



Specification for

**Air-break switches, air-break disconnectors,
air-break switch disconnectors and
fuse-combination units for voltages up to
and including 1000 V a.c. and 1200 V d.c.**



'Implementation of CENELEC HD 422'.

Spécification des interrupteurs dans l'air, sélectionneurs dans l'air, interrupteurs-sélectionneurs dans l'air et combinés à fusibles pour les tensions inférieures et égales à 1000 V en courant alternatif et 1200 V en courant continu

Spezifikation für Lastschalter in Luft, Trennschalter in Luft, Lasttrennschalter in Luft und Schalter-Sicherungseinheiten für Spannungen bis und einschließlich 1000 V Wechselstrom und 1200 V Gleichstrom

Foreword

This British Standard has been prepared under the authority of the Power Electrical Engineering Standards Committee.

It is related to Publication 408 published by the International Electrotechnical Commission (IEC), as amended by Amendment No. 1 dated September 1979. This British Standard is in agreement with Harmonization Document HD 422 as published by the European Committee for Electrotechnical Standardization (CENELEC), which has introduced changes to clauses 7.1.2, 7.1.4.2, 8.2.3.2, 8.2.4.6, 8.2.10.6 and C-8.2.4.4.

The products specified were previously covered in the following five British Standards which are now withdrawn.

- BS 861 'Air-break switches and isolators'
Part 1 'Switches and isolators for voltages not exceeding 660 volts and for currents not exceeding 200 amperes'
Part 2 'Switches and isolators for voltages not exceeding 600 volts and currents up to 1200 amperes a.c.'
- BS 2510 'Composite units of switches and fuses for use in industrial systems and domestic circuits'
- BS 3078 'Isolators (including selectors for alternating-current systems)'
- BS 3185 'Heavy-duty composite units of air-break switches and fuses for voltages not exceeding 660 V'

For ease of reproduction the text of IEC Publication 408 has been used as the basis for this British Standard.

Terminology. The words 'British Standard' should replace 'Recommendation' wherever it appears.

Cross-references. The references to other IEC Publications should be replaced by references to British Standards as follows.

Reference to IEC Publication

IEC Publication 144 'Degrees of protection of enclosures for low-voltage switchgear and controlgear'

IEC Publication 157 'Low-voltage switchgear and controlgear'
Part 1 'Circuit-breakers'

IEC Publication 158 'Low-voltage controlgear'
Part 1 'Contactors'

IEC Publication 292 'Low-voltage motor starters'
Part 1 'Direct-on-line (full voltage) a.c. starters'

IEC Publication 337 'Control switches (low-voltage switching devices for control and auxiliary circuits, including contactor relays.)'
Part 1 'General requirements'

IEC Publication 417 'Graphical symbols for use on equipment. Index, survey and compilation of the single sheets'

IEC Publication 439 (subsequently reissued as IEC Publication 439-1) 'Low-voltage switchgear and controlgear assemblies'

IEC Publication 447 'Standard directions of movement for actuators which control the operation of electrical apparatus'

Appropriate British Standard

BS 5420 'Specification for degrees of protection of enclosures of switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.'

BS 4752 'Specification for switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.'
Part 1 'Circuit-breakers'

BS 5424 'Specification for controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c.'
Part 1 'Contactors'

BS 4941 'Specification for motor starters' for voltages up to and including 1000 V a.c. and 1200 V d.c.
Part 1 'Direct-on-line (full voltage) a.c. starters'

BS 4794 'Specification for control switches' (switching devices, including contactor relays, for control and auxiliary circuits up to and including 1000 V a.c. and 1200 V d.c.)
Part 1 'General requirements'

BS 6217 'Guide to graphical symbols for use on electrical equipment'

BS 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.'

BS 6013 'Specification for standard direction of movement for actuators which control the operation of electrical apparatus'

