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British Standard Specification for
**A.C. metal-enclosed switchgear and
controlgear for rated voltages above
1 kV and up to and including 72.5 kV**

Appareillage sous enveloppe métallique pour courant alternatif de tensions assignées supérieures à 1 kV et inférieures ou égales à 72,5 kV — Spécifications

Metallgekapselte Schaltgeräte für Wechselstrom für Nennspannungen über 1 kV bis einschließlich 72,5 kV

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Foreword

This revision of this British Standard has been prepared under the direction of the Power Electrical Engineering Standards Committee and supersedes BS 5227 : 1975, which is withdrawn. The text implements the requirement of HD 187 : S3 issued by the European Committee for Electrotechnical Standardization (CENELEC). This Harmonization Document is based on IEC Publication 298 : 1981 'A.C. metal enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 72.5 kV', but makes eight modifications to it.

For ease of production the text of IEC Publication 298 : 1981 has been used as the basis of this British Standard but it incorporates those modifications introduced in HD 187 : S3. These include the deletion of figure 1 and appendix BB from the IEC text. The figures and appendices have not been renumbered.

The Technical Committee has reviewed the provisions of IEC 137, IEC 466 and IEC 694*, to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

* A British Standard, which will be identical to IEC 694, is in preparation pending CENELEC harmonization procedures.

British Standard Specification for

A.C. metal-enclosed switchgear and controlgear for rated voltages above 1 kV and up to and including 72.5 kV

SECTION ONE – GENERAL

1. Scope

This standard specifies requirements for factory-assembled metal-enclosed switchgear and controlgear for alternating current of rated voltages above 1 kV and up to and including 72.5 kV for indoor and outdoor installation, and for service frequencies up to and including 60 Hz.

Metal-enclosed switchgear and controlgear for special use, for example in flammable atmospheres, in mines or on board ships, may be subject to additional requirements.

This standard does not deal with components contained in metal-enclosed switchgear and controlgear for which individual specifications exist.

Notes 1. — Switchgear and controlgear assemblies having an insulation enclosure are covered by IEC Publication 466: High-voltage Insulation-enclosed Switchgear and Controlgear.

2. — While this standard also covers metal-enclosed switchgear and controlgear of which the insulation is an insulating gas other than air at atmospheric pressure, additional requirements for such equipment may apply depending upon its design (see BS 5524).

SECTION TWO – SERVICE CONDITIONS

2. Normal and special service conditions

Unless otherwise specified in this standard, the metal-enclosed switchgear and controlgear is designed to be used under normal service conditions.

Refer to Clause 2 of IEC Publication 694: Common Clauses for High-voltage Switchgear and Controlgear Standards, with the following modification:

For indoor installation it is assumed that inside the enclosure the humidity may attain high values, but condensation on the equipment does normally not occur.

Note. — Condensation may be prevented by special design of the building or room housing the metal-enclosed switchgear and controlgear.

For outdoor installation, it is assumed that inside the enclosure normal indoor conditions prevail. If necessary, appropriate measures shall be taken, such as air conditioning, so that common indoor components may be used.

SECTION THREE — TERMS AND DEFINITIONS

3. Definitions

For the definitions of general terms used in this standard, reference is made to BS 4727 : Part 2 : Group 06. Additionally the following definitions apply for the purpose of this standard.

3.101 *Switchgear and controlgear*

A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures.

3.102 *Metal-enclosed switchgear and controlgear*

Switchgear and controlgear assemblies with an external metal enclosure intended to be earthed and complete except for external connections (I.E.V. 441-02-04).

Note. — The metal-enclosed switchgear and controlgear is subdivided into three types:

- metal-clad switchgear and controlgear;
- compartmented switchgear and controlgear (with one or more non-metallic partitions);
- cubicle switchgear and controlgear.

3.102.1 *Metal-clad switchgear and controlgear*

Metal-enclosed switchgear and controlgear in which components are arranged in separate compartments with metal partitions intended to be earthed.

