TECHNICAL REQUIREMENTS FOR ELECTRICAL EQUIPMENT

Asynchronous electric motors

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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, construction and documentation. Some requirements are therefore applicable only for certain types of equipment. The Manufacturer/Supplier must 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 “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 and KBE 100.

**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 single-speed 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 withstand 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
ISO 8821 Vibration and shock - Mechanical vibration - Balancing - Shaft and fitment key convention
SS-EN 50209 Test of insulation of bars and coils of high-voltage machines

Specific requirements of standards are described in the Technical Specification (TS).

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 is to choose make and 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 motors 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.

3.2.2 Direction of rotation
Terminals shall be marked in accordance with IEC 60034-8. Direction of rotation must 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 may not be connected via the terminal box for the motor’s power supply. Heater and measuring equipment may not have a common terminal box.

3.2.6 Vibration
Motors shall with regard to vibrations meet the standard (IEC 60034-14) class B. Balancing shall be done with a half key in accordance with ISO 8821.

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 and D according to TBE 101 shall be in accordance with TBY 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 must withstand reverse rotation at full speed.

3.3.2 **Motor winding**
Motor windings shall be designed with continuous conductors without any joints in the water-filled parts of the motor. However, if a star-point or other connection must be arranged in a water-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 thermo wells, so that they can be replaced without need of draining the system.

3.3.4 **Pressure resistance**
Components used in wet motors must 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. Aluminum 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.

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 $U_p=4U_N + 5kV$ and having a front time of 1,2 $\mu$s and a time-to-half of 50 $\mu$s (IEC 60034-15).

4.6 **Dielectric strength (Withstand voltage tests)**
The dielectric strength of motors shall be designed to withstand voltages levels that are in according with IEC 60034-1.

4.7 **Insulation resistance**
The manufacturer 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.

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<th>Minimum Requirements</th>
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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 and KBE 100 the following are required:
- Dimensioned drawing
- Connection diagram, motor and any extra equipment
- List of apparatus for any extra equipment
- Maintenance instructions / lubrication instruction
- Torque/speed graph
- Record of temperature rise test
### 6 AGREEMENTS BETWEEN MANUFACTURER AND PURCHASER

The list below shall be used as a frame in discussions between Manufacturer/Supplier and Purchaser in connection with offers or orders.

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