Amendments issued since publication

Amd. No.	Date of issue	Text affected



CONTENTS

	Page
FOREWORD	Inside front cover
Clause	
1. GENERAL	2
1.1 Scope	2
1.2 Object	2
2. DEFINITIONS	2
3. CLASSIFICATION	6
4. CHARACTERISTICS OF EQUIPMENT	7
4.1 Summary of characteristics	7
4.2 Type of equipment	7
4.3 Rated values'	7
4.4 Auxiliary circuits	12
5. MARKINGS	13
6. STANDARD CONDITIONS FOR OPERATION IN SERVICE	13
6.1 Normal service conditions	13
7. STANDARD CONDITIONS FOR CONSTRUCTION	14
7.1 Mechanical design	14
7.2 Enclosures	15
7.3 Temperature rise	15
7.4 Dielectric properties	15
7.5 Operating conditions	15
7.6 Additional safety requirements for disconnectors and switch-disconnectors	15
8. TESTS	16
8.1 Verification of the characteristics of equipments	16
8.2 Type tests	18
8.3 Routine tests	31
APPENDIX A — Information to be given by the user when conditions for operation in service differ from the standard	32
APPENDIX B — Clearances and creepage distances	33
APPENDIX C — Equipment for direct switching of individual motors	34
FIGURES 1, 2 and 3	40-42

LOW-VOLTAGE AIR-BREAK SWITCHES, AIR-BREAK DISCONNECTORS, AIR-BREAK SWITCH-DISCONNECTORS AND FUSE-COMBINATION UNITS

1. General

1.1 Scope

This Recommendation applies to air-break switches, air-break disconnectors, air-break switch-disconnectors and fuse-combination units to be used in distribution circuits and motor circuits the rated voltage of which does not exceed 1 000 V a.c. or 1 200 V d.c.

Notes 1. — Depending on its design, a switch (or disconnector) can be referred to as “rotary switch (disconnector)”, “cam-operated switch (disconnector)”, “knife-switch (disconnector)”, etc.

2. — If they are not manually operated, switches and disconnectors may have to comply with additional requirements.

Any fuses incorporated shall conform to the requirements laid down in the relevant IEC fuse Recommendations.

This Recommendation does not apply to equipment coming within the scope of IEC Publication 157-1 “Circuit-breakers”, IEC Publication 158-1 “Contactors”, IEC Publication 292-1 “Motor starters” and IEC Publication 337-1 “Control switches”; however, when switches and fuse-combination units coming into the scope of this Recommendation are normally used to start, accelerate and/or stop a motor, they shall also comply with the additional requirements given in Appendix C.

This Recommendation does not include the additional requirements necessary for electrical apparatus for explosive gas atmospheres.

Notes 3. — In this Recommendation, the word “switch” also applies to the apparatus referred to in French as “commutateurs”, intended to modify the connections between several circuits, and inter alia to substitute a part of a circuit for another.

4. — As a general rule, in the rest of this Recommendation, switches, disconnectors, switch-disconnectors and fuse-combination units will be referred to as “equipment”

1.2 Object

The object of this Recommendation is to state:

- 1) the characteristics of the equipment;
- 2) the conditions with which the equipment must comply with reference to:
 - a) operation and behaviour in normal service,
 - b) operation and behaviour in case of specified abnormal conditions, e.g. short-circuit;
 - c) dielectric properties;
- 3) the tests intended for confirming that these conditions have been met and the methods to be adopted for these tests;
- 4) the data to be marked on the equipment.

2. Definitions

For the purpose of this Recommendation, the following definitions shall apply:

2.1 *Devices*2.1.1 *Switching device*

A device designed to make or break the current in one or more electric circuits.

2.1.2 *Mechanical switching device*

A switching device designed to close and open one or more electric circuits by means of separable contacts.

2.1.3 *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.

Note. — A switch may also be capable of making, but not breaking, short-circuit currents.

2.1.4 *Disconnecter (isolator)*

A mechanical switching device which, for reasons of safety, provides in the open position an isolating distance in accordance with specified requirements.

A disconnector is capable of opening and closing a circuit when either negligible current is broken or made, or when no significant change in the voltage across the terminals of each of the poles of the disconnector occurs. It is also capable of carrying currents under normal circuit conditions and carrying for a specified time currents under abnormal conditions such as those of short-circuit.

Notes 1. — “Negligible currents” imply currents such as the capacitance currents of bushings, busbars, connections, very short lengths of cables and currents of voltage transformers and dividers.

“No significant change in voltage” refers to such applications as the by-passing of induction voltage regulators or circuit-breakers.

2. — There are devices, referred to in this Recommendation as disconnectors, which possess a certain making and/or breaking capacity.

2.1.5 *Switch-disconnector (switch-isolator)*

A switch which, in the open position, satisfies the isolating requirements specified for a disconnector.

2.1.6 *Fuse*

A switching device that, by the melting of one or more of its specially designed and proportioned components, opens the circuit in which it is inserted and breaks the current when this exceeds a given value for a sufficient time.

