

Australian Standard[®]

**A.C. motor starters (up to and
including 1000 V)**

**Part 1: Direct-on-line (full voltage)
starters**

The following scientific, industrial and governmental organizations and departments were officially represented on the committee entrusted with the preparation of this standard:

Australian Electrical and Electronic Manufacturers Association
Australian-British Trade Association
Bureau of Steel Manufacturers of Australia
Confederation of Australian Industry
Department of Defence
Department of Productivity
Electricity Supply Association of Australia
Institution of Engineers, Australia
Metal Trades Industry Association of Australia
Metropolitan Water, Sewerage and Drainage Board, Sydney
Railways of Australia Committee
Testing Authorities

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A.C. motor starters (up to and including 1000 V)

Part 1: Direct-on-line (full voltage) starters

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PREFACE

This standard was originally prepared by a sub-committee of the Association's Committee on Industrial Switchgear and Controlgear, as a revision of AS C364—1967. The basic document used for the purpose was IEC 292-1, Low Voltage Motor Starters, Part 1: Direct-on-Line (Full Voltage) A.C. Starters.

This standard applies to a.c. direct-on-line starters, intended to start, inch, plug or accelerate a motor to normal speed and to provide means for the protection of the motor and its associated circuits against operating overloads and overheating and to cause the motor to stop. It applies also to reversing starters.

The starters dealt with are not normally designed to interrupt short-circuit currents, protection for which should form part of the installation but not necessarily in the starter.

This Part 1 of the standard also applies, where appropriate, to the following Parts:

- Part 2—Star-delta Starters
- Part 3—Autotransformer Starters
- Part 4—Rheostatic Rotor Starters.

This edition is technically identical with the 1972 edition as amended in Amendments 1 and 2 to that edition, but references to other standards have been updated.

In the application of this standard reference may be necessary to the following Australian and British standards and other publications:

- | | |
|---------|--|
| AS 1023 | Thermal Protection of Electric Motors
Part 1 — Built-in Thermal Detectors
and Associated Control
Units* |
| | Part 2 — Thermal Overload Protective
Devices |
| | Part 3 — Inherent Overheat Protectors |

- | | |
|----------|---|
| AS 1029 | A.C. Contactors (up to and including
1000 V a.c.) |
| AS 1136 | Switchgear and Controlgear Assemblies |
| AS 1431 | Control Switching Devices for Voltages
up to 650 V a.c. and 250 V d.c.
Part 2 — Push-button and Related
Control Switches (including
Indicator Lights) |
| AS 1930 | Circuit-breakers for Distribution
Circuits (Up to and Including 1000 V
a.c. and 1200 V d.c.) |
| AS 1939 | Classification of Degrees of Protection
Provided by Enclosures for Electrical
Equipment |
| AS 2005 | Fuses with Enclosed Fuse-links (Up to
and Including 1000 V a.c. and 1500 V
d.c.) |
| AS 2184 | Moulded-case Circuit-breakers (Up to
and Including 600 V a.c. and 250 V
d.c.) (Interrupting Rating 10 kA and
more) |
| AS C100 | Approval and Test Specification for
Definitions and General Requirements
for Electrical Materials and Equipment |
| AS C320 | Classification of Insulating Materials
for Electrical Machinery and Apparatus
on the Basis of Thermal Stability in
Service |
| SAA MP19 | Report on Preferred Numbers and Their
Use |
| BS 3781 | Method for Determining the
Comparative Tracking Index of Solid
Insulating Material |

*The expression 'built-in' means built into the motor.

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STANDARDS ASSOCIATION OF AUSTRALIA

Australian Standard
for
A.C. MOTOR STARTERS (UP TO AND INCLUDING 1000 V)

PART 1—DIRECT-ON-LINE (FULL VOLTAGE) STARTERS

SECTION 1. SCOPE AND GENERAL

1.1 SCOPE. This standard specifies requirements for direct-on-line starters for industrial use, intended to start, inch, plug or 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 intentionally cause the motor to stop.

