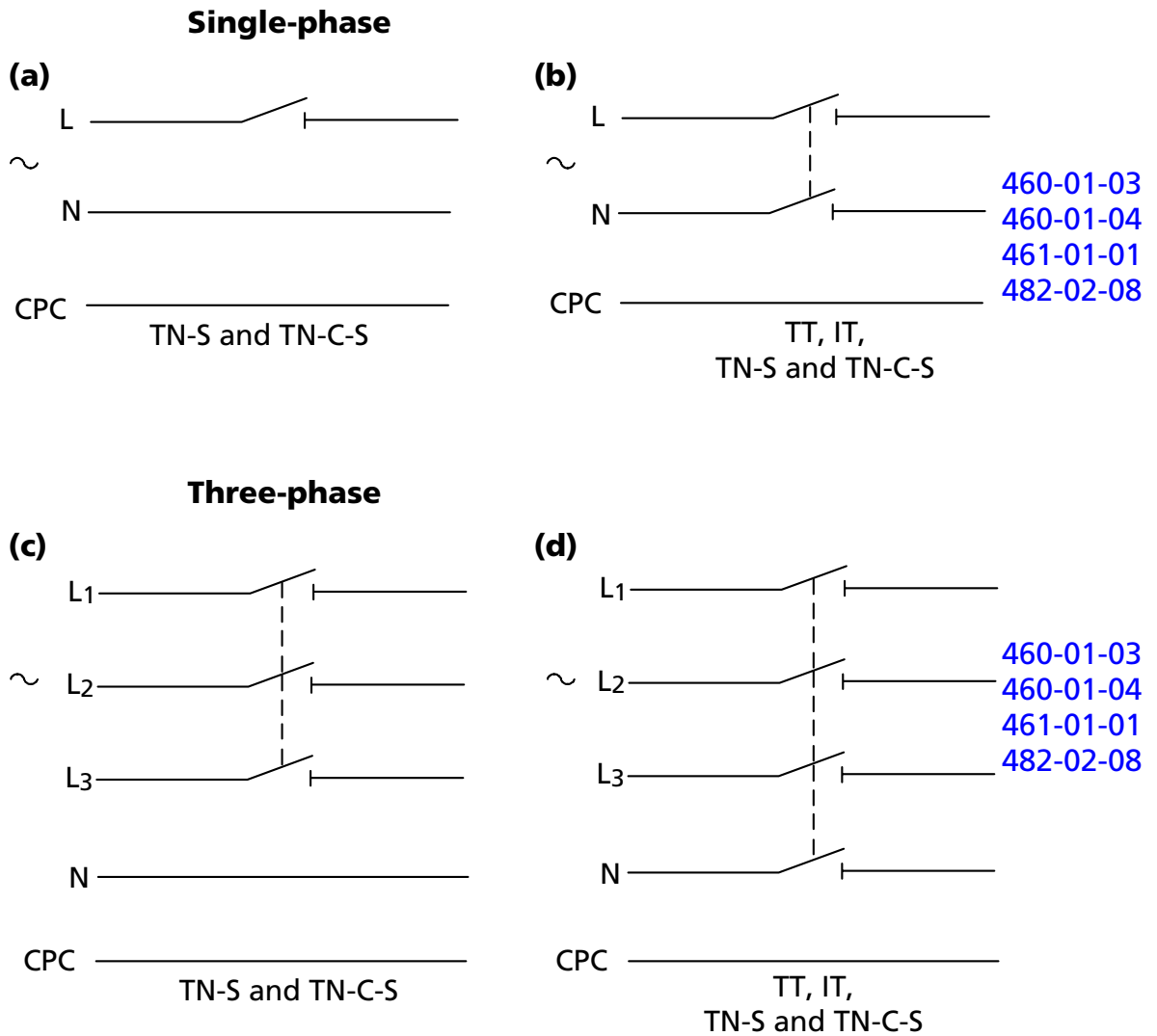
There are no differences for skilled or instructed persons and ordinary persons. Ordinary persons are not electrically competent.



460-01-02
460-01-03
460-01-04

3.6 Isolation of circuits within an installation

Fig 3.6 Examples of provision of Isolation of circuits within an installation



Regulation 461-01-01 requires the isolation of every circuit but allows the isolation of a group of circuits by a common means — a single isolating device — where service conditions allow. The consideration of the service conditions referred to is of particular importance, for example, to minimise inconvenience such as would be caused if the whole of a large installation had to be isolated for safety to enable work to be done on a small part of it.

461-01-01

Where insufficient or badly sited isolating devices are provided there is always the risk of people attempting to work on live equipment without first isolating the supply to that equipment. To avoid this risk an adequate number of isolating devices should be provided. The requirements of the Electricity at Work Regulations 1989 must be complied with, and the provision of adequate isolation assured. Careful consideration should be given to the location of these devices. If they are not suitably placed in relation to the circuits or equipment with which they are associated there is a risk that they will not be used. All devices must be adequately labelled to identify their function, unless there is no possibility of confusion of the purpose of a device.

514-01-01
537-02-09

3.7 Isolation of the neutral conductor

For the isolation of systems or circuits, Regulation 460-01-04 allows, in TN-S and TN-C-S systems, for the neutral conductor not to be isolated. Although the neutral is defined in Part 2 of BS 7671 as a live conductor, in installations which are part of these systems in normal operating conditions the neutral potential remains close to that of exposed- and extraneous-conductive-parts within the earthed equipotential zone. The exclusion applies only to TN systems supplied in accordance with the Electricity Safety, Quality and Continuity Regulations 2002. *Note:* This was formerly the Electricity Supply Regulations 1988 as amended.