Note. — The fuse comprises all the parts that form the complete switching device.

2.1.7 *Fuse-combination unit*

A combination of a switch, a disconnector or a switch-disconnector and one or more fuses in a composite unit, made by the manufacturer or in accordance with his instructions.

2.1.8 *Switch-fuse*

A switch in which one or more poles have a fuse in series in a composite unit.

2.1.9 *Disconnecter-fuse*

A disconnector in which one or more poles have a fuse in series in a composite unit.

2.1.10 *Fuse-switch*

A switch in which a fuse-link or a fuse carrier with fuse-link forms the moving contact of the switch.

2.1.11 *Fuse-disconnector (fuse-isolator)*

A disconnector in which a fuse-link or a fuse carrier with fuse-link forms the moving contact of the disconnector.

2.2 *Constructional elements*2.2.1 *Conductive part*

A part which is capable of conducting current although it may not necessarily be used for carrying service current.

2.2.2 *Exposed conductive part*

A conductive part which can be touched readily and which normally is not alive, but which may become alive under fault conditions.

Note. — Typical exposed conductive parts are walls of enclosures, operating handles, etc.

2.2.3 *Live part*

Any conductor or conductive part which is under a potential in normal use.

Note. — Live parts also include the neutral and conductive parts which are connected with it.

2.2.4 *Main circuit (of a switching device)*

All the conductive parts of a switching device included in the circuit which it is designed to close or open.

2.2.5 *Pole of a switching device*

The portion of a switching device associated exclusively with one electrically separated conducting path of its main circuit and excluding those portions which provide a means for mounting and operating all poles together.

Note. — A switching device is called single-pole if it has only one pole. If it has more than one pole, it may be called multipole (two-pole, three-pole, etc.) provided the poles are or can be coupled in such a manner as to operate together.

2.2.6 *Main contact (of a mechanical switching device)*

A contact included in the main circuit of a mechanical switching device, intended to carry in the closed position the current of the main circuit.

2.2.7 *Fuse-link (fuse-unit)*

The part of a fuse intended to be replaced after the fuse has operated.

2.3 *Conditions of operation*2.3.1 *Operation (of a mechanical switching device)*

The transfer of the moving contact(s) from one position to an adjacent position.

Notes 1. — This may be a closing operation or an opening operation.

2. — If distinction is necessary, an operation in the electrical sense, e.g. make or break, is referred to as a switching operation and an operation in the mechanical sense, e.g. close or open, is referred to as a mechanical operation.

2.3.2 *Operating cycle (of a mechanical switching device)*

A succession of operations from one position to another and back to the first position through all other positions, if any.

2.3.3 *Dependent manual operation (of a mechanical switching device)*

An operation 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.

2.3.4 *Stored energy operation (of a mechanical switching device)*

An operation by means of energy stored in the mechanism itself prior to the completion of the operation and sufficient to complete it under pre-determined conditions.

Note. — This kind of operation may be subdivided according to:

- 1) how the energy is stored (spring, weight, etc.);
- 2) how the energy originates (manual, electric, etc.);
- 3) how the energy is released (manual, electric, etc.).

2.3.5 *Independent manual operation (of a mechanical switching device)*

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

2.4 *Characteristic quantities*

2.4.1 *Rated value*

A stated value of any one of the characteristic quantities that serve to define the working conditions for which the equipment is designed and built.

2.4.2 *Utilization category (for a switching device)*

A combination of specified requirements, related to operating conditions, and selected to represent a significant group of practical applications.

Note. — The requirements to be specified may include such items as values of making and breaking capacities, the associated circuits, and the relevant conditions of use and behaviour.

2.4.3 *Prospective current (of a circuit, and with respect to an equipment)*

The current that would flow in the circuit, if each pole of the equipment were replaced by a conductor of negligible impedance.

Note. — The prospective current may be qualified in the same manner as an actual current, e.g.: prospective breaking current, prospective peak current, etc.

2.4.4 *Making capacity*

A value of current that a switch or a switch-disconnector is capable of making at a stated voltage and under prescribed conditions of use and behaviour.

For a.c., it is the r.m.s. value of the a.c. component.

2.4.5 *Short-circuit making capacity*

A value of prospective peak current that a switch or a switch-disconnector is capable of making at a stated voltage and under prescribed conditions including a short-circuit at the terminals of the apparatus.

2.4.6 *Breaking capacity*

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

For a.c., it is the r.m.s. value of the a.c. component.

