

**BS 4941 : Part 1 : 1979**

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(Reprinted, incorporating Amendment No. 1)

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

(Implementation of CENELEC HD 421)

Spécification des démarreurs de moteur pour les tensions inférieures
et égales à 1000 V en courant alternatif et 1200 V en courant continu
Partie 1. Démarreurs directs (sous pleine tension) en courant alternatif

Spezifikation für Motorstarter für Spannungen bis und einschließlich
1000 V Wechselstrom und 1200 V Gleichstrom
Teil 1. Wechselstrom- Motorstarter zum direkten einschalten

Foreword

This revision of BS 4941 : Part 1 has been prepared under the direction of the Power Electrical Engineering Standards Committee. It specifies direct-on-line (full voltage) a.c. motor starters. BS 4941 : Part 1 : 1973 was harmonized technically with IEC 292-1 : 1969, published by the International Electrotechnical Commission (IEC), but was not published as a dual-numbered standard. Since its publication Parts 2, 3 and 4 of BS 4941 were published as dual-numbered standards. BS 4941 : Part 1 incorporated IEC 292-1A : 1971 but subsequently substantial amendments to the IEC Publication have been published by way of IEC 292-1B : 1973 and IEC 292-1C : 1975 and since these affected certification it was decided to issue a revision of BS 4941 : Part 1 as a dual-numbered standard incorporating these amendments. Amendment No. 1 to the 1979 revision of BS 4941 : Part 1 brings the British Standard into alignment with the harmonized standard document HD 421 published by the European Committee for Electrotechnical Standardization (CENELEC) and removes the dual-numbering. HD 421 consists of IEC Publication 292-1 : 1969 and its Amendment No. 1 : 1979 and supplements 292-1A : 1971, 292-1B : 1973 and 292-1C : 1975, but has introduced modifications to clauses 4.4.4.3.1, 7.1.3.2 and 7.2.2. HD 421 also incorporates IEC Publication 292-2 : 1970 and IEC Publication 292-3 : 1973.

For ease of reproduction most of the text and format of the referenced IEC Publications have been used as the basis of this British Standard. Some terminology and conventions are not identical with those in British Standards; attention is drawn especially to the following.

Wherever the word 'Recommendation' appears referring to this standard, it should be read as 'Part of BS 4941'.

Cross-references

International standards	Corresponding British Standards
IEC 85 : 1984	BS 2757 : 1986 Method for determining the thermal classification of electrical insulation (Identical)
IEC 144 : 1963	BS 5420 : 1977 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. (Identical)
IEC 292	BS 4941 Specification for motor starters for voltages up to and including 1000 V a.c. and 1200 V d.c.
IEC 292-2 : 1970	Part 2 : 1977 Reduced voltage a.c. starters, star delta starters (Identical)
IEC 292-3 : 1973	Part 3 : 1977 Rheostatic rotor starters (Identical)
IEC 439 (now reissued as IEC 439-1 : 1985)	BS 5486 Low voltage switchgear and controlgear assemblies Part 1 : 1986 Specification for type-tested and partially type-tested assemblies (Identical)

The Technical Committee has reviewed the provisions of the following international standards to which reference is made in the text, and has decided that they are acceptable for use in conjunction with this standard.

International standards	Related British Standards
IEC 157-1 : 1973	BS 4752 Specification for switchgear and controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. Part 1 : 1977 Circuit-breakers
IEC 158-1 : 1970	BS 5424 Specification for controlgear for voltages up to and including 1000 V a.c. and 1200 V d.c. Part 1 : 1977 Contactors
IEC 269-1 : 1968	BS 88 Cartridge fuses for voltages up to and including 1000 V d.c. and 1500 V d.c. Part 1 : 1977 General requirements BS 1361 : 1971 Cartridge fuses for a.c. circuits in domestic and similar premises BS 1362 : 1973 General purpose fuse links for domestic and similar purposes (primarily for use in plugs)
IEC 282 : 1974	BS 2692 Fuses for voltages exceeding 1000 V a.c. Part 1 : 1975 Current limiting fuses

NOTE. In table V, note 2 to table V, table VI, note 5 to table VI and in paragraphs 3 and 5 of 8.2.2.5, the unit symbol 'deg C' should be read as '°C'. In paragraph 6, of 8.2.2.2 and paragraph 5 of 8.2.2.3 '1 deg C per hour' should be read as '1 °C/h'.