Notes 1. — This term applies to metal-enclosed switchgear and controlgear with metal partitions providing the degree of protection included in Table I (or higher) and having separate compartments at least for the following components:

- a) each main switching device;
- b) components connected to one side of a main switching device, for example feeder circuit;
- c) components connected to the other side of the main switching device, for example busbars; where more than one set of busbars is provided, each set being in a separate compartment.

3.102.2 *Compartmented switchgear and controlgear (with non-metallic partitions)*

Metal-enclosed switchgear and controlgear in which components are arranged in separate compartments as for metal-clad switchgear and controlgear, but with one or more non-metallic partitions providing the degree of protection included in Table I (or higher).

Note. — Similar protection can be achieved if the components of metal-enclosed switchgear and controlgear including main circuits are individually clad with solid insulating material provided that the conditions specified in IEC Publication 466 are met.

3.102.3 *Cubicle switchgear and controlgear*

Metal-enclosed switchgear and controlgear, other than metal-clad and compartmented switchgear and controlgear.

Note. — This term applies to switchgear and controlgear having a metal enclosure and having either:

- a) a number of compartments less than that required for metal-clad or compartmented switchgear and controlgear;

- b) partitions having a degree of protection lower than those included in Table I;
- c) no partitions.

3.103 *Transport unit*

A part of metal-enclosed switchgear and controlgear suitable for shipment without being dismantled.

3.104 *Functional unit*

A part of metal-enclosed switchgear and controlgear comprising all the components of the main circuits and auxiliary circuits that contribute to the fulfilment of a single function.

Note. — Functional units may be distinguished according to the function for which they are intended, for example: incoming unit, outgoing unit, etc.

3.105 *Enclosure*

A part of metal-enclosed switchgear and controlgear providing a specified degree of protection of equipment against external influences and a specified degree of protection against approach to or contact with live parts and against contact with moving parts.

3.105.1 *Cover*

A part of the external enclosure.

3.106 *Compartment*

A part of metal-enclosed switchgear and controlgear enclosed except for openings necessary for interconnection, control or ventilation.

- Notes 1.* — A compartment may be designated by the main component contained therein, e.g. circuit-breaker compartment, busbar compartment, etc.
2. — Openings necessary for interconnection between compartments are closed with bushings or other equivalent means.
3. — Busbar compartments may extend through several functional units without the need for bushings or other equivalent means.

3.107 *Component*

An essential part of the main or earthing circuits of metal-enclosed switchgear and controlgear which serves a specific function (for example circuit-breaker, disconnector, switch, fuse, instrument transformer, bushing, busbar, etc.).

3.108 *Partition*

A part of metal-enclosed switchgear and controlgear separating one compartment from other compartments.

- Notes 1.* — A partition becomes a part of the enclosure, if it is readily accessible in any of the positions defined in Sub-clauses 3.114 to 3.117.
2. — If a door is provided which can be closed in the positions defined in Sub-clauses 3.113 to 3.117 the partition behind the door is not considered a part of the enclosure.

3.109 *Shutter*

A part of metal-enclosed switchgear and controlgear that can be moved from a position where it permits contacts of a removable part to engage fixed contacts, to a position where it becomes a part of the enclosure or partition shielding the fixed contacts.

3.110 *Removable part*

A part of metal-enclosed switchgear and controlgear that may be removed entirely from the metal-enclosed switchgear and controlgear and replaced, even though the main circuit is alive.

3.111 *Withdrawable part*

A removable part of metal-enclosed switchgear and controlgear that can be moved to positions in which an isolating distance or segregation between open contacts is established, while the part remains mechanically attached to the enclosure.

3.112 *Segregation (of conductors)*

An arrangement of conductors with earthed metal interposed between them in such a manner that disruptive discharges can only occur to earth.

Note. — A segregation may be established between the conductors as well as between the open contacts of a switching device.

