

Technical Requirements for Electrical Equipment Titel Asynchronous electric motors	Document TBE 103
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1 General

These Technical Requirements specify general requirements applicable to asynchronous electric motors intended for use in nuclear power plants. The requirements concern design, performance and documentation. Some requirements are therefore applicable only for certain types of equipment. The Manufacturer/Supplier shall fulfil the requirements in order to meet the safety and reliability objectives of the Swedish Nuclear Power Plant (NPP) Owners.

In addition to the requirements in this document, applicable parts of TBE 100:1 “General Technical Requirements and Explanations”, shall apply.

Detailed Technical Data, and in some cases other technical requirements to be followed, for the equipment is given in the Technical Specification. If the requirements of various documents differ, the Technical Specification shall have precedence.

Section 6 is a checklist that should be used in conjunction with making an inquiry or an order.

2 Definitions

For general definitions see TBE 100:1 and KBE 100-X.

Wet motors

The term 'wet motors' refers to motors in which the rotor and stator with windings are immersed in circulating water which can be cooled in an external heat exchanger.

3 General Product Requirements

3.1 Standardisation

Asynchronous motors shall comply with relevant requirements in the following standards and in the noted order:

IEC 60034-1	Rotating electrical machines - Part 1: Rating and performance
IEC 60034-2	Rotating electrical machines - Part 2-X: Methods for determining losses
IEC 60034-6	Rotating electrical machines - Part 6: Methods of cooling
IEC 60034-7	Rotating electrical machines - Part 7: Classification of types of constructions and mounting arrangements (IM Code)
IEC 60034-8	Rotating electrical machines - Part 8: Terminal markings and direction of rotation
IEC 60034-9	Rotating electrical machines - Part 9: Noise limits
IEC 60034-12	Rotating electrical machines - Part 12: Starting performance of singlespeed three-phase cage induction motors
IEC 60034-14	Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of the vibration severity (CENELEC HD 53.14 S1)

IEC 60034-15	Rotating electrical machines - Part 15: Impulse voltage with stand levels of form-wound stator coils for rotating a.c. machines
IEC 60034-18-1	Rotating electrical machines - Part 18: Functional evaluation of insulation systems -General guidelines
IEC 60072	Dimensions and output series for rotating electrical machines
IEC 60072-1	Frame numbers 56 to 400 and flange numbers 55 to 1080.
IEC 60072-2	Frame numbers 355 to 1000 and flange numbers 1180 to 2360.
ISO 21940-11	Mechanical vibration – Rotor balancing – Part 11: Procedures and tolerances for rotors with rigid behaviour
ISO 21940-32	Vibration and shock - Mechanical vibration – Rotor balancing – Part 32: Shaft and fitment key convention
EN 50209	Test of insulation of bars and coils of high-voltage machines
IEC 60034-26	Rotating electrical machines - Part 26: Effects of unbalanced voltages on the performance of three-phase cage induction motors

Specific requirements of standards are described in the Technical Specification.

The Manufacturer/Supplier shall in the quotation show degree of compliance with the regulations and applicable product standards.

Rating shall be in accordance with IEC 60034-1 for continues running duty (duty type S1) at rated output unless otherwise specified in the Technical Specification.

Since the greatest degree of uniformity in the plant is desirable, the Manufacturer/Supplier shall choose type of equipment in consultation with the Purchaser.

3.2 Technical requirements

3.2.1 Starting prerequisites

Starting method

Motors shall be designed for direct-on-line starting, unless otherwise specified in the Technical Specification.

Starting current

The supplier shall specify the motor's starting current in the offer.

If the Purchaser has specific limitations in the motor's starting current it shall be stated in the Technical Specification.

Torque characteristic

The supplier shall specify the motor's starting torque/speed curve at U_N (rated voltage) and at 70 % of U_N in the offer. Torque/speed curve at U_N (rated voltage) and at an undervoltage level(s) can in some cases be specified in the Technical Specification within the range of 65 – 85 % of U_N .