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British Standard 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

1. General

1.1 Scope

This Recommendation applies to direct-on-line starters for industrial use, intended to start and accelerate a motor to normal speed and to provide means for the protection of the motor and its associated circuits against operating overloads, and to cause intentionally the motor to stop. It applies only for a.c.

This Recommendation applies also to reversing starters.

The direct-on-line starters dealt with in this Recommendation are not designed to interrupt short-circuit currents. Therefore, suitable short-circuit protection (see Appendix C) should form part of the installation, but not necessarily in the starter.

It applies only to starters, 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. Starters for d.c. motors and static starters are not dealt with.

The clauses of this Recommendation relating to overload protection are not applicable in the case of controlgear relying for its operation on built-in over-temperature protective devices.

Note. — The expression "built-in" means built into the motor.

1.2 Object

The object of this Recommendation is to state:

1. the characteristics of direct-on-line starters;
2. the conditions with which starters must 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

2.1 Starter

The combination of all the switching means necessary to start and stop the motor, in combination with suitable overload protection.

2.2 *Direct-on-line starter*

A starter which connects the line voltage across the motor terminals in one step.

2.3 *Reversing starter*

A starter intended to cause the motor to reverse the direction of rotation by reversing the motor primary connections while it is running.

2.4 *Manual starter*

A starter in which the force for closing the main contacts is provided exclusively by manual energy.

2.5 *Electromagnetic starter*

A starter in which the force for closing the main contacts is provided by an electro-magnet (e.g.: contactor starter).

2.6 *Motor operated starter*

A starter in which the force for closing the main contacts is provided by an electric motor.

2.7 *Pneumatic starter*

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

2.8 *Electro-pneumatic starter*

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

2.9 *Over-current*

Any current exceeding the rated current.

2.10 *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.

2.11 *Short-circuit current*

An over-current resulting from a fault in an electrical circuit.

2.12 *Overload relay or release*

An over-current relay or release intended for protection against overloads.

2.13 Thermal overload relay or release

An inverse time-delay overload relay or release depending for its operation (including its time-delay) on the thermal action of the current flowing in the relay or release.

Magnetic overload relay or release

An overload relay or release depending for its operation on the force exerted by a current flowing in the coil of an electromagnet.

Note. — Such a relay or release usually has an inverse time-delay/current characteristic.

2.14 Current setting of an overload relay or release

The value of current for which the relay or release is adjusted and in accordance with which its operating conditions are defined.

2.15 Current setting range of an overload relay or release

The range between the minimum and maximum values over which the current setting of the relay or release can be adjusted.

2.17 Phase failure sensitive thermal overload relay or release

A multiple thermal overload relay or release which, in accordance with specified requirements, operates at a current value lower than its current setting in the case of current unbalance.

3. Classification**3.1 According to the method of control, starters are designated as:**

- automatic (by pilot switch or sequence control);
- non-automatic (such as by hand operation or by push-buttons).

3.2 According to the method of operation, starters are designated as:

- manual;
- electromagnetic;
- motor operated;
- pneumatic;
- electro-pneumatic.

3.3 According to the interrupting medium, starters are divided into different groups, e.g.:

- air break;
- oil-immersed break.

3.4 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 starters****4.1 Summary of characteristics**

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

- Type of switching devices (see Clause 4.2).
- Type and characteristics of relays and releases (see Clause 4.3) and number of these devices.
- Degrees of protection of enclosures (see Clause 3.4).
- Rated values (see Clause 4.4).
- Control circuits and air supply systems (see Clause 4.5).
- Auxiliary circuits (see Clause 4.6).
- Co-ordination with short-circuit protective devices (see Appendix C).

4.2 *Types of switching devices*

The following shall be stated:

4.2.1 *Number of poles*

4.2.2 *Interrupting medium (air, oil, etc.)*

4.2.3 *Method of operation*, for example: dependent manual operation, dependent power operation (e. g.: contactor), stored energy operation, etc.

In the case of manual starters, the type of operating device shall be stated: handle, lever, push-buttons, etc.

4.3 *Types and characteristics of relays and releases*

Note. — In the remainder of the Recommendation, the words "overload relay" shall be taken to apply equally to an overload relay or an overload release as appropriate.

4.3.1 *Types*

1. Release with shunt coil (shunt trip).
2. Under-voltage opening relay or release.
3. Overload time-delay relay, the time-lag of which is:
 - a) substantially independent of previous load (e. g.: time-delay magnetic overload relay);
 - b) dependent on previous load (e. g.: thermal overload relay).
 - c) dependent on previous load (e.g. thermal overload relay) and also sensitive to phase failure (see Clause 2.17).
4. Instantaneous over-current relay or release (when applicable).
5. Other relays or releases (e. g.: phase unbalance relay).