3.113 *Service position (connected position)*

The position of a removable part in which it is fully connected for its intended function.

3.114 *Earthing position*

The position of a removable part in which the closing of a mechanical switching device causes a main circuit to be short-circuited and earthed.

3.115 *Test position (of a withdrawable part)*

The position of a withdrawable part in which an isolating distance or segregation is established in the main circuit and in which the control circuits are connected.

3.116 *Disconnected position (of a withdrawable part)*

The position of a withdrawable part in which an isolating distance or segregation is established in the circuits of the withdrawable part, that part remaining mechanically attached to the enclosure.

Note. — In high-voltage metal-enclosed switchgear and controlgear, the auxiliary circuits may not be disconnected.

3.117 *Removed position (of a removable part)*

The position of a removable part when it is outside and mechanically and electrically separated from the enclosure.

3.118 *Main circuit*

All the conductive parts of metal-enclosed switchgear and controlgear included in a circuit which is intended to transmit electrical energy.

Note. — Connections to voltage transformers are not considered part of the main circuit.

3.119 *Auxiliary circuit*

All the conductive parts of metal-enclosed switchgear and controlgear included in a circuit (other than the main circuit) intended to control, measure, signal and regulate.

Note. — The auxiliary circuits of metal-enclosed switchgear and controlgear include the control and auxiliary circuits of the switching devices.

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3.120 Rated value

A quantity value assigned, generally by a manufacturer, for a specified operating condition of the metal-enclosed switchgear and controlgear (I.E.V. 151-04-03).

Note. — See Section Four for individual rated values.

3.121 Degree of protection

The degree of protection provided by an enclosure to protect persons against contact with or approach to live parts and against contact with moving parts inside the enclosure and to protect the equipment against ingress of solid bodies

3.122 Ambient air temperature (of metal-enclosed switchgear and controlgear)

The temperature, determined under prescribed conditions, of the air surrounding the enclosure of metal-enclosed switchgear and controlgear.

3.123 Disruptive discharge

Phenomena associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly to zero.

Notes 1. — The term applies to discharges in solid, liquid and gaseous dielectrics and to combinations of these.

2. — A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength (non-self-restoring insulation); in a liquid or gaseous dielectric, the loss may be only temporary (self-restoring insulation).

SECTION FOUR — RATED CHARACTERISTICS**4. Rating**

The ratings of metal-enclosed switchgear and controlgear are the following:

- a) Rated voltage and number of phases;
- b) Rated insulation level;
- c) Rated frequency;
- d) Rated normal current (for main circuits);
- e) Rated short-time withstand current (for main and earthing circuits);
- f) Rated peak withstand current, if applicable (for main and earthing circuits);
- g) Rated duration of short circuit;
- h) Rated values of the components forming part of the metal-enclosed switchgear and controlgear including their operating devices and auxiliary equipment.

For the co-ordination of rated voltages, rated short-time withstand currents, rated peak withstand currents and rated normal currents of metal-enclosed switchgear and controlgear reference is made to BS 5311 : Part 2 and to BS 5253.

4.1 Rated voltage

Refer to Sub-clauses 4.1 and 4.1.1 of IEC Publication 694.

Note. — Components forming part of metal-enclosed switchgear and controlgear may have individual values of rated voltage in accordance with their relevant standards.

4.2 *Rated insulation level*

Refer to Sub-clauses 4.2 and 4.2.1 of IEC Publication 694. For metal-enclosed switchgear and controlgear the rated withstand voltage values, based on current practice in Canada and the United States of America, are given in the table of Appendix EE.

4.3 *Rated frequency*

Refer to Sub-clause 4.3 of IEC Publication 694 with the addition of the following rated values:

16⅔ Hz and 25 Hz

4.4 *Rated normal current and temperature rise*

4.4.1 *Rated normal current*

Refer to Sub-clause 4.4.1 of IEC Publication 694 with the addition of the following paragraph:

Some main circuits of metal-enclosed switchgear and controlgear (e.g. busbars, feeder circuits, etc.) may not have the same value of rated normal current.

