

BRITISH STANDARD 162 : 1961

UDC 621.316.3

**SPECIFICATION FOR
ELECTRIC POWER
SWITCHGEAR
AND ASSOCIATED APPARATUS**

BRITISH STANDARDS INSTITUTION

SPECIFICATION FOR
**ELECTRIC POWER
SWITCHGEAR**
AND ASSOCIATED APPARATUS

B.S. 162 : 1961

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THIS BRITISH STANDARD, having been approved by the Electrical Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 23rd January, 1961.

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The Institution desires to call attention to the fact that this British Standard does not purport to include all the necessary provisions of a contract.

In order to keep abreast of progress in the industries concerned, British Standards are subject to periodical review. Suggestions for improvements will be recorded and in due course brought to the notice of the committees charged with the revision of the standards to which they refer.

A complete list of British Standards, numbering over 9,000, fully indexed and with a note of the contents of each, will be found in the BSI Catalogue which may be purchased from BSI Sales Department. The Catalogue may be consulted in many public libraries and similar institutions.

This standard makes reference to the following British Standards:

- B.S. 7. Rubber-insulated cables and flexible cords for electric power and lighting.
- B.S. 31. Steel conduits and fittings for electrical wiring.
- B.S. 37. Electricity meters.
- B.S. 81. Instrument transformers.
- B.S. 88. Cartridge fuses of voltage ratings up to 660 volts.
- B.S. 89. Electrical indicating instruments.
- B.S. 90. Graphic (recording or chart-recording) ammeters, voltmeters, wattmeters, frequency meters and power-factor meters.
- B.S. 91. Electrical cable soldering sockets.
- B.S. 108. Graphical symbols for general electrical purposes.
- B.S. 116. Oil circuit-breakers for alternating-current systems.
- B.S. 137. Porcelain and toughened glass insulators for overhead power lines (3.3 kV, and upwards).

- B.S. 140. Liquid starters and controllers.
- B.S. 142. Electrical protective relays.
- B.S. 148. Insulating oil (low viscosity type) for transformers and switchgear.
- B.S. 158. Marking and arrangement for switchgear bus-bars, main connections and auxiliary wiring.
- B.S. 159. Busbars and busbar connections.
- B.S. 160. Slate and marble insulating slabs for electric power switchgear, up to and including 660 volts, a.c. and d.c.
- B.S. 170. The electrical performance of fractional horse power electric motors and generators.
- B.S. 223. High-voltage bushings.
- B.S. 229. Flameproof enclosure of electrical apparatus.
- B.S. 280. Field rheostats and rheostats for other purposes.
- B.S. 381C. Colours for ready mixed paints.
- B.S. 428. Forge welded steel air receivers.
- B.S. 429. Riveted steel air receivers.
- B.S. 430. Solid-drawn steel air receivers not intended for transport.
- B.S. 487. Fusion welded steel air receivers.
- B.S. 542. Cable-glands and sealing boxes.
- B.S. 587. Motor starters and controllers.
- B.S. 608. Varnished cambric insulated cables for electricity supply.
- B.S. 775. Contactors, when supplied separately or in combination with other gear.
- B.S. 861. Air-break switches (including isolating switches, totally-enclosed and flameproof types) for voltages not exceeding 660 volts.
- B.S. 861. Part 1. Air-break switches and isolators.
- B.S. 862. Air-break circuit-breakers (including totally-enclosed and flameproof types) for voltages not exceeding 660 volts.
- B.S. 921. Rubber mats for electrical purposes.
- B.S. 936. Oil circuit-breakers for alternating-current circuits up to and including 660 volts.
- B.S. 1123. Valves, gauges and other safety fittings for air receivers and compressed air installations.
- B.S. 1231. P.V.C.-insulated cables for power switchgear wiring.

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- B.S. 1649. Guards for shaft couplings.
 - B.S. 1858. Bitumen-base filling compounds for electrical purposes.
 - B.S. 2046. Protective transformers.
 - B.S. 2510. Composite units of switches and fuses in industrial systems and domestic circuits.
 - B.S. 2613. The electrical performance of rotating electrical machinery.
 - B.S. 2631. Oil switches for alternating-current systems.
 - B.S. 2692. Fuses for alternating-current circuits above 660 volts.
 - B.S. 2706. Non-ferrous conduit and conduit fittings (aluminium and zinc alloy).
 - B.S. 2746. P.V.C. insulation and sheath of electric cables.
 - B.S. 2914. Surge diverters for alternating-current high-voltage power circuits.
 - B.S. 3036. Semi-enclosed electric fuses (ratings up to 200 amperes and 250 volts to earth).
 - B.S. 3078. Isolators (including selectors) for alternating-current systems.
 - B.S. 3185. Heavy-duty composite units of air-break switches and fuses for voltages not exceeding 660 volts.
 - B.S. 3297. High-voltage post insulators.
 - B.S. 3659. Heavy-duty air-break circuit-breakers for alternating-current systems.
 - B.S. 5227. A.C. metal-enclosed switchgear and controlgear of rated voltage above 1 kV and up to and including 72.5 kV.
 - B.S. 5486. Specification for factory-built assemblies of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.
- Part 1. General requirements.