460-01-04

As shown in Section 3.5, notwithstanding the above, Regulation 476-01-03 requires the neutral to also be switched by the main switch of a single-phase supply to an installation which is intended for operation by ordinary persons. This has been provided to specifically require a double-pole main switch in domestic consumer units.

476-01-03

The installer must take care that each circuit is kept distinct and separate from all other circuits so that isolation is effective. The possible interconnection of neutral conductors which may occur during alteration or modification of an installation must be the subject of special concern.

314-01-04

If the requirement for the provision of a means of phase conductor isolation is met by fuses it will be necessary in the above systems to provide for the isolation of the neutral by links, fuses not being allowed, because isolation of the neutral by disconnection of the conductor cannot be relied upon to isolate the relevant neutral and can damage the conductor. If links cannot be provided another means of isolation should be selected.

For supplies given in accordance with the Electricity Safety, Quality and Continuity Regulations 2002, the connection of the neutral with earth may be regarded as permanent, and consequently the isolation of the neutral conductor is not necessary as there is little risk of any hazard. Indeed, in TN-C-S systems (see drawings) the neutral and protective conductor (PE) are connected together and are at a common potential within the installation and isolation of the neutral would not be worthwhile.

Part 2

460-01-04
110-04-01

In spite of the foregoing there are, however, some other places where neutral isolation is still required. These include:

- supplies to and in hazardous and potentially explosive atmosphere areas to BS EN 60079 and BS 6467
- TT and IT supply installations
- Locations where particular risks of fire exist
- certain special locations and installations, such as medical installations. These need to be considered individually (specialist advice may be required)
- self-contained generation and ups systems
- any other installations of special operation or danger, such as supplies not provided in accordance with the Electricity Safety, Quality and Continuity Regulations 2002. High voltage supplies from a REC or other supplier to a consumer's own substation are provided in accordance with the Electricity Safety, Quality and Continuity Regulations, but any LV supplies derived from the consumer's substation will be outside their scope so the designer and installer must satisfy themselves that the LV neutral is securely and reliably connected to earth and that the earthing arrangements are adequate. The relevant requirements of the Electricity Supply

482-02-08 |

Safety, Quality and Continuity Regulations provide suitable guidance.

It should be appreciated that the neutral still may have a small potential with respect to earth and may still be able to give a perceived electric shock.

BS PD 6519 : Part 1: 1995 'Guide to the effects of current on human beings and livestock' gives details of electric shock voltages and currents and recognises that a touch voltage not exceeding 50 V a.c. is usually safe, in normal circumstances (see Guidance Note 5: Protection against electric shock).

The Electricity at Work Regulations 1989, Regulation 12, states that suitable means of isolation shall be available where necessary to prevent danger, and an assessment of the risk of not isolating the neutral must be made. In certain situations, e.g. working at height, a mild shock may not be dangerous in itself but may cause a reflex action and lead to an accident.

Regulation 460-01-06 requires a provision for the disconnection of the neutral conductor with a tool by means of a conveniently located link or joint. This will provide isolation and for more convenient or practical testing as required by Part 7. The requirements for such links or joints are given in Regulations 460-01-06 and 537-02-05 (see also Guidance Note 3: Inspection & Testing).

[460-01-06](#)

[460-01-06](#)
[537-02-05](#)

3.8 Isolation of particular equipment

Specific Requirements

Chapter 55 contains specific requirements for the isolation of any generating sets incorporated within the installation, and also for step-up transformers, electrode boilers or electrode water heaters, water heaters having immersed and uninsulated heating elements and HV discharge lighting. Section 611 gives a specific exclusion or relaxation for isolation of street furniture.

[611-03-01](#)

551-06

Generators

Precautions are required where a generator is not intended to run in parallel with the public supply to prevent such operation. This may be by electrical or mechanical interlocks or other switching. This is usually of a functional type, but secure isolation must be provided where necessary for safety.

[551-06-01](#)

551-07	Where a generator is intended to run in parallel with the public supply a means of isolation must be provided to disconnect the operator from the public supply network. This means of isolation must be accessible to the supplier at all times.	551-07-04
554-02-01	HV electric signs and discharge tube installations All high voltage electric signs and discharge tube installations must comply with BS 559. A means of isolation of the circuit should be provided on the supply to the primary of the transformer(s) to comply with Regulation 476-02-04 (Regulation 555-01-03 also) and a fireman's switch provided to comply with Regulation 476-03-05 (see Section 7).	
554-03	Electrode boilers and electrode water heaters For an electrode boiler or electrode water heater a linked circuit-breaker is required to disconnect the supply from all electrodes simultaneously. Circuit-breakers can provide isolation and this must be clarified at the design and selection, or a separate isolating device may be required.	554-03-02
554-05	Water heaters or boilers with uninsulated elements Any water heater or boiler with uninsulated elements should be permanently connected to the supply through a multi-pole linked switch which is either an integral part of the heater or boiler or located close to it. The switch must also meet the isolation requirements.	554-05-03
555-01	Step-up transformers For a step-up transformer a linked switch is required to disconnect all live conductors supplying the primary. This switch must comply with the requirements for isolation.	555-01-03
611-03	Street furniture Regulation 611-03 allows the isolation (and switching) by instructed persons of street furniture (usually lighting columns) in TN systems by the withdrawal of the single-pole fuse in the supply cut-out (or multi-pole fuses for other equipment), providing the isolation is carried out by an instructed person and subject to adequate provision to prevent the equipment being accidentally re-energised by the inadvertent replacement of the fuse.	611-03-01

When work on such systems is to be carried out by skilled or instructed persons, the provision of a separate isolating device is not always necessary. Health and Safety legislation requires that risk assessment must be carried out and double-pole (or four-pole) isolation provided if considered necessary. Where the electricity supplier's (REC) cut-out fuse is to be the means of isolation, the REC's approval must be obtained, or a separate isolation device installed.