2.4.7 *Short-time withstand current*

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

2.4.8 *Applied voltage*

The voltage which exists across the terminals of a pole of a switching device just before the making of the current.

2.4.9 Recovery voltage

The voltage which appears across the terminals of a pole of a switching device after the breaking of the current.

Note. — This voltage may be considered in two successive intervals of time, one during which a transient voltage exists, followed by a second one during which power-frequency voltage (Clause 2.4.9.2) alone exists.

2.4.9.1 Transient recovery voltage

The recovery voltage during the time in which it has a significant transient character.

Notes 1. — The transient voltage may be oscillatory or non-oscillatory or a combination of these depending on the characteristics of the circuit and the switching device. It includes the voltage shift of the neutral of a polyphase circuit.

2. — The transient recovery voltage in three-phase circuits is, unless otherwise stated, that across the first pole to clear because this voltage is generally higher than that which appears across each of the other two poles.

2.4.9.2 Power-frequency recovery voltage

The recovery voltage after the transient voltage phenomena have subsided.

Note. — This definition applies also to the case of d.c., the frequency then being considered as zero.

2.4.10 Clearance

The distance between two conductive parts along a string stretched the shortest way between these conductive parts.

2.4.10.1 Clearance between poles

The clearance between any conductive parts of adjacent poles.

2.4.10.2 Clearance to earth

The clearance between any conductive parts and any parts which are earthed or intended to be earthed.

2.4.10.3 Clearance between open contacts (gap)

The total clearance between the contacts, or any conductive parts connected thereto, of a pole of a mechanical switching device in the open position.

2.4.11 Creepage distance

The shortest distance along the surface of an insulating material between two conductive parts.

Note. — A joint between two pieces of insulating material is considered part of the surface.

2.4.12 Isolating distance (of a pole of a mechanical switching device)

The clearance between open contacts meeting the safety requirements specified for disconnectors.

3. Classification

3.1 According to the method of operation of manually operated equipments, these are designated as having:

- dependent manual operation (see Definition 2.3.3);
- independent manual operation (see Definition 2.3.5).

3.2 According to the degree of protection provided by the enclosure, distinction is made in accordance with IEC Publication 144.

4. Characteristics of equipment

4.1 Summary of characteristics

The characteristics of the equipment shall be stated in the following terms, where such terms are applicable:

- △ Type of equipment (see Clause 4.2);
- △ Rated values¹. (see Clause 4.3);
- Auxiliary circuits (see Clause 4.4);
- Degrees of protection provided by enclosures (see IEC Publication 144).

4.2 Type of equipment

The following shall be stated:

- 4.2.1 Number of poles
- 4.2.2 Number of positions (if more than two)
- 4.2.3 Kind of current

Kind of current (a.c. or d.c.) and, in the case of a.c., number of phases and rated frequency.

△ 4.3 Rated 'values'.

- △ Rated 'values'. are assigned by the manufacturer. They shall be stated in accordance with
- △ Clauses 4.3.1 to 4.3.13, but it is not necessary to establish all the rated 'values'. listed.

Note. — Switches, switch-disconnectors and fuse-combination units normally intended for direct switching of individual motors shall also comply with the additional requirements of Appendix C.

4.3.1 Rated voltages

An equipment is defined by the following rated voltages:

4.3.1.1 Rated operational voltages

A rated operational voltage (U_e) of an equipment is a value of voltage which, combined with a rated operational current, determines the application of the equipment and to which are referred the making and breaking capacities, and the utilization category.

For polyphase circuits, it is stated as the voltage between phases.

Note. — An equipment may be assigned a number of combinations of rated operational voltages and rated operational currents for different utilization categories.

4.3.1.2 Rated insulation voltage

The rated insulation voltage (U_i) of an equipment is the value of voltage which designates it and to which dielectric tests, clearances and creepage distances are referred.

Unless otherwise stated, the rated insulation voltage is the value of the maximum rated operational voltage of the equipment. In no case, shall the maximum rated operational voltage exceed the rated insulation voltage.

4.3.2 Rated currents

An equipment is defined by the following rated currents:

△ 4.3.2.1 Rated conventional thermal current

The rated conventional thermal current (I_{th}) of an equipment is the maximum current stated by the manufacturer that the unenclosed equipment can carry in 8 h duty (see Sub-clause 4.3.4.1) when tested in free air, without the temperature-rise of its several parts exceeding the limits specified in Sub-clause 7.3 (Table V) when tested according to Sub-clause 8.2.2.

