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Specification for

A.C. switches of rated voltage above 1 kV

Spécification des interrupteurs à courant alternatif à tension
nominale supérieure à 1 kV

Spezifikation für Wechselstromlastschaltern für eine
Nennspannung von über 1kV

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Foreword

BS 5463 has been prepared under the authority of the Power Electrical Engineering Standards Committee, in order to make available a British Standard in alignment with the recently harmonized standard of the European Committee for Electrotechnical Standardization (CENELEC), which is based on the following IEC Publications: 265 : 1968, 265A : 1969, 265C : 1970.

The harmonized standard incorporates some material which was under consideration in the IEC and has since been published as Amendment No. 2 of IEC Publication 265 : 1968. This is mainly concerned with insulation and dielectric test requirements.

In preparing this British Standard the clause numbering of the IEC publications in question has been preserved as far as possible.

With the publication of this British Standard, BS 2631, 'Oil switches for alternating current systems' is being withdrawn.

The deviations from the IEC Publications referred to in the first paragraph are, apart from editorial changes necessary when preparing the material as a British Standard, the changes required for alignment with the CENELEC harmonized standard, and minor modifications and additions aimed at improving the clarity of the standard. The most significant deviations are in the following clauses.

2. **Normal service conditions.** Items (d) and (e) have been revised in the light of recommendations which have been considered in the IEC.
3. **Definitions.** Definitions 3.44 to 3.48 have been added in the light of recommendations which have been considered in the IEC.
Definitions 3.49 to 3.52 have been added for clarification.
5. **Rated voltage.** References to North American practices have been deleted.
6. **Rated insulation level.** The text has been amended in the light of recommendations which have been considered in the IEC. References to North American practice have been deleted.
9. **Temperature rise.** Table 5 has been amended for

alignment with the corresponding table in BS 5253. 'A.C. disconnectors (isolators) and earthing switches of rated voltage above 1 kV'.

13. **Rated short-time current.** Values of 12.5 kA and 25 kA have been added to the list of standard values. Reference to a formula for the relation between current and time has been deleted.

20. **Rated supply voltage of an operating device or auxiliary circuit.** The values in table 6 have been aligned with UK practice.

21. **Under-voltage release.** Clause 21 in the IEC Publication is considered inappropriate for the British Standard, and it has been deleted.

31. **Information to be given.** Amendments have been made in the light of recommendations which have been considered in the IEC.

32. **Nameplates.** Amendments have been made as a consequence of changes in the rated insulation levels.

34. **Dielectric tests.** The text has been amended in the light of recommendations which have been considered in the IEC.

35.3 **Measurement of temperature.** A note has been added concerning the use of bulb thermometers in places where there is any varying or moving magnetic field.

36.10 **Test circuits for breaking capacity tests.** Tables have been added giving standard values of rated transient recovery voltage.

39. **Operation under severe ice conditions.** The text given is based on recommendations which have been considered in the IEC.

41. **Power frequency voltage dry withstand tests on the main circuit.** The text has been amended in the light of recommendations which have been considered in the IEC.

NOTE. Attention is drawn to the guidance on the maintenance of electrical switchgear given in BS 5405 'Code of practice for the maintenance of electrical switchgear for voltages up to and including 145 kV'.

British Standard Specification for

A.C. switches of rated voltage above 1 kV

Section one. General

1. Scope

This British Standard specifies requirements for the following kinds of a.c. switches for indoor and outdoor installations, for voltages above 1000 V and for frequencies up to and including 60 Hz:

- general purpose switches
- transformer off-load switches
- single capacitor bank switches

This standard also applies to the operating devices of these switches and to their auxiliary equipment.

NOTE 1. Switches in which a fuse is an integral part are not covered by this standard. A standard for the combination of fuses and switches is under consideration.

NOTE 2. Motor switches are not covered by this standard.

NOTE 3. Contactors are not covered by this standard.

NOTE 4. Earthing switches are not covered by this standard. Earthing switches forming an integral part of a switch should comply with the requirements for earthing switches given in BS 5253.

NOTE 5. Switches used in insulated neutral systems may be required to operate under earth-fault conditions. This standard does not include ratings or tests to meet these conditions. A special agreement between the manufacturer and the purchaser may be necessary.

NOTE 6. The titles of the standards publications referred to in this standard are listed on the inside back cover.

2. Normal service conditions

This standard applies to switches which are designed to be used under the following conditions:

- (a) the ambient temperature does not exceed 40 °C and its average value, measured over a period of 24 h, does not exceed 35 °C;
- (b) the minimum ambient temperature is as stated in table 1.

