



BS 5424 : Part 1 : 1977

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Specification for
Controlgear for voltages up to and including
1000 V a.c. and 1200 V d.c.

Part 1. Contactors



(Implementation of CENELEC HD 419)

Spécification de l'appareillage de commande pour les tensions inférieures
et égales à 1000 V en courant alternatif et 1200 V en courant continu
Partie 1. Contacteurs

Spezifikation für Befehlschaltgeräte bis und einschließlich
1000 V Wechselstrom und 1200 V Gleichstrom
Teil 1. Schütze

BS 5425 : Part 1 : 1977

Foreword

This British Standard has been prepared under the authority of the Power Electrical Engineering Standards Committee. It is related to Publication 158-1 'Low voltage controlgear' Part 1 'Contactors' published by the International Electrotechnical Commission (IEC), as amended by IEC Publications 158-1A and 158-1B. This British Standard is in agreement with Harmonization Document HD 419 as published by the European Committee for Electrotechnical Standardization (CENELEC) which has introduced changes to clauses 7.1.3.2 and 7.2.2 and precludes the incorporation of IEC Publication 158-1C : 1982. This standard is a revision of BS 775 'Contactors' Part 1 'Contactors for voltages up to and including 1000 volts a.c. and 1200 volts d.c.' It has been necessary to adopt a new number to align with the IEC practice of having separate numbers for high and low voltages. Part 2 'A.C. contactors for voltages above 1 kV and up to and including 12 kV' of BS 775 remains for voltages above 1000 V a.c. and 1200 V d.c. If further Parts are added to IEC Publication 158, it will be possible to provide parallel Parts to BS 5424.

Because the text of an IEC Publication has been copied it includes some minor material not appropriate to a British Standard.

For the purposes of this British Standard the text of IEC 158-1 given in this publication should be modified as follows.

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 85 'Recommendations for the classification of materials for the insulation of electrical machinery and apparatus in relation to their thermal stability in service'

IEC Publication 112 'Recommended method for determining the comparative tracking index of solid insulating material under moist conditions'

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

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

IEC Publication 269-1 'Low-voltage fuses' Part 1 'General requirements'

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

IEC Publication 410 'Sampling plans and procedures for inspection by attributes'

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'

Appropriate British Standard

BS 2757 'Classification of insulating materials for electrical machinery and apparatus on the basis of thermal stability in service'

BS 3781 'Method for determining the comparative tracking index of solid insulating material'

BS 5420 '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 'Switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. Part 1 'Circuit breakers'

BS 88 'Cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c.' Part 1 'General requirements'

BS 1361 'Cartridge fuses for a.c. circuits in domestic and similar premises'

BS 1362 'General purpose fuse links for domestic and similar purposes (primarily for use in plugs)'

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 6001 'Sampling procedures and tables for inspection by attributes'

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.'

Text changes**IEC reference**

Text to be amended

1.1

Delete Note 1

4.4.1

Two British Standard values of rated control circuit voltage, 50 V d.c. and 240 V a.c., are to be added to those of Table IV

Amendments issued since publication

Amd. No.	Date of issue	Text affected



Documents

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LOW-VOLTAGE CONTROLGEAR

Part 1: Contactors

1. General

1.1 Scope

This Recommendation applies to contactors intended for closing and opening electric circuits and, if combined with suitable relays, for protecting these circuits against operating overloads which may occur therein.

It applies only to contactors, the main contacts of which are intended to be connected to circuits, the rated voltage of which does not exceed 1 000 V a.c. or 1 200 V d.c.

Notes 1. — In the present absence of international specifications, an agreement shall take place between manufacturer and user in the case of a voltage exceeding 1 000 V a.c. or 1 200 V d.c., the present Publication being considered as a basis wherever applicable.

2. — Contactors which are intended to provide short-circuit protection shall additionally satisfy the relevant conditions specified for circuit-breakers (IEC Publication 157-1).

1.2 Object

The object of this Recommendation is to state:

1. the characteristics of contactors;
2. the conditions with which contactors shall comply with reference to:
 - a) their operation and behaviour;
 - b) their dielectric properties;
 - c) the degrees of protection provided by their enclosures;
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 apparatus.

2. Definitions

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

2.1 Definitions concerning contactors

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 Controlgear

A general term covering switching devices and their combination with associated control, measuring, protective and regulating equipment, also assemblies of such devices and equipment with associated interconnections, accessories, enclosures and supporting structures, intended in principle for the control of power consuming equipment.