Notes 1. — Free air is understood to be that obtained under normal indoor conditions reasonably free from dust and external radiation.

2. — Unenclosed equipment is equipment supplied by the manufacturer without an enclosure or equipment supplied by the manufacturer with an enclosure forming an integral part of the equipment.

4.3.2.2 Rated enclosed thermal current

The rated enclosed thermal current (I_{the}) of an equipment is the maximum current stated by the manufacturer that the equipment can carry in the stated duty (see Sub-clause 4.3.4) when mounted in a specified enclosure. Tests for this rating shall be in accordance with Sub-clause 8.2.2, but are not mandatory if the test for "rated conventional thermal current" has been made, and the manufacturer is prepared to state an enclosed thermal current rating.

↑ The rating may be an unventilated rating, in which case the enclosure shall be of the size stated by the manufacturer to be the smallest enclosure that is applicable in service. Alternatively, the rating may be a ventilated rating with the ventilation in accordance with the manufacturer's data.

Note. — It is not possible to usefully define a service thermal current rating as the installation and service conditions can vary greatly. (The "rated current" Sub-clause 4.2 of IEC Publication 439 is in effect the "service thermal current rating".)

For fuse-combination units, the temperature-rises of the fuse-link contacts shall not exceed the value which ensures compliance with Notes 1 and 2 of Table V (see Sub-clause 7.3) with respect to the fuse elements; the manufacturer of the fuse-combination unit shall state the type of fuse-links to be used.

4.3.2.3 *Rated operational currents or rated operational powers*

A rated operational current (I_o) of an equipment is stated by the manufacturer and takes into account the rated operational voltage (see Clause 4.3.1.1), the rated frequency (see Clause 4.3.3), the rated duty (see Clause 4.3.4), the utilization category (see Clause 4.3.11) and the type of protective enclosure.

In the case of equipments for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by the indication of the maximum rated power output, at the rated operational voltage considered, of the motor for which the equipment is intended. The manufacturer shall be prepared to state the relationship assumed between the current and the power.

4.3.3 *Rated frequency*

The supply frequency for which an equipment is designed and to which the other characteristic values correspond.

4.3.4 *Rated duty*

The rated duties considered as normal are as follows:

4.3.4.1 *Eight-hour duty*

Duty in which the main contacts of an equipment remain closed, whilst carrying a steady current long enough for the equipment to reach thermal equilibrium but not for more than eight hours without interruption.

Notes 1. — This is the basic duty on which the rated thermal current of the equipment is determined.
2. — Interruption means breaking of the current by operation of the equipment.

4.3.4.2 *Uninterrupted duty*

Duty in which the main contacts of an equipment remain closed, whilst carrying a steady current without interruption for periods of more than eight hours (weeks, months, or even years).

Note. — This kind of service is set apart from the eight-hour duty because oxides and dirt can accumulate on the contacts and lead to progressive heating. Uninterrupted duty can be taken account of either by a derating factor, or by special design consideration (e.g.: silver contacts) (see Table V).

4.3.5 *Rated making capacity*

The rated making capacity of a switch or a switch-disconnector is a value of current, stated by the manufacturer, determined under steady-state conditions, which the apparatus can satisfactorily make under specified making conditions.

The making conditions which shall be specified are:

- the voltage between poles before contact making;
- the characteristics of the test circuit.

The rated making capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category, according to Table II.

It is recalled that, for a.c., the rated making capacity is expressed by the r.m.s. value of the a.c. component.

Note. — In the case of disconnectors having a making capacity although they be of utilization category AC-20 or DC-20, this value shall be stated separately by the manufacturer.

The rated making capacity is only valid when the apparatus is operated in accordance with the requirements of Clause 7.5.

4.3.6 *Rated breaking capacity*

The rated breaking capacity of a switch or a switch-disconnector is a value of current, stated by the manufacturer, which the apparatus can satisfactorily break under specified breaking conditions at the rated operational voltage.

The breaking conditions which shall be specified are:

- the characteristics of the test circuit;
- the recovery voltage.

The rated breaking capacity is stated by reference to the rated operational voltage and rated operational current and to the utilization category, according to Table II.

An apparatus shall be capable of breaking any value of the load current up to its highest rated breaking capacity according to Clause 4.3.11.

It is recalled that, for a.c., the rated breaking capacity is expressed by the r.m.s. value of the a.c. component.

