

<b>Examination Procedure</b>  Rubrik/Title <b>Asynchronous Electric Motors</b>	Beteckning/Document <b>KBE EP-170</b>
	Utgåva/Issue <b>4 (E)</b>
	Datum/Date <b>2017-05-22</b>
	Ersätter/Supersedes <b>3 (E)</b>

## 1 Scope

This examination procedure is intended for application to electrical asynchronous motors, using either air or water as primary coolant. With some reservation this procedure can be used for other types of motors and generators.

The procedures may be performed as Routine Inspection or Type Inspection as specified in the Inspection Plan.

## 2 Objective

To verify that the motor fulfil requirements regarding function and performance.

## 3 Examination

### 3.1 General

Requirements in Technical Specification will take precedence over this document.

The tests shall be carried out in accordance with this document. If the Manufacturer/Supplier wants to use different test methods to the test procedures it has to be reviewed and approved by the purchaser.

The accuracy of measuring equipment for electrical quantities shall be according to the Manufacturers QA program.

Measured values shall be within specified tolerances.

### 3.2 Airgap measurement

Airgap measurement shall be performed on larger motors with openings in the end shields. The airgap shall be measured using gauges from each end of the motor, checking at least four positions at each end. The measurement points shall be uniformly distributed around the rotor.

### 3.3 Winding resistance measurement

Line-to-line resistance on the stator windings shall be measured from the motor terminals and the measuring method shall be specified.

Before the measurements are carried out, the motor shall be allowed to cool down to room temperature. Ambient temperature shall be measured and recorded.

### **3.4 Constant losses**

The testing shall be carried out with the motor completely assembled and installed in the same mounting position as intended during normal use. Wet motors shall be completely filled up with water.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Currents
- Input power (measured using the two-wattmeter method or equivalent)
- Frequency and speed.

### **3.5 No-Load test (type test)**

The no-load losses shall be stabilized at rated frequency and voltage.

The no-load losses are considered stabilized when the no-load power input varies by 3% or less when measured at two successive 30 min intervals.

While running, the motor shall be checked for mechanical unbalance, noise level and direction of rotation. (IEC 60034-2-1)

### **3.6 Friction and winding losses, iron loss**

Test at a minimum number of seven values of voltage, including rated voltage, so that:

- four or more values are read approximately equally spaced between 125 % and 60 % of rated voltage
- three or more values are read approximately equally spaced between 50 % and approximately 20 % of rated voltage, or (for an uncoupled running machine) to a point where the current no longer decreases

The motor shall be connected to rated voltage and frequency and be operated until thermal equilibrium is reached.

All measurements shall be made at rated frequency. The iron-, friction-, ventilation- and additional losses shall be documented. (IEC 60034-2-1)

### **3.7 No-load test (routine test)**

When running at no-load measurement of current and speed shall be made. Measurement shall be carried out at rated voltage and frequency.

Measured no-load losses shall be within specified tolerances. Abnormal noise level or signs of improper balancing, whether measured or observed, will not be accepted.

The direction of rotation shall be in accordance with IEC 60034-8.

### **3.8 Load losses (Load curve test)**

The test shall be performed according to IEC 60034-2-1.

The machine shall be loaded with suitable means.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Current
- Input power (measured using the two-wattmeter method or equivalent)
- Output power
- Frequency
- Speed

The aggregated loss method as described in IEC 60034-2-2 may be applied for larger motors.

### **3.9 Temperature rise**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Current
- Input power (measured using the two-wattmeter method or equivalent)
- Output power
- Frequency
- Speed
- Temperatures (ambient, core, winding, bearings, coolant inlet and coolant outlet)
- Coolant flow, if water cooling is used

The motor shall be tested at rated output.

For wet motors and similar incorporated assemblies, pump motor, the loading is adjusted by using maximum pumping flow through the built-in pump unit.

The temperature rise test shall proceed until a thermal equilibrium has been reached.

The temperature rise shall be measured and evaluated in accordance with IEC 60034-1.

Measured values shall be within the temperature rise limits on the motors electrical insulation system (EIS) IEC 60085. See IEC 60034-1 for applicable thermal class.

### **3.10 Over speed and vibration testing (routine test)**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Current
- Frequency or rotation speed.
- Bearing vibration levels in two mutually perpendicular directions. On wet motors, vibration may be measured on the motor casing at the bearings.
- Bearing temperature
- Time

Over speed testing shall be carried out at 120 % of maximum rated rotation speed for two minutes. Special attention shall be paid to the occurrence of abnormal noise.