2.1.4 *Contactor (mechanical)*

A mechanical switching device having only one position of rest, operated otherwise than by hand, capable of making, carrying and breaking currents under normal circuit conditions including operating overload conditions.

Notes 1. — A contactor is usually intended to operate frequently.

2. — A contactor may also be capable of making and breaking short-circuit currents.

3. — In French, a contactor the main contacts of which are closed in the position of rest is usually called "rupteur". The word "rupteur" has no equivalent in the English language.

2.1.5 (Vacant.)

2.1.6 *Electromagnetic contactor*

A contactor in which the force for closing or opening the main contacts is provided by an electro-magnet.

2.1.7 *Pneumatic contactor*

A contactor in which the force for closing or opening the main contacts is provided by a device using compressed air, without the use of electrical means.

2.1.8 *Electro-pneumatic contactor*

A contactor in which the force for closing or opening the main contacts is provided by a device using compressed air under the control of electrically operated valves.

2.1.9 *Latched contactor*

A contactor, the moving elements of which leave the position of rest when the operating means are energized, but which are prevented by means of a latching arrangement from returning to the position of rest when the operating means are de-energized. The latching and the release of the latching may be mechanical, magnetic, electrical, pneumatic, etc.

Note. — Because of the latching, the latched contactor actually acquires a second position of rest and, according to the definition 2.1.4, it is not a contactor. However, since the latched contactor in both its utilization and its design is more closely related to contactors in general than to any other classification of switching device, it is considered proper to require that it complies with the specifications for contactors wherever they are applicable.

2.1.10 *Main circuit*

All the conducting parts of a contactor included in the circuit which it is designed to close or open.

2.1.11 *Pole of a contactor*

The portion of a contactor 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 contactor 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.

2.1.12 *Main contact*

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

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2.1.13 *Breaking current*

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

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

2.1.14 *Breaking capacity*

A value of breaking current that the contactor is capable of breaking at a stated voltage and under prescribed conditions of use and behaviour.

2.1.15 *Making capacity*

A value of current that the contactor 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.

2.1.16 *Recovery voltage*

The voltage which appears across the terminals of a pole of a contactor 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 2.1.16.2) alone exists.

2.1.16.1 *Transient recovery voltage (restriking 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 contactor. It includes the voltage shift of the neutral of a poly-phase 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.

2.1.16.2 *Power-frequency recovery voltage*

The recovery voltage after the transient voltage phenomena have subsided.

Notes 1. — The power-frequency recovery voltage may be referred to as a percentage of the rated voltage.

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

2.1.17 *Short-time withstand current*

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

2.1.18 *Over-current*

Any current exceeding the rated current.

2.1.19 *Overload*

Operating conditions in an electrically undamaged circuit, which cause an over-current.

Note. — An overload may cause damage if sustained for a sufficient time.

2.1.20 *Conducting part*

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

2.1.21 *Clearance*

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

2.1.21.1 *Clearance between poles*

The clearance between any conducting parts of adjacent poles.

2.1.21.2 *Clearance to earth*

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

2.1.21.3 *Clearance between open contacts (gap)*

The total clearance between the contacts, or any conducting parts connected thereto, of a pole of a contactor in the open position.

2.1.22 *Creepage distance*

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

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

2.1.23 *Accidentally dangerous part*

A conducting part which can be touched readily by an operator and which is normally not alive, but which may become alive, for instance as a result of an insulation failure.

Note. — Typical accidentally dangerous parts are walls of enclosures, operating handles, etc.

2.1.24 *Ambient air temperature*

The temperature, determined under prescribed conditions, of the air surrounding the complete contactor (e.g., for enclosed contactors, it is the air outside the enclosure).

2.2 *Definitions concerning positions, control and auxiliary circuits of a contactor*

2.2.1 *Position of rest*

The position which the moving elements of the contactor take up when its electro-magnet or its compressed-air device is not energized.

2.2.2 *Control circuit*

All the conducting parts of a contactor (other than the main circuit) used for the closing operation or opening operation, or both, of the contactor.

Note. — Pneumatic contactors do not include control circuits.

2.2.3 *Control contact*

A contact included in a control circuit of a contactor and mechanically operated by the contactor.

Note. — A control contact is part of the design of a contactor.