British Standards are revised, when necessary, by the issue either of amendment slips or of revised editions. It is important that users of British Standards should ascertain that they are in possession of the latest amendments or editions.

The following B.S.I. references relate to the work on this standard:
 Committee references ELE/10 & ELE/10/10
 Draft for comment CY(ELE) 193

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CO-OPERATING ORGANIZATIONS

The Electrical Industry Standards Committee under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

- *Admiralty
- *Air Ministry
 - Associated Offices Technical Committee
- *Association of Consulting Engineers (Incorporated)
- Association of Supervising Electrical Engineers
- *British Electrical and Allied Industries Research Association
- *British Electrical and Allied Manufacturers' Association
 - British Electrical Development Association
- *British Railways, The British Transport Commission
- *Cable Makers' Association
- *Crown Agents for Oversea Governments and Administrations
 - Electric Lamp Industry Council
 - Electric Light Fittings Association
 - Electrical Contractors' Association (Incorporated)
 - Electrical Contractors' Association of Scotland
- *Electricity Council, Generating Board and the Area Boards in
 - England and Wales
 - Electronic Engineering Association
- *Engineering Equipment Users' Association
 - Independent Cable Makers' Association
- *Institution of Electrical Engineers
- *Ministry of Aviation
- *Ministry of Labour (Factory Inspectorate)
- *Ministry of Power
 - Ministry of Works
 - National Inspection Council for Electrical Installation Contracting
- *National Physical Laboratory (D.S.I.R.)
- *Oil Companies Materials Association
- *Post Office
 - Public Transport Association (Incorporated)
- *South of Scotland Electricity Board
- War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard:

- Aluminium Development Association
- Association of Mining, Electrical and Mechanical Engineers
- Copper Development Association
- Engineer Surveyors' Association
- Lloyd's Register of Shipping
- London Transport Executive, The British Transport Commission
- National Coal Board

BRITISH STANDARD SPECIFICATION FOR ELECTRIC POWER SWITCHGEAR AND ASSOCIATED APPARATUS FOREWORD

This edition of B.S. 162 revises and supersedes the edition published in 1938. The requirements have been fully reviewed and brought up to date and the definitions brought into line with current usage.

The appendices have been extended to give fuller guidance on matters closely associated with the specification, particular attention having been paid to safety requirements.

In order to avoid numerous references throughout the specification to Statutory Regulations*, it should be noted that where switchboards are installed on premises subject to the Factories Act, the Electricity Special Regulations 1908 and 1944 (Statutory Rules and Orders 1908, No. 1312 and 1944, No. 739) will apply and it is therefore recommended that in such cases users of this standard refer to those Regulations and also to the Memorandum by the Senior Electrical Inspector of Factories on the Electricity Regulations. When considering installations which include compressed-air systems, reference should be made to Section 31 of the Factory Act, 1937.

With the publication of B.S. 5227 : 1975 'A.C. metal-enclosed switchgear and controlgear of rated voltage above 1 kV and up to and including 72.5 kV', B.S. 162 no longer applies to such equipment and the reader should therefore consult the new standard for this equipment.

With the publication of B.S. 5486 'Specification for factory-built assemblies of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.' Part 1 : 1977 'General requirements', B.S. 162 no longer applies to such equipment and the reader should therefore consult the new standard for this equipment.

*As added
Mar., 1978*

NOTE. The figures in British units are to be regarded as the standard. The metric conversions are approximate. More accurate conversions should be based on the tables in B.S. 350, 'Conversion factors and tables'.

SPECIFICATION

SCOPE

1. This standard co-ordinates the requirements for electric power switchgear and associated apparatus for voltages in excess of 100 volts for direct-current and alternating-current of frequencies up to 100 cycles per second such as are employed in connection with generating, transmitting, transforming and converting plant and large motors.

It is not intended to cover the requirements for specific apparatus for which separate British Standards may exist (see Table 1), nor the additional requirements for switchgear for use in mines and explosive atmospheres.

Copies of such Regulations are obtainable from H.M. Stationery Office.

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A.C. metal-enclosed switchgear and controlgear of rated voltage above 1 kV and up to and including 72.5 kV is excluded, and any reference to it in this British Standard should be disregarded.

*As added
Mar., 1978*

Factory-built assemblies of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. are excluded, and any reference to them in this British Standard should be disregarded.

DEFINITIONS

NOTE. The term 'switching devices' is used in a comprehensive sense throughout the standard and includes circuit-breakers, switches, isolators, fuses, and earthing devices.

2. For the purpose of this British Standard the following definitions apply:

1. *Switchgear*. A general term covering switching devices, also assemblies of those devices with control, measuring, protective and regulating equipments with the associated inter-connections and supporting structures.

2. *Electrically-exposed installation*. An installation in which the apparatus is subject to over-voltages of atmospheric origin (see Appendix E).

NOTE 1. Such installations are usually those connected to overhead transmission lines either directly or through a short length of cable.

NOTE 2. Apparatus may be required for installations which are semi-exposed to over-voltages of atmospheric origin, that is of magnitude less than for an exposed installation. Such installations are usually those connected to overhead transmission lines through two-winding transformers, or a longer length of cable, which reduce the amplitude of incoming over-voltages. These cases require special consideration. The apparatus will be chosen from the appropriate exposed or non-exposed insulation class, as a special class of insulation is not proposed for this case.