611-03-02

The installation designer must ascertain whether it is to be maintained by skilled or instructed persons, or ordinary, i.e. electrically unskilled persons, e.g. lamp changers. If the installation is to be maintained by skilled or instructed persons the cut-out may be used as a means of isolation. If not, an isolator must be provided.

476-02

Motors

Regulation 476-02-03 requires that all motor circuits shall be provided with a means of isolation. This regulation does not specifically require every individual motor to have its own means of isolation, nor for a local means of isolation to be provided near every motor. A common means of isolation at the motor control centre (MCC) or an isolator on every motor circuit at the MCC are acceptable — depending upon the installation operational requirements. Many large industrial plants do not have local isolation at the motors as an open isolator may not be noticed and plant start-up may be compromised if a motor e.g. a conveyor is not running. Industrial plants may operate on a 'Permit to Work' system (see Section 3.9). However, every fixed motor must be provided with an efficient means of switching off (not necessarily an isolator) which must be readily accessible, easily operated and so placed so as to prevent danger. Lock-off stop buttons are a means of emergency switching and stopping, and are not recommended as a means of isolation because they do not act directly on the supply to the motor, but only indirectly through the motor starter control circuit (see Section 5).

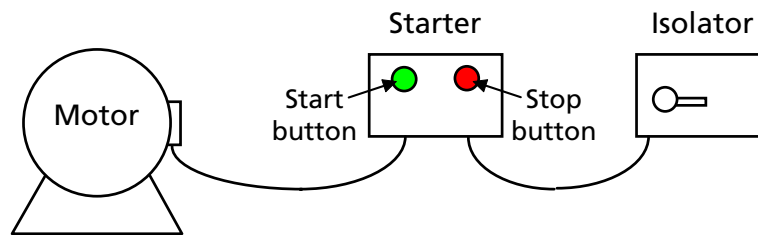
476-02-03

461-01-01

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463-01-01

Fig 3.7 Motor with readily accessible starter and local isolator



Due to the complexity and safety considerations of large multi-motor industrial installations, it is recommended reference be made to BS EN 292, BS EN 418 and BS EN 60204-1. The HSE may also provide advice.

Certain equipment may require power when the motor isolator is in the 'OFF' position, e.g. an anti-condensation heater. In such a case, a notice of durable material in accordance with Regulation 461-01-03 must be fixed in each position where there are live parts which are not capable of being isolated by a single device.

514-11-01

461-01-03

3.9 Procedures for isolation (Permits to Work) 461

To provide safe working practices in larger installations where several items of equipment may operate and various supplies may be present, including high voltage, main and standby supplies, control systems, etc and where hazardous environments are encountered, a 'Permit to Work' safety system is usually employed. Under this system, the nominated persons responsible for specific areas or aspects of the system control and operate the various safety measures for the installation and a standard form is signed by each confirming that the installation and supplies are safely isolated. Multiple padlocking of various isolators or switches is a common feature and the whole is a formal procedure for safety. For further guidance see the HSE publication 'Electricity at Work — safe working practices' (HSE booklet HS(G)85).

A full treatment of such procedures is outside the scope of this Guidance Note as BS 7671 does not cover the subject. Regulation 13 of the Electricity at Work Regulations 1989 requires attention to this matter.

Regulation 461-01-04 requires means to be provided for the discharge of capacitive or inductive energy from an isolated installation or circuit. Stored energy is not normally a problem in low voltage wiring systems but equipment, especially if it has an electronic content or is known to have capacitors incorporated, should always be checked to ensure that it is discharged. Inductive stored energy collapses when the supply is removed, but capacitive stored energy can remain. A discharge resistor is usually fitted to capacitors.

Whatever procedures are laid down in written instructions, and 'Permits to Work' may well form part of these, the following are the main points which should be included:

Before work commences:

- (i) check that the circuit or equipment involved may be isolated without danger or inconvenience being caused — there may be common isolation with other circuits — and obtain permission to isolate the circuit or equipment
- (ii) the circuit or equipment may have more than one source of supply, such as a separate control circuit — check all supplies
- (iii) check that the circuit does not include an uninterruptible power supply (UPS) or other standby system
- (iv) if the isolating device is an off-load device, switch off all connected circuits and equipment before operating the isolator
- (v) Open the isolating device and check that all poles are open and proved dead by the use of an approved voltage indicator, which itself should be proved both before and after use
- (vi) secure the means of isolation in the open position
- (vii) display warning notices as appropriate
- (viii) issue safety documentation notices as appropriate

On completion of work:

- (ix) check that the work is completed, inspected and tested, all tools, used materials and rubbish removed, all connected circuits and equipment are switched off and that all persons concerned are informed that the supply is about to be restored
- (x) close the isolating device and remove warning notices
- (xi) re-commission the circuits and equipment, and inform the responsible person in charge of the installation.

In smaller installations, for maintenance, repair or new work the electrician usually has to make his or her own isolation arrangements before carrying out the work. All devices should be clearly labelled to facilitate this and adequate locking or warning facilities provided. If the isolating device is out of sight of the person carrying out the work, extra precautions are necessary to prevent accidental operation by others.

Section 4 — Detailed Requirements — Switching Off for Mechanical Maintenance

4.1 General 462

For compliance with Regulation 462-01-01 the method of switching off for mechanical maintenance will depend on the type of hazard associated with the work to be performed.

462-01-01

‘Switching off for mechanical maintenance’ is different from the other recognised forms of isolation and switching as specific equipment is not required to be provided for this function. The normal functional switching or isolation devices may be utilised. However, specific switches may be provided for local use by non-electrically skilled persons for mechanical maintenance.