After the over speed test the voltage withstanding shall be checked.

The test result is approved if no permanent abnormal deformation has been caused, and if no other weakness, which might cause abnormal motor operation, can be detected.

No difference shall be detected in the vibration frequency spectra and amplitude after the over speed test.

After the over speed test the motor shall fulfil the voltage withstanding requirements.

### **3.11 Over-voltage test (routine test)**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Frequency or rotation speed
- Currents
- Time

The test shall be carried out at  $1,3xU_N$  for one minute.

After the over-voltage test the voltage withstanding shall be checked.

The test result is approved if no sudden increases in current occur during the test.

After the over-voltage test the motor shall fulfil the voltage withstanding requirements.

### **3.12 Short-circuit test (routine test)**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The rotor may either be secured in a locked position or be allowed to rotate very slowly during the test.

Power supply voltage shall be adjusted to give the necessary current values.

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Currents
- Input power (measured by the two-wattmeter method or equivalent)
- Winding temperature
- Frequency

After the short-circuit test the voltage withstanding shall be checked.

Measured currents, input power and calculated power factor under locked rotor conditions shall be within specified tolerances.

After the short-circuit test the motor shall fulfil the voltage withstanding requirements.

### **3.13 Tan delta test**

To test the electrical insulation on bars and coils with  $U_N$  from 5 kV to 24 kV shall the test procedures be in accordance with the European standard EN 50209 as a routine test or as a destructive random test.

### **3.14 Noise level**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The motor noise shall be measured under no-load conditions.

When necessary the testing shall be performed according to IEC 60034-9.

The noise level found shall not exceed the level, which is typical for the motor type.

### **3.15 Impulse voltage withstand test**

The test shall be carried out in accordance with IEC 60034-15.

The test levels shall be in accordance with TBE 103 section 4.6.

The test can be performed as sample test (destructive test) or as routine test.

### **3.16 Withstand voltage test (routine test)**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

There shall be reliable connection between the stator core and frame, and between the casing of any auxiliary equipment and the frame.

#### **Alternative 1:**

If both ends of each phase are individually accessible, the test voltage shall be applied between one phase and the frame. Further, the windings which are not tested shall also be connected to the frame. All phases are to be checked in this way.

#### **Alternative 2:**

If the phases are internally connected, the test shall be made between one phase and the frame.

Before and after the test, the insulation resistance shall be measured in accordance with section 3.17.

#### **Auxiliary equipment (heaters, sensors etc.)**

The test voltage shall be applied between the equipment terminals and the frame.

#### **Test voltage**

The test voltage shall be at power frequency, with as near a sinusoidal waveform as possible.

The power source shall be capable of supplying sufficient current to maintain the test voltage, even though leakage currents may occur. The test shall be commenced at a voltage of not more than one half of the full test voltage and increased to the full value steadily or in steps of not more than 5 % of full value. The time allowed for increase of the voltage from half to full value being not less than 10 s. The full test voltage shall be maintained for 1 min.

For windings on asynchronous rotating machines the test voltage (r.m.s.) shall be  $U_{\text{test}} = 1000 \text{ V} + 2xU_N$ , with a minimum of 1500 V.

For auxiliary equipment the test voltage shall be in accordance with TBE 100.

During routine testing of quantity produced machines and rated for  $U_N \leq 1 \text{ kV}$  the 1 minute test may be replaced by a test of 1 second at 120 % of the test voltage.

The test result is approved if no insulation breakdown or spark-over occurs.

### **3.17 Insulation resistance**

The testing shall be carried out with the motor completely assembled, and installed in the same mounting position as in normal use. Wet motors shall be filled up with water.

The measurement voltage for windings shall be according to table 1, but may not exceed the motor's test voltage according to section 3.16.

**Table 1**

<b>Rated voltage kV</b>	<b>Measurement voltage kVDC</b>
< 3	0,5
≤ 6	1,0
> 6	2,5
≥ 10	5,0

Measurements shall be made using a DC insulation tester of sufficient capacity.

For temperature sensors and other accessories the test voltage for measuring insulation resistance shall be according to TBE 100.

The test voltage for insulation of bearings shall be 100 VDC.

Readings shall be made after the measurement voltage has been applied for a period of at least one minute.