3. *Electrically non-exposed installation*. An installation in which the apparatus is not subject to over-voltages of atmospheric origin (see Appendix E).

NOTE. Such installations are usually those connected to cable networks.

4. *Outdoor switchgear*. Switchgear designed for use entirely out of doors. Such switchgear may be open-type or metal-enclosed gear.

5. *Indoor switchgear*. Switchgear designed for use entirely indoors. Such switchgear may be open-type, cellular-type or metal-enclosed type.

6. *Open-type switchgear*. Switchgear in which the live parts are not provided with protective covers.

7. *Cellular-type switchgear*. Switchgear in which the various items of main apparatus used for controlling the circuits are mounted in separate compartments or cells built up from fireproof insulating or semi-insulating material, except that the doors or screens may be of metal.

8. *Metal-enclosed switchgear*. Switchgear in which all components are within an earthed metal casing.

9. *Fixed-type metal-enclosed switchgear.* A form of metal-enclosed switchgear in which the circuit-breaker or switch is permanently fixed in position, and isolation of the circuit-breaker is achieved by some means other than removal of the circuit-breaker or switch.

10. *Draw-out metal-enclosed switchgear.* A form of metal-enclosed switchgear in which the circuit-breaker or switch may be isolated from the fixed portion of the equipment along guides provided for the purpose. This form may be further qualified as 'horizontal' or 'vertical'.

11. *Metalclad switchgear.* Metal-enclosed switchgear in which individual components are covered in earthed metal casings.

NOTE. Metalclad switchgear may be one of or a combination of the types defined in Definitions 12 to 16. The description is governed primarily by the kind of insulation surrounding the busbars.

12. *Air-insulated metalclad switchgear.* Metalclad switchgear in which the whole or a portion of the space between busbars or main connections and their casings is an air space.

13. *Compound-filled metalclad switchgear.* Metalclad switchgear in which all the busbars and main connections and their supporting insulators contained within their casings are totally immersed in insulating compound.

14. *Oil-filled metalclad switchgear.* Metalclad switchgear in which all the busbars and main connections and their supporting insulators contained within their casings are totally immersed in insulating oil.

15. *Gas-filled metalclad switchgear.* Metalclad switchgear in which the casings containing the busbars, main connections and their supporting insulators are filled with air, or other gas, above atmospheric pressure.

16. *Bushing-type metalclad switchgear.* Metalclad switchgear in which the busbars and main connections are in the form of bushings, which may be terminated in oil or compound-filled chambers.

17. *Cubicle switchgear.* Metal-enclosed switchgear, other than metalclad switchgear, in which the component parts of the main electrical circuit are assembled together within a metal casing or cubicle, with or without sub-dividing barriers.

18. *Truck cubicle switchgear.* A form of cubicle switchgear with horizontal isolation where the switching device and components to be isolated are carried on a truck capable of withdrawal by wheeling or sliding along the floor or on tracks provided thereon.

19. *Phase-segregated switchgear.* Switchgear in which the phases are separated by barriers of metal or other fire-resisting material in such a manner as to restrict any fault to an earth fault.

20. *Kiosk.* A weatherproof enclosure which may contain switchgear, transformer, control, terminal equipment, etc., but which has no internal operating space or passage-way for occupation by an operator.

21. *Panel.* A self-contained structure comprising apparatus for one or more of the following duties: switching, control, measurement, protection and regulation.

22. *Switch panel.* A self-contained structure comprising switching devices. Control, measuring, protecting, and regulating equipment may also be mounted on the switch panel.

NOTE. The term 'switch-unit' is often used in relation to panels of metal-enclosed switchgear.

23. *Control panel*.* A self-contained structure on which are mounted controlling and indicating devices for the remote control of switchgear.

24. *Metering panel*.* A self-contained structure on which are mounted recording or integrating meters.

25. *Relay panel*.* A self-contained structure on which are mounted relays associated with protection and operation.

26. *Instrument panel*.* A structure on which are mounted indicating instruments. It is normally part of a switch panel but may be a separately-mounted self-contained structure.

27. *Board.* An assemblage of panels, the particular function of which is indicated by the same prefix as is used for the panels, e.g. switch board, control board, etc.

28. *Electrical clearances.* The minimum distance required between live parts and earthed material ('earth clearance') or between live parts at different potentials ('phase clearance') in order to prevent flashover.

29. *Work section.* Applied to open-type switchgear: a space where a person may work in safety provided that some part of him always remains within that space.

30. *Safety clearance to conductors (Section clearance).* The minimum distance required between an unscreened live conductor and the limits of a work section wherever spatial separation is relied upon for the safety of personnel. Where screens are interposed, the distance is to be taken as a taut-string measurement around the edge of the screen.

31. *Safety clearance to insulation (Ground clearance).* The minimum distance required between any exposed insulator which supports or contains live conductors, and the limits of a work section wherever spatial separation is relied upon for safety. Where screens are interposed the distance is to be taken as a taut-string measurement around the edge of the screen.

NOTE. While this clearance is applicable to all situations, the short term 'ground clearance' is employed since the principal application is to determine the height of insulating material above ground level.

