WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-51-05

SUBMERSIBLE MOTORS OF 40-140 kW

1 TECHNICAL REQUIREMENTS

1.1 General

This standard specification is for submersible motors of rating between 40 kW and 140 kW. The standard specification for other submersible 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
$40kW \leq P < 75kW$	90.0%
$75kW \leq P < 90kW$	91.5%
$90kW \leq P \leq 140kW$	92.0%

(b) Degree of protection : IP 68 to BS EN 60034-5 for continuous submersion in water.

(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.

1.2 Operating Conditions

(a) Ambient air temperature : 40°C maximum continuous for 4 hours.
35°C average over any 24 hours.
5°C minimum.

(b) Humidity : Up to 98% relative humidity.

(c) Water temperature range : 5°C - 40°C

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

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

BS EN 60085	Electrical insulation, Thermal classification
BS 4999	General requirements for rotating electrical machines.
BS EN 60034	Rotating Electrical Machines.

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 the maximum power absorbed by the driven unit e.g. pumpset operates at any point between the specified duty points under the most arduous operating conditions.

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

3 DESIGN AND CONSTRUCTION

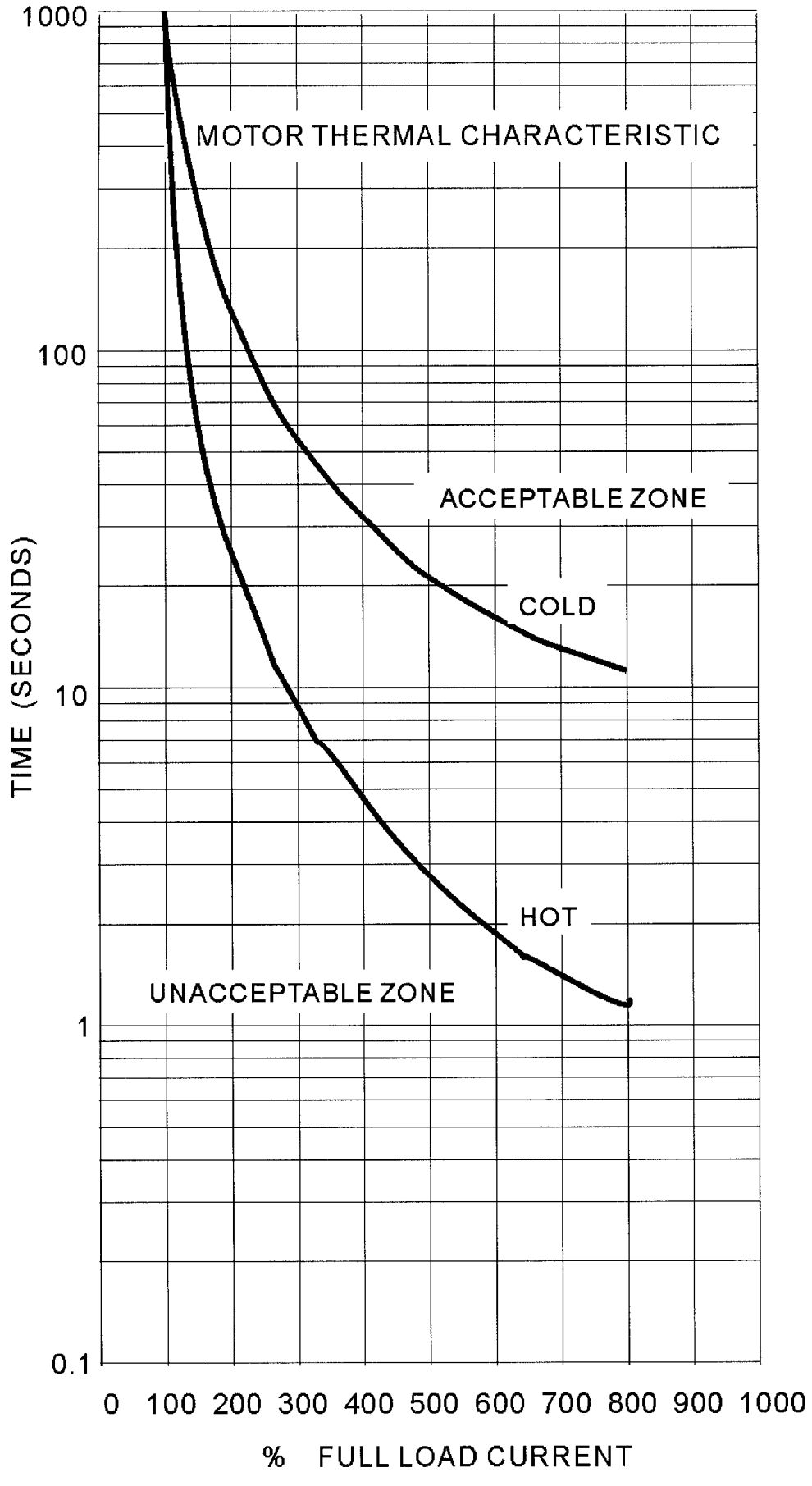
3.1 Enclosure and Cooling

The motor shall have a degree of protection IP68 to BS EN 60034-5 for continuous submersion in water. The motor shall be provided with lifting facilities for easy handling during erection or maintenance.