Table 1. Minimum ambient temperature
(table I of IEC Publication 265)

Class of switch	Minimum ambient temperature	
	Indoor installation	Outdoor installation
	°C	°C
1	-5	-25
2	-20	-50
3	—	-10

(c) the altitude does not exceed 1000 m;

(d) for operation under conditions of substantial pollution see 34.9;

(e) for outdoor installation, the manufacturer should take into account the presence of condensation, rain, snow, a layer of ice or hoar frost of up to 1 mm thickness, rapid temperature changes and a wind pressure of 700 N/m²; in the case of severe ice conditions and after an agreement between the manufacturer and the purchaser, refer to clause 39;

(f) for indoor installation, the humidity conditions are under consideration.

NOTE. If switches are to be used under conditions different from those mentioned (a), (c), (d), (e) and (f) the manufacturer should be consulted. This applies particularly in cases where heavy ice coating or abnormal deposits may occur, e.g. deposits of salt from the sea, or deposits of industrial origin.

3. Definitions

For the purposes of this British Standard the following definitions apply. For further definitions relating to switchgear see BS 4727 : Part 2 : Group 06.

3.1 switch (mechanical). A mechanical switching device capable of making, carrying and breaking currents under normal circuit conditions, which may include specified operating overload conditions, and also carrying for a specified time currents under specified abnormal circuit conditions such as those of short-circuit. It may also be capable of making, but not breaking, short-circuit currents.

3.2 switch-disconnector (switch-isolator). A switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

3.3 isolating distance. The clearance between open contacts (gap) in a pole of a switch meeting the safety requirements specified for disconnectors.

3.4 operating cycle. A closing operation followed by an opening operation with an intentional time delay between the two operations sufficient for any transient currents to subside.

3.5 auxiliary contact. A contact included in an auxiliary circuit and mechanically operated by the switch.

3.6 indicating device. A device which indicates, at the location of the switch, whether the separable contacts of the switch are in the open or closed position.

3.7 interlocking device. A device which makes the operation of a switch dependent upon the position or operation of one or several other pieces of equipment.

3.8 under-voltage release. A device, mechanically connected to the switch, which releases the holding means and permits the switch to open with or without delay when the voltage across the terminals of the release falls below a predetermined value.

3.9 rating. A general term employed to designate the characteristic values that define the working conditions for which the switch is designed and built.

3.10 rated voltage. The voltage used to designate the switch and to which the operating conditions are related.

3.11 rated normal current. The r.m.s. value of the current which the switch is able to carry continuously at its rated frequency under the testing conditions specified in section four with the temperature rise of its different parts not exceeding the values given in table 5.

3.12 rated frequency. The service frequency for which the switch is designed and rated.

3.13 rated insulation level

3.13.1 For equipment with highest voltage for equipment equal to or greater than 300 kV, the rated switching and lightning impulse withstand voltages.

3.13.2 For equipment with highest voltage for equipment lower than 100 kV and provisionally between 100 kV and 300 kV, the rated one minute power frequency and lightning impulse withstand voltages.

3.14 rated one minute power frequency withstand voltage. The r.m.s. value of the sinusoidal alternating voltage at power frequency which the insulation of the switch withstands under specified test conditions.

3.15 rated impulse withstand voltage. The peak value of the standard impulse voltage wave which the insulation of the switch withstands under specified test conditions.

NOTE. Depending on the shape of the wave, the term may be qualified as 'switching impulse withstand voltage' or 'lightning impulse withstand voltage'.

3.16 indoor switch. A switch designed solely for installation within a building or other housing, where the switch is protected against wind, rain, snow, abnormal dirt deposits, abnormal condensation, ice and hoar frost.

3.17 outdoor switch. A switch suitable for installation in the open air, i.e. capable of withstanding wind, rain, snow, dirt deposits, condensation, ice and hoar frost.

3.18 short-time current. The current that a switch can carry in the closed position, during a specified short time, under prescribed conditions of use and behaviour.

It is expressed as an r.m.s. value.

3.19 peak withstand current. The value of peak current that a switch can withstand in the closed position under prescribed conditions of use and behaviour.

3.20 breaking current. The current in a pole of a switch at the instant of initiation of the arc during a breaking operation.

3.21 breaking capacity. A value of breaking current that a switch is capable of breaking at a stated voltage under prescribed conditions of use and behaviour.

3.22 mainly active load breaking capacity. The breaking capacity when breaking a load at an inductive power factor of 0.7.