* Combinations of panels defined in Definitions 23 to 26 may be referred to by combinations of the appropriate prefixes.

32. Busbar. A relatively short conductor forming a common junction between a number of circuits connected separately thereto.

33. Connections. Conductors in switchgear which carry current to or from an individual piece of apparatus.

34. Main connections. Connections intended for operation at the service voltage. The definition includes neutral earthing connections but, at low and medium voltages, excludes branch connections for protective gear or instruments.

35. Auxiliary connections. Connections, other than main connections, operating at low or medium voltage, to connect auxiliary apparatus associated with switchgear.

NOTE. Auxiliary connections include connections to the secondary windings of voltage and current transformers, which are sometimes termed 'secondary connections'.

36. Small wiring. Auxiliary connections forming the connections within the switchgear, control panels, relay or instrument panels, between individual pieces of apparatus mounted thereon.

37. Multicore cables. Auxiliary connections forming cable connections between the switchgear and any remote apparatus which are used primarily for connecting the electrical control, protection, indication and metering circuits.

38. Auxiliary cables. Auxiliary connections which are cable connections in a switchgear installation used primarily to provide low or medium voltage power and lighting supplies for operation, maintenance and inspection of the switchgear.

39. Pilot cables. Multicore cables which are used for connecting two or more separate switchgear installations for the purpose of protection.

40. Local control. Control at a point at, or adjacent to, the switching device itself by electrical or mechanical or other means.

41. Remote control. Control at a point distant from the switchgear by electrical or mechanical or other means.

NOTE. If there is more than one remote control point, the terms 'main' and 'standby' remote controls should be used, according to which is normally operated.

42. Remote selective control. Control at a point distant from the switchgear by the transmission of electrical signals through common communications channels using selective means to operate one of a number of switching devices.

43. Slab. Slate, marble or other insulating material having a continuous flat surface on which switchgear may be mounted.

44. Common air supply. An arrangement whereby the individual switchgear equipments are supplied, either directly or after expansion, from a common source of compressed air.

45. Unit air supply. An arrangement whereby each individual switchgear equipment is provided with its own source of compressed air.

SERVICE CONDITIONS

NOTE. This clause should be read in conjunction with Appendix F, 'Selection of rated voltage'.

3. a. System earthing (a.c. switchgear). This standard provides for alternating current switchgear suitable for use on systems as given in conditions (i), (ii) A, (ii) B and (iv) below. Where the system is effectively earthed in accordance with condition (i), and adequate surge protection is provided, alternating current switchgear having insulation suitable for the test voltages specified in Column 5 of Table 11 (see Sub-clause 46 c) and clearances in accordance with Table 8 (see Clause 33) may be used.

Alternating current switchgear for use on systems having other earthing conditions (e.g. (ii) C and (iii)) require special consideration.

The following system earthing conditions are recognized:

Condition (i). At least one of the neutral points of a three-phase system permanently earthed, either solidly or through a resistor or reactor of low impedance.

NOTE. A three-phase system is considered to be effectively earthed if, during phase-earth faults, the voltage to earth of the sound phases does not exceed 80 per cent of the voltage between lines of the system. Generally this involves solid earthing of all transformer neutrals.

Condition (ii). At least one of the neutral points of a three-phase system earthed normally through an arc suppression coil.

On such a system it is the intention that the majority of phase-to-earth faults will be self-clearing without interruption of the supply. When phase-to-earth faults occur which are not self-clearing three methods of system operation are recognized:

A. The fault is automatically disconnected from the system after a short delay.

B. When non-automatic disconnection is used the faults are generally cleared quickly although they may be allowed to persist for several hours provided that the total duration does not exceed 125 hours per annum, with a maximum of eight hours in any 24.

C. Faults are allowed to remain for a longer duration than in B but not approaching continuous operation with one phase earthed.

Condition (iii). All the neutral points of a three-phase system insulated from earth.

Condition (iv). A single-phase system having one line earthed.

b. Altitude. Switchgear shall be suitable for use at an altitude not exceeding 3300 feet (1000 metres) above sea level.

Where switchgear is intended for service at an altitude exceeding 3300 feet above sea level, the clearances in air as given in the appropriate tables shall be increased by 3 per cent for each 1000 feet in excess of 3300 feet above sea level.

c. Ambient temperature. Switchgear shall be suitable for use where the ambient temperature has a peak value not exceeding 40°C and an average value not exceeding 35°C, when measured over a 24 hour period.

d. Atmospheric conditions. Switchgear shall be suitable for use in normal atmospheric conditions. Where there is excessive atmospheric pollution caused by dust, smoke, chemical fumes, salt laden spray, etc., special consideration shall be given to the design and finish of those parts of the switchgear and ancillary equipment exposed directly to the atmosphere. (See Appendix G: Local atmospheric and climatic conditions.)

It is recognized that for outdoor applications it is necessary to relate the creepage distance, provided on the outdoor surface of insulators, with the atmospheric conditions likely to be met in service.

PART 1. DESIGN AND CONSTRUCTION

SAFETY REQUIREMENTS

4. Switchgear shall be designed throughout to secure safety during operation, inspection, cleaning and maintenance* and shall be so arranged as to minimize the risk of fire arising or spreading.

