

THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

SPECIFICATION FOR THREE-PHASE CAGE INDUCTION MOTORS

(Formerly OCMA ELEC 1)

PUBLICATION No. 132 : 1988

EEMUA



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THE ENGINEERING EQUIPMENT AND MATERIALS USERS ASSOCIATION

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3. Curve for determining the temperature correction factor.

F O R E W O R D

The purpose of this specification is to define the requirements for electric motors. It forms a supplement to relevant National and International Standards.

In 1983, the Engineering Equipment Users Association and the Oil Companies Materials Association were combined to form the Engineering Equipment and Materials Users Association (EEMUA). The relevant EEMUA Technical Committee, who were now responsible for the EEUA and OCMA publications within their range of expertise, set up a small Working Group to revise the OCMA Specification No ELEC-1 (Three-phase Cage Induction Motors), first published in Nov 1953, taking into account the technical advances and changes in Standards that had taken place since the last revision in July 1981.

This EEMUA Publication is the result of that work and replaces the present OCMA publication ELEC-1 "Three-phase Cage Induction Motors"

RELEVANT STANDARDS

The following National, International and Industry Standards are referred to, or are associated with this specification. Motors complying with equivalent National Standards of other countries may be offered for consideration by Purchasers, in which case the particular Standards concerned should be clearly stated in the Tender.

BRITISH STANDARDS.

- BS 88 Specification for cartridge fuses for voltages up to and including 1000 V a.c. and 1500 V d.c.
- BS 822 Terminal markings for electrical machinery and apparatus:
Part 6 - Terminal markings for rotating electrical machinery
(Applies to small power machines only)
- BS 2692 Fuses for voltages exceeding 1000 V a.c.
- BS 2757 Method for determining the thermal classification of electrical insulation.
- BS 4121 Mechanical cable glands for rubber and plastics insulated cables.
- BS 4278 Specification for eyebolts for lifting purposes.
- BS 4683 Specification for electrical apparatus for use in explosive atmospheres.
- BS 4727 Glossary of electrotechnical, power, telecommunications electronics, lighting, and colour terms.
Part 2 Group 03 - Rotating machinery terminology.
- BS 4999 Specification for general requirements for rotating electrical machines.
- BS 5000 Specification for rotating electrical machines of particular types or for special applications.
- BS 5345 Code of practice for the selection, installation and maintenance of electrical apparatus for use in potentially explosive atmospheres (other than mining applications or explosives manufacture).
- BS 5372 Specification for cable terminations for electrical equipment.
- BS 5501 Electrical equipment for potentially explosive atmospheres.
- BS 5512 Specification for rolling bearings - dynamic load ratings and rating life.
Part 1 - Calculation method.
- BS 5907 Specification for high voltage fuse-links for motor circuit applications.

BS 5999 Specification for identification of apparatus terminals and general rules for a uniform system of marking, using an alphanumeric notation.

BS 6121 Mechanical cable glands for elastomer and plastics insulated cables.

INTERNATIONAL STANDARDS.

IEC 34 Rotating electrical machines.

IEC 72/ Dimensions and output ratings for rotating machines
72A

IEC 79 Electrical apparatus for explosive gas atmospheres.

IEC 85 Recommendations for thermal evaluation and classification of electrical insulation.

IEC 269 Low voltage fuses.

IEC 445 Identification of apparatus terminals and general rules for a uniform system of terminal markings using alphanumeric notation.

ISO 281-1 Rolling Bearings - Dynamic load ratings and rating life
Part 1 - Calculation methods.

INDUSTRY STANDARDS.

ESI 44-5 Testing insulation systems of stator coils for rotating electrical machines.

EEMUA 101 Lifting Points - A design guide.

EEMUA 104 Noise - A guide to information required from Vendors.

EEMUA 106 General specification for Silencers and Acoustic Enclosures.

EEMUA 140 Noise procedure specification.

EEMUA 141 Guide to the Use of the Noise procedure specification.

1. GENERAL

This specification covers standard three phase cage induction motors for operation on rated voltages up to 15 kV.

Unless specified otherwise, motors shall comply with the requirements of the National Standards of the country of origin, provided they are based on the recommendations of the International Electrotechnical Commission, supplemented by this specification. Motors for use in hazardous areas shall also comply with the particular specification(s) for the type of explosion protection concerned.

2. SERVICE CONDITIONS

2.1 Operating Conditions

2.1.1. Motors shall comply with the requirements of BS 4999; Part 101 Section 4 Clause 11 and be suitable for a Relative Humidity of 90% with occasional condensation. They shall also be suitable in all respects, for operation in the environmental conditions typical of Refineries, Chemical Plants, Oil Fields, Marketing Depots and Installations as stated by the Purchaser.

2.1.2. Motors shall be designed to prevent the accumulation of moisture within the enclosure. Where a drain hole is provided, it shall be at the lowest part of the stator, subject to accessibility for the removal of the threaded plug when the machine is in the operating position.