When possible, all links between output terminals shall be removed and separate measurements made between each phase terminal and the frame.

Accessories shall be tested separately.

The following parameters shall be measured and recorded:

- Insulation resistance between windings and frame
- Insulation resistance between accessories and frame
- Winding temperatures

Unless otherwise specified in the Technical Specification, the minimum requirements in TBE 103 table 1 shall be met.

### **3.18 Visual inspection**

A systematic visual inspection shall be carried out before packing the motor, covering at least the following points:

#### **Motor**

- Rating plate

A rating plate shall be fitted. Data shown shall be in accordance with the specification.

- Welding

Cracks, root faults, slag inclusions or porosity may not occur.

- Bolted joints

Tightened and properly secured

- Counterweights

Properly secured

- Windings

Insulation integrity, mechanical security of windings and winding connections

- Terminals
  - size of terminal boxes (maximum standard size required)
  - protection class of terminal boxes
  - marking
  - terminals appropriate to specified supply voltage
  - connections for cable screens
  - creep age and airgap distances
  - crimped connections
  - incorrect or loose cores/strands
  - terminal dimensions
  - connection for external earth conductor
  - bolt dimensions and positioning

- Lubrication

Lubrication schedule plate shall be provided. Motor shall be lubricated. Excess grease shall have been removed.

- Painting

Quality, type, thickness

- Cleanliness
- Drain hole

According to Technical Specification

- Lifting eyes
- If necessary, brushes and brush-rocker

### Accessories

- General

Number of accessories, protection class, fitting and connections, conductor identification, bushings, tightening

- Heaters

Type, rated data, identification, separate terminal box

- Instrumentation transformers

Type, rated data, identification

- Temperature sensors

Type, nominal resistance, identification, separate terminal box

- Bearing monitoring

Type, identification

- Speed sensor

Type, identification, contact devices

- SPM transducers

Assembly instructions

### **3.19 Torque curve**

The torque/Speed curve shall be determined at rated voltage and at reduced voltage as specified in the TBE 103 section 3.2.1 using one of the methods described below.

#### **Method 1**

The motor is connected to a calibrated DC generator, capable of absorbing the power developed over the rotation speed range involved.

#### **Method 2**

The torque is measured using a dynamometer connected between the motor and its load.

#### **Method 3**

The motor is fitted with a tacho-generator, the output signal of which is differentiated in a RC-filter. The torque curve can then be calculated from the recorded values of acceleration and speed if the moment of inertia is known.

Correction shall be made for potential voltage drops when the motor is started. The value of maximum torque shall also be corrected to allow for direct on line starting at no load. By this reason, tests with the supply voltage reduced to 25 and 75% of rated value are required.

#### **Method 4**

Built-in pump units may, as an alternative to the methods described above, be tested by starting at maximum load (maximum flow).

The following parameters shall be measured and recorded during the test:

- Supply voltage
- Current
- Input power (measured using the two-wattmeter method or equivalent)
- Frequency
- Speed
- Torque

#### **Acceptance criteria**

Measured values of torque shall be within specified tolerances. Synchronous torque shall be negligible.

## **4 Acceptance criteria**

Acceptance criteria stated in the Technical Specification are valid as overarching requirements.

## 5 Documentation

Inspection performed is to be documented in an inspection certificate, record or technical report as required in the Inspection Plan. Several examinations within one and the same Inspection Plan may be reported in the same document.

Examinations carried out as routine (100%) inspection are to be reported to the Purchaser as original documents.

The document shall as a minimum include the following:

- Items examined

Product, designation, quantity, serial numbers and reference to the Purchasers order.

- Identity / Traceability

The identity of the objects under examination in comparison with type tested items and in comparison with relevant specifications shall be specified, unless the identity is certified in a separate document (as per KBE EP-180).

- Examination procedure

It shall be clearly stated if the inspection has been performed according to this Examination Procedure or to any other procedure agreed upon.

- Measurement equipment

Type of equipment, accuracy, identification, etc. and current calibration data for the equipment used where performance is significant to the results

- Results

It shall be evident that the items have fulfilled stated requirements and acceptance criteria. Measured and recorded values that are to be documented as per the procedure as well as any deviations from requirements in applicable specifications or test procedures shall be reported.

- Approval

Date of inspection and name of responsible inspector are to be included. The document shall be reviewed and approved in accordance with the Manufacturers or the laboratory's internal QA/QC routines.