3.23 closed loop breaking capacity. The breaking capacity at an inductive power factor of 0.3 in a closed loop circuit, i.e. a circuit in which both sides of the switch remain live after breaking and in which the voltage appearing across the terminals is substantially less than the system voltage.

3.24 transformer off-load breaking capacity. The breaking capacity when the load is an unloaded transformer.

3.25 single capacitor bank breaking capacity. The breaking capacity when the load is a single capacitor bank.

3.26 line-charging breaking capacity. The breaking capacity when the load is an unloaded overhead line.

3.27 cable-charging breaking capacity. The breaking capacity when the load is an unloaded cable.

3.28 peak making current. The highest peak value of the current in a pole of a switch when the current is established by the closing of the switch.

3.29 prospective current (of a circuit). Under consideration.

3.30 short-circuit making capacity. A value of the peak making current that a switch is capable of making on short circuit at a stated voltage under prescribed conditions of use and behaviour.

NOTE. For those switches which materially influence the short-circuit current, the peak value of the prospective current may be taken to represent the peak making current.

3.31 power factor (of a circuit). The cosine of the angle that represents the phase displacement between current wave (a.c. component) and the corresponding voltage wave.

NOTE. When breaking the current of a closed loop, the corresponding voltage wave is the voltage wave which appears across the open contacts of each pole after the final extinction of the arc in all poles. In this case the power factor depends on the impedances in the loop and not on the characteristics of the loads.

3.32 general purpose switch. A switch which, at least, has a rated mainly active load breaking capacity equal to its rated normal current, and a rated transformer off-load breaking capacity.

3.33 Transformer off-load switch. A switch which has a rated transformer off-load breaking capacity.

NOTE. A transformer off-load switch is not required to be capable of breaking its rated normal current and should be interlocked so as to prevent its operation on load.

3.34 single capacitor bank switch. A switch which has a rated single capacitor bank breaking capacity equal to its rated normal current.

3.35 single capacitor bank. A bank of shunt capacitors in which the inrush current is limited by the inductance of the supply system and the capacitance of the bank of capacitors being energized, there being no other capacitors connected in parallel to the system sufficiently close to increase the inrush current appreciably.

3.36 closing operation. An operation by which the switch is brought from the open position to the closed position.

3.37 opening operation. An operation by which the switch is brought from the closed position to the open position.

3.38 dependent manual operation. An operation carried out solely by means of directly applied manual energy, such that the speed and force of the operation are dependent upon the action of the operator.

3.39 dependent power operation. An operation carried out by means of energy other than manual, where the completion of the operation is dependent upon the continuity of the power supply (to solenoids, electric or pneumatic motors, etc.).

3.40 stored energy operation. An operation carried out by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under predetermined conditions.

NOTE. This kind of operation may be subdivided according to:

- (a) how the energy is stored (spring, weight, etc.);
- (b) how the energy originates (manual, electric, etc.);
- (c) how the energy is released (manual, electric, etc.).

3.41 independent manual operation. A stored energy operation where the energy, originating from manual power, is stored and released in one continuous operation, such that the speed and force of the operation are independent of the action of the operator.

3.42 overvoltage. A voltage to earth, expressed as a peak value, which is greater than the peak voltage to earth corresponding to the highest system voltage.

3.43 assigned maximum overvoltages. The maximum permissible overvoltages which may occur under prescribed test conditions when breaking currents lower than or equal to the rated breaking capacity. They shall include the overvoltage values for the load side and for the supply side of the switch measured at its terminals.

NOTE. Maximum permissible overvoltage values are under consideration.

3.44 external insulation. The distance in atmosphere, and the surface in contact with open air, of solid insulation of the equipment, which are subject to dielectric stresses and to the effect of atmosphere and other external conditions such as pollution, humidity, vermin, etc.

3.45 internal insulation. The internal solid, liquid or gaseous parts of the insulation of equipment, which are protected from the effects of atmospheric and other external conditions such as pollution, humidity, vermin, etc.

3.46 self-restoring insulation. Insulation which completely recovers its insulating properties after a disruptive discharge caused by the application of a test voltage.

3.47 non-self-restoring insulation. Insulation which loses its insulating properties or does not recover them completely, after a disruptive discharge caused by the application of a test voltage; insulation of this kind is generally, but not necessarily, internal insulation.

3.48 disruptive discharge. A discharge associated with the failure of insulation under electrical stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly zero. It applies to electrical breakdown in solid, liquid and gaseous dielectrics and to combinations of these.

A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength; in a liquid or gaseous dielectric the loss may be only temporary.

