

**WATER SUPPLIES DEPARTMENT**

**STANDARD SPECIFICATION E-51-03**

**SQUIRREL CAGE INDUCTION MOTORS OF 40 -140 kW RATING**

1 TECHNICAL REQUIREMENTS

1.1 General

This standard specification is for low voltage squirrel cage induction motors of rating between 40 kW and 140 kW. The standard specification for other motor ratings is provided separately.

The motor shall comply with the following requirements:

- (a) Type : Energy efficient squirrel-cage induction motor with the following minimum full load efficiency:

Rated Output (P)	Minimum motor efficiency	
	2-pole	4-pole
40kW ≤ P < 45kW	93.3%	93.6%
45kW ≤ P < 55kW	93.7%	93.9%
55kW ≤ P < 75kW	94.0%	94.2%
75kW ≤ P < 90kW	94.6%	94.7%
90kW ≤ P < 110kW	95.0%	95.0%
110kW ≤ P < 140kW	95.0%	95.4%

- (b) Degree of protection : Totally enclosed IP 55 to BS EN 60034-5.
- (c) Duty rating : Maximum continuous rating (MCR), S1 duty.
- (d) Insulation : Class F or Class B design with temperature rise not exceeding the limits applicable to Class B in BS EN 60034-1.
- (e) Max. speed : 1500 r/min. synchronous speed.
- (f) Noise level : Limiting mean sound power level (Lw) in dB(A) for airborne noise emitted by motor not to exceed 90dB(A) to BS EN 60034-9 Method II.
- (g) Vibration level : BS 4999 Part 142 Table 1 Quality grade N or Table 2 as appropriate.

1.2 Operating Conditions

- (a) Altitude : not greater than 1000 m.

- (b) Ambient temperature : 40°C maximum continuous for 4 hours.  
35°C average over 24 hours.  
5°C minimum.
- (c) Humidity : up to 98% relative humidity.

### 1.3 Electrical Conditions

- (a) Electricity supply : 380V 3 phase, 50 hertz, 4 wire system with solidly earthed neutral.
- (b) Voltage variations :  $\pm 6\%$
- (c) Frequency variations :  $\pm 2\%$

### 1.4 Standards

The equipment supplied shall comply with the latest version of the relevant British Standard Specifications and Codes of Practice. In particular, the following standards are applicable:

- (a) BS EN 50347 General purpose three-phase induction motors having standard dimensions and outputs
- (b) BS EN 60034 Rotating electrical machines.
- (c) BS EN 60085 Electrical insulation, Thermal classification
- (d) BS 4999 General requirements for rotating electrical machines.
- (e) BS 5512 Method of calculating dynamic load ratings and rating life of rolling bearings.

Other equivalent Standards issued by internationally recognized engineering institutions or organizations may also be accepted. Manufacturers offering equipment complying with other standards shall supply duplicate copies of such standards in English together with the tender.

### 1.5 Starting Performance

The motor shall be suitable for both direct-on-line and star/delta starting. Direct-on-line starting current at rated voltage shall not exceed seven times the full load current.

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.

At the lowest specified voltage across the motor winding (i.e. 49% rated voltage),

the accelerating torque at any speed up to the peak torque point shall be not less than 10% of the motor rated full load torque.

The motor shall be suitable for two starts in succession followed by a cooling period of 30 minutes before attempting another starting sequence. The motor shall also be capable of at least three starts per hour, equally spaced, during normal operating conditions.

## 2 RATING

The motor power output shall be not less than 120% for fresh water pumpset and 115% for salt water pumpset of the maximum power absorbed by the pump over the entire pump operating range specified, while running in solo or in parallel under the most arduous operating conditions specified. No reduction in this 20% for fresh water pumpset (15% for salt water pumpset) margin will be allowed for test tolerances on pump output, efficiency etc.

The uncorrected power factor of the motor shall be not less than 0.83 lagging at full load.

## 3 DESIGN AND CONSTRUCTION

### 3.1 Enclosure

Dimensions and frame number of motor shall comply with BS EN 50347. Motors of the same rating shall be interchangeable.

Motors shall be provided with lifting facilities for easy handling during erection or maintenance.