Mechanical maintenance is defined in Part 2 of BS 7671 as ‘The replacement, refurbishment or cleaning of lamps and non-electrical parts of equipment, plant and machinery’. However, it is not a function that is recognised in the Electricity at Work Regulations 1989 and great care must be taken to ensure adequate safety when non-electrically skilled persons are undertaking maintenance. This maintenance specifically excludes removal of electrical equipment covers and adjustment of devices and should not allow access to parts that normally move. If there is access to live parts, isolation is required and the Electricity at Work Regulations apply.

Part 2

A device for switching off for mechanical maintenance should be manually operated and have clear indication of the OFF or open position. Devices must be installed in such a way as to prevent unintentional reclosure by accidental knocks, mechanical shock, vibration etc. and should also be

537-03-02

537-03-03

462-01-03

capable of being secured against inadvertent reclosure.

Switching off for mechanical maintenance is not appropriate for mechanical work which requires access to the interior of equipment where live parts would be exposed. Where work is to be carried out on, or near, live conductors for the purpose of mechanical or electrical maintenance a means of isolation must be provided. Consideration should be given to using one device to fulfil all the requirements of both functions. The precautions to prevent equipment from becoming unintentionally or inadvertently re-energised prescribed in Regulation 462-01-03 should be similar to those already mentioned in the Section dealing with isolation (see Section 3.4 — Securing the means of isolation). Except where there is no possibility of confusion devices should be clearly identified with their function, and provision made to secure from unintentional or inadvertent operation unless the device for switching off is continuously under the control of a person performing maintenance.

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462-01-02

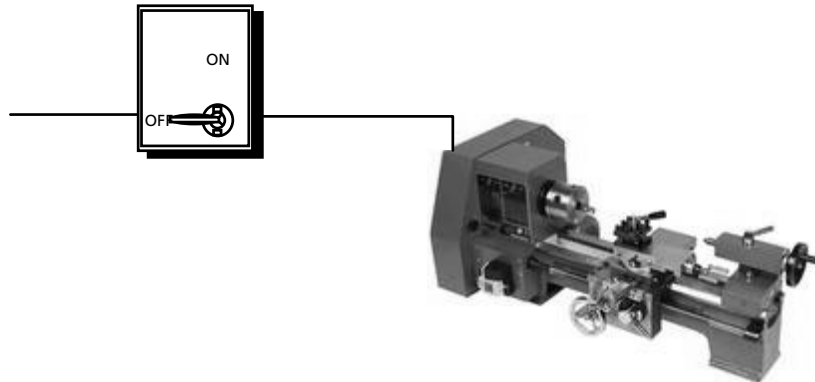
It must always be borne in mind that switching off for mechanical maintenance is an operation likely to be performed by non-electrically skilled persons. Therefore, all devices for the purpose must be capable of on-load operation in the appropriate Utilization Category according to the load e.g. resistive, motor, electromagnetic as specified in the appropriate Part of BS EN 60947 : Specification for low voltage switchgear and controlgear (see Section 2.7). Devices in accordance with the product standards listed in Regulation 537-02-02 may also be capable of on-load switching. Manufacturers' literature may also provide some information and BS EN 60204-1 contains guidance.

537-03-04

537-02-02

An example of a device which may be used for switching off for mechanical maintenance is an isolator for a lathe. No special precautions need be taken to prevent the lathe from becoming unintentionally or inadvertently reactivated during mechanical maintenance, provided that the isolator is continuously under the control of the person carrying out such maintenance.

Fig 4.1 Example of switching off for mechanical maintenance



Light switches are an example of functional switching which may be utilised for switching off for mechanical maintenance, where appropriate, as a luminaire may be switched off at the local switch for relamping or cleaning so long as live parts are not accessible except as described in Section 4.4.

4.2 Switching off the supply
462

First consideration should be given to switching off the supply to the equipment concerned by the use of the equipment isolating device which, together with an effective means of securing the isolation, may be the most appropriate method. A plug and socket-outlet of rating up to 16 A may be used as a device for switching off for mechanical maintenance by non-electrically skilled persons. Larger plugs and socket-outlets may be used for isolation, but their operation should be by skilled or instructed persons only.

[462-01-01](#)
[537-03-01](#)
[537-03-05](#)

4.3 Switching off the control circuit
537

Switching off by a device in the starter control circuit may be adequate, as indicated in Regulation 537-03-01, where other factors are incorporated to enhance the level of safety.

[537-03-01](#)

There is the possibility of a short-circuit or earth fault in the control circuit effectively short-circuiting a device installed in the control circuit. This could result in the unexpected re-activation of a machine. Careful design of the control circuit is needed to avoid such

[464-02-01](#)

an occurrence, and any subsequent modification needs equal care. Control circuits should be constructed in accordance with the requirements in BS EN 60204-1 and in 'C' standards for particular machines, (see Section 5.1), utilising as low a control voltage as is reasonably practicable for the functionality of the control system.

Where a control circuit transformer is utilised, one pole should be connected to earth and the other pole only should be fused. All control equipment operating coils should be connected to the earthed pole to prevent earth faults causing mal-operation of the control circuit, which could cause danger. Centre-tapped earth control circuits should not be used, as an earth fault could still allow control equipment to operate.

4.4 Luminaires

The removal of lamps having bayonet or Edison screw caps can permit access to normally live parts. Bayonet lampholders to BS 7895 : 1997 inherently control the supply to the lamp or restrict access to live parts. In the case of bayonet lampholders to BS EN 61184 and Edison screw lampholders to BS EN 60238 an exception to Regulation 412-03-01 is dealt with in Regulations 412-03-04 and 471-05-02.

[412-03-01](#)

[412-03-04](#)
[471-05-02](#)

Suitably located and, if necessary, labelled means for switching are required for replacement or changing of lamps to prevent burns or unintentional access to live parts. In some situations the functional switching may not provide a safe means of switching off for lamp changing, etc therefore other suitable provisions must be made for this operation. If live replacement or changing or cleaning is to take place, the requirements of the Electricity at Work Regulations 1989, where applicable, must be observed, particularly Regulation 14 - Work on or near live conductors.