3.49 unearthed neutral system. A system which has no intentional connection to earth except through indicating, measuring, or protective devices of very high impedance.

3.50 resonant earthed system; system earthed through an arc-suppression coil. A system earthed through a reactor, the reactance being of such value that during a single line-to-earth fault, the power frequency inductive current passed by this reactor substantially neutralizes the power frequency capacitive component of the earth fault current.

NOTE. With resonant earthing of a system, the residual current in the fault is limited to such an extent that an arcing fault in air is self extinguishing.

3.51 earthed neutral system. A system in which the neutral is connected to earth, either directly, or through a resistance or reactance of low enough value to reduce materially transient oscillations and to ensure a current sufficient for selective earth fault protection.

3.51.1 A three-phase system, with effectively earthed neutral at a given location, is a system characterized by a factor of earthing at this point which does not exceed 80 %.

NOTE. This condition is obtained approximately when, for all system configurations, the ratio of zero sequence reactance to positive sequence reactance is less than three and the ratio of zero sequence resistance to positive sequence reactance is less than one.

3.51.2 A three-phase system, with non-effectively earthed neutral at a given location, is a system characterized by a factor of earthing at this point that may exceed 80 %.

3.52 factor of earthing (of a three-phase system, and at the location of a switch). For a given system layout, the ratio, expressed as a percentage, of the highest r.m.s. line-to-earth power frequency voltage on a sound phase at the location of the switch during a fault to earth (affecting one or more phases at any point), to the line-to-line r.m.s. power frequency voltage which would be obtained at the same location with the fault removed.

NOTE 1. This factor is a pure numerical ratio and characterizes in general terms the earthing conditions of a system as viewed from the stated location, independently of the actual operating values of the voltage at that location.

NOTE 2. The factor of earthing is calculated from the phase-sequence impedance components of the system as viewed from the stated location, using for the machines the subtransient reactances. The practical rule given in the note to 3.51.1 results from such a calculation.

NOTE 3. 'Factor of earthing' should not be confused with 'earth-fault factor' which is a newer term coming into general use as a substitute for the former. The earth-fault factor is referred to the voltage to earth and is consequently equal to the factor of earthing multiplied by $\sqrt{3}$.

Section two. Rules for rating

4. Rating

The characteristics of a switch, including its operating device and auxiliary equipment, that shall be used to determine the rating, are the following:

- (a) rated voltage;
- (b) rated insulation level;
- (c) rated frequency;
- (d) rated normal current;
- (e) rated breaking capacities;
- (f) rated short-time current;
- (g) rated peak withstand current;
- (h) rated short-circuit making capacity;
- (i) rated pressure of compressed gas supply for operation;
- (j) rated pressure of compressed gas supply for interruption;
- (k) rated voltage of an operating device or an auxiliary circuit.

5. Rated voltage

It is recommended that the rated voltage of a switch be selected from the highest system voltages, as listed in 5.1 and 5.2.

5.1 For rated voltages 3.6 kV to 72.5 kV:

3.6 kV	24 kV
7.2 kV	36 kV
12 kV	52 kV
17.5 kV	72.5 kV

NOTE. This list is based on practice in most European and several other countries.

5.2 For rated voltages above 72.5 kV:

100 kV	300 kV
123 kV	362 kV
145 kV	420 kV
170 kV	525 kV
245 kV	765 kV

6. Rated insulation level

The rated insulation level of a switch shall be selected from the values given in tables 2, 3 and 4.

The withstand voltage values in tables 2, 3 and 4 apply at the standard reference atmosphere (temperature, pressure and humidity) specified in BS 923.

6.1 Rated voltages up to and including 72.5 kV. The voltages shall be selected from the values given in table 2 which is based on practice in most European and several other countries.

The choice between lists 1 and 2 should be made by considering the degree of exposure to lightning and switching overvoltages, the type of system neutral earthing and, where applicable, the type of overvoltage protective device.

Equipment designed to list 1 is suitable for installations such as the following:

- (a) In systems and industrial installations not connected to overhead lines where:

- (1) the system neutral is earthed either solidly or through an impedance which is low compared with that of an arc-suppression coil; surge protective devices, such as diverters, are generally not required;
- (2) the system neutral is earthed through an arc-suppression coil and adequate overvoltage protection is provided in a special system, e.g. an extensive cable network where surge diverters capable of discharging the cable capacitance may be required.

- (b) In systems and industrial installations connected to overhead lines only through transformers, where cables or additional capacitors of at least 0.05 μF per phase are connected between the transformer lower voltage terminals and earth, on the transformer side of the switchgear and as close as possible to the transformer terminals.