Water-sealing type motor shall have self-circulation cooling to BS EN 60034-6, characteristic code IC 4W1W0 (viz. machine cooled by water in an internal closed circuit and immersed in water externally). Dry-type motor shall have self-circulation cooling to BS EN 60034-6, characteristic code IC 4A1W0 (viz. machine cooled by air in an internal closed circuit and immersed in water externally).

3.2 Thermal Insulation and Short-time Characteristic

The motor windings and accessories shall be designed for Class F or Class B insulation with a maximum temperature rise limit of Class B to BS EN 60034-1.
The short-time overload withstand characteristic of the motor shall be within the acceptable zone as shown in the following graph. A copy of the motor characteristic curve shall be submitted with the tender.



Motor Short-time Overload Withstand Characteristic

3.3 Motor Stator Windings

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

Both ends of the phase winding shall be brought out and terminated on stud connectors. Copper / copper alloy links shall be provided and connected for DOL starting.

3.4 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 of bearing shall be not less than 50,000 hours under the most onerous conditions.

3.5 Cabling and Termination

Power supply cable and control cable shall be supplied integral with the motor. The length of the power supply and control cables shall be 50 meters unless otherwise specified. The voltage drop on cable at full load shall not be greater than 2.5%.

The power supply cable shall be waterproof, flexible, resistant to abrasion and impact, of adequate current rating and complete with an integral earth continuity conductor. The earth continuity conductor shall have the same current carrying capacity as the line conductors and terminate at an earthing terminal inside the casing. Cable cores shall be identified by colour codes or lettering. The cable shall be synthetic rubber insulated and oversheathed, 450/750V grade to BS 6007 with a maximum conductor temperature of 85°C.

The cables and termination at the motor end shall be suitable for continuous operation under water and shall have the same degree of protection as for the motor. The other end of the cables shall be suitably sealed to keep out of moisture.

The size of power supply cable shall be selected according to the motor rated full load current (FLC) from the following Table 1.

Table 1 - Power Supply Cable Schedule (50 meters)

Stranded Copper Size (mm^2)	Permissible Motor Rated Full Load Current for 1 cable (A)	Permissible Motor Rated Full Load Current for 2 cables * (A)
10	-	74
16	-	100
25	76	132
35	94	163
50	114	197
70	145	251
95	176	304
120	203	-
150	234	-
185	266	-
240	313	-

* 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 current and the permissible maximum voltage drop on cables is 2.5%.

3.6 Markings and Data Plates

An instruction plate and a data plate of stainless steel, brass or other non-tarnishing metal shall be provided. The instruction plate shall give the connections and 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

Embedded Temperature Detectors (ETDs) shall be installed to monitor the internal temperature of the stator winding and shall be wired by a waterproof flexible cable to an external monitoring unit.

Unless otherwise specified, motors of 70 kW or above shall be provided with a set of positive temperature coefficient (PTC) type thermistors to monitor the temperature of the stator winding and to afford Class I Protection against over-heating on load and stalling as detailed in BS EN 60034-11. The thermistors shall be set to operate at 140°C. A monitoring unit in an IP 55 enclosure, suitable for external mounting, shall be supplied.

For smaller motor, winding embedded thermostat switch shall be used.

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 and shall have a pair of normally open contact rated not less than 5A, 220V 50 Hz inductive.

5 INSPECTION AND TESTING

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

If required in the Particular Specification, 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 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.

	Tests	Standards
(a)	Temperature rise	(BS EN 60034-1)
(b)	Power factor at rated load and at pump duty points	-
(c)	Locked rotor torque	-
(d)	Starting (locked rotor) current	-
(e)	Noise level	(BS EN 60034-9)

If the type test reports are not available or if required by the Particular Specification, the above tests shall be carried out on one of the supplied motors of the same design, rating and construction for verification.

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

	Tests	Standards
(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 one 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. Refer to Clause 5.1, if the motors are required to be inspected and witness-tested by the Inspecting Engineer the calibration need not be witnessed 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.

- End of this Specification -