

ANNEXURE-X

**TECHNICAL SPECIFICATION OF ELECTRICAL MOTORS &
ELECTRIC ACTUATORS**

SECTION : 3.1- MOTORS

1.0.0 INTENT OF SPECIFICATION

This section covers the technical requirements of HT and LT Motors.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the following Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

-

- | | |
|-----------------|--|
| a) IS: 325 | Three phase induction motors |
| b) IS: 12615 | Energy efficient induction motors |
| c) IS: 900 | Code of practice for installation and maintenance of induction motors |
| d) IS: 996 | Single-phase AC induction motor for general purpose |
| e) IS: 1231 | Dimensions of three-phase foot-mounted induction motors |
| f) IS: 2223 | Dimensions of flange mounted AC induction motors |
| g) IS: 4029 | Guide for testing three-phase induction motors |
| h) IS: 8789 | Values of performance characteristics for three-phase induction motors |
| i) IS: 13555 | Guide for selection and application of 3-phase AC induction motors for different types of driven equipment |
| j) IS: 5571 | Guide for selection of electrical equipment for hazardous areas |
| k) IS: 12065 | Permissible limits of noise level for rotating electrical machines |
| l) IS: 12075 | Mechanical vibration of rotating electrical machines |
| m) IS: 9334 | Electrical motor operated actuators |
| n) IS 60034-5 | Degree of protection provided by Integral design of rotating electrical machines |
| o) IS 60034-8 | Terminal marking and direction of rotation |
| p) IS 60079-1 | Equipment protection by flame proof enclosure |
| q) IS 60034-1 | Rotating electrical machines. |
| r) IS 60079 | Explosive atmospheres |
| s) IS/IEC 60529 | Degrees of protection provided by enclosures (IP code) |
| t) IEC 60034 | Rotating electrical machines. |

3.0.0 TECHNICAL REQUIREMENTS

3.1.0 Design ambient temperature

Motors shall be suitable for an ambient temperature of 50 degree C and relative humidity of 95% and shall deliver the rated output without exceeding its guaranteed temperature limits.

3.2.0 Supply voltage

Motors rated up to and including 415V are termed as LT motors and the motors rated higher than 415V are termed as HT motors.

Motors shall be capable of delivering the rated output under following voltage and frequency variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5%
- Voltage variation for LT motors : (±) 10%
- Voltage variation for HT motors : (±) 10%
- Combined variation of voltage and frequency : 10% (absolute sum)

All the motors shall be so designed that maximum inrush currents, locked rotor torque and pullout torque developed at extreme voltage and frequency variations do not endanger the motor and the driven equipment.

3.3.0 System Parameters

Sl. No.	Description	HT System	LT System
1.	Voltage level	3.3kV Above 160 kW	240 V : up to 0.2 kW 415 V : >0.2 kW and up to 160 kW.
2.	System earthing	Earthed through resistance. Earth fault current : 300 Amps	415V: Solidly grounded.
3.	System fault level	44 kA for 3 sec	50 kA for 1 second
4.	Fault withstand rating of motor terminal box (Breaker operated)	44 kA for 0.25 sec	50 kA for 0.25 second

3.4.0 Type

- AC Motors shall be squirrel cage induction type unless otherwise it is specified. All the motor shall be bi-directional.

3.5.0 Duty

- All AC motors shall be squirrel cage three phase/single phase induction motors. All the motor shall be designed for bi-directional rotation.
- Motors shall be suitable for installation in hot, humid and tropical atmosphere and polluted at places with coal ash and or fly ash.

3.6.0 Design margin

- Motor rating shall be selected higher than the maximum load demand of the driven equipment, as per the criteria stated in mechanical section of this specification, under entire operating range, including voltage and frequency variation.
- The motor name plate rating shall have more than 10% margin over the input power requirement of the HT driven equipment and 15% for LT driven equipment at rated duty point.
- The motor characteristics shall match the requirements of the driven equipment so that adequate starting, accelerating; pull up, breakdown and full load torques are available for the intended service.
- Service shall be considered as 1.0 only.

3.7.0 Method of Starting

- All the motors shall be suitable for direct on-line starting on full load.
- HT Motors will be controlled through vacuum circuit breaker.
- LT motors rated up to 90kW will be controlled through MPCB/MCCB and contactor. LT motors rated more than 90 kW will be controlled through air circuit breaker

3.8.0 Efficiency

All the continuous duty motors shall be energy efficient type. For LT motors, it shall be IE2 class as per IS 12615. For HT motors, efficiency shall be more than 95%.

3.9.0 Temperature rise

- Winding Insulation shall be Class F.
- Temperature rise of motors shall not exceed 70°C over air temperature of 50°C by resistance method, while delivering its maximum rated output.