Table 2. Rated insulation levels up to 72.5 kV

Rated voltage <i>U</i>	Rated lightning impulse withstand voltage				Rated one minute power frequency withstand voltage	
	To earth and between poles of switches and switch-disconnectors, across the terminals of open switches		Across the terminals of open switch-disconnectors		To earth and between poles of switches and switch-disconnectors, across the terminals of open switches	Across the terminals of open switch-disconnectors
	List 1	List 2	List 1	List 2		
kV (r.m.s.)	kV (peak)	kV (peak)	kV (peak)	kV (peak)	kV (r.m.s.)	kV (r.m.s.)
3.6	20	40	23	46	10	12
7.2	40	60	46	70	20	23
12	60	75	70	85	28	32
17.5	75	95	85	110	38	45
24	95	125	110	145	50	60
36	145	170	165	195	70	80
52	250	250	290	290	95	110
72.5	325	325	375	375	140	160

Table 3. Rated insulation levels from 100 kV to 245 kV

Rated voltage, <i>U</i>	Rated lightning impulse withstand voltage		Rated one minute power frequency withstand voltage	
	To earth and between poles of switches and switch-disconnectors, across the terminals of open switches	Across the terminals of open switch-disconnectors	To earth and between poles of switches and switch-disconnectors, across the terminals of open switches	Across the terminals of open switch-disconnectors
kV (r.m.s.)	kV (peak)	kV (peak)	kV (r.m.s.)	kV (r.m.s.)
100	380 450	440 520	150 185	175 210
123	450 550	520 630	185 230	210 265
145	550 650	630 750	230 275	265 315
170	650 750	750 860	275 325	315 375
245	850 950 1050	950 1050 1200	360 395 460	415 460 530

Table 4. Rated insulation levels from 300 kV to 765 kV

Rated voltage, <i>U</i>	Rated lightning impulse withstand voltage		Rated switching impulse withstand voltage		
	To earth and between poles of switches and switch-disconnectors	Across the terminals of open switches and switch-disconnectors*	To earth and between poles of switches and switch-disconnectors	Across the terminals of open switches and switch-disconnectors	
				Class A†	Class B†
kV (r.m.s.)	kV (peak)	kV (peak)	kV (peak)	kV (peak)	kV (peak)
300	950 1050	950 (+170) 1050 (+170)	750 850	850	700 (+245)
362	1050 1175	1050 (+205) 1175 (+205)	850 950	950	800 (+295)
420	1300 1425	1300 (+240) 1425 (+240)	950 1050	1050	900 (+345)
525	1425 1550	1425 (+300) 1550 (+300)	1050 1175	1175	900 (+430)
765	1800 2100	1800 (+435) 2100 (+435)	1300 1425	1550	1100 (+625)

* See 34.6. Values in parentheses are the peak value of the power frequency voltage applied to the opposite terminal

† See 34.7. Values in parentheses (class B) are the peak value of the power frequency voltage applied to the opposite terminal.

This covers the cases where :

(1) the system neutral is earthed either solidly or through an impedance which is low compared with that of an arc-suppression coil; overvoltage protection by means of surge diverters may be desirable;

(2) the system neutral is earthed through an arc-suppression coil and where adequate overvoltage protection by surge diverters is provided.

(c) In systems and industrial installations connected directly to overhead lines where:

(1) the system neutral is earthed either solidly or through an impedance which is low compared with that of an arc-suppression coil and where adequate overvoltage protection by spark gaps or surge diverters is provided depending on the probability of overvoltages and their amplitude and frequency;

(2) the system neutral is earthed through an arc-suppression coil and where adequate overvoltage protection by surge diverters is provided.

In all other cases, or where a very high degree of security is required, equipment designed to list 2 shall be used.

6.2 Rated voltages from 100 kV to 245 kV. The voltages shall be selected from values given in table 3 using lightning impulse withstand voltage and power frequency withstand voltage values of the same line.

Guidance on the choice of insulation levels may be obtained from IEC Publication 71.

6.3 Rated voltages of 300 kV and above. The voltages shall be selected from the values of table 4 using lightning impulse withstand voltage and switching impulse withstand voltage values from the same line.

Guidance on the choice of insulation levels may be obtained from IEC Publication 71.