Note. — Types referred to in Items 4 and 5 require consultation between manufacturer and user according to the particular application.

4.3.2 *Characteristics*

1. Release with shunt coil and under-voltage opening relay or release:
 - rated voltage;
 - rated frequency.
2. Overload relay:
 - either the associated motor full-load current, or the ultimate trip current (see Clause 7.5.3.2);
 - rated frequency (when necessary);
 - current setting (or range of settings);
 - time-current characteristics (or range of characteristics), when necessary;
 - number of poles;
 - nature of the relay: thermal or magnetic.

Note. — Depending on the nature of the relay, the opening conditions are given in Clause 7.5.3.2 or in Clause 7.5.3.3.

4.3.3 *Designation and current settings of overload relays*

Overload relays are designated by their type and their current setting.

An overload relay is said to be:

- of Type 1 if the current setting refers to the associated motor full-load current (see Clause 7.5.3.2.1 1);
- of Type 2 if the current setting is the ultimate trip current (see Clause 7.5.3.2.1 2)

Both types are designated by the current setting (or the upper and lower limits of the current setting range, if adjustable).

The current setting (or current setting range) shall be marked on the overload relay or its scale. The marking may be either directly in amperes, or as a function of the current value marked on the relay or, *in the case of a thermal overload relay*, on the heaters if these are replaceable.

However, if the current setting is influenced by the conditions of use or other factors which cannot readily be marked on the relay, then the relay or any interchangeable parts thereof (e. g. : operating coils, heaters or current transformers) shall carry a number or an identifying mark which makes it possible to obtain the relevant information from the manufacturer or his catalogue, or preferably, from data furnished with the starter.

In the case of indirect (current transformer operated) overload relays, the marking may refer either to the primary current of the current transformer through which they are supplied, or to the current setting of the overload relays. In either case, the ratio of the current transformer shall be stated.

4.3.4 *Time-current characteristics of overload relays*

The time-current characteristics shall be given in the form of curves supplied by the manufacturer. These shall indicate how the tripping time, starting from the cold state (see Clause 4.3.5), varies with the current up to a value of at least eight times the full-load current of the motor with which it is intended that the relay be used. The manufacturer shall indicate, by suitable means, the tolerances applicable to these curves.

These curves must be given for each extreme value of the current setting and, if the time-current characteristics are adjustable, it is recommended that they be given in addition for each extreme value of the time setting.

Note. — It is recommended that the current be plotted as abscissae and the time as ordinates, using logarithmic scales. Further, in order to facilitate the study of co-ordination of different types of protection, it is recommended that the current be plotted as multiples of the setting current and the time in seconds on the standard graph sheet detailed in IEC Publication 282-1, High-voltage Fuses, Part 1: Current-limiting Fuses (First edition, Clause 17.9).

4.3.5 *Influence of ambient air temperature*

The time-current characteristics (see Clause 4.3.4) refer to a stated value of ambient air temperature, and are based on no previous loading of the overload relay (*viz.* from an initial cold state). This value of the ambient air temperature shall be clearly given on the time curves; the preferred values are $+ 20\text{ }^{\circ}\text{C}$ or $+ 40\text{ }^{\circ}\text{C}$.

The overload relays shall be able to operate within the ambient air temperature range of $- 5\text{ }^{\circ}\text{C}$ to $+ 40\text{ }^{\circ}\text{C}$, and the manufacturer shall be prepared to state the effect of variations in ambient air temperature on the characteristics of overload relays.

4.4 *Rated values*

The rated values established for a starter shall be stated in accordance with Clauses 4.4.1 to 4.4.8, but it is not necessary to establish all the rated values listed.

4.4.1 *Rated voltages*

A starter is defined by the following rated voltages:

4.4.1.1 *Rated operational voltages*

A rated operational voltage (U_o) of a starter is a value of voltage which, combined with a rated operational current, determines the application of the starter 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.

Note. — For rated voltages of control circuits, see Clause 4.5.1.

4.4.1.2 *Rated insulation voltage*

The rated insulation voltage (U_i) of a starter 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 starter. In any case, the maximum rated operational voltage shall not exceed the rated insulation voltage.