This standard applies also to reversing starters.

The direct-on-line starters dealt with in this standard are not normally 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.

Direct-on-line starters intended for application in merchant ships may also need to comply with supplementary requirements.

The standard applies only to starters, the main contacts of which are intended to be connected to circuits the rated voltage of which does not exceed 1000 V a.c. It does not apply to direct-on-line starters intended for installation in rail or road vehicles, or in aircraft, nor are starters for d.c. motors and static starters dealt with.

For overload protection reference should be made to AS 1023, Parts 1 to 3.

NOTES:

1. This standard may, as far as is practicable, apply to either starters or controllers designed to connect the windings of a change-pole motor on any of its various speeds.
2. Information to be supplied by the purchaser is listed in Appendix A.

1.2 OBJECT. The object of this standard is to state:

- (a) the characteristics of direct-on-line starters;
- (b) the conditions with which direct-on-line starters must comply with reference to—
 - (i) their construction, operation and behaviour in normal operation;
 - (ii) their dielectric properties;
 - (iii) the degrees of protection provided by their enclosures;
- (c) the tests intended for confirming that these conditions have been met and the methods to be adopted for these tests;
- (d) the data to be marked on the apparatus.

1.3 SAFETY REQUIREMENTS. This standard does not include all the electrical safety requirements with which compliance may be necessary to secure approval for connection or sale of starters. These matters are covered in AS C100.

SECTION 2. DEFINITIONS

2.0 APPLICATION OF SECTION. For the purpose of this standard the definitions given in this Section apply.

NOTE: Reference may be made to AS 1029 for other definitions not given hereunder.

2.1 DEFINITIONS CONCERNING STARTERS.

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

2.1.2 Direct-on-line a.c. motor starter—a starter which connects and disconnects line voltage across the terminals of a motor in one step, and which is arranged to start the motor without the use of any current-limiting devices such as auto-transformers, resistors, etc.

A 'direct-on-line a.c. motor starter' is hereinafter referred to as a 'starter'.

2.1.3 Reversing starter—a starter intended to cause the motor to reverse the direction of rotation by reversing the motor primary connections.

2.1.4 Manual starter—a starter in which the force for closing the main contacts is provided exclusively by manual energy.

2.1.5 Electromagnetic starter—a starter in which the force for closing the main contacts is provided by an electromagnet (e.g. contactor starter).

2.1.6 Motor operated starter—a starter in which the force for closing the main contacts is provided by an electric motor.

2.1.7 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.

2.1.8 Electropneumatic 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.

2.1.9 Latched starter—a starter, the moving elements of which leave the position of rest when the operating means are energized, but which after closing 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, electrical, pneumatic, etc.

NOTE: Because of the latching, the latched starter actually acquires a second position of rest according to Clause 2.2.1.

2.1.10 Overcurrent—any current exceeding the rated current.

2.1.11 Overload—operating conditions in an electrically undamaged circuit, which cause an overcurrent.

NOTE: An overload may cause damage if sustained for a sufficient time.

2.1.12 Short-circuit current—an overcurrent resulting from a fault in an electrical circuit.

NOTE: In general a short-circuit current is of appreciable magnitude, in particular in excess of the highest overload.

2.1.13 Overload relay or release—an overcurrent relay or release intended for protection against overloads.

2.1.14 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.

2.1.15 Main circuit—all the conducting parts of a starter included in the circuit which it is designed to close or open. This does not include the auxiliary contacts and circuits connected to them.

2.1.16 Clearance—the distance between two conducting parts along a string stretched the shortest way between these conducting parts.

2.1.16.1 Clearance between poles—the minimum clearance between any conducting parts of adjacent poles.

2.1.16.2 Clearance to earth—the minimum clearance between any conducting parts and any parts which are earthed or intended to be earthed.

2.1.16.3 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.

2.1.17 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.

2.1.18 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, e.g. as a result of an insulation failure.