7. Rated frequency

It is recommended that the rated frequency of a switch be selected from the following list:

16 $\frac{2}{3}$ Hz
50 Hz
60 Hz

8. Rated normal current

It is recommended that the rated normal current of a switch be selected from the following standard values:

10 A	} for single capacitor bank switches only	2 000 A
16 A		2 500 A
31.5 A		3 150 A
100 A		4 000 A
200 A		5 000 A
400 A		6 300 A
630 A		8 000 A
800 A		10 000 A
1 250 A		
1 600 A		

9. Temperature rise

The temperature rise of any part of a switch shall not exceed the maximum temperature rise given in table 5, under the conditions specified in the test clauses.

10. Rated breaking capacities

10.1 The standard values of the rated mainly active load breaking capacity, the rated closed loop breaking capacity and the rated single capacitor bank breaking capacity are the same as the standard values of rated normal currents listed in clause 8.

10.2 The standard values of the rated line charging breaking capacity and the rated cable charging breaking capacity are the following:

2.5 A	16 A
4 A	25 A
6.3 A	40 A
10 A	63 A

10.3 The standard values of the rated transformer off-load breaking capacity are the following:

2.5 A	10 A
4 A	16 A
6.3 A	

11. Operation in normal service conditions

All switches are able to make the circuits to which their rated breaking capacities apply.

The following conditions shall apply to the operation of switches in the following duties.

(a) The opening and closing operations shall be performed in accordance with the manufacturer's instructions. If necessary, a making operation may immediately follow a breaking operation, but it is strongly recommended that a breaking operation shall not immediately follow a making operation since, without knowledge of the conditions of the circuit, the rated breaking capacity of the switch may be exceeded.

(b) The frequency of the applied voltage shall be the rated frequency $\pm 25\%$.

In respect of breaking capacities, switches are classified in three basic types:

- general purpose switches
- transformer off-load switches
- single capacitor bank switches.

11.1 General purpose switches

11.1.1 Mainly active load breaking capacity. All general purpose switches shall be capable of breaking, at any voltage up to and including their rated voltage, any mainly active load current up to and including their rated mainly active load breaking capacity (see 3.22).

NOTE. According to 3.32 their rated mainly active load breaking capacity at least equals their rated normal current.

The number of operations after which a switch has to be reconditioned (see clause 12(d)) depends on the type of switch.

When a switch is required to withstand frequent operation at full load current, the number of tests will be substantially larger than in the case when an infrequent number of operations at full load is required (see 36.14.1). To cater for these conditions two categories, I and II, of switches are provided for. Category I switches are for use under standard conditions of service. Category II switches are limited to current ratings up to and including 630 A and are intended to be used only where frequent operation at full load current is intended.

Table 5. Maximum temperature rises for the various materials and parts

Nature of material or part	Maximum value of	
	Temperature	Temperature rise at an ambient air temperature not exceeding 40 °C
	°C	°C
1. Contacts in air:		
Copper, copper alloy or aluminium alloy which are silver faced (see notes 1, 2 and 8)	105	65
Bare copper or tinned aluminium alloy	75	35
2. Contacts in oil:		
Copper, copper alloy or aluminium alloy which are silver-faced (see note 2)	90	50
Bare copper or tinned aluminium alloy	80	40
3. Terminals of switches to be connected to external conductors by screws or bolts:		
Silver-faced (see note 3)	105	65
Bare	90	50
4. Metal parts acting as springs	(see note 4)	(see note 4)
5. Metal parts in contact with insulation of the following classes (see note 5):		
Class Y: for non-impregnated materials	90	50
Class A for materials immersed in oil or impregnated	100	60
Class E: in air	120	80
in oil	100	60
Class B: in air	130	90
in oil	100	60
Class F: in air	155	115
in oil	100	60
Enamel: oil base	100	60
synthetic, in air	120	80
synthetic, in oil	100	60
6. Any part of metal or of insulating material in contact with oil, except contacts	100	60
7. Oil for oil-immersed switches	90	50

NOTE 1. When applying the temperature rise of 65 °C, care should be taken to ensure that no damage is caused to the surrounding insulating materials.

NOTE 2. The quality of the silver facing shall be such that a layer of silver remains at the points of contact after the mechanical endurance test. Otherwise, the contacts shall be regarded as 'bare'.

NOTE 3. The values of temperature and temperature rise are valid whether or not the conductor connected to the terminals is silver-faced.

NOTE 4. The temperature shall not reach a value where the elasticity of the materials is impaired. For pure copper this implies a temperature limit of 75 °C.

NOTE 5. For an explanation of the classes see BS 2757.

NOTE 6. When materials other than those mentioned in table 5 are used, the nature and quality of these materials shall be considered.

NOTE 7. The limits for temperature rise of contacts in vacuum, gases other than air, and liquids other than oil are under consideration.