RELEVANT SPECIFICATIONS

5. The apparatus used shall, where applicable, comply with the current editions of the British Standards listed overleaf in Table 1.

* The maintenance of electrical switchgear is dealt with in CP 1008.

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**TABLE 1. APPARATUS AND MATERIALS REQUIRED TO
COMPLY WITH BRITISH STANDARDS**

Item	B.S. Number
Air receivers	
Forge welded	428
Fusion welded	487
Riveted	488
Solid drawn	430
Busbars	159
Bushings	223
Cables	
Paper insulated	480
PVC insulated	1231, 2746
Rubber insulated	7
Varnished-cambric insulated	608
Cable glands and sealing boxes for use in mines	542
Cable sockets	91
Circuit-breakers:	
Air-break	862, 3659
Oil-break	116, 936
Compound, sealing	1858
Composite units of switches and fuses	2510, 3185
Conduit, steel	31
Conduit, aluminium	2706
Contactors	775
Current transformers	81, 2046
Flameproof enclosures	229
Fuses	88, 2692, 3036
Guards for shaft couplings	1649
Identification of busbars and wiring	158
Instruments	89, 90
Insulators:	
Post	3297
Overhead line (suspension)	137

TABLE 1 *continued.*

Item	B.S. Number
Isolators:	
Up to 200 amp (air-break only)	861 Part 1: 1955
Above 200 amp	3078
Meters	37
Motors	2613, 170
Motor-starters and controllers	140, 587
Oil, insulating	148
Relays	142
Rheostats	280
Rubber mats	921
Slabs, slate and marble	160
Surge diverters	2914
Switches:	
Air-break	861
Oil-break	2631
Symbols	108
Valves etc. for compressed-air installations	1123
Voltage transformers	81, 2046

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MECHANICAL STRENGTH

6. Assemblies of apparatus and their connections* shall be so supported and proportioned as to be capable of safely withstanding stresses to which they may be subjected, including those due to short circuit and climatic conditions, as stated by the purchaser (see Appendix A, Items 2 and 3 b).

Wind and ice loadings for open type outdoor switchgear shall, unless otherwise specified, be based on wind pressures of 8 lb/sq ft (0.004 kg/cm²) on the projected area of ice covered conductors and ice loading of $\frac{3}{8}$ in (9.5 mm) radial thickness, the assumed weight of ice being 57 lb/cu ft (915 kg/m³).

HIGH-TENSILE BOLTS

7. Where high-tensile bolts are employed they shall be clearly and permanently distinguishable.

NOTE. For example, the marking may be as specified in B.S. 1083, 'Precision hexagon bolts screws, nuts and plain washers'.

PROTECTION AGAINST VERMIN

8. Switchgear shall be so arranged as to minimize interference from vermin, with special regard to the danger of flashover, both in the service and isolated positions.

BUSBAR AND CONNECTIONS

9. All busbars and connections shall be so designed as to obviate electrical contact with one another or with earth, particularly under short-circuit.

Switchgear shall be provided with terminals for connection to the incoming and outgoing conductors. Where these conductors will be cables, cable sockets or other suitable terminations shall be provided.

The apparatus shall be so arranged that terminals, or other devices, for the attachment of main cables are so located that the cables are free from unnecessary bends, preferably do not cross other connections or apparatus, and can be readily connected.

SMALL WIRING

10. Small wiring shall be securely fixed in position and shall be so arranged as to enable connections to be easily traced. Small wiring subject to movement in service shall have stranded conductors and the insulation shall be adequately protected against abrasion.

All small wiring shall be marked in accordance with B.S. 158. When insulated connections are used, the insulation shall have fire-resisting properties (see B.S. 2746). Bare connections for small wiring may be employed in suitable circumstances.

Terminals and terminal boards for small wiring shall be accessibly located and so positioned as to minimize the number of small wiring connections impeding access to other connections.

* Busbars and busbar connections are covered by B.S. 159.

Small wiring circuits, other than those supplied from current transformers, shall be protected as near as possible to the source of supply, consistent with maintaining accessibility. Small wiring circuits, fed from a supply common to a number of panels, shall be protected so that failure of a circuit in any one panel does not prevent operation of other panels.

Circuits of one panel shall be capable of isolation for maintenance purposes without affecting other circuits.

INTERCHANGEABILITY

11. All instruments, switches, circuit-breakers, fittings, transformers and other components which are respectively of the same design and rating shall be interchangeable.

EARTHING OR INSULATION OF METALWORK

12. Precautions shall be taken to safeguard the operator, and other personnel who may have access to the plant, from electric shock either by adequate earthing (supplementary bonding may be necessary) or effective insulation of all parts with which they may come into contact. See Appendix D, 'Recommendations for earthing'.

LABELS

13. Substantially non-corrodible labels, indelibly and legibly marked, shall be provided and effectively secured to each panel; in the case of drawout metal-enclosed switchgear, to the fixed portion; in the case of truck cubicle switchgear, to the fixed portion and to the truck, to indicate the circuit controlled.

NOTE. On switchboards where maintenance may be undertaken from the rear of the board, additional labels on the rear of the panels may be specified by the purchaser.