2.2 Electrical Conditions

2.2.1. Motors shall comply with the requirements of BS 4999, Part 101 Section 4, Clause 12, and be suitable for a frequency variation of minus 5% to plus 2% of the nominal frequency co-incident with the voltage variation of 95% to 105% of rated voltage (U_n).

NOTE In the case of a motor intended for use in the United Kingdom, where the power supply to the machine is subject to the Electricity Supply Regulations, the range shall be 94% to 106% of rated voltage (U_n), which is the maximum permitted.

2.2.2. The requirements for motors which are to be connected to sources which give supplies falling outside the conditions described in 2.2.1 will necessitate additional or modified requirements as agreed with the Purchaser. Such motors are those which are intended for variable speed operation.

2.2.3. The insulation level of motors that are required to operate on unearthed neutral systems with one line at earth potential for prolonged periods must be agreed with the Purchaser.

3. WINDINGS AND INSULATION

3.1 All Motors - General Requirements

- 3.1.1. Unless otherwise specified, the insulation of the windings shall be Class 'F', but the temperature rise of the machine shall be limited to that applicable to Class 'B' insulation.
- 3.1.2. All windings shall be adequately supported, braced and blocked to provide sufficient rigidity during normal conditions of service. Such bracing shall, in particular, be adequate for direct-on-line starting and re-switching at a value of residual voltage of at least 30% of rated voltage and 180° out of phase with the supply voltage. Bracing shall be sufficient to prevent the resonant vibration of overhung end-windings. In the case of vertical motors winding support shall prevent any dropping or permanent displacement of the windings.
- 3.1.3. All insulated windings shall be non-hygroscopic, oil resistant and the materials resistant to flame propagation. All windings shall be impregnated and suitably processed to effectively seal them and thus to prevent deterioration from adverse environmental conditions at site during the construction period, when they may be lying idle for long periods, and also during normal operation.
- 3.1.4. Stator windings shall be connected in 'Star' unless otherwise agreed with the Purchaser.

3.2 Additional Requirements for motors for operation on system Voltages above 1000 V.

- 3.2.1. Motors shall be entirely suitable for switching by all normal switching devices including air, bulk/minimum oil, SF₆ and vacuum break types of contactor and circuit breaker and the life expectancy shall not be affected, irrespective of the switching device used.
- 3.2.2. Manufacturers shall take account of the characteristics of possible switching transients (rise time, amplitude and associated rate of change of voltage), the transient distribution within the windings of the motor, and the resulting peak interturn voltage level.
- 3.2.3. Stator coils shall be either manufactured and tested in accordance with a Quality Assurance Specification, details of which shall be submitted to the Purchaser with the initial tender, or confirmation of compliance of all motors with the latest edition of the Electricity Supply Industry Standard 44-5 shall be given irrespective of machine voltage and output rating.
- 3.2.4. Conductors shall preferably be of rectangular configuration. However, consideration will be given to the use of round wire type conductors provided they do not rely upon enamel coatings to achieve the insulation level required. Round wire type conductors shall be layered or sectionalised to ensure that the

appropriate maximum interturn voltage cannot be exceeded.

- 3.2.5 Round wire type coils relying solely on enamel insulation and random wound coils are not acceptable.
- 3.2.6. Normal requirements for surge withstand capability and testing are specified in Clause 3.2.8. below. Unless otherwise specified, motors supplied shall comply with these normal requirements.
- 3.2.7. Certain motor applications dictated by the motor duty, cable type, circuit configuration or any combination of these, as specified by the Purchaser may, produce higher voltage surge levels than those considered by Clause 3.2.8.

For these motor applications the Manufacturer shall either :-

a) Confirm compliance with the special higher motor insulation and test requirements specified in Clause 3.2.9.

or

b) Confirm that suitable, proven surge protection can be offered, with the guarantee that it will reduce the motor interturn insulation voltage stress level permitting application of motors complying with Clause 3.2.8.

3.2.8. Surge Withstand - Normal Requirements.

3.2.8.1. The surge withstand capability of a winding to earth shall be a peak voltage of $(4U_n + 5kV)$, and a wavefront rise time to the peak voltage of 1.2 μ microseconds.

3.2.8.2. The surge withstand capability of the coil interturn insulation shall be a peak voltage ' U_{peak} ' :

$$U_{peak} = k \times \frac{\sqrt{2} \cdot U_n}{\sqrt{3}} \quad \text{with } k = 3$$

with a wavefront rise time to peak of not greater than 0.5 μ microseconds.

3.2.8.3. The normal peak voltage levels for standard rated line voltages are given in Table 1.

3.2.8.4. Type tests, where specified in the Enquiry or Order, and Routine Quality Assurance Tests shall be in accordance the Electricity Supply Industry Standard 44-5.

3.2.9. Surge Withstand - Special Requirements.

3.2.9.1. Where special surge withstand requirements are specified and unless otherwise agreed between the Purchaser and the Manufacturer, the motors shall comply with the requirements of Clause 3.2.8. except that the surge withstand capability of the coil interturn insulation shall be a peak voltage ' U_{peak} ' where

$$U_{peak} = k \times \frac{\sqrt{2} U_n}{\sqrt{3}} \quad \text{with } k = 5$$