Note. — In the case of disconnectors having a breaking capacity although they be of utilization category AC-20 or DC-20, this value shall be stated separately by the manufacturer.

The rated breaking capacity is only valid when the apparatus is operated in accordance with the requirements of Clause 7.5.

4.3.7 *Rated short-time withstand current*

The rated short-time withstand current of a switch, a disconnector or a switch-disconnector is the value of short-time withstand current that the apparatus can carry without damage (see Clause 8.2.5).

Unless otherwise stated by the manufacturer, the duration is one second, and the value of the current is twenty times the maximum rated operational current.

Note. — For values different from these, the manufacturer shall state both the value of the short-time withstand current and the duration.

For a.c., the value of the current is the r.m.s. value of the a.c. component and it is assumed that the highest peak value likely to occur does not exceed n times this r.m.s. value, the factor n being given by Table X.

4.3.8 *Rated short-circuit making capacity*

The rated short-circuit making capacity of a switch or a switch-disconnector is the value of short-circuit making capacity assigned to the apparatus by the manufacturer for the rated operational voltage, at rated frequency (if any) and at a specified power-factor (or time-constant). It is expressed as the maximum prospective peak current.

For a.c., the relationship between power-factor, prospective peak current and r.m.s. current shall be in accordance with Table X.

4.3.9 *Rated conditional short-circuit current*

The rated conditional short-circuit current of an equipment is the value of prospective current, stated by the manufacturer, which the equipment, protected by a specified current-limiting

switching device, can satisfactorily withstand for the operating time of this device under the test conditions specified in Clause 8.2.6.

Notes 1. — For a.c., the rated conditional short-circuit current is expressed by the r.m.s. value of the a.c. component.

2. — The current-limiting switching device may either form an integral part of the equipment or be a separate unit.

4.3.10 Rated fused short-circuit current

The rated fused short-circuit current of an equipment is the rated conditional short-circuit current when the current-limiting switching device is a fuse (see Clause 8.2.7).

The details of the fuse shall be stated by the manufacturer.

4.3.11 Utilization category

The utilization categories as given in Table I and Table C-I (see Appendix C) are considered standard in this Recommendation.

Note. — The utilization categories referred to in Tables I and II do not apply to an equipment normally used to start, accelerate and/or stop individual motors. The utilization categories for such an equipment are dealt with in Appendix C (see Clause C-4.3.6).

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and the rated operational voltage, as well as the power-factors or time-constants of the circuit. The conditions for making and breaking given in Table II correspond in principle to the applications listed in Table I.

TABLE I
Utilization categories

Nature of current	Category	Typical applications
Alternating current	AC-20	Connecting and disconnecting under no-load conditions.
	AC-21	Switching of resistive loads, including moderate overloads.
	AC-22	Switching of mixed resistive and inductive loads, including moderate overloads.
	AC-23	Switching of motor loads or other highly inductive loads.
Direct current	DC-20	Connecting and disconnecting under no-load conditions.
	DC-21	Switching of resistive loads, including moderate overloads.
	DC-22	Switching of mixed resistive and inductive loads, including moderate overloads (e.g.: shunt motors).
	DC-23	Switching of highly inductive loads (e.g.: series motors).
<i>Note.</i> — The switching of capacitors or of tungsten filament lamps shall be subject to special agreement between manufacturer and user.		

TABLE II
Verification of rated making and breaking capacities (See Clause 8.2.4)
Conditions for making and breaking corresponding to the several utilization categories⁽¹⁾

	Category	Value of the rated operational current	Make			Break		
			I/I_e	U/U_e	$\cos \phi$	I_c/I_e	U_r/U_e	$\cos \phi$
A.C.	AC-20	(All values)	(²)	1.1	(²)	(²)	1.1	(²)
	AC-21	(All values)	1.5	1.1	0.95	1.5	1.1	0.95
	AC-22	(All values)	3	1.1	0.65	3	1.1	0.65
	AC-23	$I_e \leq 17 \text{ A}$	10	1.1	0.65	8	1.1	0.65
		$17 \text{ A} < I_e \leq 100 \text{ A}$	10	1.1	0.35	8	1.1	0.35
		$I_e > 100 \text{ A}$	8 (³)	1.1	0.35	6 (⁴)	1.1	0.35
D.C.	DC-20	(All values)	I/I_e	U/U_e	L/R (ms)	I_c/I_e	U_r/U_e	L/R (ms)
	DC-21	(All values)	(²)	1.1	(²)	(²)	1.1	(²)
	DC-22	(All values)	1.5	1.1	1	1.5	1.1	1
	DC-23	(All values)	4	1.1	2.5	4	1.1	2.5
	DC-23	(All values)	4	1.1	15	4	1.1	15

⁽¹⁾ I_e Rated operational current (see Clause 4.3.2.3).
 U_e Rated operational voltage (see Clause 4.3.1.1);
 I Current made;
 U Voltage before make;
 U_r Recovery voltage;
 I_c Current broken.