NOTE: Typical accidentally dangerous parts are walls or enclosures, operating handles, etc.

2.1.19 Short-time withstand current—the current that a starter can carry in the closed position during a specified short time under prescribed conditions of use and behaviour.

2.1.20 Ambient temperature—the temperature, determined under prescribed conditions, of the air surrounding the complete starter, e.g. for enclosed contactors it is the air outside the enclosure.

2.2 DEFINITIONS CONCERNING POSITIONS, CONTROL AND AUXILIARY CIRCUITS OF A DIRECT-ON-LINE STARTER.

2.2.1 Position of rest—the position which the moving elements of the starter take up when its electromagnet or its compressed-air device is not energized.

2.2.2 Control circuit—a circuit (other than a path of the main circuit) devoted to the closing operation or opening operation, or both of the starter.

NOTE: Pneumatic starters do not include control circuits.

2.2.3 Control contact—a contact included in a control circuit of a starter and mechanically operated by the starter.

NOTE: A control contact is part of the design of a starter.

2.2.4 Auxiliary circuit—all the conducting parts of a starter intended to be included in a circuit other than the main circuit and the control circuits of the starter.

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.

2.2.5 Auxiliary contact—a contact included in an auxiliary circuit and mechanically operated by the starter.

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.

2.2.5.1 ‘a’ contact (make or normally open contact)—a control or auxiliary contact which is open when the main contacts of the starter are open and closed when they are closed.

2.2.5.2 ‘b’ contact (break or normally closed contact)—a control or auxiliary contact which is closed when the main contacts of the starter are open and open when they are closed.

2.2.6 Closed position—the position in which the predetermined continuity of the main circuit of the starter is obtained.

2.2.7 Open position—the position in which the predetermined clearance between open contacts in the main circuit of the starter is obtained.

2.2.8 Operation (of a starter)—the transfer of the moving contact(s) from one position to another 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.

2.2.9 Operating cycle (of a starter)—a succession of operations from one position to another and back to the first position through all other positions, if any.

NOTE: A succession of operations not forming an operating cycle is referred to as an operating series.

2.2.10 Closing operation—an operation by which the starter is brought from the open position to the closed position.

2.2.11 Opening operation—an operation by which the starter is brought from the closed position to the open position.

SECTION 3. CLASSIFICATION

3.1 DESIGNATION OF STARTERS ACCORDING TO THE METHOD OF CONTROL. 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-button).

3.2 DESIGNATION OF STARTERS ACCORDING TO THE METHOD OF OPERATION. According to the method of operation, starters are designated as —

manual
electromagnetic
motor operated
pneumatic
electropneumatic

3.3 GROUPING OF STARTERS ACCORDING TO THE INTERRUPTING MEDIUM. According to the interrupting medium, starters are grouped as —

air-break
oil-immersed break
vacuum-break.

3.4 DISTINCTION ACCORDING TO DEGREE OF PROTECTION PROVIDED BY THE ENCLOSURE. Starters are grouped in accordance with AS 1939.

SECTION 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:

- (a) Type of starter (see Clause 4.2).
- (b) Type and characteristics of relays and releases (see Clause 4.3) and number of these devices.
- (c) Degrees of protection of enclosures (see Clause 3.4).
- (d) Rated values (see Clause 4.4).
- (e) Control circuits and air supply systems (see Clause 4.5).
- (f) Auxiliary circuits (see Clause 4.6).
- (g) Coordination with short-circuit protective devices (see Clause 4.7).

4.2 TYPE OF STARTERS. The following shall be stated:

- (a) Number of poles in the main circuit.
- (b) Number of phases and rated frequency.
- (c) Interrupting medium (air, oil, vacuum, etc.).
- (d) Method of control —
 - (i) manually controlled, including type of operating device, i.e. handle, lever, push button, or other device;
 - (ii) indirectly controlled, i.e. electromagnetic, motor-operated, pneumatic.