4.4.2 *Temperature rise*

Refer to Sub-clause 4.4.2 of IEC Publication 694 with the addition of the following supplement:

The temperature rise of components contained in metal-enclosed switchgear and controlgear which are subject to individual specifications not covered by the scope of IEC Publication 694 shall not exceed the temperature-rise limits permitted in the relevant standard of that component.

The temperature rise for accessible enclosures and covers shall not exceed 30 K. In the case of enclosures and covers which are accessible but need not be touched during normal operation, the temperature-rise limit may be increased by 10 K.

When applying a temperature rise equal to or higher than 65 K for parts of the enclosure non-accessible to operators, every precaution shall be taken to ensure that no damage is caused to the surrounding insulating materials.

4.5 *Rated short-time withstand current*

Refer to Sub-clause 4.5 of IEC Publication 694.

4.6 *Rated peak withstand current*

Refer to Sub-clause 4.6 of IEC Publication 694.

Note. — In principle, the rated short-time withstand current and the rated peak withstand current of a main circuit cannot exceed the corresponding rated values of the weakest of its series connected components. However, for each circuit or compartment, advantage may be taken of apparatus limiting the short-circuit current, such as current-limiting fuses, reactors, etc.

4.7 *Rated duration of short circuit*

Refer to Sub-clause 4.7 of IEC Publication 694.

4.8 *Rated supply voltage of closing and opening devices and auxiliary circuits*

Refer to Sub-clause 4.8 of IEC Publication 694.

4.9 *Rated supply frequency of operating devices and auxiliary circuits*

Refer to Sub-clause 4.9 of IEC Publication 694.

4.10 *Rated pressure of compressed gas supply for operation*

Refer to Sub-clause 4.10 of IEC Publication 694.

SECTION FIVE — RULES FOR DESIGN AND CONSTRUCTION

5. Design and construction

Metal-enclosed switchgear and controlgear shall be designed so that normal service, inspection and maintenance operations, including the usual checking of phase sequence, earthing of connected cables, locating of cable faults, voltage tests on connected cables or other apparatus and the elimination of dangerous electrostatic charges, can be carried out safely.

All components of the same rating and construction which may need to be replaced shall be interchangeable.

If there are removable parts with different ratings and if parts are interchangeable within the assembly of metal-enclosed switchgear and controlgear, any possible combination of removable and fixed parts shall withstand the rated insulation level specified for the fixed parts of the equipment concerned.

The various components contained within the enclosure are subject to the individual specifications applying to them.

For main circuits with current limiting fuses, the manufacturer of the switchgear and controlgear may assign the fused short-circuit current.

5.1 *Requirements for liquids in switchgear and controlgear*

Refer to Sub-clause 5.1 of IEC Publication 694.

5.2 *Requirements for gases in switchgear and controlgear*

Refer to Sub-clause 5.2 of IEC Publication 694.

5.3 *Earthing*

Refer to Sub-clause 5.3 of IEC Publication 694 with the addition of the following supplement concerning the earthing of metal-enclosed switchgear and controlgear:

An earthing conductor shall be provided extending the whole length of the metal-enclosed switchgear and controlgear. The current density in the earthing conductor, if of copper, shall not exceed 200 A/mm² under the specified earth fault conditions; however, its cross-section area shall not be less than 30 mm². It shall be terminated by an adequate terminal intended for connection to the earth system of the installation.

Note. — If the earthing conductor is not made of copper, equivalent thermal and mechanical requirements shall be met.

In general, the continuity of the earth system shall be ensured taking into account the thermal and mechanical stresses caused by the current it may have to carry. The maximum value of earth fault currents depends upon the type of system neutral earthing employed and shall be indicated by the user.

Where earthing connections have to carry the full three-phase short-circuit current (as in the case of the short-circuiting connections used for earthing devices) these connections shall be dimensioned accordingly.