[462-01-02](#)

[462-01-03](#)

Section 5 — Detailed Requirements — Emergency Switching and Emergency Stopping

5.1 General 463

An adequate and sufficient risk assessment is a legal requirement, and should identify hazards that can be alleviated by the application of Regulation 463-01-01. The British Standard on principles for risk assessment is BS EN 1050.

463-01-01

This document cannot cover the detailed safety requirements for all emergency switching and stopping arrangements and further guidance should be sought from relevant machine standards.

BS 7671 does not cover the electrical equipment of machines, but can often apply to the installation of machines.

The point at which responsibility moves from the installation requirements to the machine's electrical equipment requirements is not always immediately obvious. The machine's electrical equipment begins at the point where it receives its supply(ies). BS EN 60204-1 requires each source of supply to have a supply disconnecting device to switch off the supply and provide isolation, and although this disconnecting device forms part of the electrical equipment of the machine it need not be mounted on the machine. If it is mounted on the machine, the conductors to the disconnecting device are part of the installation, but if the disconnecting device is not, for example wall-mounted, then it and the conductors to the machine are part of the electrical equipment of the machine.

General requirements for the emergency control of machines are given in BS EN 292 and BS EN 60204-1; see Annex D of BS EN 60204-1 for an explanation of emergency operation functions. Principles for the design of emergency stop equipment are given in

BS EN 418. Requirements for electrical equipment of machines used for emergency stop and emergency switching-off are specified in Clauses 9 and 10 of BS EN 60204-1.

Specific legal requirements are stated in the Supply of Machinery (Safety) Regulations 1992 as amended and the Provision and Use of Work Equipment Regulations 1998. The HSE provides valuable guidance material on emergency switching and on risk assessment.

European standards relating to safety of machinery can be classified in three types:

Type A standards

Basic safety standards, giving basic design principles and concepts (e.g. BS EN 292).

Type B standards: Generic safety standards

B1: Particular safety aspects
(e.g. BS EN 60204-1 for electrical equipment of machines)

B2: Standards for safeguards
(e.g. BS EN 574 for two-hand controls)

Type C standards: Machine safety standards

Product standards for specific types of machine (e.g. BS EN 693 for hydraulic presses).

These standards should always be applied to the extent that they are relevant, noting that the 'C' standard for a particular machine type will contain specific requirements for that machine. Type 'C' standards should contain sufficient provisions to enable designers and manufacturers to meet the requirements of the Machinery Directive (in the UK, the Supply of Machinery (Safety) Regulations).

In some applications, emergency switching can involve interfacing with the machine's control system. In such cases the machine manufacturer will often have advice available. Well-tried and accepted control methods and devices should be used whenever possible.

The behaviour of the control system can be specified according to BS EN 954-1 "Safety-related parts of control systems – general principles for design", which specifies five categories:

Category B:

Safety-related parts of control systems and/or their protective equipment, as well as their components, are designed, constructed, selected, assembled and combined in accordance with relevant standards so that they can withstand the expected influence. The occurrence of a fault can lead to the loss of the safety function.

Category 1:

Requirements of B apply. Well-tried components and well-tried safety principles are used. The occurrence of a fault can lead to the loss of the safety function but the probability of occurrence is lower than for category B.

Category 2:

Requirements of B and the use of well-tried safety principles apply. The occurrence of a fault can lead to the loss of the safety function between the checks. The safety function is checked at suitable intervals by the machine control system. Loss of the safety function is detected by the check.

Category 3:

Requirements of B and the use of well-tried safety principles apply. When the single fault occurs the safety function is always performed.

Safety-related parts are designed, so that:

- a single fault in any of these parts does not lead to the loss of the safety function, and
- whenever reasonably practicable the single fault is detected.

Some but not all faults will be detected, and an accumulation of undetected faults can lead to the loss of the safety function.

Category 4:

Requirements of B and the use of well-tried safety principles apply.

When the faults occur the safety function is always performed.

Safety-related parts shall be designed, so that:

- a single fault in any of these parts does not lead to a loss of the safety function, and
- the faults will be detected in time to prevent the loss of the safety function.

With the increasing complexity of modern control systems it is difficult to describe the behaviour of control systems in terms of these categories, particularly when programmable devices are used. IEC/EN 61508 addresses more complex systems by specifying requirements for the procedures to be followed when developing such systems. This standard is generic in nature, and a number of IEC standards have been, or are in the process of being, developed for particular industry sectors. These are: IEC 61511 for the process industry, IEC 61513 for the nuclear industry, and IEC 62061 for the machinery sector. These standards focus on the performance of safety functions, rather than on the parameters of particular components. They classify safety performance into one of four SILs (Safety Integrity Levels) depending on the probability that the safety function will be performed when required. It is important to note that the SIL is an attribute of the whole of the subsystem that performs the safety function, not an attribute of any component.

Where these standards have been applied to control systems, the requirements for emergency switching will have been specified in a Safety Requirements Specification.

5.2 Basic considerations
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537

For emergency switching, requirements similar to those for isolation covering the disconnection of live conductors are prescribed by BS 7671. A full assessment of risks should be carried out with the assistance of the standards detailed in Section 5.1 where appropriate to identify emergency operations. If there is a risk of electric shock the circuit phase and neutral conductors must be interrupted in TT and IT systems.