Where labels are provided for making clear the method of operation of apparatus they shall be concise and preferably diagrammatic in form.

LOCKS AND INTERLOCKS

14. Unless otherwise specified, only locks which are integral with the equipment shall be supplied by the manufacturer. When locks and interlocks associated with operation are specified, the following requirements apply:

- a. Interlocks shall be preventive, as distinct from corrective in operation.
- b. Means shall be provided for interlocking the isolators (including off-load selectors) so that they can be operated only if the circuit-breaker is open (or closed in the case of by-pass isolators) and also for locking these devices in the OFF and EARTH positions.

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c. Means shall be provided for interlocking 'on load' selectors with the appropriate circuit-breaker(s) which couple the busbars.

d. Means shall be provided for locking circuit-breakers, when required for earthing duty, in the closed position so that both electrical and mechanical tripping devices become inoperative.

e. Means shall be provided for locking switches which are required for earthing duty, in the earth position.

VOLTAGE TRANSFORMERS

15. Voltage transformers associated with individual circuits shall be connected to that side of the circuit-breaker which is remote from the busbars, and preferably in the zone of the main protection of the circuit.

Voltage transformers connected to busbars shall be provided with means of isolation from the busbars.

Voltage transformers of the electromagnetic type shall, wherever practicable, be provided on the primary side with fuses of suitable breaking capacity or other protective devices. Suitable fuses, mounted on or as close as practicable to the voltage transformer, shall be provided in the circuit associated with the secondary winding.

NOTE. The voltage transformer secondary fuses should be so situated as to be capable of being rewired or replaced without the necessity for isolating the voltage transformer or taking the circuit out of service.

Where a voltage transformer is separated from the main circuit by a dividing barrier, or by an enclosure, its primary connections shall, for the length between the circuit and the dividing barrier or enclosure, be of sufficient size to withstand the thermal and magnetic effects of the maximum short-circuit current associated with the short-circuit duty (see Clause 6). Also, the primary connections shall, for the length between the dividing barrier or enclosure and the voltage-transformer fuses, be capable of carrying the resulting current for the operating time of the fuses.

INDICATING DEVICES

16. Unless the operating position (e.g. contacts open, closed or in the earth position) of the switching devices is self-evident from inspection, it shall be given on the switch panel by automatic mechanical indicating devices. For circuit-breakers the indications shall also be given automatically on the control panel.

Where duplicate busbars are provided, unless it is self-evident from inspection, an automatic mechanical indicating device shall be provided on the switch panel to show to which set of busbars the electrical circuit is connected.

Electrically-operated indicating devices shall operate reliably at any voltage within the range of 80 per cent and 120 per cent of their rated voltage.

COLOUR AND POSITION OF SIGNAL LAMPS

17. Signal lamps shall be coloured in accordance with Table 2. The construction and placing of signal lamps shall be such that they are clearly distinguishable from one another.

TABLE 2. COLOURS OF SIGNAL LAMPS

Colour	Function	Notes
Red	Circuit-breaker, switch or isolator closed	These colours shall be applied to these functions only.
Green	Circuit-breaker, switch or isolator open	
White	Indicative of normal functioning or condition of apparatus	e.g. Trip circuit healthy. Protection in service.
Amber	Indicative of abnormal conditions requiring action	e.g. Discrepancy. Operation of protective or alarm device.

The positions of red and green lamps shall be as given in Table 3, unless otherwise specified.

TABLE 3. POSITIONS OF RED AND GREEN SIGNAL LAMPS

Colour	Relative position of lamps
Red	On the top or to the right
Green	At the bottom or to the left

EARTHING OF CIRCUITS AND BUSBARS

18. Earthing equipment, whether fixed or portable, shall be so constructed that no danger to personnel or material damage to permanent equipment would be caused if the circuit should inadvertently be energized during, or after earthing.

NOTE. Circuits and busbars, etc., should preferably be arranged for earthing via a circuit-breaker or oil switch or via an equivalent special earthing device.

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PART 2. REQUIREMENTS, ADDITIONAL TO PART 1, FOR OPEN-TYPE SWITCHGEAR FOR VOLTAGES NOT EXCEEDING 660 V A.C. AND D.C.

SLABS USED TO SUPPORT LIVE PARTS

19. Plain slate slabs shall not be used to support live metal parts unless additional adequate insulation is employed.

FIXING BOLTS IN SLABS

20. If live conductors are present on the front of the panel, earthed fixing bolts shall be suitably covered by insulating caps.

FINISH OF MARBLE OR SLATE SLABS

21. Marble slabs shall be polished on the front face and edges and shall be treated with insulating enamel or varnish on the back and the inside of all holes after drilling.

Plain slate slabs shall have an oil finish on front, back, edges, and inside all unbushed holes.

Enamelled slate slabs shall be enamelled on the front face, the bevelled edge and the edges, and shall be treated with insulating varnish, or enamel on the back after drilling, and also on the inside of all unbushed holes.

BUSHES

22. Where bushes are required for the slabs, in addition to the insulation required under Clause 21, they shall be specified in the enquiry and order.

MOUNTING OF SLABS

23. Slabs consisting of insulating or semi-insulating material shall preferably rest either upon each other, or on dividing fillets or on a part of the frame, and shall preferably not hang from their bolts.