4.4.2 *Rated currents*

A starter is defined by the following rated currents:

4.4.2.1 *Rated conventional thermal current*

The rated conventional thermal current (I_{th}) of a starter is the maximum current stated by the manufacturer that the unenclosed starter can carry in 8 h duty (see Sub-clause 4.4.4.1) when tested in free air, without the temperature-rise of its several parts exceeding the limits specified in Sub-clause 7.3 (Tables V and VI) 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.— An unenclosed starter is a starter supplied by the manufacturer without an enclosure or a starter supplied by the manufacturer with an enclosure forming an integral part of the starter.

4.4.2.2 *Rated enclosed thermal current*

The rated enclosed thermal current (I_{the}) of a starter is the maximum current stated by the manufacturer that the starter can carry in the stated duty (see Sub-clause 4.4.4) 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 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 Sub-clause 4.2 of IEC Publication 439 is in effect the “rated service thermal current”.)

4.4.2.3 *Rated operational currents or rated operational powers*

A rated operational current (I_e) of a starter is stated by the manufacturer and takes into account the rated operational voltage (see Sub-clause 4.4.1.1), the rated frequency (see Sub-clause 4.4.3), the rated duty (see Sub-clause 4.4.4), the utilization category (see Sub-clause 4.4.6) and the type of protective enclosure.

In the case of a starter 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 starter is intended. The manufacturer shall be prepared to state the relationship assumed between the current and the power.

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4.4.3 *Rated frequency*

The supply frequency for which a starter is designed and to which the other characteristic values correspond.

4.4.4 *Rated duty*

The rated duties considered as normal are as follows:

4.4.4.1 *Eight-hour duty*

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

Notes 1.— This is the basic duty on which the rated current of the apparatus is determined.

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

4.4.4.2 *Uninterrupted duty*

Duty in which the main contacts of a starter remain closed, whilst carrying a steady current without interruption for periods of more than 8 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 VI).

4.4.4.3 *Intermittent periodic duty or intermittent duty*

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

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%.

4.4.4.3.1 *Classes of intermittent duty*

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

- Class 0.03: up to 1 operating cycle per hour;
- Class 0.1 : up to 12 operating cycles per hour;
- Class 0.03: up to 3 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.

It is recalled that an operating cycle is a complete working cycle comprising one make and one break.

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.

Note. — For intermittent duty, the difference between the thermal time-constant of the overload relay and that of the motor may render a thermal relay unsuited for overload protection. It is recommended that, for installations intended for intermittent duty, the question of overload protection be covered by special agreement between manufacturer and user.

4.4.4.4 *Temporary duty*

Duty in which the main contacts of a starter remain closed for periods of time insufficient to allow the starter 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.

4.4.5 *Making and breaking capacities*

The making and breaking capacities of a starter are defined in accordance with utilization categories as specified in Clause 4.4.6.

Note. — Certain starters may also be subjected to requirements as to their making and breaking capacities in the case of a short-circuit occurring where they are installed. They must then comply with the requirements of this Recommendation, and with the requirements of IEC Publication 157-1, Low-voltage Distribution Switchgear, Part 1: Circuit-breakers (First edition, Clauses 8.2.4 and 8.2.5), for the rated short-circuit making and breaking capacities and for the rated short-time current.

4.4.5.1 *Rated making capacity*

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

The making conditions which must 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 current and to the utilization category, according to Table II.

The rated making capacity is expressed by the r.m.s. value of the symmetrical component of the current.

Note. — The peak value of the current during the first half-cycles following closing of the starter may be appreciably greater than the peak value of the current under steady conditions used in the definition of making capacity, depending on the characteristics of the circuit, and the instant on the voltage wave when closing occurs.

A starter must 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 d.c. component may be, within the limits which result from power-factors indicated in Table II.

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

4.4.5.2 *Rated breaking capacity*

The rated breaking capacity of a starter is a value of current which the starter 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 must 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 current and to the utilization category, according to Table II.

A starter shall be capable of breaking any value of the load current up to its highest rated breaking capacity according to Clause 4.4.6.

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

4.4.6 Utilization category

The two 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 as shown in Table II and other test conditions used in the definition of the rated making and breaking capacities.

For starters 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 application
AC-3	Starting of squirrel-cage motors, switching-off motors during running
AC-4	Starting of squirrel-cage motors including inching ¹⁾ and, for reversing starters only, plugging ²⁾

¹⁾ By inching (jogging) is understood energizing a motor once or repeatedly for short periods to obtain small movements of the driven mechanism.