2.2.4 *Auxiliary circuit*

All the conducting parts of a contactor intended to be included in a circuit other than the main circuit and the control circuits of the contactor.

Note. — Some auxiliary circuits serve supplementary requirements such as signalling, interlocking, etc., and as such they may be part of the control circuit of another switching device.

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2.2.5 *Auxiliary contact*

A contact included in an auxiliary circuit of a contactor and mechanically operated by the contactor.

Note. — An auxiliary contact is intended to satisfy supplementary requirements such as signalling, interlocking, etc., and as such it may be part of a control circuit of another switching device.

2.2.6 *a-contact (make contact)*

A control or auxiliary contact which is closed when the main contacts of the contactor are closed and open when they are open.

2.2.7 *b-contact (break contact)*

A control or auxiliary contact which is open when the main contacts of the contactor are closed and closed when they are open.

2.2.8 *Closed position*

The position in which the pre-determined continuity of the main circuit of the contactor is secured.

2.2.9 *Open position*

The position in which the pre-determined clearance between open contacts in the main circuit of the contactor is secured.

2.2.10 *Operation (of a contactor)*

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

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.

2.2.11 *Operating cycle (of a contactor)*

A succession of operations from one position to the other and back to the first position.

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

2. — A succession of operations not forming an operating cycle is referred to as an *operating series*.

2.2.12 *Closing operation*

An operation by which the contactor is brought from the open position to the closed position.

2.2.13 *Opening operation*

An operation by which the contactor is brought from the closed position to the open position.

3. **Classification**

3.1 According to the method of control, contactors are designated as:

- electromagnetic,
- pneumatic,
- electro-pneumatic.

Note. — This Recommendation may also concern contactors fitted with other types of control as far as it is practically applicable.

- 3.2 According to the interrupting medium, contactors are divided into different groups, e.g.:
- air break,
 - oil-immersed break.
- 3.3 According to the degree of protection provided by the enclosure. Full details are given in IEC Publication 144, Degrees of Protection of Enclosures for Low-voltage Switchgear and Control-gear.

4. Characteristics of contactors

4.1 Summary of characteristics

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

- Type of contactor (see Clause 4.2);
- Rated values (see Clause 4.3);
- Control circuits and air-supply systems (see Clause 4.4);
- Auxiliary circuits (see Clause 4.5);
- Degrees of protection of enclosures (see Clause 3.3).

4.2 Type of contactor

The following shall be stated:

4.2.1 Number of poles

4.2.2 Kind of current

Kind of current, and in the case of a.c., number of phases and rated frequency.

4.2.3 Interrupting medium (air, oil, etc.)

4.2.4 Method of control (see Clause 3.1)

4.3 Rated values

The rated values established for a contactor shall be stated in accordance with Clauses 4.3.1 to 4.3.8, but it is not necessary to establish all the rated values listed.

4.3.1 Rated voltages

A contactor is defined by the following rated voltages:

4.3.1.1 Rated operational voltages

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

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

Notes 1. — A contactor may be assigned a number of combinations of rated operational voltages and rated operational currents for different duties and utilization categories.

2. — For rated voltages of control circuits, see Clause 4.4.1.

4.3.1.2 Rated insulation voltage

The rated insulation voltage (U_i) of a contactor 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 contactor. In no case shall the maximum rated operational voltage exceed the rated insulation voltage.

4.3.2 Rated currents

A contactor is defined by the following rated currents:

4.3.2.1 Rated conventional thermal current

The rated conventional thermal current (I_{th}) of a contactor is the maximum current stated by the manufacturer that the unenclosed contactor can carry in an 8 h duty (see Clause 4.3.4.1) when tested in free air in accordance with Clause 8.2.2, without the temperature-rise of its several parts exceeding the limits specified in Clause 7.3 (Tables V and VI).

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

2. – An unenclosed contactor is a contactor supplied by the manufacturer without an enclosure or a contactor supplied by the manufacturer with an enclosure forming an integral part of the contactor.

4.3.2.2 Rated enclosed thermal current

The rated enclosed thermal current (I_{the}) of a contactor is the maximum current stated by the manufacturer that the contactor can carry in the stated duty (see Clause 4.3.4) when mounted in a specified enclosure. Tests for this rating shall be in accordance with 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 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 rated service thermal current as the installation and service conditions can vary greatly (the "rated current" in Clause 4.2 of IEC Publication 439, Factory-built Assemblies of Low-voltage Switchgear and Controlgear, is in effect the "rated service thermal current").