3.2.2 Direction of rotation

Terminals shall be marked in accordance with IEC 60034-8. Direction of rotation shall be clearly indicated in the installation documents, and marked with an arrow on high-voltage motors.

3.2.3 Terminal box design

For motors rated at 1 kV or below, the terminal box shall be so designed that copper cables with crimped cable lugs can be used optionally. Other arrangements may be accepted for smaller motors prior to the Purchaser's approval.

3.2.4 Terminal box size

If several different sizes of terminal boxes can be installed on a given motor, the largest type shall be chosen, unless otherwise stated in the Technical Specification.

3.2.5 Auxiliary equipment connections

Auxiliary equipment shall not be connected via the terminal box for the motor's power supply.

Heater and measuring equipment shall not have a common terminal box.

3.2.6 Mechanical vibration and balancing

Limits of maximum vibration shall be in accordance with IEC 60034-14 Table 1:

Grade A applies to machines with no special vibration requirements

Grade B applies to machines with special vibration requirements.

Motors under test with rigid mounting shall, in accordance with IEC 60034-14, have no horizontal and vertical natural frequencies in:

±10 % of the rotational frequency of the machine;

± 5 % of twice the rotational frequency, or

± 5 % of once and twice the electrical line frequency.

Complete assembled rotors shall be balanced to balance quality grade 2,5 with magnitude not exceeding a magnitude of 2,5 mm/s according to ISO 21940-11.

Balancing shall be done with a half key in accordance ISO 21940-32.

3.2.7 Bearing monitoring

Unless otherwise specified in the Technical Specifications, fittings for shock-pulse measurement transducers shall be provided at both bearing plates of motors having a power rating of 55 kW or more.

3.2.8 Surface treatment

Surface treatment of motors located in areas with severity B, C, D and E according to TBE 101 shall be in accordance with TBM or requirements specified in TS. It shall withstand decontamination agent and high-pressure washing.

3.3 Wet motors – Additional requirements

3.3.1 Operating conditions

Wet motors shall be designed for direct-on-line starting at rated voltage, and shall withstand reverse rotation at full speed.

3.3.2 Motor winding

Motor windings shall be designed with continuous conductors without any joints in the liquid-filled parts of the motor. However, if a star-point or other connection shall be arranged in a liquid-filled part, the Purchaser shall have approved the method and type of insulation to be used in advance.

3.3.3 Temperature sensors

Motors shall be fitted with sensors for winding temperature monitoring in accordance with requirements specified in the Technical Specification. Alternatively, measuring winding circuit resistance may monitor the temperature.

Temperature sensors shall be fitted in thermos wells, so that they can be replaced without need of draining the system.

3.3.4 Pressure resistance

Components used in wet motors shall not be damaged in any way by hydrostatic testing at a pressure of 1,3 times the design pressure of the motor casing or coolant circulation system.

4 Nuclear Specific Requirements

4.1 Motors to be installed in the reactor containment

4.1.1 Materials

Choice of material shall be performed in accordance with the environment existing at normal and extreme conditions and at design basis event with respect to temperature, pressure, radiation and humidity. Aluminium shall be avoided.

4.1.2 Lubrication

The lubrication interval shall be two years or more.

4.2 Starting conditions

4.2.1 Starting time for motors with rated output of 7,5 kW or less

Motors with rated output of 7,5 kW or less shall be designed for short starting times: less than three seconds at rated voltage.

4.2.2 Starting time for other motors

Motors with rated output of 7,5 kW or more that run equipment such as fans, shall have a starting time of less than 12 seconds at rated voltage and less than 15 seconds at 70 % of rated voltage, unless otherwise stated in the Technical Specification.

4.3 Restart

At rated voltage and at the intended load, electric motors shall withstand three starts in succession from hot state after running at normal operating conditions, without the stator winding temperature exceeding the limits set down in standards by more than 20°C.