[463-01-01](#)
[460-01-04](#)

The switching requirements are summarised below:

(i) *electric shock hazard*

three-phase and single-phase TN-S and TN-C-S systems: phase conductors must be switched, neutral conductors may be switched

[463-01-01](#)
[460-01-04](#)

three-phase and single-phase TT and IT systems: phase and neutral conductors must be switched

(ii) other hazards
three-phase and single-phase TN-S and TN-C-S systems: phase conductors must be switched, neutral conductors may be switched 530-01-03

three-phase and single-phase TT and IT systems: phase conductors must be switched, neutral conductors may be switched.

A means of emergency stopping is required where electrically driven machines may give rise to danger. BS EN 60204-1 specifies three categories of stop functions as follows: 476-03-02

Category 0:

stopping by immediate removal of power to the machine actuators (i.e. an uncontrolled stop).

Category 1:

a controlled stop with power available to the machine actuators to achieve the stop (e.g. by DC injection braking) and then removal of power when the stop is achieved.

Category 2:

a controlled stop with power left available to the machine actuators (e.g. to retain a suspended load).

These stop categories are intended to avert mechanical hazards, rather than to avoid the risk of electric shock, so they should be considered separately from the need to provide isolation.

The risk assessment should identify which of the stop categories is most appropriate, bearing in mind that emergency stopping must not create additional hazards. 463-01-03

Regulation 463-01-01 requires that this measure must act rapidly and a detailed knowledge of the equipment is necessary to enable compliance. It should be borne in mind that in complex industrial processes the nature of the emergency may require skilled personnel to advise on the emergency switching procedure to be adopted. Discussion and agreement with those responsible for the safe operation of the plant is therefore essential. 463-01-01
537-04-05
476-03-01
476-03-02

The interruption, re-establishment after an interruption or fluctuation in whatever manner of the 463-01-03

power supply to a machine must not lead to a dangerous situation.

In particular:

- the machinery must not start unexpectedly
- the machinery must not be prevented from stopping if the command has already been given
- no moving part of the machinery or piece held by the machinery must fall or be ejected
- automatic or manual stopping of the moving parts whatever they may be must be unimpeded
- the protection devices must remain fully effective.

Regulation 537-04-05 generally requires the use of systems or devices which must be reset after operation. This can be achieved by the use of emergency stopping devices conforming to BS EN 60947-5-5 and BS EN 418..

537-04-05

Machines must be fitted with one or more readily accessible emergency stop devices to enable actual or impending danger to be averted. The following exceptions are allowed by the Supply of Machinery (Safety) Regulations 1992 as amended:

476-03-02

- machines in which an emergency stop device would not lessen the risk, either because it would not reduce the stopping time or because it would not enable the special measures required to deal with the risk to be taken
- hand-held portable machines and hand-guided machines.

The device must:

- have clearly identifiable, clearly visible and quickly accessible controls
- stop the dangerous process as quickly as possible, without creating additional hazards
- where necessary, trigger or permit the triggering of certain safeguard movements.

463-01-03

The emergency stop control must remain engaged; it must be possible to disengage it only by an appropriate operation; disengaging the control must not restart the machinery, but only permit restarting; the stop control must not trigger the stopping function before being in the engaged position.

537-04-05

The emergency stops should be located at machine control points and at other appropriate locations around the equipment. They must be readily accessible in all circumstances and should not be used as functional stops.

The machine functional control system selected can override all other control systems with the exception of the emergency stop. If machinery has been designed and built to allow for its use in several control or operating modes presenting different safety levels e.g. to allow for adjustment, maintenance, inspection etc, it must be fitted with a mode selector which can be locked in each position. Each position of the selector must correspond to a single operating or control mode.

Machinery or parts of machinery designed to work together

In the case of machinery or parts of machinery designed to work together, the manufacturer must so design and construct the machinery that the stop controls, including the emergency stop, will stop not only the machinery itself but also all equipment upstream and/or downstream if its continued operation could be dangerous.

Independent items of machinery

The emergency stopping of one of several independent items of machinery (e.g. a conveyor system or steel mill) could result in consequential dangers greater than those of the initial emergency. One form of emergency switching could be the rapid computer-controlled shutdown of a complex process plant from a single manual initiation. The emergency switching must be arranged so that its operation does not introduce a further hazard or interfere with other emergency operations.

463-01-03

Workshops

In certain locations, such as workshops where students or trainees are under instruction, consideration should be given to one or more emergency switching devices to cut off all the machines etc, but not the lighting or any safety supplies, in the event of danger. The use of a key operated reset switch should be considered to allow the supply to be reset by nominated persons only. Guidance is given in BS 4163 : 2000 'Health and

safety for design and technology in schools and similar establishments. Code of practice.'

Restarting

As for normal starting, it must be possible to restart the machine only by voluntary actuation of a control provided for that purpose.

Modifications

When modifications are carried out on existing machinery or equipment it is necessary to consider the whole control and emergency systems to check that the proposed modifications do not introduce new hazards that were not considered in previous risk assessments.

The device requirements for emergency stopping equipment do not prescribe that these devices shall be suitable for isolation, so their operation may not result in an isolated condition.

537-04

5.3 Means of emergency switching **463** **537**

The means of emergency switching is required to:

- (i) act as directly as possible on the appropriate supply conductors, and 463-01-02
- (ii) be of a latching type, requiring only a single initiative action to operate the whole emergency switching sequence, and 463-01-02
537-04-05
- (iii) be readily accessible and durably marked, preferably coloured red, and 463-01-04
537-04-04
- (iv) stop all mechanical movement of electrically powered equipment where this movement may give rise to danger, and 463-01-05
476-03-02
- (v) include adequate devices where additional emergency switching may be needed. 537-04-04

Because of the need to place the device or devices local to where the hazard may occur, it is likely that devices in the control circuits of contactors or circuit-breakers will be required. The device is required to be of the latching type capable of being restrained in the OFF or STOP position. Switching devices such as contactors must be arranged to open and stop the plant on de-energisation of the coil.