NOTE. If desired, screens may be substituted for the lower slabs. These should not be of earthed metal if live-conductors are present on the front of adjacent slabs.

BUSBARS, BACK CONNECTIONS AND SMALL WIRING

24. All busbars, connections and small wiring at the back of the boards shall be spaced as uniformly as possible and arranged without unnecessary crossing, and

an ample number of cleats or insulators shall be provided. In addition, indoor open busbars and bare connections thereto shall be separated as far as is reasonably practicable from other live parts and from earthed metal.

NOTE. Clearances of busbars and busbar connections are covered by B.S. 159.

Busbars in a horizontal plane, unless otherwise protected, shall have adequate means provided to prevent accidental short-circuit due to anything falling across them.

Back connections shall be arranged as far as possible so that all bolts and screws at the back of the panel can be safely tightened by the use of suitably insulated tools.

Where cables cannot be brought to the top or bottom of the assembly, provision shall be made for supporting them from the framework between the equipment away from the back connections up to a point from which they may be taken directly to the terminals clear of other connections and live parts.

Switchboards intended for service which does not permit complete shutting-down so that all conductors can be made wholly dead when necessary for cleaning, examination, adjustment or repair of working parts requiring frequent attention (such as those of circuit-breakers), shall be provided with means so that portions containing such parts may individually be made dead; and in order to prevent danger from live conductors on adjacent portions, permanent or removable screens shall be provided so that work on any dead portion may be carried on safely.

LOCATION OF AIR-BREAK CIRCUIT-BREAKERS

25. Where possible, air-break circuit-breakers shall be placed at the top of equipment, but the operating-handles shall be at a convenient height, so as to facilitate easy operation. The general arrangement shall be such that there shall be no risk of the moving handles causing personal injury to the operators.

RHEOSTAT MOUNTINGS AND DRIVES

26. Rheostats shall be mounted in positions which allow adequate ventilation and permit ready inspection and maintenance. When it is necessary that the rheostat be placed behind the switchboard, provision shall be made for its ready and safe removal so as to give access to all parts behind the switchboard requiring maintenance. If chain drives are used, adequate provision shall be made to guard against danger from breakage and displacement of the chain.

When the rheostat handle is mounted so that the operator is within reach of live metal, the handwheel shall be insulated from earth and live metal. When the handle is out of reach of live metal it shall be earthed.

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PART 3. REQUIREMENTS, ADDITIONAL TO PART 1, FOR METAL-ENCLOSED AND CELLULAR-TYPE SWITCHGEAR FOR ALL VOLTAGES

SECTION ONE : REQUIREMENTS APPLICABLE TO BOTH METAL-ENCLOSED AND CELLULAR TYPES

ENCLOSURES

27. a. Segregation of enclosures. All live parts, including busbars, connections, circuit-breakers, isolators, voltage-transformers, current-transformers, etc., shall be suitably enclosed under normal operating conditions. All joints in chambers containing insulating materials, other than air at atmospheric pressure, shall be secured against leakage of the filling-material over the range of working temperatures, and the chambers shall be so designed and filled as to allow for the expansion, or contraction of the filling material. Loss of filling material by capillary action of the small wiring shall not be possible.

Special attention shall be given to the arrangement and enclosure of small wiring and auxiliary equipment within compartments containing main connections to ensure that as far as practicable:

(i) Insulation failure or flashover of primary equipment does not damage the auxiliary connections concerned with the operation of protection.

(ii) Operation of contactors or fuses, or failures of small wiring do not cause breakdown of primary insulation.

(iii) Fuses and other auxiliary apparatus requiring attention when the equipment is in service are accessible without exposing live main connections.

(iv) Wiring not relating to apparatus in a primary compartment is not run in that compartment except in a specially-provided duct.

b. Safety of access. Access to busbars, main connections and other items of the equipment for all normal maintenance operations shall be by doors or shutters with locking facilities. Other parts of the enclosure shall be so fixed as to require tools for their removal.

In draw-out metal-enclosed switchgear, shutters or other devices shall be fitted to cover contacts which may be live when the removable portion of the switchgear is withdrawn for isolation or inspection purposes, and such shutters, with this removable portion withdrawn shall be capable of being locked in their closed positions.

Automatic shutters shall operate with certainty upon the withdrawal and replacement of a removable portion, but shall be so arranged as to permit the cover over a set or sets of live contacts to be locked by hand in the closed position while the cover over dead contacts may be opened.

NOTE. The construction should be such that if the shutters are opened by hand, they will automatically close on being released.

Busbar spout shutters shall be clearly labelled 'BUSBARS-UPPER' or '-LOWER', '-REAR', or '-FRONT', or in the case of bus-section equipments, 'LEFT' and 'RIGHT', as appropriate. Unless otherwise specified they shall be painted signal red (*colour 537) and circuit spout shutters shall be painted lemon yellow (*colour 355).

The means of isolation shall be such that when an equipment or section of equipment has been isolated for inspection and maintenance no live parts are accessible except by the opening of covers which are provided with means of locking.

CLEARANCES

28. The minimum clearances and lengths of insulators of Table 4 apply to assemblies of apparatus with their connections in air as installed (see sub-clause 3 b). They are not intended to apply to individual apparatus.