3.10.0 Starting voltage

- a) Motors shall be capable of starting and accelerating the load at following starting voltage, with direct on line starting, without exceeding specified winding temperatures.
 - HT Motors : 85% of rated voltage
 - LT motors : 80% of rated voltage
- b) During fast changeover of power supply source, vector difference between the motor residual voltage and the incoming supply voltage will be about 150% of the rated voltage and the motors shall withstand voltage stress and torque stress developed during that time, which may last for a period of one (1) second.
- c) The motor shall be capable of operating at full load at a supply voltage of 80% of the rated voltage for 5 minutes.
- d) The motor shall be capable of withstanding the stresses imposed if started at 110% rated voltage.
- e) Motor shall not stall if the supply voltage drops to 70% of the rated voltage two (2) second duration

3.11.0 No. of Starts

Continuous duty motors shall be suitable for the following starting requirements under the specified conditions of load, torque and inertia.

- No. of consecutive hot starts shall be 2 (with initial temperature of the motor at full load operating level).
 - No. of consecutive cold starts shall be 3 (with initial temperature of the motor at ambient temperature).
 - For conveyor motors, no. of consecutive hot starts shall be 3 (with initial temperature of the motor at full load operating level).
-

3.12.0 Starting current

- Motor shall be designed for direct online starting at full voltage. Starting current shall not exceed 6 times full load current for all auxiliaries. No further tolerances are applicable on starting current specified above for HT motors.
- For LT motors, the applicable starting current shall be limited to 7.2 times of full load current including all tolerance.

3.13.0 Locked rotor withstand time

- The locked rotor withstand time for HT motors under hot conditions at 110% rated voltage shall be more than the starting time at minimum permissible voltage specified above by atleast three seconds or 15% of the accelerating time whichever is greater.
- For the LT motors having starting time upto 20 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 2.5 seconds more than the starting time.
- For the motors having starting time more than 20 seconds and up to 45 seconds at minimum permissible voltage, the locked rotor withstand time under hot condition at highest voltage limit shall be at least 5 seconds more than the starting time.
- For motors having starting time more than 45 seconds at minimum permissible voltage, 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.
- The motors shall be designed to withstand 120% of rated speed for 2 minutes without any mechanical damage

3.14.0 Torque Requirements

- Accelerating torque at any speed with the lowest permissible starting voltage shall be at least 10% motor full load torque.
- Pull out torque at rated voltage shall not be less than 205% of full load torque.
- Motors subjected to reverse rotation shall be designed to withstand the stresses encountered when starting with non-energized shaft rotating at 125% of rated speed in reverse direction.
- The motor shall be designed to withstand momentary overload of 60% of full load torque for 15 second without any damage.

3.15.0 Enclosure

- a) All motor enclosures shall conform to the degree of protection IPW 55 unless otherwise specified. Motor for outdoor or semi outdoor service shall be of weather proof construction.
- b) For hazardous location, the enclosure of motors shall have flame proof construction conforming to applicable standard.

3.16.0 Cooling

- LT motors shall be totally enclosed fan cooled (TEFC), type IC411. The cooling shall be effected by self driven bi-directional centrifugal fan protected by fan cover.
-

- HT motors can be totally enclosed fan cooled (TEFC) or totally enclosed tube ventilated (TETV) or closed air circuit air cooled (CACA) type.
- Motors rated >3000kW can be closed air circuit water cooled (CACW).
- Motors with CACA/CACW heat exchangers shall have dial type thermometer with adjustable alarm contacts to indicate the following:
 - Hot and cold air temperatures of the closed air circuit for CACA motors.
 - Hot and cold, air and water temperatures for CACW motors.
- The Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 5A at 240 V AC.

3.17.0 Winding

- Winding shall be class F insulation with temperature limited to class B. Insulation shall be Non-hygroscopic, oil resistant, and flame resistant. Winding, fittings and hardware shall be corrosion resistant. Winding shall be tropicalized and suitably varnished, baked and treated for operating satisfactorily in humid and corrosive atmosphere.
- For the VFD operated drives, insulation shall be designed to take care of stresses due to high dV/dt. Motors shall be wound with dual coated winding wires and impregnated with VPI process. Further for such application, insulated bearings shall be provided to avoid circulating current caused by shaft induced voltages.
- Space heaters rated for 240V AC, 50 Hz supply shall be provided for motors rated 30kW and above to maintain windings in dry condition when motor is standstill.
- For HT motors, insulation shall be Vacuum Impregnated (VPI).
- HT motors shall withstand 1.2/50 microsec impulse Voltage wave of 4U+5 kV (U=Line voltage in kV). The coil inter-turn insulation shall be as per IEC-60034 – Part 15 followed by 1 min power frequency high voltage test of appropriate voltage on inter turn insulation.