537-04-05

537-04-03

The same considerations regarding control circuit switching as for switching off for mechanical maintenance must be applied (see Section 4.3).

With regard to accessibility of emergency switching, a device situated within 2 m of a single item of equipment or an appliance could be considered readily accessible if it is sensibly located clear of obstructions, moving parts, sources of heat etc.

463-01-04

A plug and socket-outlet or similar device must not be selected, i.e. intentionally provided, as a device for emergency switching but may be used as such in an emergency. The clear intent is that the designer must anticipate the need for emergency switching and make the proper provision. A plug and socket may be difficult to disengage in an emergency, but may be suitable for isolation where ease of use and access is not critical.

537-04-02

5.4 Devices for emergency switching 537

Examples of suitable devices include:

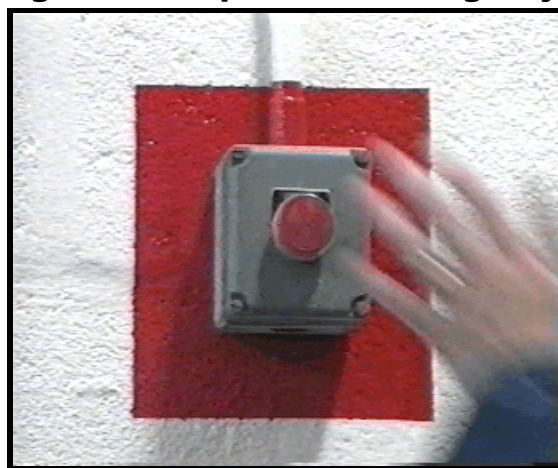
- (i) a single switch in the supply circuit, adequately rated to switch the full load current — including stalled motor conditions
- (ii) a push-button in a control circuit, subject to the considerations noted in Sections 4.3 and 5.3. A manually operated direct-acting device is preferred to a remotely controlled device.

537-04-01
537-04-02

537-04-03

There are other suitable devices which require specialist advice.

Fig 5.1 Example of an emergency switch



Section 6 — Detailed Requirements — Functional Switching

6.1 General 464

Functional switching is the most general and perhaps widely used of the switching types. As defined in Part 2 it means the normal operation and control of an item or items of electrical equipment, from the on/off switching of a single lamp to the computer control of a major industrial installation.

[Part 2](#)

A separate functional device is necessary for each part of the installation that requires separate functional control, but a common functional device may control a number of items of current-using equipment.

[464-01-01](#)

Functional switching devices can be solid-state and need not necessarily control all the live conductors of a circuit, but a single-pole switching or control device must not be placed in the neutral conductor.

[464-01-03](#)

[537-05-02](#)

[131-13-01](#)

[464-01-02](#)

6.2 Control systems

Functional control systems must be designed and constructed so that they are safe and reliable, in a way that will prevent a dangerous situation arising. Above all, they must be designed and constructed such that:

[464-02-01](#)

— they can withstand the rigours of normal use and external factors

— errors in logic do not lead to dangerous situations.

Functional control devices should be:

— clearly visible and identifiable and appropriately labelled and identified where necessary

[514-01-01](#)

— positioned for safe operation without hesitation or loss of time, and without ambiguity

— designed so that the movement of the control is consistent with its effect

- located outside any danger zones, except for certain controls where necessary, such as an emergency stop
- positioned so that their operation cannot cause additional risk
- designed or protected so that the desired effect, where a risk is involved, cannot occur without an intentional operation
- made so as to withstand foreseeable stress; particular attention must be paid to emergency stop devices liable to be subjected to considerable strain.

Where a control is designed and constructed to perform several different actions, namely where there is no one-to-one correspondence (e.g. keyboards, etc), the action to be performed must be clearly displayed and subject to confirmation where necessary.

Controls must be so arranged that their layout, travel and resistance to operation are compatible with the action to be performed, taking account of ergonomic principles. Constraints due to the necessary or foreseeable use of personal protection equipment such as footwear or gloves must be taken into account.

Where machinery is equipped with warning devices (such as signals, etc), these must be unambiguous and easily perceived, e.g. over high background noise.

The requirements of any specific legislation concerning colours and safety signals must be complied with.

The HSE Approved Code of Practice on the Provision and Use of Work Equipment Regulations 1998, and BS EN 292 and BS EN 60204 provide further guidance for machine systems.

6.3 Devices for functional switching **537**

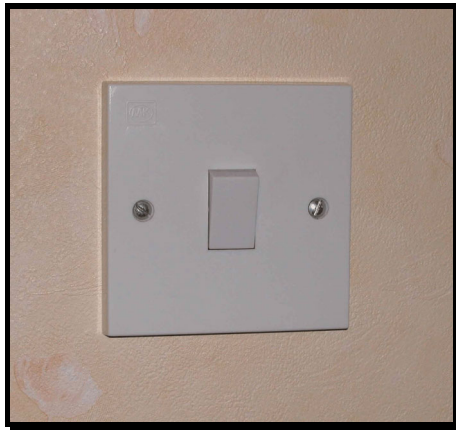
Devices must be suitable for the most onerous load and switching duty envisaged. Consideration should be given to the maximum load, life expectancy and the number of operations it is expected the devices may have to perform. Off-load isolators, fuses and links should never be used for functional switching, but other devices that may be specified as isolators may be used for functional switching providing the

[537-05-01](#)
[537-05-03](#)

applicable requirements for functional switching are met.

An example of a functional device is a light switch (see Fig 6.1) complying with BS EN 60669-1 or BS 3676.

Fig 6.1 A light switch - functional switching



Functional switching arrangements to change over between alternative sources of supply must comply with the requirements of Chapter 56 of BS 7671 and Regulation 464-01-05. All live conductors should be switched and precautions taken to avoid circulating currents and to ensure the continued integrity of earthing systems (see Section 3.2).