4.3.2.3 Rated operational currents or rated operational powers

A rated operational current (I_e) of a contactor 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 4.3.6) and the type of protective enclosure.

In the case of contactors for direct switching of individual motors, the indication of a rated operational current may be replaced or supplemented by an indication of the maximum rated power output, at the rated operational voltage considered, of the motor for which the contactor 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 a contactor 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 a contactor remain closed whilst carrying a steady current long enough 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 apparatus is determined.

2. — Interruption means breaking of the current by operation of the contactor.

4.3.4.2 Uninterrupted duty

Duty in which the main contacts of a contactor 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 de-rating factor, or by special design considerations (e.g. silver contacts) (see Table VI).

4.3.4.3 Intermittent periodic duty or intermittent duty

Duty in which the main contacts of a contactor remain closed for periods bearing a definite relation to the no-load periods, both periods being too short to allow the contactor to reach thermal equilibrium.



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Intermittent duty is characterized by the value of the current, the duration of current flow and by the on-load factor which is the ratio of the in-service period to the entire period, often expressed as a percentage.

Example: An intermittent duty comprising a current flow of 100 A for 4 min in every 10 min may be stated as: "Intermittent duty 100 A, 4 min/10 min" or "Intermittent duty 100 A, 6 operating cycles per hour, 40%".

Standard values of on-load factor are 15%, 25%, 40% and 60%.

4.3.4.3.1 *Classes of intermittent duty*

According to the number of operating cycles which they shall be capable of carrying out per hour, contactors are divided into the following classes:

- Class 0.03: up to 3 operating cycles per hour;
- Class 0.1 : up to 12 operating cycles per hour;
- Class 0.3 : up to 30 operating cycles per hour;
- Class 1 : up to 120 operating cycles per hour;
- Class 3 : up to 300 operating cycles per hour;
- Class 10 : up to 1 200 operating cycles per hour.

Note. — On the occasion of a future revision, Class 30 will be considered.

It is recalled that an operating cycle is a complete working cycle comprising one closing operation and one opening operation.

For intermittent duty with a large number of operating cycles per hour, the manufacturer shall indicate, either in terms of the true cycle if this is known, or in terms of conventional cycles designated by him, the values of the rated operational currents which shall be such that:

$$\int_0^T i^2 dt \leq I_{th}^2 \times T$$

where T is the total operating cycle time.

4.3.4.4 *Temporary duty*

Duty in which the main contacts of a contactor remain closed for periods of time insufficient to allow the contactor to reach thermal equilibrium, the current-carrying periods being separated by no-load periods of sufficient duration to restore equality of temperature with the cooling medium.

Standard values of temporary duty are 10 min, 30 min, 60 min and 90 min with contacts closed.

4.3.5 *Making and breaking capacities*

A contactor is defined by its making capacities and breaking capacities, in accordance with utilization categories as specified in Table II (see Clause 4.3.6).

Note. — Certain contactors associated with over-current devices may also be subject to requirements as to their making and breaking capacities in the case of a short-circuit occurring where they are installed. They shall then comply with the requirements of this Recommendation including Appendix C or alternatively with the requirements of IEC Publication 157-1, Low-voltage Distribution Switchgear, Part 1: Circuit-breakers, for the rated short-circuit making and breaking capacities and the rated short-time withstand current.

4.3.5.1 *Rated making capacity*

The rated making capacity of a contactor is a value of current determined under steady state conditions which the contactor can make without welding or undue erosion of the contacts or excessive display of flame, 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.

For a.c., the rated making capacity is expressed by the r.m.s. value of the symmetrical component of the current.

Note. — For a.c., the peak value of the current during the first half-cycles following closing of the contactor may be appreciably greater than the peak value of the current under steady state conditions used in the definition of making capacity, depending on the power-factor of the circuit and the instant on the voltage wave when closing occurs.

A contactor shall be capable of closing on a current corresponding to the symmetrical value of the current which defines its making capacity, whatever the value of the asymmetrical component may be, within the limits which result from power-factors indicated in Table II.

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

4.3.5.2 Rated breaking capacity

The rated breaking capacity of a contactor is a value of current which the contactor can break without undue erosion of the contacts or excessive display of flame, 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.

A contactor shall be capable of breaking any value of the load current up to its highest rated breaking capacity according to Clause 4.3.6.