(1) For a.c., the conditions for making are expressed in r.m.s. values, but it is understood that the peak value of asymmetrical current, corresponding to the power-factor of the circuit, may assume a higher value.

(2) If the making and/or breaking capacities are different from zero, the values of current and the power-factor (time-constant) shall be stated by the manufacturer.

(3) With a minimum of 1000 A for I .

(4) With a minimum of 800 A for I_c .

4.3.12 Mechanical endurance

With respect to its resistance to mechanical wear, an equipment is characterized by the number, stated by the manufacturer, of no-load operating cycles (i.e., without current on the main contacts) which can be made before it becomes necessary to service or replace any mechanical parts; however, normal maintenance according to the manufacturer's instructions is permitted.

The preferred numbers of no-load operating cycles are:
300, 1 000, 3 000, 10 000, 30 000, 100 000, 300 000 and 1 000 000.

Each operating cycle consists of one closing operation followed by one opening operation.

If the number of operating cycles is not stated by the manufacturer, the values in Table III shall apply.

TABLE III
Number of mechanical operating cycles, unless otherwise stated

Rated operational current I_e (in amperes)	Number of mechanical operating cycles
$0 < I_e \leq 63$	10 000
$63 < I_e \leq 250$	3 000
$250 < I_e \leq 800$	1 000
$800 < I_e$	300

4.3.13 *Electrical endurance*

With respect to its resistance to electrical wear, an equipment is characterized by the number of on-load operating cycles, corresponding to the service conditions given in Table IV, which can be made without repair or replacement.

Unless otherwise stated by the manufacturer, the number of on-load operating cycles for all utilization categories, except AC-20 and DC-20, shall be not less than 1/20 of the number of no-load operating cycles corresponding to the mechanical endurance of the equipment. For the case of utilization categories AC-20 and DC-20, when Note (2) of Table II (see Clause 4.3.11) applies, the number of on-load operating cycles shall be stated by the manufacturer.

TABLE IV

*Verification of the number of on-load operating cycles
Conditions for making and breaking corresponding to the several utilization categories⁽¹⁾*

	Category	Value of the rated operational current	Make			Break		
			I/I_e	U/U_e	$\cos \varphi$	I_c/I_e	U_r/U_e	$\cos \varphi$
A.C.	AC-21	(All values)	1	1	0.95	1	1	0.95
	AC-22	(All values)	1	1	0.65	1	1	0.65
	AC-23 {	$I_e \leq 17 \text{ A}$	1	1	0.65	1	1	0.65
		$I_e > 17 \text{ A}$	1	1	0.35	1	1	0.35
D.C.	DC-21	(All values)	I/I_e	U/U_e	L/R (ms)	I_c/I_e	U_r/U_e	L/R (ms)
	DC-22	(All values)	1	1	1	1	1	1
	DC-23	(All values)	1	1	2	1	1	2
		(All values)	1	1	7.5	1	1	7.5

 I_e Rated operational current (see Clause 4.3.2.3); U Voltage before make;

U_e Rated operational voltage (see Clause 4.3.1.1); U_r Recovery voltage;

I Current made; I_c Current broken.

(1) For a.c., the conditions for making are expressed in r.m.s. values, but it is understood that the peak value of asymmetrical current, corresponding to the power-factor of the circuit, may assume a higher value.

4.4 *Auxiliary circuits*

The characteristics of auxiliary circuits are:

- a) the number of those circuits;
- b) the number and kind of contacts (a-contact, b-contact, etc.);
- c) for each of these circuits:
 - rated voltage;
 - rated frequency, if any;
 - rated current;
 - rated making and breaking capacities of the contacts.

Unless otherwise stated, the rated current of auxiliary circuits is 6 A and the rated voltage and frequency (if any) of the auxiliary circuits are the rated voltage and frequency of the main circuit.

5. Markings

Each equipment shall be marked in a durable manner with the following data. The markings shall be on the equipment itself or on a nameplate or nameplates attached to the equipment, and shall be located in a place such that they are visible and legible when the equipment is installed.

