

WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-51-04

SQUIRREL CAGE INDUCTION MOTORS BELOW 40 kW

1 GENERAL

This standard specification is for low voltage squirrel cage induction motors of rating below 40 kW.

The motors shall comply with the following requirements:

- (a) Type : Energy efficient squirrel-cage induction motor to Class IE3 of IEC 60034-30-1 with the following minimum full load efficiency measured according to IEC 60034-2-1:

Rated output power	Minimum motor efficiency (%) for Class IE3 motors with the following number of poles / synchronous speed		
	2 poles / 3000 rpm	4 poles / 1500 rpm	6 poles / 1000 rpm
0.75 kW	80.7	82.5	78.9
1.1 kW	82.7	84.1	81.0
1.5 kW	84.2	85.3	82.5
2.2 kW	85.9	86.7	84.3
3 kW	87.1	87.7	85.6
4 kW	88.1	88.6	86.8
5.5 kW	89.2	89.6	88.0
7.5 kW	90.1	90.4	89.1
11 kW	91.2	91.4	90.3
15 kW	91.9	92.1	91.2
18.5 kW	92.4	92.6	91.7
22 kW	92.7	93.0	92.2
30 kW	93.3	93.6	92.9
37 kW	93.7	93.9	93.3

- (b) Standards : IEC 60034 and IEC 60072 except where modified herein.
- (c) Degree of protection : Totally enclosed IP55 to IEC 60034-5.
- (d) Duty rating : Maximum continuous rating (MCR), S1 duty to IEC 60034-1.
- (e) Insulation : Class F design with temperature rise not exceeding the limits applicable to Class B in IEC 60034-1.
- (f) Ambient temperature : 40°C maximum continuous for 4 hours.
35°C average over 24 hours.

5°C minimum.

- (g) Humidity : Up to 98% relative humidity.
- (h) Electricity supply : 380V three-phase, 50 Hz, four-wire system with solidly earthed neutral.
- (i) Voltage variations : -10% to +6%
- (j) Frequency variations : $\pm 2\%$

2 STARTING PERFORMANCE

Motors shall be suitable for both direct-on-line (DOL) and star/delta starting. Unless otherwise specified in the Particular Specification, their DOL starting currents at rated voltage shall not exceed 7.5 times the full load currents.

The starting time (time taken to attain 90% of the rated speed) under the most arduous conditions shall be as follows:

85% rated voltage at motor terminals - not more than 4 seconds.

49% rated voltage at motor terminals - not more than 10 seconds.

The motors shall be suitable for two starts in succession followed by a cooling period of 15 minutes before attempting another starting sequence. The motors shall also be capable of at least six starts per hour, equally spaced, under normal operating conditions.

3 ENCLOSURE CONSTRUCTION

Motor frames, end covers, end shields and external fan cowls shall be of adequate mechanical strength and robustness. Motors rated at 15 kW or above shall have cast iron casings. Dimensions and frame number of the motor shall comply with IEC 60072.

Motors rated at more than 3 kW or weighted more than 25 kg shall be provided with lifting lugs for easy handling during erection or maintenance.

4 RATING

For the procurement of motors supplied together with pumps, the rated motor power output shall be not less than 110% of the maximum power absorbed by the pump over the entire pump operating range specified for the pumpset.

For the procurement of motors intended to replace existing aged units, the rated motor power output shall be not less than 120% and 115% of the maximum power absorbed by the pump over the entire pump operating range specified for (1) fresh water or raw water pumpset; and (2) salt water or recycled water pumpset respectively.

The foregoing power margin shall not be reduced by any factors such as tolerances of

pumpset or accuracy of test equipment.

For motors rated at more than 15 kW, the uncorrected power factor at full load shall be not less than the limits shown in the table below.

Number of poles	Minimum uncorrected power factor at full load
2	0.85 lagging
4	0.83 lagging
6	0.80 lagging

For motor integrated into a machine such as air compressor that it cannot be tested separately from the machine or a motor specifically designed to operate at ambient air temperature exceeding 40°C, the requirement of over-rating of the driving motor as specified in Para. 4 of this Specification could be exempted.

The motor shall be designed with reference to IEC TS 60034-25 or other equivalent standards to withstand over-voltage, higher rate of rise of voltage, over-heating due to harmonics, flow of bearing current and other stressing effects arising from the pulse width modulated (PWM) waveform of the supply voltage.

When used in conjunction with a variable speed drive (VSD) or inverter supply, provisions of fixed speed fan with dedicated power supply mounted on the motor top as recommended by the motor manufacturer shall be required.

5 CABLING AND TERMINATION

The insulation of terminals, connectors, cables and conductors shall be made of moisture-resistant homogeneous materials, e.g. butyl rubber, PVC, PVC heat-shrinkable tubing or similar homogeneous material.

The cable terminal box for the motor power supply cable(s) shall be adequately sized and suitable for cable entry from below. The terminal box shall be diagonally split to enable quick and easy installation and maintenance. Both ends of the three-phase winding shall be brought out and terminated on six insulated connectors in the terminal box. Copper links shall be provided by the manufacturer and connected for DOL or assisted starting (by variable speed drive or soft-starter) except star/delta starting.

For motors rated at more than 3 kW, an earthing terminal shall be provided adjacent to the cable terminal box, or alternatively equipped with a tapped hole with screw.

6 AUXILIARY EQUIPMENT

6.1 Anti-condensation Heaters

For motors rated at more than 15 kW, an anti-condensation heater suitable for operation on a 220V, single-phase, 50 Hz supply shall be fitted in the motor. Terminals shall be provided for the heater to be switched off when the motor is running and vice versa. A separate terminal box with a degree of protection IP55 to IEC 60529 for the anti-condensation heater shall be provided.

A warning label of durable material with inscriptions “Separate Supply for Space Heater – Isolate Before Opening this Lid” shall be fixed on the lid of the heater terminal box.

6.2 Motor Protection

The motor directly connected to the main power supply shall be protected by a triple pole thermal overload relay for motor protection. The functions of motor protection shall include, but not be limited to thermal overload and phase failure with manual reset facilities.

7 MARKING

A permanent stainless steel rating plate to IEC 60034-1 giving the motor data and the phase connections for the required direction of rotation shall be provided.

8 TEST REQUIREMENTS

The following tests shall be conducted on each motor rated at more than 3 kW at the manufacturer’s works in accordance with the specified applicable standards:

	<u>Tests</u>	<u>Standards</u>
(a)	Resistance of windings (cold) and direction of rotation	IEC 60034-1
(b)	No load losses, power factor and current	IEC 60034-2-1
(c)	Withstand voltage	IEC 60034-1
(d)	Vibration	IEC 60034-14

Test reports shall be submitted for approval within 14 days after completion of the tests.

9 INFORMATION FOR ASSESSMENT

The following type test reports on motors of the same design, frame size and construction shall be submitted for assessment prior to manufacturing.

	<u>Tests</u>	<u>Standards</u>
(a)	Temperature rise	IEC 60034-1
(b)	Power factor at rated output	-
(c)	Locked rotor torque	-
(d)	Starting (locked rotor) current	-
(e)	Efficiency at rated output	IEC 60034-2-1