If the recovery time is longer than one hour, the supplier shall specify this in the offer. The requirement is not applicable for motors ≥ 6 kV.

4.4 Phase opposition

Low-voltage motors shall be designed to withstand a start at full operational voltage when the remnant voltage at the motor terminals is $0,6 U_N$ and in full phase opposition. The corresponding value for high-voltage motors (>1 kV) is $0,9 U_N$.

4.5 Impulse voltage withstand levels

Motors with form-wound stator coils rated at more than 1 kV shall be designed so that they, when running, can withstand impulse voltage (U_p) of at least $U_p = 4 U_N + 5$ kV and having a front time of $1,2 \mu s$ and a time-to-half of $50 \mu s$.

4.6 Dielectric strength (Withstand voltage tests)

The dielectric strength of motors shall be designed to withstand voltage levels that are in accordance with IEC 60034-1.

4.7 Insulation resistance

The Manufacturer/Supplier shall state in the quotation the values for the insulation resistance on the motors electrical insulating system (EIS). Table 1 below is the minimum requirements for the EIS.

Table 1

Motor type	Minimum Requirements
High-voltage motors at 40°C	10 000 MΩ
Low-voltage motors at 20°C	1000 MΩ
Wet motors at 20°C	2000 MΩ
Motor accessories	According to TBE 100:1
Bearing insulation	Manufacturer's/Supplier's standard

4.8 Replacement parts

Replacement parts that might affect the qualification status shall be specified.

4.9 Bearing cages

Ball and roller bearing cages of plastic material are not allowed without approval by the Purchaser.

5 Documentation

In addition to documentation required in TBE 100:1 and KBE 100-X the following are required:

- Dimensioned drawing
- Connection diagram, motor and any extra equipment
- List of apparatus for any extra equipment
- Maintenance instructions / lubrication instruction

6 Agreements between Manufacturer/Supplier and Purchaser

This checklist should be used as a base between Manufacturer/Supplier and Purchaser when discussing tenders or orders.

1	Review and complementary addition of the Technical Specification	
2	Review of valid Inspection plan and inspection procedures	
3	Verification of seismic requirements	
4	Type of motor; cast iron or aluminium?	
5	Temperature rise tests at rated voltage and output	
6	Torque/speed curve at U_N and at $0,7 U_N$	
7	Requirements on starting time	
8	Numbers of starts in succession and recovery time	
9	Connection point for earth wire – dimension and design	
10	Terminal box size in relation to the connecting cable	
11	Top or side mounted terminal box	
12	Surface treatment	
13	Drain hole	
14	Sensors for measuring of winding temperature, number and location	
15	Number and location of fitting for shock pulse measurements	
16	Measuring method and the mounting arrangement for bearing monitoring	
17	Heater for downtime heating	
18	Will the motor be delivered with draw key	
19	Radial load	
20	Noise level	
21	Current transformers	
22	Torque at installation of connection terminals for feeder cable	
23	Equivalent diagram	
24	ATEX (EX-classification)	

25	Temperature sensors and other accessories	
26	Bearing current requirements	
Additional requirements regarding motors for speed controlled operation:		
27	Is the motor designed for speed-controlled operation with respect to heating	
28	Can the cooling of the motor be maintained at low speed, external fan	
29	Range of speed regulation?	
30	Are there any requirements for special connection cable with respect to EMC	
Additional requirements for motors located inside the reactor containment:		
31	Ability to handle pressure variations in connection with pressure tests of the reactor containment	
32	Is it possible to have a lubrication interval of two years?	
33	Does the polymer material involved meet the current environmental requirements?	
34	Is material sensitive for radiation included in the motor, e.g. lubricating grease?	
35	Functional evaluation of electrical insulation systems (ageing) IEC 60034-18	
Balancing and vibration		
36	Balancing test record	
37	If possible vibration measurements shall be made under cold, warm, unloaded and loaded test conditions.	