- a) the manufacturer's name or trademark;
- b) type designation or serial number;
- c) number of this Recommendation;
- d) rated operational voltages (see Clause 4.3.1.1);
-  e) utilization category and rated operational currents (or rated powers), at the rated operational voltages of the equipment (see Sub-clause 4.3.2.3);
- f) either value of the rated frequency, e.g.: ~ 50 Hz or the indication "d.c." (or the symbol ---).

If not evident from information stated elsewhere by the manufacturer, the following shall also be stated on the equipment nameplate:

-  g) rated insulation voltage (see Clause 4.3.1.2);
-  h) rated thermal current (see Sub-clauses 4.3.2.1 and 4.3.2.2);
- i) rated duty (see Clause 4.3.4);
- j) rated short-time withstand current together with its duration, if applicable (see Clause 4.3.7);
- k) rated short-circuit making capacity, if applicable (see Clause 4.3.8);
- l) rated conditional short-circuit current, if applicable (see Clause 4.3.9);
- m) rated fused short-circuit current with prescribed fuse-link(s), if applicable (see Clause 4.3.10);
- n) IP number, in case of an enclosed equipment.

Note. — If the available space is insufficient to carry all the above data, the equipment shall carry at least the information under a) and b) permitting the complete data (in particular, in case of a fuse-combination unit, the relevant characteristics of the fuse-links to be used) to be obtained from the manufacturer.

6. Standard conditions for operation in service

6.1 Normal service conditions

Equipments complying with this Recommendation shall be capable of operating under the following standard conditions.

For non-standard conditions in service, see Appendix A.

6.1.1 Ambient air temperature

The ambient air temperature does not exceed $+40^\circ\text{C}$ and its average over a period of 24 h does not exceed $+35^\circ\text{C}$.

The lower limit of the ambient air temperature is -5°C .

Note. — Equipments intended to be used in ambient air temperatures above $+40^\circ\text{C}$ (e.g. in forges, boiler rooms, tropical countries) or below -5°C shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

6.1.2 Altitude

The altitude of the site of installation does not exceed 2 000 m (6 600 ft).

Note. — For installations at higher altitudes, it is necessary to take into account the reduction of the dielectric strength and of the cooling effect of the air. Equipments so used shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may take the place of such an agreement.

6.1.3 *Atmospheric conditions*

The air is clean and its relative humidity does not exceed 50% at a maximum temperature of + 40 °C. Higher relative humidities may be permitted at lower temperatures, e.g. 90% at + 20 °C. Care should be taken of moderate condensation which may occasionally occur due to variations in temperature.

6.1.4 *Conditions of installation*

The equipment is installed in accordance with the manufacturer's instructions.

7. *Standard conditions for construction*7.1 *Mechanical design*7.1.1 *General*

Materials shall be suitable for the particular application.

The closed and the open positions of the equipment shall be definite and shall be clearly indicated either adjacent to the actuator or by the position of the latter. If symbols are used, "I" and "O" shall be used to indicate the closed and open positions respectively.

7.1.2 *Actuator (operating handle)*

The actuator of the equipment shall be insulated from the live parts for the rated insulation voltage.

Moreover:

- if it is made of metal, it shall be capable of being satisfactorily connected to a protective conductor unless it is provided with additional reliable insulation;
- if it is made of or completely covered by insulating material, any internal metal parts, which might become accessible in the event of insulation damage, shall also be insulated from live parts for the rated insulation voltage or shall be capable of being satisfactorily connected to a protective conductor.



* The direction of the movement of the actuator shall comply with the requirements of IEC Publication 447.

Note. — The latter publication was accepted as CENELEC Harmonization Document HD 331.

7.1.3 *Clearances and creepage distances*

See Appendix B.

7.1.4 *Terminals*

Terminal connections shall be such that the conductors may be connected by means of screws or other equivalent means so as to ensure that the necessary contact pressure is maintained permanently.

Terminals shall be so designed that they clamp the conductor between metal surfaces with sufficient contact pressure and without significant damage to the conductor.

Terminals shall not allow the conductors to be displaced, or be displaced themselves in a manner detrimental to the operation or the insulation (by reducing clearances and/or creepage distances).

7.1.4.1 *Arrangement of terminals*

The terminals intended for the connection of external conductors shall be so arranged that they are readily accessible under the intended conditions of use.