For a.c. the rated breaking capacity is expressed by the r.m.s. value of the symmetrical component of the current.

4.3.5.3 Ability to withstand overload currents

▲ A contactor shall be capable of withstanding the thermal stresses due to starting and accelerating a motor to normal speed and operating overloads.

Contactors of utilization categories AC-2, AC-3 and AC-4 shall withstand a current equivalent to eight times their maximum rated operational current for category AC-3 ($8 \times I_e \text{ max/AC-3}$).

The duration of the test shall be 10 s for rated operational currents not exceeding 630 A.

For rated operational currents exceeding 630 A, this duration may be shorter and, if so, the manufacturer shall state the duration.

Note. — The overload current withstand test is considered to cover cases where the starting current is less than $8 \times I_e \text{ max/AC-3}$ and the starting duration longer than 10 s, provided that the value of $I^2 t$ is not larger than that corresponding to $8 \times I_e \text{ max/AC-3}$ during 10 s.

4.3.6 Utilization category

The utilization categories as given in Table I are considered standard in this Recommendation. Any other type of utilization category shall be based on agreement between manufacturer and user, but information given in the manufacturer's catalogue or tender may constitute such an agreement.

Each utilization category is characterized by the values of the currents and voltages, expressed as multiples of the rated operational current and of the rated operational voltage, and by the power-factors or time-constants as shown in Table II and other test conditions used in the definitions of the rated making and breaking capacities.

For contactors defined by their utilization category, it is therefore unnecessary to specify separately the rated making and breaking capacities as those values depend directly on the utilization category as shown in Table II.

The utilization categories of Table II correspond in principle to the applications listed in Table I.

TABLE I
Utilization categories

Category		Typical applications
A.C.	AC-1	Non-inductive or slightly inductive loads, resistance furnaces. Slip-ring motors : Starting, plugging ¹⁾ . Squirrel-cage motors : Starting, switching off motors during running. Squirrel-cage motors : Starting, plugging ¹⁾ , inching ²⁾ .
	AC-2	
	AC-3	
	AC-4	
D.C.	DC-1	Non-inductive or slightly inductive loads, resistance furnaces. Shunt-motors : Starting, switching off motors during running. Shunt-motors : Starting, plugging ¹⁾ , inching ²⁾ . Series-motors : Starting, switching off motors during running. Series-motors : Starting, plugging ¹⁾ , inching ²⁾ .
	DC-2	
	DC-3	
	DC-4	
	DC-5	
¹⁾ By plugging, is understood stopping or reversing the motor rapidly by reversing motor primary connections while the motor is running. ²⁾ By inching (jogging), is understood energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism. <i>Note.</i> — The application of contactors to the switching of rotor circuits, capacitors or 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	$\cos \varphi$ ⁽²⁾	I_c/I_e	U_r/U_e	$\cos \varphi$ ⁽²⁾
A.C.	AC-1	(All values)	1.5	1.1	0.95	1.5	1.1	0.95
	AC-2	(All values)	4	1.1	0.65	4	1.1	0.65
	AC-3	$I_e \leq 17 \text{ A}$	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
	AC-4	$I_e \leq 17 \text{ A}$	12	1.1	0.65	10	1.1	0.65
		$17 \text{ A} < I_e \leq 100 \text{ A}$	12	1.1	0.35	10	1.1	0.35
		$I_e > 100 \text{ A}$	10 ⁽⁵⁾	1.1	0.35	8 ⁽³⁾	1.1	0.35
D.C.	DC-1 DC-2 } (shunt- DC-3 } motors) DC-4 } (series- DC-5 } motors)	(All values)	I/I_e	U/U_e	L/R ⁽⁶⁾ (ms)	I_c/I_e	U_r/U_e	L/R ⁽⁶⁾ (ms)
		(All values)	—	—	—	—	—	—
		(All values)	4	1.1	2.5	4	1.1	2.5
		(All values)	4	1.1	2.5	4	1.1	2.5
		(All values)	4	1.1	15	4	1.1	15
		(All values)	4	1.1	15	4	1.1	15



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) In 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 (see Clause 4.3.5.1, Note).

2) Tolerance for $\cos \varphi$: ± 0.05 .

3) With a minimum of 1 000 A for I or I_e .

4) With a minimum of 800 A for I_e .

5) With a minimum of 1 200 A for I .

6) Tolerance for L/R : $\pm 15\%$.