²⁾ By plugging is understood stopping or reversing the motor rapidly by reversing the motor primary connections while it is running (see Clause 8.2.4.6).

Note. — The application of starters to the switching of induction motors with individual power-factor correction by capacitors shall be subject to special agreement between manufacturer and user.

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

Category		Make			Break		
		<i>I</i>	<i>U</i>	$\cos \varphi$ ²⁾	<i>I</i>	<i>U_r</i>	$\cos \varphi$ ²⁾
AC-3	$I_e \leq 100 \text{ A}$	10 I_e	1.1 U_e	0.35 ³⁾	8 I_e	1.1 U_e	0.35 ³⁾
	$I_e > 100 \text{ A}$	8 I_e ³⁾		0.35 ³⁾	6 I_e ⁴⁾		0.35 ³⁾
AC-4	$I_e \leq 100 \text{ A}$	12 I_e	1.1 U_e	0.35 ³⁾	10 I_e	1.1 U_e	0.35 ³⁾
	$I_e > 100 \text{ A}$	10 I_e ⁵⁾		0.35 ³⁾	8 I_e ³⁾		0.35 ³⁾

I_e = rated operational current (see Clause 4.4.2.3)
 U_e = rated operational voltage

I = current made or broken
 U = voltage before make
 U_r = recovery voltage

¹⁾ 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 4.4.5.1, Note).
²⁾ Tolerance for $\cos \varphi$: ± 0.05 .
³⁾ With a minimum of 1000 A.
⁴⁾ With a minimum of 800 A.
⁵⁾ With a minimum of 1200 A.
⁶⁾ However, for values of I_e not exceeding 17 A, the value of $\cos \varphi$ is given in Appendix D.

4.4.7 Mechanical endurance

With respect to its resistance to mechanical wear, a starter 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.

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.

4.4.8 Electrical endurance

With respect to its resistance to electrical wear, a starter 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 Category AC-3 shall be not less than 1/20 of the number of no-load operating cycles corresponding to the mechanical endurance of the starter.

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 utilization categories ¹⁾

Category	Make			Break		
	I	U	$\cos \varphi$ ²⁾	I	U_r	$\cos \varphi$ ²⁾
AC-3	$6 I_e$	U_e	0.35	I_e	$0.17 U_e$	0.35
AC-4	$6 I_e$	U_e	0.35	$6 I_e$	U_e	0.35

I_e = rated operational current
(see Clause 4.4.2.3)

U_e = rated operational voltage

I = current made or broken

U = voltage before make

U_r = recovery voltage

¹⁾ 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 4.4.5.1, Note).

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

4.5 *Control circuits and air-supply systems*

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

4.5.1 *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 circuit in the starter 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 circuit 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 rated control circuit voltages, 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.

4.5.2 *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 starter is the air pressure upon which the operating characteristics of the pneumatic control system are based.

4.6 *Auxiliary circuits*

The characteristics of auxiliary circuits are:

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

4.7 *Co-ordination with short-circuit protective devices*

The following information shall be given by the manufacturer:

- types and characteristics of short-circuit protective devices (see Appendix C);
- type of co-ordination (see Appendix C).

5. Nameplates

Each starter 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 starter is installed:

- a) the manufacturer's name or trademark;
- b) type designation or serial number;
- c) rated operational voltages (see Clause 4.4.1.1);
- d) utilization category and rated operational currents (or rated powers), at the rated operational voltages of the starter (see Sub-clause 4.4.2.3);
- e) rated frequency, e.g.: ~ 50 Hz;
- 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 should also be stated on the starter nameplate:

- g) rated insulation voltage (see Clause 4.4.1.2);
- h) rated thermal current (see Sub-clause 4.4.2.1 and 4.4.2.2);
Note. — If the overload relay is Type 2, its rating shall be given on the nameplate of the starter.
- i) rated making and breaking capacities. These indications may be replaced, if applicable, by the indication of the utilization category (see Tables I, II and III);
- j) rated duty with the indication of the class of intermittent duty, if any (see Clause 4.4.4).

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

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

For starters 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 7.5.2.

The following information shall be placed on the overload relay:

- n) type number: 1 or 2 (see Clauses 4.3.3 and 7.5.3.2.1);
- o) current setting or setting range or an identifying mark, according to Clause 4.3.3. The information given shall make it possible for a user to obtain the time-current characteristics from the manufacturer, or from his catalogue, or from data supplied with the starter.

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