

CHAPTER-3.0

TECHNICAL SPECIFICATION FOR MOTORS

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- 1) IS-325
- 2) IS-12615
- 3) IEC-34 (for energy efficient motors)
- 4) Three phase induction motors : IS:325, IEC:60034
- 5) Single phase AC motors : IS:996, IEC:60034
- 6) Crane duty motors : IS:3177, IEC:60034
- 7) DC motors/generators : IS:4722

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- 04.00.00 **Type and rating**
- 04.01.00 **A.C. Motors**
- 04.01.01 Motors shall be general purpose, constant speed, squirrel cage, three phase / single phase, induction type.
- 04.01.02 All motors shall be rated for continuous duty unless stated otherwise.
- 04.01.03 The motor name-plate rating at 50 Deg.C shall have at least 15% margin over the input power requirement of the driven equipment at rated duty point unless stated otherwise in driven equipment specification or in general electrical specification.
- 04.01.04 The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating, pull up, break down and full load torques are available for the intended service.
- 04.01.05 Continuous duty LT motors upto 160 KW Output rating (at 50 deg.C ambient temperature), shall be Premium Efficiency class-IE3, conforming to IS 12615, or IEC:60034-30.
- 04.01.06 Frequent starting HT motors shall be fed through vacuum circuit breaker.
- 04.01.07 All motors of rating up to 160 KW for CHP and 200KW for remaining areas shall be connected to 415 V system. All motors of rating above 200KW shall be connected to 6.6KV system and motors above 160 KW for CHP shall be connected to 6.6 KV system.
- 04.01.08 All motors shall be supplied with foundation bolts (if applicable), drain holes with plugs.
- 04.01.09 Motors in the explosion hazardous areas shall be explosion proof.
- 04.02.00 **D.C. Motors**
- 04.02.01 D.C. motor provided for emergency service shall be shunt wound type and rated for 220V DC.
- 04.02.02 Motor shall be sized for operation with fixed resistance starter for maximum reliability. Starter panel complete with all accessories shall be included in the scope of supply.
- 05.00.00 **Performance**
- 05.01.00 Running Requirements
- 05.01.01 Motor shall run continuously at rated output over the entire range of voltage and frequency variations as required for the driven equipment.
- 05.01.02 The motor shall be capable of operating satisfactorily at full load for 5 minutes without injurious heating with 75% rated voltage at motor terminals.
- 05.02.00 Starting Requirements
- Motor shall be designed for direct on line starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. Starting current shall be limited to 6 times FLC including tolerance. However for BFP or motor rated above 4000 KW, starting current shall be limited to 450% FLC subject to tolerance.
- 05.02.01 The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- 05.02.02 H.T Motor shall start with rated load and accelerate to full speed with 80% rated voltage at motor terminals. L.T Motor shall start with rated load and accelerate to full speed with 85% rated voltage at motor terminals.

- 05.02.03 a) The motor shall be capable of three equally spaced starts in an hour, the motor initially being at a temperature not exceeding the rated load operating temperature.
- b) The motor shall be capable of two starts in succession with coasting to rest between starts and the motor initially at rated operating temperature.
- 05.02.04 Pump motor subject to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% rated speed in reverse direction.
- 05.03.00 Stress During Bus Transfer
- 05.03.01 during bus transfer, due to the phase difference between the incoming voltage and motor residual voltage.
- 05.03.02 ~~The motor shall be designed to withstand any torsional and/or high current stresses, which may result, without experiencing any deterioration in the normal life and performance characteristics.~~
- 05.04.00 Locked Rotor Withstand Time
- 05.04.01 For motors with starting time upto 20 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 secs. more than starting time.
- 05.04.02 For motors with starting time more than 20 secs. and upto 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 secs. more than starting time.
- 05.04.03 For motors with starting time more than 45 secs. at minimum permissible voltage during starting, the locked rotor withstand time under hot condition at highest voltage limit shall be more than starting time by at least 10% of the starting time.
- 05.04.04 Speed switches mounted on the motor shaft shall be provided in cases where above requirements are not met.
- 05.04.05 H.T Motors Starting time mentioned above is at minimum permissible voltage of 80% rated voltage.
- 05.04.06 Hot thermal withstand curve shall have a margin of at least 10% over the full load current of the motor to permit relay setting utilising motor rated capacity.
- 06.00.00 **Specific Requirements**
- 06.01.00 Enclosure
- 06.01.01 All H.T & L.T motor enclosures shall conform to the degree of protection IP-55 for outdoor & IP-54 for indoor unless otherwise specified. Motor for outdoor or semi-outdoor service shall be of weather-proof construction.
- 06.01.02 For hazardous area approved type of increased safety enclosure shall be furnished.
- Motors located in hazardous areas shall have flame proof enclosures conforming to IS:2148 as detailed below

	(a) Fuel oil area	:	Group – IIB
	(b) Hydrogen generation	:	Group - IIC (or Group-I, Div-II as per NEC) plant area
06.02.00	Cooling		
06.02.01	All motors shall be either Totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or Closed air circuit air cooled (CACA) type. However, motors rated 3000KW or above shall be Closed air circuit water cooled (CACW).		
06.03.00	Winding and Insulation		
06.03.01	All insulated winding shall be of copper.		
06.03.02	HT and LT motors shall have class F insulation but temperature rise shall be limited to class B (as measured by resistance method).		
06.03.03	Windings shall be impregnated to make them non-hygroscopic ,flame resistant and oil resistant.		
06.03.04	The winding insulation process shall be total Vacuum Pressure Impregnated i.e resin poor method. The lightning Impulse & interturn insulation surge withstand level shall be as per IEC-60034 part-15		
06.03.05	Starting duty : Two hot starts in succession, with motor initially at normal running temperature.		
06.04.00	Tropical Protection		
06.04.01	All motors shall have fungus protection involving special treatment of insulation and metal against fungus, insects and corrosion.		
06.04.02	All fittings and hardware shall be corrosion resistant.		
06.05.00	Bearings		
06.05.01	Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application.		
06.05.02	Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred.		
06.05.03	Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.		
06.05.04	Sleeve bearings shall be split type, ring oiled, with permanently aligned, close running shaft sleeves.		
06.05.05	Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with drains to guard against over lubrication.		
06.05.06	Oiled bearing shall have an integral self cooled oil reservoir with oil ring inspection ports, oil sight glass with oil level marked for standstill and running conditions and oil fill and drain plugs.		
06.05.07	Forced lubricated or water cooled bearing shall not be used without prior approval of Owner.		
06.05.08	Lubricant shall not deteriorate under all service conditions. The lubricant shall be limited to normally available types with IOC equivalent.		
06.05.09	Bearings shall be insulated as required to prevent shaft current and resultant bearing damage.		
06.06.00	Noise & Vibration		

- 06.06.01 Noise level for all the motors shall be limited to 85dB(A) except for BFP motor for which the maximum limit shall be 90dB(A).
- 06.06.02 Vibration shall be limited within the limits prescribed in IS:12075 / IEC 60034-14 Motors shall withstand vibrations produced by driven equipment. HT motor bearing housings shall have flat surfaces, in both X and Y directions, suitable for mounting 80mmX80mm vibration pads. Motors with heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate inlet and outlet primary air temperature.
- 06.07.00 Motor Terminal Box
- 06.07.01 Motor terminal box shall be detachable type and located in accordance with Indian Standards clearing the motor base- plate/ foundation
- 06.07.02 Terminal box shall be capable of being turned 360 Deg. in steps of 90 Deg., unless otherwise approved. However, in the case of rectangular type, Terminal Box shall be rotatable in steps of 180 Deg.
- 06.07.03 The terminal box shall be split type with removable cover with access to connections and shall have the same degree of protection as motor.
- 06.07.04 The terminal box shall have sufficient space inside for termination/ connection of PVC insulated or XLPE insulated armoured aluminium cables as the case may be.
- 06.07.05 Terminals shall be stud or lead wire type, substantially constructed and thoroughly insulated from the frame.
- 06.07.06 The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- 06.07.07 The terminal box shall be capable of withstanding maximum system fault current for a duration of 0.25 sec.
- 06.07.08 For HT motor, the terminal box shall be phase-segregated type. The neutral leads shall be brought out in a separate terminal box (not necessarily phase segregated type) with shorting links for star connection.
- 06.07.09 Motor terminal box shall be furnished with suitable cable lugs and double compression brass glands to match with cable used.
- 06.07.10 The gland plate for single core cable shall be non-magnetic type.
- 06.07.11 In case no differential protection is required star point of the winding shall be formed in the neutral terminal box to be provided on one side of the motor. The phase segregated terminal box shall be placed on the other side of the motor.
- 06.07.12 All terminal boxes shall be provided with earthing studs for termination of protective earth conductor.
- 06.08.00 Grounding
- 06.08.01 The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.
- 06.08.02 The grounding connection shall be suitable for accommodation of ground conductors as follows :

Motor above 125 KW		50 x 6 mm GS Flat
Motor above 25 KW up to 125 KW		35 x 6 mm GS Flat

Motor above 1 KW up to 25 KW	:	25 x 3 mm GS Flat
Motor up to 1 KW	:	8 SWG GI 6 SWG GI Wire

The above size is the minimum. Higher size shall be used if found necessary as per earthing calculation. Calculation to be submitted by the bidder.

06.08.03 The cable terminal box shall have a separate grounding pad.

06.09.00 Rating Plate

In addition to the minimum information required by IS, the following information shall be shown on motor rating plate :

- a) Temperature rise in Deg.C under rated condition and method of measurement.
- b) Degree of protection.
- c) Bearing identification no. and recommended lubricant.
- d) Location of insulated bearings.

07.00.00 **Accessories**

07.01.00 General

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driven equipment specification or application.

07.02.00 Space Heater

07.02.01 Motor of rating 30 KW and above shall be provided with space heaters, suitably located for easy removal or replacement.

07.02.02 The space heater shall be rated 240 V, 1 phase 50 Hz and sized to maintain the motor internal temperature above dew point when the motor is idle. Heaters to be automatically OFF when the motor is switched ON.

07.03.00 Temperature Detectors

07.03.01 In HT motors, at least four numbers simplex / two numbers duplex platinum resistance type temperature detectors shall be provided in each phase stator winding. Output of winding temperature high sensors shall be connected to provide alarm only to the control room.

07.03.02 Each bearing of HT motor shall be provided with dial type thermometer with adjustable alarm contact and 2 number duplex platinum resistance type temperature detectors.

07.03.03 The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 ohms at 0 Deg.C.

07.03.04 Leads of all duplex type motor winding RTDs and motor bearing RTDs shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDs shall be connected to numerical protection relay and another set shall be kept free for DCS connectivity.

07.04.00 Vibration monitor

Vibration monitors shall be provided for all HT motors and shall be suitably connected to the DCS.

07.05.00 Indicator/Switch

07.05.01 Dial type local indicator with alarm contacts shall be provided for the following :

- a) HT motor bearing temperature.

- b) Hot and cold air temperature of the closed air circuit for CACA and CACW motor.
- 07.05.02 Flow switches shall be provided for monitoring cooling water flow of CACW motor and oil flow of forced lubrication bearing, if used.
- 07.05.03 Alarm switch contact rating shall be minimum 0.5 A at 220V D.C. and 5A at 240V A.C.
- 07.06.00 Current Transformer for Differential Protection
- 07.06.01 Motors of rating 2000 kW and above shall be provided with differential protection. Matching CTs shall be provided by the bidder for the same. The 3 nos. current transformers, one for each phase shall be mounted in a separate compartment in the neutral side terminal box. The three phases shall be connected to form the star point after they pass through the CTs. The CTs shall be of relay accuracy and CT characteristics shall be compatible with the differential relay . The additional 3 nos. CTs of identical characteristics shall be provided in the 6.6 kV switchgear panel.
- 07.06.02 The arrangement shall be such as to permit easy access for C.T. testing and replacement.
- 07.07.00 Accessory Terminal Box
- 07.07.01 All accessory equipment such as space heater, temperature detector, current transformers etc., shall be wired to and terminated in terminal boxes, separate from and independent of motor (power) terminal box.
- 07.07.02 Accessory terminal box shall be complete with double compression brass glands and pressure type terminals to suit cable connections.
- 07.08.00 Drain Plug
- 07.08.01 Motor shall have drain plugs so located that they shall drain the water, resulting from the condensation or other causes from all pockets of the motor casing.
- 07.09.00 Lifting Provisions
Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.
- 07.10.00 Dowel Pins
The motor shall be designed to permit easy access for drilling holes through motor feet or mounting flange for installation of dowel pins after assembling the motor and driven equipment.
- 07.11.00 Painting
Motor including fan shall be painted with corrosion proof paints as per IS-5.
- 08.00.00 **TESTS**
- 08.01.00 **TYPE TEST**
- 08.01.00 **HT MOTORS**
- 08.01.01 The bidder shall carry out the type tests as indicated in the "LIST OF TYPE TESTS TO BE CONDUCTED " on the equipment mentioned there in. The bidder shall indicate the charges for each of these type tests separately in the relevant schedule of BPS and the same shall be considered for the evaluation of the Bids. The type test charges shall be paid only for the test(s) actually

conducted successfully under this contract and upon certification by the Owner's Engineer.

08.01.02 The type tests shall be carried out in presence of the Owner's representative, for which minimum 15 days notice shall be given by the Bidder. The Bidder shall obtain the Owner's approval for the type test procedure before conducting the type test. The type test procedure shall clearly specify the test set-up, instruments to be used, procedure, acceptance norms, recording of different parameters, interval of recording, precautions to be taken etc. for the type test(s) to be carried out.

08.01.03 In case the bidder has conducted such specified type test(s) within last ten years as on the date of bid opening, he may submit the reports of the type tests indicated in the "LIST OF TYPE TESTS TO BE CONDUCTED " to the Owner for waiver of conductance of such type test(s). These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. The Owner reserves the right to waive conducting of any or all of the specified type test(s) under this contract. In case type tests are waived, the type test charges shall not be payable to the bidder.

08.01.04 Further the Bidder shall only submit the reports of the type tests as listed in "LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED" and carried out within last ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client. In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.

08.01.05 **LIST OF TESTS TO BE CONDUCTED**

The following type tests shall be conducted on each type and rating of HT motor

- (a) No load saturation and loss curves upto approximately 115% of rated voltage
- (b) Measurement of noise at no load.
- (c) Momentary excess torque test (subject to test bed constraint).
- (d) Full load test
- (e) Temperature rise test at rated conditions. During heat run test, bearing temp., winding temp., core temp., coolant flow and its temp. shall also be measured. In case the temperature rise test is carried at load other than rated load, specific approval for the test method and procedure is required to be obtained. Wherever ETD's are provided, the temperature shall be measured by ETD's also for the record purpose.

08.01.06 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of HT motor

- (a) Degree of protection test for the enclosure followed by IR, HV and no load run test.
- (b) Terminal box-fault level withstand test for each type of terminal box of HT motors only.

08.02.00 **LT Motors**

08.02.01 LT motors shall be of type tested quality. For each type & rating of LT motors rated above 50 KW, the bidder shall submit for Owner's approval the reports of all the type tests as per relevant standards and carried out within last ten years from the date of bid opening. These reports should be for the tests conducted on the equipment similar to those proposed to be supplied under this contract and the test(s) should have been either conducted at an independent laboratory or should have been witnessed by a client.

08.02.02 In case the Bidder is not able to submit report of the type test(s) conducted within last ten years from the date of bid opening, or in case the type test report(s) are not found to be meeting the specification requirements, the Bidder shall conduct all such tests under this contract free of cost to the Owner and submit the reports for approval.

08.03.00 All acceptance and routine tests as per the specification and relevant standards shall be carried out. Charges for these shall be deemed to be included in the equipment price.

08.03.01 **LIST OF TESTS FOR WHICH REPORTS HAVE TO BE SUBMITTED**

The following type test reports shall be submitted for each type and rating of LT motor of above 50 KW only

1. Measurement of resistance of windings of stator and wound rotor.
2. No load test at rated voltage to determine input current power and speed
3. Open circuit voltage ratio of wound rotor motors (in case of Slip ring motors)
4. Full load test to determine efficiency power factor and slip .
5. Temperature rise test .
6. Momentary excess torque test.
7. High voltage test .
8. Test for vibration severity of motor.
9. Test for noise levels of motor(Shall be limited as per clause no 7.06.00 of this section)
10. Test for degree of protection and
11. Over speed test.

12. Type test reports for motors located in fuel oil area having flame proof enclosures as per IS 2148 / IEC 60079-1

09.00.00 **Drawings, Data & Manuals**

09.01.00 Drawings, data & manuals for the motors shall be submitted as indicated below

- a) List of the motors
- b) Individual motor data sheet as per format of the proposal data sheets.
- c) Scheme & write up on forced lubrication system, if any
- d) Type test report

09.02.00 After award of the Contract

- a) Dimensional General Arrangement drawing
- b) Foundation Plan & Loading
- c) Cable end box details
- d) Space requirement for rotor removal
- e) Thermal withstand curves hot & cold
- f) Starting and speed torque characteristics at 80% & 100% voltage
- g) Complete motor data
- h) Erection & Maintenance Manual
- i) Test reports
- j) QAP

10.00.00 **DIMENSIONS OF TERMINAL BOXES FOR LV MOTORS**

Motor MCR in KW	Minimum distance between centre of stud and gland plate in mm
UP to 3 KW	As per manufacturer's practice.
Above 3 KW - upto 7 KW	85
Above 7 KW - upto 13 KW	115
Above 13 KW - upto 24 KW	167
Above 24 KW - upto 37 KW	196
Above 37 KW - upto 55 KW	249
Above 55 KW - upto 90 KW	277
Above 90 KW - upto 125 KW	331
Above 125 KW-upto 200 KW	203

For HT motors the distance between gland plate and the terminal studs shall not be less than 500 mm.