4.3.7 *Mechanical endurance*

With respect to its resistance to mechanical wear, a contactor is characterized by the number 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 including replacement of contacts as specified in Clause 8.2.7.3 is permitted.

△ By convention, the mechanical endurance of a design of contactor is defined as the number of no-load operating cycles which would be attained or exceeded by 90% of all the apparatus of this design under the conditions specified in the preceding paragraph.

The preferred numbers of no-load operating cycles, expressed in millions, are:

0.001 — 0.003 — 0.01 — 0.03 — 0.1 — 0.3 — 1 — 3 and 10.

If no mechanical endurance is stated by the manufacturer, a class of intermittent duty implies a minimum mechanical endurance corresponding to 8 000 h of operation at the highest corresponding frequency of operating cycles.

4.3.8 *Electrical endurance*

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

Unless otherwise stated, the number of on-load operating cycles for categories AC-3, DC-2 and DC-4 shall be not less than 1/20 of the number of no-load operating cycles corresponding to the mechanical endurance of the contactor.

It is recommended that the manufacturer state the above-mentioned number of on-load operating cycles.

TABLE III

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_e/I_e	U_r/U_e	$\cos \varphi$ (°)
A.C.	AC-1	(All values)	1	1	0.95	1	1	0.95
	AC-2	(All values)	2.5	1	0.65	2.5	1	0.65
	AC-3	$I_e \leq 17$ A	6	1	0.65	1	0.17	0.65
		$I_e > 17$ A	6	1	0.35	1	0.17	0.35
	AC-4	$I_e \leq 17$ A	6	1	0.65	6	1	0.65
		$I_e > 17$ A	6	1	0.35	6	1	0.35
D.C.	DC-1	(All values)	1	1	1	1	1	1
	DC-2	(All values)	2.5	1	2	1	0.10	7.5
	DC-3	(All values)	2.5	1	2	2.5	1	2
	DC-4	(All values)	2.5	1	7.5	1	0.30	10
	DC-5	(All values)	2.5	1	7.5	2.5	1	7.5
		(All values)	2.5	1	7.5	2.5	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_e Current broken.

1) In 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 (see Clause 4.3.1.1, Note).

2) Tolerance for $\cos \varphi$: ± 0.05 .

3) Tolerance for L/R : $\pm 15\%$.

4.4 *Control circuits and air-supply systems*

The characteristics of control circuits and air-supply systems are:

4.4.1 *For control circuits*

- the rated control circuit voltage (U_c) (nature and frequency if a.c.);
- the rated control supply voltage (U_s) (nature and frequency if a.c.).

Note. — A distinction has been made above between the *control circuit voltage*, which is the voltage which would appear across the normally open contacts of a control device in the coil circuit, and the *control supply voltage*, which is the voltage applied to the input terminals of the control circuits of the contactor and may be different from the control circuit voltage, due to the presence of built-in transformers, rectifiers, resistors, etc.

The rated control circuit voltage and rated frequency, if any, are the values on which the insulation characteristics of the operating coil circuit are based.

The rated control supply voltage and rated frequency, if any, are the values on which the operating and temperature-rise characteristics of the control circuits are based. The correct operating conditions are based upon a value of the control supply voltage not less than 85% of its rated value with the highest value of control circuit current flowing, nor more than 110% of its rated value. The control supply voltage for the open circuit shall not exceed 120% of the rated control supply voltage U_s .

If the rated control circuit voltage is different from that of the main circuit, its value should preferably be chosen from Table IV.

TABLE IV

*Standard values of the rated control circuit voltage,
if different from that of the main circuit*

D.C. V	Single-phase a.c. V
24, 48, 110, 125, 220, 250	24, 48, 110, 127, 220

Note. — The manufacturer shall be prepared to state the value or values of the current taken by the control circuits at the rated supply voltage.

4.4.2 *For air-supply systems*

- Rated pressure and its limits.
- Volumes of air, at atmospheric pressure, required for each closing and each opening operation.

The rated supply pressure of a pneumatic or electro-pneumatic contactor is the air pressure upon which the operating characteristics of the pneumatic control system are based.

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4.5 *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 breaking capacity 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 shall be the rated voltage and frequency of the main circuit.

 4.6 *Protection of a contactor by a short-circuit protective device*

The following information shall be given by the manufacturer:

- type of protection (see Appendix C, Clause C4);
- types and characteristics of short-circuit protective devices (see Appendix C, Clause C5).