NOTE 8. It is essential that special care be taken when using silver-faced aluminium contacts in a corrosive atmosphere in outdoor installations.

11.1.2 Closed loop breaking capacity. General purpose switches with rated normal currents equal to or greater than 200 A shall be capable of breaking, at any voltage up to and including 0.25 times their rated voltage, any closed loop current up to and including their rated closed loop breaking capacity (see 3.23). Their rated closed loop breaking capacity shall equal their rated normal current.

11.1.3 Transformer off-load breaking capacity. All general purpose switches shall be capable of breaking, at any voltage up to and including their rated voltage, any transformer off-load current up to and including their rated transformer off-load breaking capacity (see 3.24).

11.1.4 Line-charging breaking capacity. General purpose switches with rated normal currents equal to or greater than 200 A shall be capable of breaking, at any voltage up to and including their rated voltage, any line-charging breaking current up to and including their rated line-charging breaking capacity (see 3.26).

11.1.5 Cable-charging breaking capacity. General purpose switches with rated normal currents equal to or greater than 200 A shall be capable of breaking, at any voltage up to and including their rated voltage, any cable-charging breaking current up to and including their rated cable-charging breaking capacity (see 3.27).

11.2 Transformer off-load switches

11.2.1 Transformer off-load breaking capacity. Transformer off-load switches shall be capable of breaking, at any voltage up to and including their rated voltage, any transformer off-load current up to and including their rated transformer off-load breaking capacity (see 3.24).

11.3 Single capacitor bank switches

11.3.1 Single capacitor bank breaking capacity. Single capacitor bank switches shall be capable of breaking, at any voltage up to and including their rated voltage, any single capacitor bank current up to and including their rated single capacitor bank breaking capacity (see 3.25).

NOTE 1. According to 3.34 their rated single capacitor bank breaking capacity equals their rated normal current.

NOTE 2. No concentrated capacitances should be connected to the supply side in close proximity to a single capacitor bank switch (see 3.35).

12. Behaviour in normal service conditions

When performing the operations in clause 11 the behaviour of the switch shall comply with the following conditions:

(a) During operation the switch shall neither show signs of excessive distress nor endanger the operator.

From liquid filled switches there shall be no outward emission of flame, and the gases produced together with the liquid carried with the gases shall be allowed to escape in such a way as not to cause electrical breakdown.

For other types of switches flame or metallic particles such as might impair the insulation level of the switch shall not be projected beyond the boundaries specified by the manufacturer.

(b) The overvoltages produced shall not exceed the assigned maximum overvoltages. External flashover shall not occur.

(c) After performing a number of operations corresponding to those specified in 36.14 for any of the appropriate test series 1 to 6, the mechanical parts and insulators of the switch shall be practically in the same condition as before the performance, the switch shall be able to carry its rated normal current without its temperature rise exceeding the values specified in table 5 and its short-circuit making performance shall meet the requirements specified in clause 15.

In case a single capacitor bank switch is required for very frequent operation, a special agreement between the purchaser and the manufacturer on the conditions of operation shall be made.

(d) After performing a number of operations corresponding to those specified in 36.14 for any of the appropriate test series 1 to 6, it may be necessary to carry out inspection of, and maintenance work on, the switch in order to restore it to the original conditions specified by the manufacturer before putting it back into service. For example, the following may be necessary.

(1) repair or replacement of the arcing contacts and any other specified renewable parts;

(2) renewal or filtration of the oil, or of any other extinguishing medium, and the addition of any quantity of the medium necessary to restore its normal level;

(3) removal from the insulators of deposit caused by the decomposition of the extinguishing medium.

(e) The isolating properties of a switch-disconnector in the open position shall not be reduced below those specified in clause 6, by the deterioration of insulating parts in the neighbourhood of, or parallel to, the isolating distance.

13. Rated short-time current

It is recommended that the rated short-time current of a switch be chosen from the following standard values:

3.15 kA	20 kA	50 kA
10 kA	25 kA	63 kA
12.5 kA	31.5 kA	100 kA
16 kA	40 kA	

The standard value of the short-time is 1 s.

If a value of more than 1 s is necessary, the value of 3 s is recommended.

NOTE. For switches backed by fuses which are not an integral part of them, short-circuit ratings may be selected, taking into account the limiting effects of the fuse on the current (if any) and on its duration.

14. Rated peak withstand current

The value of the rated peak withstand current shall be equal to 2.5 times the rated short-time current.

NOTE. For switches backed by fuses which are not an integral part of them, short-circuit ratings may be selected, taking into account the limiting effects of the fuse on the current (if any) and on its duration.