Each part of the main circuit which can be disconnected from the other parts shall be capable of being earthed.

The enclosure of each functional unit shall be connected to this earthing conductor. All the metallic parts intended to be earthed and not belonging to a main or auxiliary circuit, shall also be connected to the earthing conductor directly or through metallic structural parts.

For the interconnection within the functional unit, fastening by bolting or welding is acceptable for providing electrical continuity between the frame, covers, doors, partitions or other structural parts. Doors of the high-voltage compartments shall be connected to the frame by adequate means.

The metallic parts of a withdrawable part which are normally earthed shall also remain earth-connected in the test and disconnected position under the prescribed conditions for the isolating distance (see BS 5253) and also in any intermediate position whilst the auxiliary circuits are not totally disconnected.

5.4 *Auxiliary equipment*

Refer to Sub-clause 5.4 of IEC Publication 694.

5.5 *Dependent power closing*

Refer to Sub-clause 5.5 of IEC Publication 694.

5.6 *Stored energy closing*

Refer to Sub-clause 5.6 of IEC Publication 694.

5.7 *Operation of releases*

Refer to Sub-clause 5.7 of IEC Publication 694.

5.8 *Low and high pressure interlocking devices*

Refer to Sub-clause 5.8 of IEC Publication 694.

5.9 *Nameplates*

Refer to Sub-clause 5.9 of IEC Publication 694 with the addition of the following supplement:

Each functional unit of metal-enclosed switchgear and controlgear and its removable parts, if any, shall be provided with durable and clearly legible nameplates which shall contain the following information:

- manufacturer's name or trade mark;
- type designation or serial number;
- applicable rated values;
- number of the relevant standard.

The nameplates of each functional unit shall be legible during normal service. The removable parts, if any, shall have a separate nameplate with the data relating to the functional units they belong to, but this nameplate need only be legible when the removable part is in the removed position.

Note. — The word "rated" need not appear on the nameplate.

5.101 *Degree of protection and internal fault*

5.101.1 *Protection of persons against approach to live parts and contact with moving parts*

For metal-clad and for compartmented switchgear and controlgear, the degree of protection shall be specified separately for the enclosure and for partitions.

For cubicle switchgear and controlgear, it is only necessary to specify the degree of protection for the enclosure.

The degree of protection shall be indicated by means of a designation specified in Table I.

The characteristic numeral indicates the degree of protection provided by the enclosure with respect to persons, also to the equipment inside the enclosure.

Table I gives details of objects which will be "excluded" from the enclosure for each of the degrees of protection.

The term "excluded" implies that a part of the body or an object held by a person, either will not enter the enclosure or, if it enters, that adequate clearance will be maintained and no moving part will be touched.

TABLE I

Degree of protection	Protection against approach to live parts and contact with moving parts
IP2X	By fingers or similar objects of diameter greater than 12 mm
IP3X	By tools, wires etc. of diameter or thickness greater than 2.5 mm
IP4X	By wires of diameter or strips of thickness greater than 1.0 mm

Note. — The designation of the degree of protection corresponds to BS 5490. No degree of protection is provided by metal-enclosed switchgear and controlgear against harmful ingress of water.

5.101.2 *Protection of equipment against external effects*

- a) Protection against ingress of solid bodies: No additional provisions beyond those in Sub-clause 5.101.1 are to be taken.
- b) Protection against weather: Equipment for outdoor installation provided with appropriate protective features is to be indicated by the characteristic letter W placed immediately after the letters IP.

- c) Protection against atmospheric agents: The relevant service conditions shall be observed, see Clause 2.

5.101.3 *Protection of equipment against mechanical damage*

Under consideration. For the time being the manufacturer shall be consulted where enclosures may be subjected to mechanical impacts or similar effects.

5.101.4 *Internal fault*

Failure within the enclosure of metal-enclosed switchgear and controlgear due either to a defect or an exceptional service condition or mal-operation may initiate an internal arc.