5. **Nameplates**

Each contactor shall be provided with a nameplate carrying the following data, marked in a durable manner, and located in a place such that they are visible and legible when the contactor is installed:

- a) the manufacturer's name or trademark;
- b) type designation or serial number;
- c) rated operational voltages (see Clause 4.3.1.1);
- d) utilization category and rated operational currents (or rated powers), at the rated operational voltages of the contactor (see Clause 4.3.2.2);
- e) either value of the rated frequency, e.g.: ~ 50 Hz or the indication "d.c." (or the symbol ---);
- f) if different from those of the coil: nature of current, rated frequency and rated control supply voltage (U_s).

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

- g) rated insulation voltage (see Clause 4.3.1.2);
- h) rated thermal current (see Clause 4.3.2.1);
- i) rated making and breaking capacities. These indications may be replaced, if applicable, by the indication of the utilization category (see Tables I and II);
- j) rated duty with the indication of the class of intermittent duty, if any (see Clause 4.3.4).

The following information concerning the operating coils of the contactor shall be placed either on each coil or on the contactor:

- k) either the indication "d.c." (or the symbol ---) or value of the rated frequency, e.g.: ~ 50 Hz;
- l) rated coil voltage.

For contactors operated by compressed air:

- m) rated supply pressure of the compressed air and the limits of variation of this pressure, if they are different from those specified in Clause 7.5.

Note. — If the available space on the nameplate is insufficient to carry all the above data, the contactor shall carry at least the information under a) and b) permitting the complete data to be obtained from the manufacturer.

6. Standard conditions for operation in service

6.1 Normal service conditions

Contactors 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 °C and its average over a period of 24 h does not exceed + 35 °C.

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

Note. — Contactors intended to be used in ambient air temperatures above + 40 °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 constitute such an agreement.

6.1.2 Altitude

The altitude of the site of installation does not exceed 2000 m (6600 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. Contactors so used shall be designed or used according to an agreement between manufacturer and user. Information given in the manufacturer's catalogue may constitute 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 contactor shall be 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 and capable of passing the appropriate tests.

Special attention shall be called to flame and humidity resisting qualities, and to the necessity to protect certain insulating materials against humidity.

No contact pressure shall be transmitted through insulating material other than ceramic, or other material with characteristics not less suitable, unless there is sufficient resiliency in the metallic parts to compensate for any possible shrinkage of the insulating material.

In the case of oil-immersed contactors, the tank shall be provided with means for indicating the correct oil level.

7.1.2 *Clearances and creepage distances*

The clearances and creepage distances shall be as large as practicable and creepage distances shall, wherever practicable, incorporate ridges, in order to break the continuity of conducting deposits which may form.

Note. — Recommendations are given in Appendix B.

7.1.3 *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 (minimum prescribed values to be maintained for clearances and creepage distances).

7.1.3.1 *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.

7.1.3.2 *Earth terminal*

The chassis, frameworks and the fixed parts of the metal enclosures of equipment shall be interconnected electrically and connected to a terminal which enables them to be earthed. This requirement can be met by the normal structural parts providing adequate electrical continuity.

When an earth terminal is provided, it shall be readily accessible, and so placed that the earth connection of the equipment is maintained when the cover or other removable parts are removed.

Under no circumstances shall a removable metal part of the enclosure be insulated from that part carrying the earth terminal when the removable part is in place.

The earth terminal shall be suitably protected against corrosion.

The earth terminal shall be permanently and indelibly marked with either the sign $\perp$ (IEC 417-5017a) or the sign $\oplus$ (IEC 417-5019a).

7.2 *Enclosures*

7.2.1 *Degrees of protection of enclosures*

Recommendations concerning degrees of protection provided by enclosures are given in IEC Publication 144.

Mechanical details

The enclosure shall be so arranged that when it is opened, the terminals, as well as all parts requiring maintenance as prescribed by the manufacturer, are readily accessible.

Sufficient space shall be left in the interior of the enclosure for the accommodation of external conductors from their point of entry into the enclosure as far as the terminals.

The movable parts of the protective enclosure shall be firmly secured to the fixed parts by a device such that they cannot be accidentally loosened or detached owing to the effects of operation of the apparatus or of its vibration.

When an enclosure is so designed as to allow the covers to be opened without the use of tools, means shall be provided to prevent loss of the fastening devices.