15. Rated short-circuit making capacity

The absence of any indication to the contrary on the rating plate implies that the switch has no rated short-circuit making capacity. If a switch has a rated short-circuit making capacity, this shall be equal to the rated peak withstand current. For voltages below the rated voltage, the short-circuit making capacity remains constant.

Indoor switches for all voltages and outdoor switches for voltages up to and including 38 kV shall have a rated short-circuit making capacity.

Switches which have a rated short-circuit making capacity shall be capable of making at any voltage up to and including their rated voltage any current up to and including their rated short-circuit making capacity.

NOTE. For switches backed by fuses which are not an integral part of them, short-circuit ratings may be selected, taking into account the limiting effects of the fuse on the current (if any) and on its duration.

16. Behaviour when carrying short-time currents

All switches shall be capable of carrying their rated peak withstand current and their rated short-time current without causing:

- mechanical damage to any part;
- separation of the contacts;
- a temperature rise that, added to the maximum temperature obtained when carrying the rated normal current continuously, is likely to damage the insulation of the current-carrying parts.

After the passage of these currents the switch shall be able to carry its rated normal current without its temperature rise exceeding the values specified in table 5 and to perform the operations specified in 36.14.

17. Behaviour when making short-circuit currents

Switches having a rated short-circuit making capacity shall, when making on short-circuit, comply with the following conditions of behaviour.

- (a) During operation the switch shall neither show signs of excessive distress nor endanger the operator.

From liquid filled switches there shall be no outward emission of flame, and the gases produced, together with the liquid carried with the gases, shall be allowed to escape in such a way as not to cause electrical breakdown.

For other types of switches flame or metallic particles such as might impair the insulation level of the switch shall not be projected beyond the boundaries specified by the manufacturer.

- (b) After performing operations corresponding to those specified in 36.14 for test duty 7, the mechanical parts and insulators of the switch shall be practically in the same condition as before. The switch shall be capable of carrying its rated normal current without the temperature rise of its metallic parts in contact with insulating material exceeding by more than 10 °C the values given for them in table 5. A general purpose switch shall still be capable of two breaking operations at its rated mainly active load breaking capacity. (For transformer off-load switches and single capacitor bank switches, the conditions of these two breaking operations are under consideration.) The short-circuit making capacity may be materially reduced.

- (c) It is understood that after performing operations corresponding to those specified in 36.14 for test duty 7, it may be necessary to carry out inspection of, and maintenance work on, the switch in order to restore it to the original conditions specified by the manufacturer before putting it back into service. For example, the following may be necessary:
 - (1) repair or replacement of the arcing contacts and any other specified renewable parts;
 - (2) renewal or filtration of the oil, or of any other extinguishing medium, and the addition of any quantity of the medium necessary to restore its normal level;
 - (3) removal from the insulators of deposit caused by the decomposition of the extinguishing medium.

- (d) The isolating properties of a switch-disconnector in the open position shall not be reduced below those specified in clause 6, by deterioration of insulating parts in the neighbourhood or parallel to the isolating distance.

Switches which do not have a short-circuit making capacity are generally damaged when closed on short-circuit and have then to be replaced. Appropriate precautions, for example the use of remote control, should be taken to avoid danger to the operator.

18. Rated pressure of compressed gas supply for operation

The rated pressure of a compressed gas supply for a pneumatic operating device is the pressure above atmospheric pressure at which the operating conditions are determined.

Preferred rated pressures are: 5, 10, 15 and 20 bar*.

The pneumatic operating device shall be capable of opening and closing the switch when the gas pressure is between 85 % and 110 % of the rated pressure.

19. Rated pressure of compressed gas supply for interruption

The rated pressure of compressed gas supply for interruption of a switch embodying confined gas interrupting devices is the pressure above atmospheric pressure at which the performance characteristics of the switch shall be determined.

The manufacturer shall establish and specify the value of rated pressure of compressed gas supply for interruption and the range of gas pressure within which the switch will perform in accordance with other provisions specified herein.

20. Rated supply voltage of an operating device or auxiliary circuit

The rated supply voltage of an operating device or an auxiliary circuit is the supply voltage which determines the conditions of operation and of heating, as well as the insulation of the circuit.

Supply voltage means the voltage measured across the terminals of the circuit on the switch itself during operation, including, if necessary, auxiliary equipment supplied or required by the manufacturer to be installed with the apparatus. It does not include voltage drop of the connections to the supply circuit.

The rated supply voltage should have one of the preferred values given in table 6.

* 1 bar = 10⁵ N/m² = 100 kPa.