4.3 TYPES AND CHARACTERISTICS OF RELAYS AND RELEASES.

NOTE: Hereinafter, the words 'overload relay' are to be taken to apply equally to an overload relay or an overload release as appropriate.

4.3.1 Types. Relays and releases are of the following types:

- (a) Release with shunt coil (shunt trip-energized to open the starter).
- (b) Under-voltage opening relay or release-opens the starter at a set point below nominal voltage.
- (c) Overload relay, the time-lag of which is —
 - (i) substantially independent of previous load (e.g. time-delay magnetic overload relay);
 - (ii) dependent on previous load (e.g. thermal overload-relay).
- (d) Instantaneous overcurrent relay or release (when applicable).
- (e) Other relays or releases (e.g. phase unbalance relay, built-in overload releases).

4.3.2 Characteristics. The characteristics of relays and releases are as follows:

- (a) For thermal overload protective devices see AS 1023, Parts 1, 2 and 3.
- (b) Overload relays other than thermal —
 - (i) either the associated motor full-load current, or the ultimate trip current (see Clause 7.5.3.4);

- (ii) rated frequency;
- (iii) current setting (or range of settings);
- (iv) time-current characteristics (or range of characteristics), when necessary;
- (v) number of poles.
- (c) Release with shunt coil and under-voltage opening relay or release —
 - (i) rated voltage;
 - (ii) rated frequency.

4.3.3 Designation and Current Settings of Overload Relays (See also AS 1023, Parts 1, 2 and 3).

4.3.3.1 General. Overload relays are designated by their type and their setting.

An overload relay is said to be of —

Type 1 if the setting refers to the associated motor full-load current.

Type 2 if the setting is the ultimate trip current.

4.3.3.2 Rated thermal current of overload relays or releases, other than thermal. The rated thermal current shall be the current which determines the temperature-rise conditions of the main circuit in the absence of any closing or opening operation of the contacts.

NOTES:

1. The rated thermal current of the relay may exceed that of the starter in which it is installed.
2. The rated thermal current of the relay may differ according to the type of enclosure.

4.3.3.3 Current settings of overload relays or releases, other than thermal. The current setting or the range of current settings shall be marked on the relay or release or on its scale, either directly in amperes or in a multiple of the rated current of the relay or release. For indirectly operated relays or releases, the markings may refer either to the main circuit current or the actual current through the relay or release.

If the current setting is influenced by factors which cannot readily be marked on the relay or release, then the relay or release or any interchangeable parts thereof, e.g. current transformers, shall carry a number or a mark which makes it possible to obtain the relevant information from the manufacturer or from his catalogue.

4.3.3.4 Time-current characteristics of overload relays or releases other than thermal. The time-current characteristics should correspond to an ambient temperature of 25°C. They shall be based on no previous loading of the overload relay or release (from cold state) and shall be stated in the form of tables or curves supplied by the manufacturer showing how the opening time varies with the current up to a value of at least eight times the current setting. The tables or curves shall be given for each extreme value of current setting and, in addition if the time characteristics are adjustable, for each extreme value of the time setting.

If the reference temperature differs from 25°C, its value shall be clearly given in the table or time curves.

The manufacturer shall be prepared to state the influence of variations in the ambient temperature on the characteristics of the relays or releases.

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 coordination 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 for time-current characteristics as illustrated by the time/current zone figures in AS 2005.

4.4 RATED VALUES.

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

Rated voltages —	Clause 4.4.2
Rated currents —	Clause 4.4.3
Rated frequency —	Clause 4.4.4
Rated duty —	Clause 4.4.5
Making and breaking capacities —	Clause 4.4.6
Utilization category —	Clause 4.4.7
Mechanical endurance —	Clause 4.4.8
Electrical endurance —	Clause 4.4.9

4.4.2 Rated Voltages. A starter is defined by the following rated voltages:

- (a) *Rated operation voltages (U_o).* A rated operational voltage 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.