[Chap 56](#)
[464-01-05](#)

Except for use on d.c., a plug and socket-outlet rated at not more than 16 A may be used for functional switching. Higher rated plugs and socket-outlets may be used if the plug and socket-outlet has an adequate breaking capacity for the use intended.

[464-01-04](#)
[537-05-05](#)

Chapter 55 of BS 7671 prescribes specific requirements for functional control of particular equipment, including requirements for rotating machines, Regulation 552-01, lighting points, Regulation 553-04-01, and for other current-using equipment, Section 554.

[552-01](#)
[553-04-01](#)
[Sect 554](#)

Section 7 — Detailed Requirements — Fireman’s Switches

7.1 General 476 537

A fireman’s switch is provided for a specific purpose. A specific requirement for the application to discharge lighting circuits operating above low voltage is given in Regulation 476-03-05 but such switches are also required for applications in specialist installations. Further guidance and advice can be obtained from the HSE and the local fire authority.

476-03-05

A fireman’s switch should not be used for isolation or for electrical maintenance because, although such switches are designed to prevent the switch being inadvertently returned to the ON position, generally they cannot be secured in the OFF position and are installed in places to which the public have access. The switches are required by Regulation 476-03-07 to be installed in a conspicuous position which is reasonably accessible to the fire service. Unless otherwise agreed by the Fire Officer a switch must be mounted at not more than 2.75 m above the ground or local floor level.

476-03-07

The essential design requirements are contained in Regulations 476-03-05 to 476-03-07 and 537-04-06.

476-03-05
476-03-06
476-03-07
537-04-06

7.2 Location and identification of fireman’s switches 476 537

As noted in Regulation 476-03-07, all fireman’s switches must comply with any requirements of the local fire authority and may need to be approved by the Fire Officer. These requirements should be established at an early stage of the design.

476-03-07

In large commercial developments consisting, for example, of a number of individual premises (such as shopping centres), the requirement in Regulation 476-03-06 for a single switch may present difficulties. This is a matter which must be the subject of agreement with the local fire authority.

476-03-06

The requirements for identification of fireman's switches are contained in Regulation 537-04-06.

537-04-06

Regulation 537-04-06(i) gives labelling requirements and the size of lettering (given as not less than 36 point) depends on viewing distance and letter style. It is best to agree specific labelling requirements and letter size with the local fire authority.

Fig 7.1 Fireman's switch

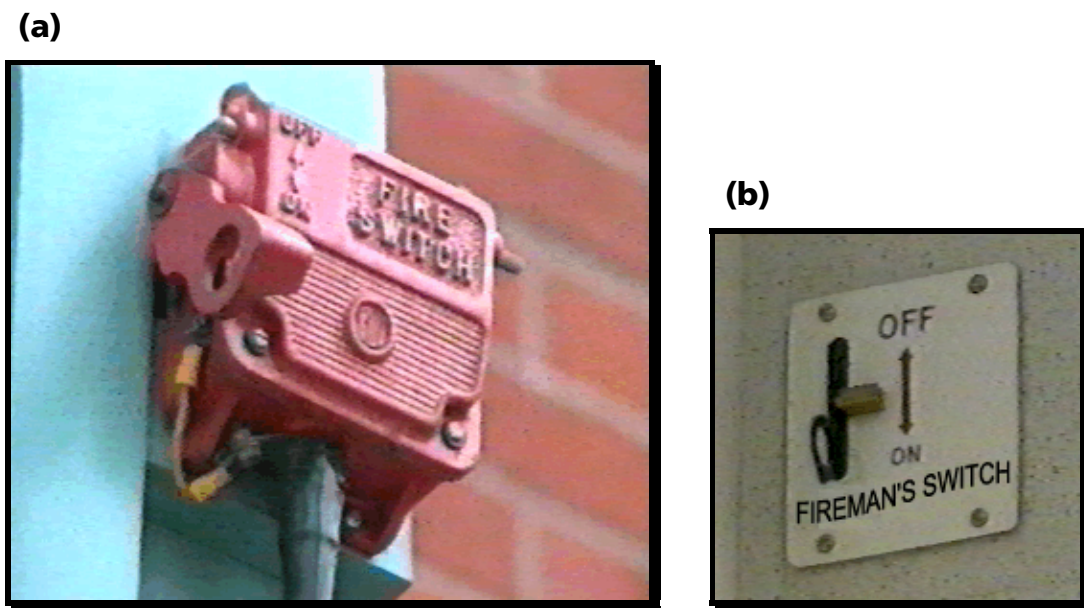
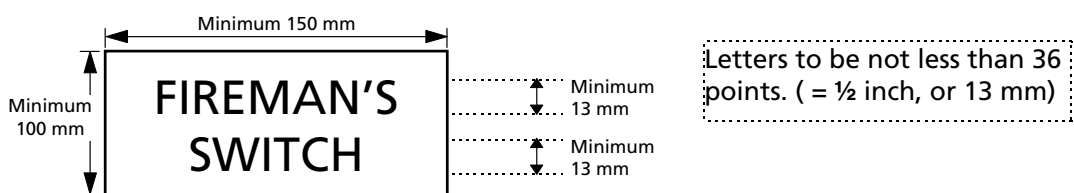


Fig 7.2 Nameplate for a fireman's switch



537-04-06

7.3 Installations and connections

In larger installations, or for supplies to equipment with high loads, it may not be practicable to insert the fireman's switch directly in the supply cable to the equipment, due to cable size, and an interposing contactor may be necessary. The contactor should be of adequate construction, be arranged to open on de-energisation and break the same supply conductors as required for isolation. It may not be necessary to break the neutral. The installation should be agreed with the local Fire Officer.

463-01-01

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