There is little probability of such an event occurring in constructions which satisfy the requirements of this standard, but it cannot be completely disregarded.

Such an event may lead to the risk of injury, if persons are present, but with an even lower probability.

It is desirable that the highest possible degree of protection to persons should be provided. The principal objective should be to avoid such arcs or to limit their duration and consequences.

Experience has shown that faults are more likely to occur in some locations inside an enclosure than in others, so special attention should be paid to these.

For guidance, a list of such locations and of causes is given in Table AAI of Appendix AA, columns (1) and (2). Measures to decrease the probability of internal faults or to reduce the risk are recommended in column (3). Examples of measures to limit the consequences of internal faults are given in Table AAII of Appendix AA.

If such measures are considered to be insufficient, then, to cover only the case of an arc occurring entirely in air within the enclosure of the metal-enclosed switchgear and controlgear, a test in accordance with Appendix AA may be agreed between the manufacturer and user, to verify that the chosen criteria are fulfilled as agreed.

Such a test should be unnecessary on those parts of circuits which are protected by current limiting devices, for example, fuses.

Note. — The overpressure in the building caused by arcing due to an internal fault in the metal-enclosed switchgear and controlgear and the effects of the ejection of gases from pressure relief devices should be taken into consideration.

5.102 *Enclosure*

5.102.1 *General*

Enclosures shall be metallic. When the metal-enclosed switchgear and controlgear is installed, the enclosure shall provide at least the degree of protection specified in Table I. It shall also assure protection in accordance with the following conditions:

The floor surface, even if not metallic, may be considered as part of the enclosure. The measures to be taken in order to obtain the degree of protection provided by floor surfaces shall be subject to an agreement between manufacturer and user.

The walls of a room shall not be considered as parts of the enclosure.

For outdoor installation, the manufacturer shall take into account the influence of climatic conditions.

5.102.2 *Covers and doors*

Covers and doors which are parts of the enclosure shall be metallic. When they are closed, they shall provide the degree of protection specified for the enclosure.

Covers or doors shall not be made of woven wire mesh, expanded metal or similar. When ventilating openings and vent outlets are incorporated in the cover or door, reference is made to Sub-clause 5.102.4.

Two categories of covers or doors are recognized with regard to access to high-voltage compartments:

- a) Those which need not be opened for the normal purposes of operation or maintenance (fixed covers). It shall not be possible for them to be opened, dismantled or removed without the use of tools;
- b) those which need to be opened for the normal purposes of operation (removable covers, doors). These shall not require tools for their opening or removal. They shall be provided with locking facilities (for example, provision for padlocks), unless the safety of persons is assured by a suitable interlocking device.

With metal-clad or compartmented switchgear and controlgear, covers or doors should only be opened when the part of the main circuit contained in the compartment being made accessible is dead.

5.102.3 *Inspection windows*

Inspection windows shall provide at least the degree of protection specified for the enclosure.

They shall be covered by a transparent sheet of mechanical strength comparable to that of the enclosure. Precautions shall be taken to prevent the formation of dangerous electrostatic charges, either by clearance or by electrostatic shielding (for example, a suitable earthed wire-mesh on the inside of the window).

The insulation between live parts of the main circuit and the inspection windows shall withstand the test voltages specified in Sub-clause 4.2.1 of IEC Publication 694 for voltage tests to earth and between poles.

5.102.4 *Ventilating openings, vent outlets*

Ventilating openings and vent outlets shall be so arranged or shielded that the same degree of protection as that specified for the enclosure is obtained. Such openings may make use of wire mesh or the like provided that it is of suitable mechanical strength.

Ventilating openings and vent outlets shall be arranged in such a way that gas or vapour escaping under pressure does not endanger the operator.

5.103 *Partitions and shutters*

5.103.1 *General*

Partitions and shutters shall provide at least the degree of protection specified in Table I.

Partitions and shutters made of insulating material shall meet the following requirements: