WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-51-01

LOW VOLTAGE SQUIRREL CAGE INDUCTION MOTORS OF 140 kW AND ABOVE

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WATER SUPPLIES DEPARTMENT

STANDARD SPECIFICATION E-51-01

LOW VOLTAGE SQUIRREL CAGE INDUCTION MOTORS OF 140 kW AND ABOVE

1 TECHNICAL REQUIREMENTS

1.1 General

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

The motor shall comply with the following requirements:

(a) Type	:	Energy efficient squirrel cage induction motor with full load efficiency not less than 95.4%.
(b) Degree of protection	:	Totally enclosed to BS EN 60034-5 IP 54.
(c) Duty rating	:	Maximum continuous rating (MCR), S1 duty.
(d) Insulation	:	Class F or Class B design with temperature rise not exceeding the limit 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 90 dB(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 metres
(b) Ambient temperature	:	40 °C maximum continuous for 4 hours. 30 °C average over any 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 variation	:	±6%.
(c) Frequency variation	:	±2%.

1.4 Standards

The equipment supplied shall comply with the latest version of the relevant British Standards 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 EN 60751	Industrial platinum resistance thermometer sensors
(e) BS 4999	General requirements for rotating electrical machines
(f) 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 reduced voltage assisted starting. Direct-on-line starting current at rated voltage shall not exceed 7 times the full load current. If tests are to be taken to determine the starting current at reduced voltage, due allowance shall be made for the effect of saturation.

The motor shall be designed to permit not less than three starts per hour equally spaced during normal running conditions. The motor shall also be suitable for two starts in succession followed by a 30-minute interval before attempting another starting sequence.

The minimum permissible voltage across motor windings at starting shall be 80% nominal for direct-on-line started motors, and 49% nominal for motors with star/delta or auto-transformer starters.

Direct-on-line started motor with 80% rated voltage across its windings shall run to 90% synchronous speed within 4 seconds. Assisted started motor at 49% rated voltage across its windings viz. without changing to its final connection, shall run to at least 90% of its synchronous speed within 10 seconds. During such starting intervals, the pump discharge valve shall open in its normal manner.

At 49% of rated voltage at motor terminals, 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.

1.6 Running

Motors shall be capable of operating continuously at any voltage in the range 94 - 106% of rated voltage and at any frequency between 49-51 Hz.

The motor shall be capable of operation at full load with 75% rated voltage at 50 Hz for a period of 5 minutes without injurious heating.

1.7 Transient Recovery

The motor shall be capable of recovering normal operation in the event of a system disturbance causing temporary loss of supply voltage for periods of up to 0.2 seconds (fault clearance time) followed by a sudden restoration initially to 80% rated voltage. At this voltage, the motor shall be capable of accelerating to ultimate recovery under the most arduous load conditions, e.g. open fan vane, open pump discharge valve, speed controller in maximum speed position, etc.

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 numbers of motors shall comply with BS EN 50347.

Motors for driving pumpsets of the same capacity and supplied under the same contract shall be interchangeable.

Acoustic enclosure shall not be used unless specified in the Particular Specification.

The frame design of motor shall facilitate easy removal of rotor assembly and allow motor stator winding repair/cleaning to be carried out.

The colour of final coat of the motor shall be same as the pump.

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.

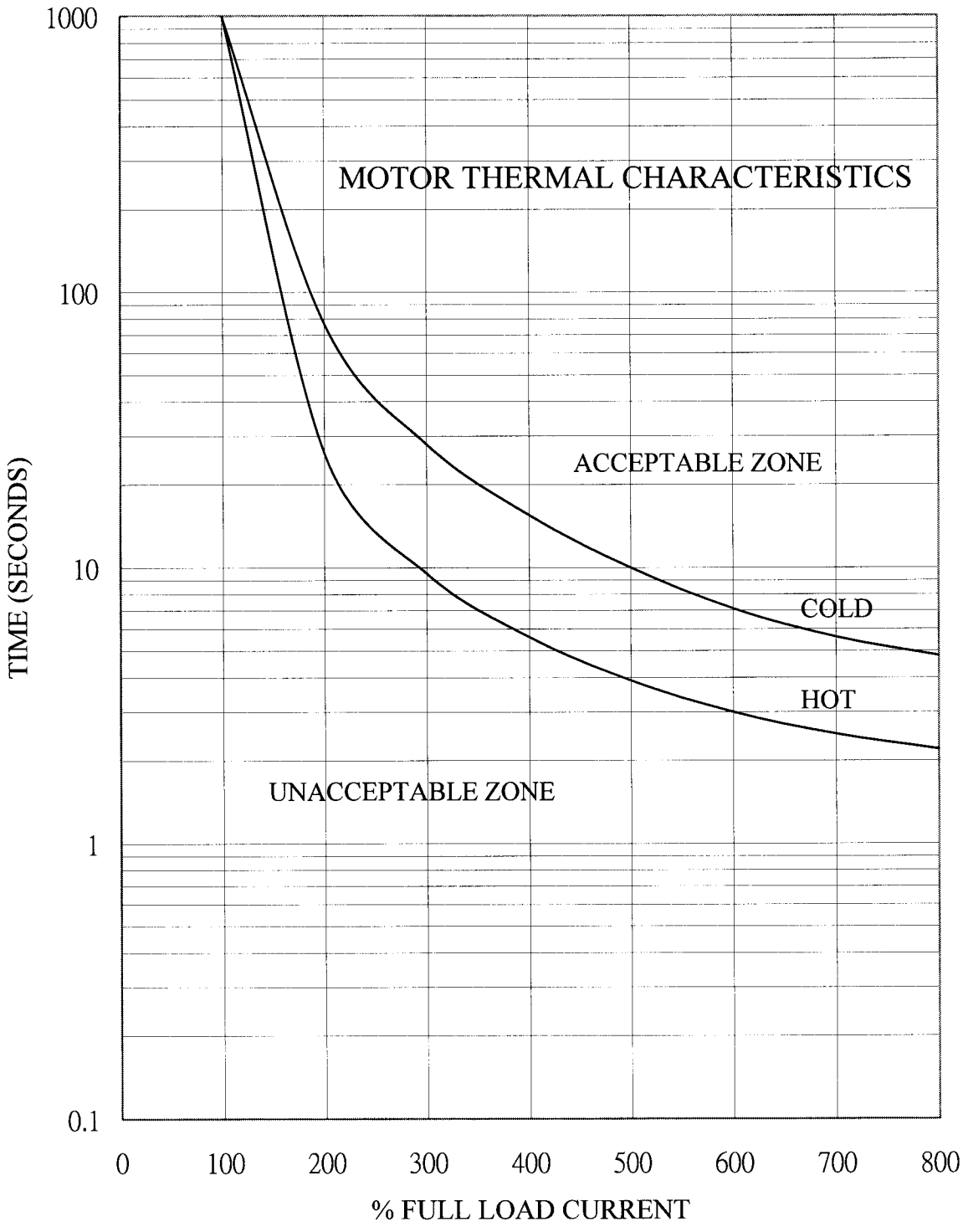
The motor ventilating fan at non-drive end (NDE) shall be directly driven by the motor, i.e., with no auxiliary power supply required. The motor fan for outlet air shall be designed such that at the worst operating condition and rated output, the maximum operating temperature of the stator windings does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

The inlet and exhaust air grills shall be designed such that there will be no recirculation of exhaust air on individual motors or between adjacent motors. To avoid water condensation, the exhaust air grill shall be so positioned that it does not direct air on to the pump casing or its inlet or discharge pipes.

3.3 Class of Insulation and Thermal 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 motor thermal characteristic shall be within the acceptable zone as shown in the graph below. If the maximum temperature rise is limited by the rotor, this shall be stated.



Motor Short-time Overload Withstand Characteristic

3.4 Stator Windings

The stator windings shall be designed for a minimum life of 25 years of service at rated load and voltage. All windings shall be adequately supported, braced and blocked to provide sufficient rigidity during all conditions of service.

Motors shall be designed to permit high voltage tests conducted after erection on site in accordance with BS 4999 Part 143 and BSEN 60034-1.

Natural rubber insulated cables shall not be used for connection between the stator windings and motor terminals.

The insulation of stator windings shall be vacuum impregnated process. Where an alternative insulation process is proposed by the manufacturer, full details shall be provided with the offer with test data given to verify the service life of the windings to 25 years.

3.5 Rotor

3.5.1 Vibration Level

The limits of vibration during works testing shall not exceed the limits specified in BS 4999, Part 142, Table 2 or Table 1 Grade N. The limits shall also be applicable to vertically mounted motors, notwithstanding that the standard applies normally to horizontally mounted motors only.

3.5.2 Dynamic Balancing

Each rotor shall be dynamically balanced to confirm that vibration levels are within the specified limit.

3.6 Bearings

Bearings shall be of metric sizes. Ball or roller bearings to BS 5512 shall be used. Vertical shafts shall have thrust and guide bearings of the approved types.

Consideration shall be given to bearing service life, noise, losses and maintenance convenience in the selection of bearings. The life associated with 90% reliability (L10 life) of the bearing shall be not less than 50,000 hours under the most onerous conditions.

Bearings shall be easily accessible for inspection and shall be liberally rated to ensure cool even running. Bearings shall be suitable for reverse rotation at the normal running speed.

Bearings shall be adequately lubricated by oil or grease and sealed against leakage of lubricant along the shaft. Construction shall be such that bearings can be dismantled and reassembled without risk of damage.

The bearing assembly shall be designed to exclude the ingress of dust and water. It

shall be provided with a grease relief device such that when the motor runs at its rated speed any surplus grease is ejected out of the motor casing.

Housing for ball/roller bearings shall be packed with suitable lithium-based grease at the time of delivery. The relubrication interval shall not be less than 4000 hours.

Nipples for lubrication purposes shall be in accordance with BS 1486, Part 1 Type No. 11B or 12.

Grease nipples shall be readily accessible without removal of guarding. Where necessary, these may be remotely mounted at a point as near as practicable to the lubrication point.

3.7 Motor Foundation

A motor bedplate/foundation block shall be provided unless the motor is to be mounted on the soleplate of the pump. Provision shall be made for fitting jacking screws to facilitate alignment of the coupling.

Vertical motors shall be designed for flange mounting on a detachable motor stool and soleplate to be supplied with the motor.

3.8 Lifting

The complete motor shall be capable of being dismantled or reassembled by the use of one electric overhead crane.

Heavy parts of the motors shall be provided with a suitable arrangement for lifting and handling during erection and overhaul. Details of the arrangements shall be included in the instruction manual. Components to be removed during maintenance which weigh 1,000 kg or more shall be marked with their respective weights.

3.9 Provision for Cabling

3.9.1 Cabling provision at bedplates

Where necessary, provision of a slot shall be made in the steel bedplate to facilitate vertical entry of cables to the bottom of the motor terminal box. The contractor shall advise the Purchaser within 6 weeks after the placing of order of any aperture that may be required in the pumpset foundation for the motor cables e.g. through floor hole for a vertically mounted motor.

3.9.2 Cabling provision at cable boxes

The termination box for a horizontally mounted motor shall be positioned at the top of the motor with the cable end box angled downwards to facilitate cable entry from below.

If the direction of the cable end box or the position of the cable box is not specified in the Particular Specification, the contractor shall obtain the requirements from the

Purchaser prior to manufacture.

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.

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

3.9.3 Cabling Provision at Motor Casing

The terminal leads from the cable box to the windings shall be adequately braced to withstand the forces produced by maximum fault current. The contractor shall provide information to verify the thermal rating of the stator lead is not less than the motor rated current.

3.9.4 Main Cable Termination

Motor terminations shall generally be suitable for use with the motor supply cable sizes given in Table 1 below (based on installation in enclosed cable trenches). The correct size of cable to be used will be confirmed prior to manufacture of the motor.

Table 1 - Power Supply Cable and Terminations

Stranded Copper Size mm^2	Type of Cable	Max. Motor Full Load Current Amp.		Compression Fitting Palm Width (max.) mm	Terminal Stud Centre Lines (min.) mm	Stud to Gland Plate Dimension (min.) mm
		1 Cable	2 Cables*			
70	XLPESWAPVC 3 core	-	278	30	44	225
95		-	342	35	49	255
120		-	394	40	57	280
150		-	459	45	62	315
185		302	524	50	67	355
240		358	619	52	72	400
300		408	706	57	77	450
300	XLPEAWAPVC 3 x 1 core	455	788	57	77	450
400		499	-	65	85	450
500		553	-	70	90	500
630		700	-	75	95	500

*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.

3.10 Cable Termination Box

3.10.1 General Construction

The cable termination box shall comprise an air insulated termination chamber and a cable end box. The degree of protection of the cable termination box shall be IP 55 to BS EN 60529.

The cable termination box shall be fabricated from mild steel plate of minimum 4 mm thickness. Cast iron boxes are not acceptable.

Joints shall be machined flat and fitted with neoprene rubber gaskets.

The insulation of terminals, connectors, cables and conductors shall be of moisture-resistant homogeneous materials, e.g. butyl rubber, PVC, PVC thermo-shrinking tubing.

The cable termination box shall allow sufficient space for cable termination and be designed with clearance and mounting suitable for use with heat-shrinkable PVC cable termination for the incoming power supply cable.

3.10.2 Termination Chamber

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

Studs shall be so fixed as to prevent them from turning when the nuts are tightened down. Means shall be provided to prevent slackening of cable connections due to vibration.

The stud connector insulation shall be of epoxy resin, phenolic resin, glass-fibre polyester or other approved high-pressure moulding. Porcelain insulators are not acceptable.

Current carrying studs and sockets shall be of hard-drawn cadmium copper with the socket portion locally annealed for crimping.

Detachable polycarbonate plastic shrouds shall be fitted over each insulated connector. Polycarbonate plastic shrouds shall be of minimum wall thickness of 1.6 mm and minimum breakdown voltage of 1 kV.

The termination chamber shall be provided with a front access cover and shall be bolted to the motor frame with M10 high tensile steel studs and nuts. The minimum

clearance from the stator casing shall be 130 mm to allow access to the rear fixing nuts.

3.10.3 Cable End Box

The cable end box shall be fixed to the termination chamber by means of M8 or M10 high tensile steel bolts or studs and nuts.

The cable end box shall be provided with a front access cover.

The cable box shall be arranged for bottom entry of cables and with a detachable gland plate. Where single core cables are specified, the gland plate shall be made of brass.

Cable tails at the junction between the cable gland plate and the insulated stud connectors shall be held in place by a tufnol or laminated densified wood (permali) cable spacing block with bolts and nuts.

3.10.4 Clearance and Creepage Distances

Electrical clearance and creepage distances inside cable box shall comply with Table 2 below. These clearance and creepage distances shall also apply to terminals or connectors which have to be insulated on site, and shall apply even if the terminals or connectors are fully insulated but are not intended to apply to permanently insulated conductors.

Table 2 - Clearance & Creepage Distances

Motor Rating	Minimum Clearance between phases & to earth	Minimum Creepage Distances over Bushings and Surfaces Resistant to Tracking
kW	mm	mm
100 - 199	12.5	19.0
200 and above	19.0	25.0

3.10.5 Termination Box Auxiliaries

(a) Cable Gland

Brass cable glands shall be provided for the motor supply cables. Insulated aluminium glands or aluminium glands insulated from gland plate by approved material shall be provided for single core cables.

(b) Cable Lug

Cable lugs shall be supplied for the motor supply cables.

3.11 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.

3.12 Markings and Data Plates

An instruction plate and a data plate of stainless steel, brass or other approved non-tarnishing metal shall be provided. Lettering and numerals shall be either stamped or embossed. Data plates with lithographed or painted-on information are unacceptable.

The instruction plate shall give the connections and phase rotation for the required direction of rotation.

The data plate shall be stamped with all information required by BS EN 60034-1. The minimum coolant (air) quantity shall also be marked.

The motor serial number shall be stamped with metal dies on the driving-end shaft face of the motor in addition to being stamped on the stator.

4 PROTECTIVE EQUIPMENT

4.1 Embedded Temperature Detectors (ETD)

A set of Embedded Temperature Detectors complying with BS EN 60034-11, complete with monitoring units shall be provided to afford Class II Protection for the motor.

Resistance Temperature Detectors (RTD) shall be used. The monitoring unit shall incorporate a winding temperature indicator in addition to the alarm and trip contacts.

The ETD monitoring units shall be mounted in the pumpset instrument panel provided per Cl. 5.1 and shall incorporate the following features:

(a) Alarm contacts to operate at 120 °C
(contacts rated at 2A inductive, 220V a.c.)

(b) Trip contacts to operate at 140 °C
(contacts rated at 2A inductive, 220V a.c.)

(c) Power supply - 220V a.c.

(d) Terminal blocks for the necessary connections.

Detailed diagrams indicating the exact positions of the ETDs within the windings and

full particulars of the detectors including the name of the manufacturer, model number and installation method shall be provided in the operation and maintenance manual to enable replacement.

4.2 Bearing Temperature Detectors and Indicators

Thermometer pockets shall be provided on each bearing to enable insertion of a test thermometer, RTD complying with BS EN 60751 Grade 2 shall be provided to monitor the temperature of each motor bearing. The RTD shall be supplied with a 220V a.c. powered monitoring unit and provided with independent alarm and trip volt free contacts. The alarm and trip setting shall be adjustable. The monitoring unit shall be installed in the pumpset instrument panel and shall provide a suitable output for the temperature indication.

5. AUXILIARY EQUIPMENT

5.1 Pumpset Instrument Panel

An individual instrumentation panel shall be provided for each pumpset. The panel shall be rectangular, free floor standing, fabricated with sheet steel of a minimum thickness of 2 mm, suitably braced to afford rigidity. It shall have a rear or side hinged access door with chromium plated car-type handle. The degree of protection shall be IP 55 to BS EN 60529. All indicating instruments shall be flush mounted with the front panel.

The panel shall be mounted adjacent to the motor.

The following equipment shall be mounted in this panel:

(a) Motor winding temperature indicator and monitoring unit

(b) Motor bearing temperature indicator and monitoring unit

(c) Pump bearing temperature indicator and monitoring unit

(d) No-flow switch monitoring unit (when specified)

(e) Emergency stop button (with two latched change-over contacts)

(f) Local controls for pumpset and ancillary equipment (when specified)

(g) Control relays and timers required for interfacing between pumpset alarms and pumpset control circuitry

(h) Control switch and protection fuses for A.C. supply

(i) Anti-condensation heater complete with control switch and thermostat

(j) Motor running indication beacon

(k) Sufficient terminals (including terminals for no-flow switch connection) and cable glands for external cable connections

5.2 Auxiliaries

5.2.1 Spreader, Slings and Tools

General and special maintenance tools shall be supplied.

Special tools required for the dismantling, reassembly and maintenance together with the necessary slings and spreaders for transport of the motor and its components shall be supplied.

5.2.2 Anti-condensation Heaters for Motor

Anti-condensation heaters suitable for operation on a 220V, single phase, 50 hertz, supply shall be fitted in the motor.

Motor anti-condensation heaters shall be designed to permit replacement of the unit. Heater elements shall be of a rating such that the temperature measured at the motor casing at any point shall be 2 °C – 15 °C above the ambient temperature. Heaters shall be designed to provide even heating to the motor windings.

A separate termination box shall be supplied for the anti-condensation heater. The box shall be provided with an E1W gland for 2.5 mm^2 2-core PVCSWAPVC cable and a warning label "Danger - Heater Supply Live Terminal".

5.2.3 Marshalling Box for Protective Devices

Protective devices mounted on the motor shall be wired to an IP 55 marshalling box mounted on the motor casing. Screen cables or special temperature compensation cables, where required, for connection between the box and the pumpset instrument panel shall be supplied by the manufacturer. Suitable cable glands shall be provided for all cable terminations.

5.2.4 Small Wiring

Wiring shall be in accordance with Waterworks Standard Specification E-00-01 except where modified herein.

High temperature insulation shall be provided on all wiring where contact with heated parts of the motor is anticipated.

Wiring in conduits shall not be used. Wiring shall be run in a manner which enables its being checked without the removal of cleats.

An allowance shall be made on the length of each wire at the point of connection to the terminal in order to permit the cutting off and re-making of the wire terminations without causing a disturbance to the main run of the wiring.

Wires shall be coloured black for a.c. connections, grey for d.c. connections and yellow/green for earth connections.

Ferrules shall be fitted for each wire core such that they would not be detached unintentionally when the wire is removed from the terminal.

6. INSPECTION AND TESTING

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

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

Indicating meters (ammeter, voltmeter, wattmeter etc.) used during tests shall be of accuracy ±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 in Clause 6.2 below.

(e) Packing and protection checks.

Inspection reports/certificates with description on test arrangement, circuits, calculations, and test results shall be forwarded to the Purchaser immediately after the 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.

6.2 Motor Tests

6.2.1 General

Tests conducted at the manufacturer's works shall be in accordance with BS 4999 Part 143 with tolerance limits to BS EN 60034-1. No positive tolerance from specified limits shall be allowed for noise level, temperature rise and starting (locked rotor) current. Curves of power factor and efficiency against motor output shall be prepared to ascertain their values at pump duty points specified in the Contract.

The following basic tests shall be conducted by the manufacturer on at least one motor of each size and design supplied under the contract:

(a)	Temperature rise	(BS EN 60034-1)
(b)	Efficiency at rated load and at pump efficiency test duty points	(BS EN 60034-2)
(c)	Power factor at rated load and at pump efficiency test duty points	
(d)	Locked rotor torque	
(e)	Starting (locked rotor) current (by transient recorder at rated voltage)	
(f)	Noise level	(BS EN 60034-9)

The following routine tests shall be conducted on each motor supplied:

(a)	No load losses, current and power factor tests	(BS EN 60034-2)
(b)	High voltage (dielectric) test	(BS EN 60034-1)
(c)	Stator winding resistance measurement	
(d)	Vibration tests	(BS 4999 Part 142)

6.2.2 High Voltage Tests on Assembled Motors

High voltage tests shall be conducted in accordance with BS 4999 Part 143 and BS EN 60034-1.

The insulation resistance of the winding shall be measured and recorded at one minute and 10 minute intervals with a 500V megger immediately before and after the high voltage tests.

6.2.3 Noise Level Test

The motor shall be tested for noise level to BS EN 60034-9 Method II. The calculated sound power level value at reference condition shall not exceed 90 dB(A). Measurement and calculation details shall be included in the test report.

6.2.4 Efficiency Test

The efficiency figures for the motor shall be established by summation of losses in accordance with BS EN 60034-2.

6.2.5 Power Factor Test and Temperature Rise Test

The power factor and temperature rise tests shall be conducted by direct loading at rated supply voltage and frequency. Alternative method of testing e.g. equivalent loading method would only be accepted on prior approval from the Purchaser.

The guaranteed figures for the power factor at motor rated load and at the pump efficiency test duty point shall be met.

Temperature rise test shall be conducted in accordance with BS 4999 Part 143 and BS EN 60034-1. The test shall be conducted for at least 4 hours and until the thermal equilibrium is reached, i.e. when the rise of temperature of the stator winding does not exceed 2 ^{o}C over a period of one hour.

The stator winding temperature shall be measured by an instrument which has been calibrated to an accuracy equivalent to 0.5^{o}C.

Where air ducting, acoustic baffles, filters etc. are required for the motors supplied, temperature rise test shall be conducted with these devices fitted.

The motor outlet air and casing temperature shall be measured during the temperature rise test to verify that the actual rise in temperature throughout the test is within the specified figure.

6.3 Protection equipment tests

Embedded temperature detectors, or any other protective devices shall be calibrated by suitable means before being fitted into the motor. ETDs and the monitoring units shall be tested in accordance with BS EN 60034-11 and the test results shall be included in the test report.

The calibration tests need not be witnessed by the Inspecting Engineer.

6.4 Test on Pumpset Instrument Panel

The monitoring and control functions of the panel shall be tested functionally and witnessed by the Inspecting Engineer to verify compliance with operation requirements. The calibration of instruments need not be witnessed by the Inspecting Engineer, but the calibration certificate/report shall be available at the time of inspection and shall form part of the test report.

7. INFORMATION TO BE SUBMITTED WITH THE TENDER

7.1 Catalogues

Catalogues of the main pumpset and auxiliary equipment, cable boxes and the various protective equipment shall be submitted.

The catalogues shall incorporate (as far as practicable) all information called for in the tender schedules.

7.2 Pump and Motor Starting Characteristics

The pumpset starting characteristic shall be furnished by the tenderer and shall include the following:

(a) Pump torque characteristic at the most arduous load condition with closed valve.

(b) Pump torque characteristic at the most arduous conditions with delivery valve fully open.

(c) Motor torque characteristic at the lowest specified voltage across the motor terminals i.e. 49% nominal voltage.

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.

7.3 Performance Data

All performance data shall be provided and the technical schedules shall be fully completed.

7.4 Motor Thermal Characteristics

The short-time overload withstand characteristics of the motor (both hot state and cold state) shall be submitted by plotting on a graph paper against the motor thermal characteristics as given in Clause 3.3.

- End of this Specification -