### 3.2 Ventilation and Cooling

Motors shall be designed for method of cooling IC411 to BS EN 60034-6.

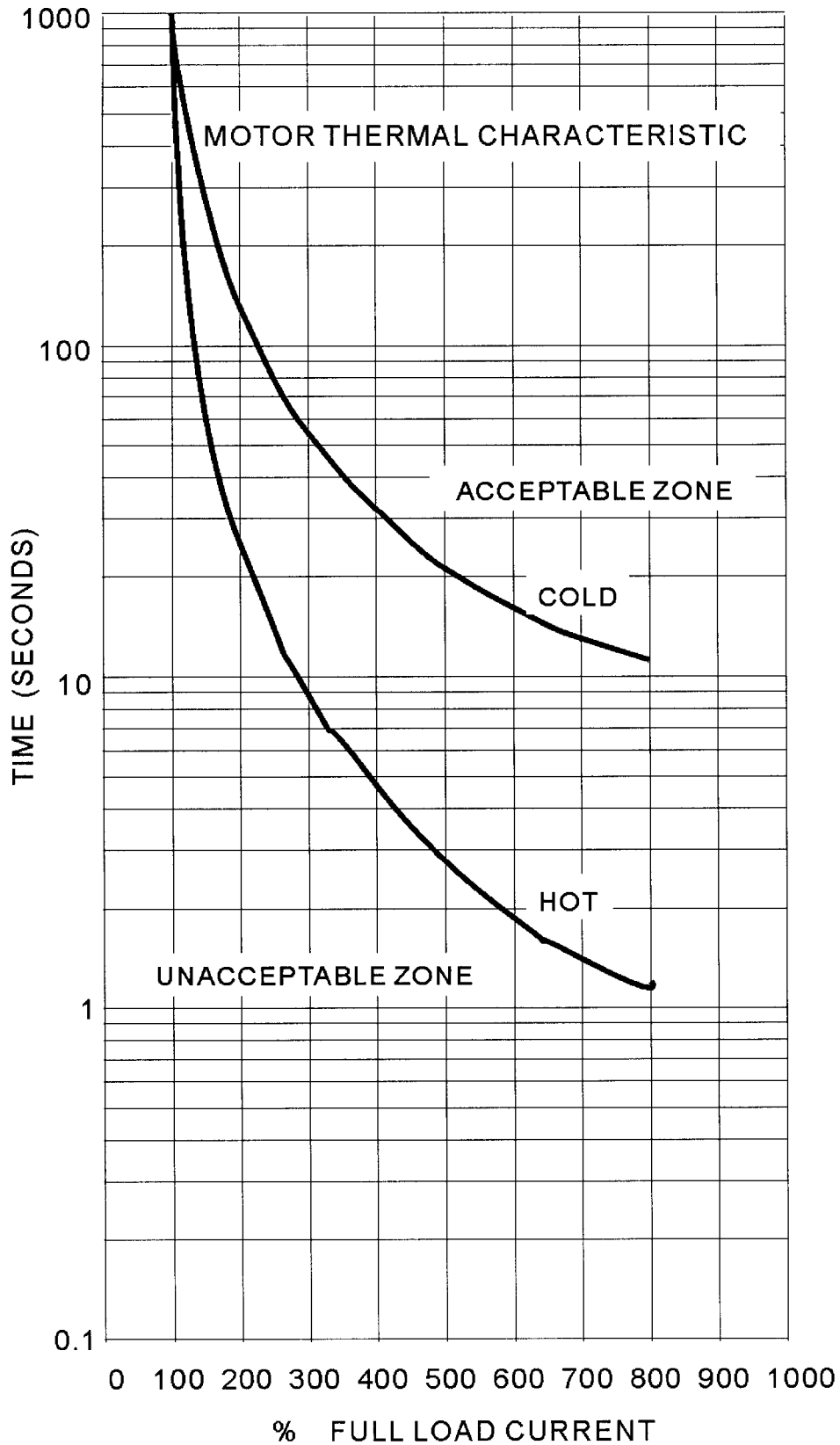
The motor air inlet shall normally be arranged to draw ventilating air directly from the surroundings.

The motor ventilating fan at non-drive end (NDE) shall be directly driven by the motor, i.e., with no auxiliary power supply required. The motor fan for outlet air shall be designed such that at the worst operating condition and rated output, the maximum operating temperature of the stator windings does not exceed the value specified for Class B insulation and the casing temperature is less than 75 °C at 40 °C ambient.

### 3.3 Thermal Insulation and Short-time Characteristic

The motor windings and accessories shall be designed for Class F or Class B insulation with Class B maximum temperature rise limit to BS EN 60034-1.

The short-time overload withstand characteristic of the motor shall be within the acceptable zone as shown in the graph below. A copy of the motor characteristic curve shall be submitted with the tender.



Motor Short-time Overload Withstand Characteristic

### 3.4 Motor Stator Windings

The stator winding shall be designed for a minimum life of 25 years of service at rated load and voltage.

### 3.5 Bearings

Motor bearings shall be of rolling type and metric sizes. Approved type thrust and guide bearings shall be provided for vertical-shaft motors. The life associated with 90% reliability (L10 life) of the bearing shall be not less than 50,000 hours under the most onerous conditions.

### 3.6 Provision for Cabling and Termination

#### 3.6.1 Cabling provision at cable boxes

The Cable terminal box for the motor power supply cable(s) shall be adequately sized and suitable for cable entry from below.

Both ends of the three-phase winding shall be brought out and terminated on stud connectors in the termination chamber. Copper links shall be provided by the manufacturer and connected for DOL starting. The terminal bases for the six-terminal cable box for star-delta starting shall be in staggered formation to facilitate cable termination.

An earthing terminal, outside the cable box, with the same current carrying capacity as the line terminals but not smaller than that suitable for the termination of a 50 x 6.3 mm copper strip shall be provided. A tapped hole with screw external to the cable box would be acceptable.

The cable box shall be fabricated from mild steel plate of minimum 3 mm thick with degree of protection IP55 to BS EN 60529. The cable box shall be provided with a detachable brass gland plate and an external earthing stud.

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

Permanent terminal markings and direction of rotation in accordance with BS EN 60034-8 shall be provided in the cable box.

#### 3.6.2 Motor Supply Cables

Motor terminations shall generally be suitable for use with the size of motor supply cable selected from Table 1 below. The actual cable size will be confirmed subsequent to the award of contract.

Table 1 - Power Supply Cable and Terminations

Stranded Copper Size mm <sup>2</sup>	Motor Full Load Current (A)				Compression Fitting Palm (max.) mm	Terminal Stud Centre (min.) mm	Stud to Gland Plate (min.) mm
	PVC SWAPVC 3-core Cable		XLPE SWAPVC 3-core Cable				
	1 Cable	2 Cables*	1 Cable	2 Cables*			
16	-	82	-	113	22	33	140
25	-	109	86	150	22	33	155
35	-	134	104	180	25	36	180
50	96	166	127	220	27	41	205
70	117	203	161	278	30	44	225
95	142	247	198	342	35	49	255
120	167	289	228	-	40	57	280
150	192	-	265	-	45	62	315
185	216	-	302	-	50	67	355
240	259	-	-	-	52	72	400
300	293	-	-	-	57	77	450

\* Note : This is applicable to star-delta starting motor for which each of the supply cables will share 0.577 of the motor rated full load amp.

### 3.6.3 Cable Glands

Where specified, brass cable glands complying with BS 6121 type E1W shall be provided for power supply cable termination.

### 3.7 Anti-condensation Heaters

An anti-condensation heater suitable for operation on a 220V, single phase, 50 hertz supply shall be fitted. Arrangements will be made in the switchgear, supplied by others, for the heater to be switched off when the motor is running. A separate totally enclosed (IP 55) terminal box shall be provided for the anti-condensation heater.

Heater elements shall be rated and positioned such that the temperature measured at any point on the motor casing is within 2-15°C above the ambient temperature.

### 3.8 Rotor Locking Device

A rotor locking device shall be fitted in the motor prior to shipment for protecting the bearings against damage during transport. The device shall be of robust design and be reusable for future maintenance.

### 3.9 Markings and Data Plates

An instruction plate and a data plate of stainless steel or other non-tarnishing metal shall be provided. The instruction plate shall give the connections and the phase sequence for the required direction of rotation while the data plate shall be stamped with the information specified in BS EN 60034-1.

## 4 EMBEDDED TEMPERATURE DETECTORS

Unless otherwise specified, motors of 70 kW or above shall be provided with a set of Embedded Temperature Detectors (ETDs) to monitor the temperature of the stator winding and to afford Class II Protection against over-heating as detailed in BS EN 60034-11. An ETD monitoring unit in an IP 55 enclosure, suitable for external mounting, shall be supplied.

Thermistors of positive temperature coefficient type (PTC), thermo-couples or resistance temperature detectors may be used as ETDs. Alarm and trip contacts shall be at the monitoring unit and set to operate at 120°C and 140°C respectively.

Full particulars of the ETDs and the monitoring unit (Manufacturers' names, model numbers, installation method and technical data) shall be included in the technical manuals supplied.

The monitoring unit shall operate at 220V a.c. 50 Hz. The contact rating shall be 5A, 220V 50 Hz inductive.

## 5 INSPECTION AND TESTING

### 5.1 Inspection and Testing at the Manufacturer's Works - General

The motors shall be inspected and witness-tested by the Inspecting Engineer appointed by the Purchaser at the manufacturer's work prior to shipment.

Measuring instruments (ammeter, voltmeter, wattmeter etc.) used during tests shall be of accuracy  $\pm 0.5\%$  or better.

The inspection work shall in general cover the following:

- (a) General inspection checks including physical dimensions, workmanship, quality, quantity, and standards.
- (b) Check on model and nameplate data.

- (c) Functional checks of correct operation, alarms, indications and setting of equipment.
- (d) Routine and basic tests as specified.
- (e) Packing and protection checks.

Inspection reports/certificates with description on test arrangement, circuits, calculations, and test results shall be forwarded to the Purchaser within four weeks from the date of inspection.

Type tests on equipment and standard calibration tests on instruments / equipment by manufacturers shall not form part of the normal inspection and hence need not be witnessed by the Inspecting Engineer.

5.2 Test Requirements for Motors

The following type test reports, to BS 4999 or BS EN 60034, conducted by the manufacturer on motor of the same design, rating and construction shall be submitted for verification. If the type test reports are not available or unless otherwise stated in the particular specification, the following tests shall be carried out on one of the supplied motor of the same design, rating and construction.

<u>Tests</u>	<u>Standards</u>
(a) Temperature rise	(BS EN 60034-1)
(b) Power factor at rated load	-
(c) Locked rotor torque	-
(d) Starting (locked rotor) current	-
(e) Noise level	(BS EN 60034-9)

The following tests shall be conducted at the manufacturer works in accordance with the specified applicable standards:

<u>Tests</u>	<u>Standards</u>
(a) No load losses and current (routine test on each motor)	(BS EN 60034-2)
(b) High voltage (dielectric) test (routine test on each motor)	(BS EN 60034-1)
(c) Vibration tests (routine test on each motor)	(BS 4999 Part 142)
(d) Efficiency test at rated motor output and at pump duty points (basic test on <u>one</u> motor of each rating and design)	(BS EN 60034-2)



5.3 Test on ETDs

Embedded temperature detectors shall be calibrated prior to fitting onto the winding in accordance with BS EN 60034-11. The calibration need not be witnessed by the Inspecting Engineer but the calibration report shall be submitted to the Inspecting Engineer for verification

6 INFORMATION TO BE SUBMITTED

6.1 Descriptive Literature

Descriptive literature relevant to the motor, ETDs and ETD monitoring unit shall be submitted with the tender.

6.2 Motor Starting Torque Characteristics

The following torque-speed characteristics shall be furnished by the tenderer:

- (a) Torque characteristic at rated voltage.
- (b) Torque characteristic at the lowest specified voltage across the motor terminals.

The Y-axis shall be torque in N-m while the X-axis shall be the motor speed in r/min. Characteristic curves plotted on per-unit values are not acceptable.

- End of this Specification -