NOTE. Clearances of busbars and busbar connections are covered by B.S. 159.

The clearances and lengths of insulators for indoor switchgear incorporating circuit-breakers of Group A (see B.S. 116 : 1952) shall be not less than those given in Table 4. Class A clearances are the minimum values for use under standard conditions of service. Class B clearances shall be used only where special or more onerous conditions of service apply.

The clearances and lengths of insulators for indoor switchgear incorporating circuit-breakers of Group B (see B.S. 116 : 1952) shall be not less than those for Class B in Table 4.

a. The specified clearances are required for bare conductors only. They shall not be reduced except under one of the following conditions:

(i) When a barrier of solid insulation is interposed and the clearance distances, as measured by a taut string between conductors or to earth are not less than the values specified in Table 4. Such insulation shall be capable of withstanding, for one minute, the full power-frequency high-voltage test value specified in Clause 45, for the appropriate rated voltage; the test being made in accordance with the relevant British Standard for the material.

(ii) When appropriate conductors are covered with insulation capable of withstanding, for one minute, the full power-frequency high-voltage test value specified in Clause 45 for the appropriate rated voltage.

(iii) When the space between the conductors is completely filled with insulating-material other than air at atmospheric pressure, as in oil-filled, compound-filled, or gas-filled switchgear, capable of withstanding, for one minute, the full power-frequency high-voltage test value specified in Clause 45 for the appropriate rated voltage.

* B.S. 381C, 'Colours for ready-mixed paints'.

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TABLE 4. CLEARANCE IN AIR FOR INDOOR SWITCHGEAR

1	2		3		4	
Rated voltage	Minimum length of insulator†		Minimum clearance to earth		Minimum clearance between phases or between connections of the same phase separable electrically from each other	
	Class A	Class B	Class A	Class B	Class A	Class B
kV	in mm	in mm	in mm	in mm	in mm	in mm
Up to 0.415*	$\frac{3}{4}$ 19.0	$\frac{3}{4}$ 19.0	$\frac{5}{8}$ 15.8	$\frac{5}{8}$ 15.8	$\frac{3}{4}$ 19.0	$\frac{3}{4}$ 19.0
0.6†	$\frac{3}{4}$ 19.0	1 25.4	$\frac{3}{4}$ 19.0	1 25.4	$\frac{3}{4}$ 19.0	1 25.4
3.3	2 50.8	$3\frac{1}{2}$ 88.9	2 50.8	$2\frac{1}{2}$ 63.5	2 50.8	$3\frac{1}{2}$ 88.9
6.6	$3\frac{1}{2}$ 88.9	5 127.0	$2\frac{1}{2}$ 63.5	3 76.2	$3\frac{1}{2}$ 88.9	5 127.0
11	5 127.0	7 177.8	3 76.2	$4\frac{1}{2}$ 114.3	5 127.0	7 177.8
15	6 152.4	7 177.8	4 101.6	$4\frac{1}{2}$ 114.3	$6\frac{1}{2}$ 165.1	7 177.8
22	8 203.2	8 203.2	$5\frac{1}{2}$ 139.7	$5\frac{1}{2}$ 139.7	$9\frac{1}{2}$ 241.3	$9\frac{1}{2}$ 241.3
33	12 304.8	12 304.8	$8\frac{3}{4}$ 222.2	$8\frac{3}{4}$ 222.2	14 355.6	14 355.6
Above 33	Values subject to agreement between the manufacturer and the purchaser.					

* The clearances specified for 0.415 kV are suitable for 0.44 kV.

† The clearances specified for 0.6 kV are suitable for 0.66 kV.

‡ The length of insulator given is the direct length from the live metal to earth, regardless of the shape, i.e. a taut string measurement.

b. The lengths of insulators and clearance distances specified in Table 2 apply to assemblies of apparatus for use on 3-phase systems earthed in accordance with the provisions of Sub-clause 3 *a* conditions (i), (ii) A and (ii) B.

c. For single-phase systems conforming with Sub-clause 3 *a* condition (iv), the lengths of insulators and clearances of assemblies of apparatus shall be not less than those given in Columns 2 and 4 of Table 4, but the minimum clearances to earth, instead of being in accordance with Column 3 shall be not less than the values of the minimum lengths of insulator given in Column 2. Except that the minimum clearance to earth for single-phase systems for voltages not exceeding 250 volts to earth shall be $\frac{5}{8}$ in.

d. For indoor neutral-earthing switchgear the lengths of the insulators and clearances in Table 4 shall apply with the proviso that values appropriate to the standard three-phase rated voltage nearest to the rated voltage of the neutral earthing switchgear shall be taken in accordance with Table 5.

**TABLE 5. BASIS OF CLEARANCES FOR INDOOR
NEUTRAL-EARTHING SWITCHGEAR**

1	2	3
Three-phase system voltage	Rated voltage of neutral earthing switchgear	Three-phase rated voltage on which clearances to Table 4 are to be based
kV	kV	kV
3.3	1.91	3.3
6.6	3.81	3.3
11	6.35	6.6
15	8.6	6.6
22	12.7	11
33	19.1	22
44	25.4	33
66	38.1	44