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Interrupteurs à basse tension dans l'air, sectionneurs à basse tension dans l'air, interrupteurs-sectionneurs à basse tension dans l'air et combinés à fusibles à basse tension

Low-voltage air-break switches, air-break disconnectors, air-break switch-disconnectors and fuse-combination units



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INTERNATIONAL ELECTROTECHNICAL COMMISSION

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

FOREWORD

- 1) The formal decisions or agreements of the IEC on technical matters, prepared by Technical Committees on which all the National committees having a special interest therein are represented, express, as nearly as possible, an international consensus of opinion on the subjects dealt with.
- 2) They have the form of recommendations for international use and they are accepted by the National Committees in that sense.
- 3) In order to promote international unification, the IEC expresses the wish that all National Committees should adopt the text of the IEC Recommendation for their national rules in so far as national conditions will permit. Any divergence between the IEC Recommendations and the corresponding national rules should, as far as possible, be clearly indicated in the latter.

PREFACE TO THE FIRST EDITION

This Recommendation has been prepared by Sub-Committee 17B, Low-Voltage Switchgear and Controlgear, of IEC Technical Committee No. 17, Switchgear and Controlgear.

Work was commenced in January 1969; two other drafts were elaborated in October 1969 and November 1970. As a result of the meeting held in Brussels in 1971, a final draft was submitted to the National Committees for approval under the Six Months' Rule in November 1971.

The following countries voted explicitly in favour of publication:

Australia	Poland
Austria	Portugal
Belgium	Romania
Czechoslovakia	South Africa
Denmark	Sweden
France	Switzerland
Germany	Turkey
Israel	Union of Soviet
Italy	Socialist Republics
Japan	United Kingdom
Netherlands	United States of America
Norway	Yugoslavia

PREFACE TO THE SECOND EDITION

This standard has been prepared by Sub-Committee 17B: Low-voltage Switchgear and Controlgear, of IEC Technical Committee No. 17: Switchgear and Controlgear.

This second edition is based on the first edition, 1972, Amendment No. 1, 1979 and Amendment No. 2, 1983.

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

1. General

1.1 Scope

This standard 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 standards.

This standard 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 standard are normally used to start, accelerate and/or stop a motor, they shall also comply with the additional requirements given in Appendix C.

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

Notes 3. — In this standard, 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 one part of a circuit for another.

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

1.2 Object

The object of this standard 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 standard, 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 standard 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 live, but which may become live 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 conductor 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 (Sub-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 equipment, these are designated as having:

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

3.2 According to the degree of protection provided by the enclosure, distinction is made in accordance with IEC Publication 144: Degrees of Protection of Enclosures for Low-voltage Switchgear and Controlgear.

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 Sub-clause 4.2);

Rated values (see Sub-clause 4.3);

Auxiliary circuits (see Sub-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 Sub-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_o) 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_e) of an equipment is stated by the manufacturer and takes into account the rated operational voltage (see Sub-clause 4.3.1.1), the rated frequency (see Sub-clause 4.3.3), the rated duty (see Sub-clause 4.3.4), the utilization category (see Sub-clause 4.3.11) and the type of protective enclosure.

In the case of equipment 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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 Sub-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 standard.

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 Sub-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 Sub-clause 8.2.4)
Conditions for making and breaking corresponding to the several utilization categories¹⁾

	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-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	$I_c \leq 17 \text{ A}$	10	1.1	0.65	8	1.1	0.65
		$17 \text{ A} < I_c \leq 100 \text{ A}$	10	1.1	0.35	8	1.1	0.35
		$I_c > 100 \text{ A}$	$8^{3)}$	1.1	0.35	$6^{4)}$	1.1	0.35
D.C.	DC-20	(All values)	²⁾	1.1	²⁾	²⁾	1.1	²⁾
	DC-21	(All values)	1.5	1.1	1	1.5	1.1	1
	DC-22	(All values)	4	1.1	2.5	4	1.1	2.5
	DC-23	(All values)	4	1.1	15	4	1.1	15
I_e Rated operational current (see Sub-clause 4.3.2.3); U_e Rated operational voltage (see Sub-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 1 000 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 (A)	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 Sub-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 categories¹⁾*

	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 Sub-clause 4.3.2.3);
 U_e Rated operational voltage (see Sub-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.

4.4 Auxiliary circuits

The characteristics of auxiliary circuits are:

- the number of those circuits;
- the number and kind of contacts (a-contact, b-contact, etc.);
- 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:

- the manufacturer's name or trade mark;
- type designation or serial number;
- number of this standard;
- rated operational voltages (see Sub-clause 4.3.1.1);