- (b) *Rated insulation voltage (U_i).* The rated insulation voltage 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 rated insulation voltage.

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

4.4.3 Rated Currents. A starter is defined by the following rated currents:

- (a) *Rated thermal current (I_{th}).* The rated thermal current of a starter is the maximum operational current, which is the maximum current that the starter, can carry in 8-hour duty (see Clause 4.4.5.2) when fitted with the maximum rating of overload relay, adjusted to the maximum setting if adjustable, without the temperature rise of its several parts exceeding the limits specified in Clause 7.3 (Tables 7.1 and 7.3) when tested according to Clause 8.3.3.

NOTE: The rated thermal current can differ according to the type of enclosure.

- (b) *Rated operational currents (I_o) or rated operational powers (P_o).* A rated operational

current of a starter is stated by the manufacturer and shall take into account the rated current of the overload relay installed in this starter, the rated operational voltage (see Clause 4.4.2(a)), the rated frequency (see Clause 4.4.4), the rated duty (see Clause 4.4.5), the utilization category (see Clause 4.4.7), and the type of protective enclosure.

The indication of a rated operational current may be replaced by the 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.

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

The preferred rated frequency is 50 Hz.

4.4.5 Rated Duty.

4.4.5.1 General. A starter may be required to operate under one or a combination of different rated duties.

The rated duties considered as normal are as described in Clause 4.4.5.2 to 4.4.5.5.

4.4.5.2 8-hour duty. 8-hour duty is the duty in which the main contacts of a starter remain closed while carrying a steady current long enough for the starter to reach thermal equilibrium, but not for more than 8 h 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 starter.

4.4.5.3 Uninterrupted duty. Uninterrupted duty is the duty in which the main contacts of a starter remain closed, while carrying a steady current without interruption for periods of more than 8 h (weeks, months, or even years).

NOTE: This kind of service is set apart from the 8-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 7.3).

4.4.5.4 Intermittent duty (intermittent periodic duty). Intermittent duty is the 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 per cent'.

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

Unless otherwise specified, the load factor shall be taken as 60 per cent for Classes 0.03 to 1 inclusive, and 40 per cent for Classes 3 and 10 (see Clause 4.4.5.5).

4.4.5.5 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 of intermittent duty:

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	1200 operating cycles per hour.

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, and i is the instantaneous value of current, which includes any inrush current (e.g. motor starting) during the ON period.

NOTES:

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

4.4.6 Making and Breaking Capacities.

4.4.6.1 General. The making and breaking capacities of a starter are in accordance with utilization categories, and are as specified in Table 4.2 (see Clause 4.4.7).

Certain starters associated with overcurrent 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 standard and with the requirements of the relevant Australian standards for circuit-breakers.

4.4.6.2 Rated making capacity. The rated making capacity of a starter is a value of current determined under steady state conditions 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 —

- (a) the voltage between poles before contact making; and
- (b) 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 4.2.

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 few 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 power factor of the circuit and the instant on the voltage wave when closing occurs.

A starter 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 4.2.

The rated making capacity is only valid when the starter is operated in accordance with the requirements of Clause 7.5.2.

4.4.6.3 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 shall be specified are —

- (a) the characteristics of the test circuit; and
- (b) 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 4.2.

A starter shall be capable of breaking any value of the load current up to its highest rated breaking capacity according to Clause 4.4.7.

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

4.4.7 Utilization Category. The utilization categories given in Table 4.1 are considered standard. Any other type of utilization category shall be based on agreement between purchaser and manufacturer, 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 given in Table 4.2 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 given in Table 4.2.

The rating of a starter, particularly for Category AC-4 application, is also determined to a large extent by factors other than its making and breaking capacity, such as contact life, rate of operation, etc.

The utilization categories of Table 4.1 correspond to the making and breaking capacities listed in Table 4.2.

4.4.8 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 8.3.8.3 is permitted.

The number of no-load operating cycles shall be stated by the manufacturer.

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 10.