Temperature Detectors

- All HT motors shall be provided with six (6) nos. duplex, or twelve (12) nos. simplex type winding temperature detectors, i.e. two (2) nos. duplex or four (4) nos. Simplex per phase.
- HT motor bearing shall be provided with duplex type temperature detectors.
- The temperature detector mentioned above shall be resistance type, 3 wire, platinum wound, 100 Ohms at 0°C.
- Leads of all simplex type motor winding RTDS and motor bearing RTDS shall be wired up to respective switchgear metering & protection compartment. From which one set of RTDS will be connected to numerical protection relay and another set shall be kept free for DCS connectivity.
- Five number of Temperature detectors / thermistors shall be provided for L.T. motors above 90 KW (3 numbers winding temperatures & 2 numbers bearing temperatures)

3.18.0 Bearings

- Motor shall be provided with antifriction bearings, unless sleeve bearings are required by the motor application. Bearings shall be provided with seals to prevent leakage of lubricant or entrance of foreign matters like dirt, water etc. into the bearing area.

- Sleeve bearings shall be split type, ring oiled with permanently aligned, close running shaft sleeves. Grease lubricated bearings shall be pre-lubricated and shall have provisions for in-service positive lubrication with grease nipple and relief holes.
- Vertical shaft motors shall be provided with thrust and guide bearings. Thrust bearing of tilting pad type is preferred. However, if anti-friction bearings can take vertical thrust, thrust and guide bearings are not required.
- Lubricant shall not deteriorate under all service conditions. The lubricants shall be limited to normally available types. For motors rated 30kW and above re-lubrication facility shall be provided.
- For motor with forced lubrication, a shaft driven oil pump shall be provided along with an electrical auxiliary pump. Alternatively, two motor driven pumps may be provided, one working and one standby. All necessary auxiliaries and accessories shall be provided to complete the system. A pressure gauge and pressure switch for low oil pressure warning and to start the standby oil pump automatically shall also be provided. A motor driven jacking oil pump may be provided, for heavy shaft loads.
- Flow switches shall be provided for monitoring oil flow of forced lubrication bearings, if used. Alarm switch contact rating shall be minimum 0.5 A at 220 V DC and 10A at 230 V AC.
- For bearing temperature measurement, duplex RTDs shall be provided for each bearing and shall be wired upto the terminal box.
- Each bearing shall be provided with dial type thermometer.
- For all VFD operated motors and motors rated above 1000KW having shaft length more than 1.5M shall have insulated bearings to prevent flow of shaft currents.

3.19.0 Terminal Boxes

- Separate terminal boxes of IP 55 degree of protection shall be provided for stator leads. For single core cables, gland plate shall be non-magnetic material. Terminal box shall be capable of being turned 360° in steps of 90°, unless otherwise approved. The terminal boxes shall be split type with removable cover with access to connections.
- Terminals for motors shall be stud type, thoroughly insulated from the frame. The terminals shall be clearly identified by phase markings, with corresponding direction of rotation marked on the non-driving end of the motor.
- The terminal box shall be capable of withstanding maximum system fault current for 0.25 sec for all breaker operated motors and shall be provided with explosion vent.
- For contactor operated LT motors, the terminal box shall be capable of withstanding the fault current for 0.2 sec minimum and operating time of MPCB/MCCB.
- Removable gland plates of thickness not less than 2.5 mm sheet steel or 3 mm aluminium (for single core cables) shall be provided for cable boxes.
- Cable spreader box shall be provided for larger cable sizes.
- Cable boxes of HT motors shall be phase segregated type. The terminals of three phases shall be segregated by barriers of metal or fibre glass. For HT motors, cable box design shall be suitable for accommodating cable termination kits.
- Separate terminal box for space heaters shall be provided.

- A separate terminal box of IP 55 degree of protection shall be provided for temperature detectors.
- Motor 1000 KW and above shall be provided with three differential current transformers mounted over the neutral leads within the enclosure. Loose 3 numbers CT for mounting on switchgear side shall be in bidder's scope. The arrangement shall be such as to permit easy access for C.T. testing and replacement. Current transformer characteristics shall match Owner's requirements to be intimated later to the successful bidder. The CT details shall be finalized during detail engineering. Neutral terminal box shall have IP 55 degree of protection.
- The secondary leads of CT shall be wired to separate auxiliary terminal box of IP 55 degree of protection
- All the accessory terminal boxes shall be located on the same side of the main (power) terminal box.
- For LT motors, terminal box shall be located on top, unless otherwise specified.

3.20.0 Earthing Terminals

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer. The terminal box shall have a separate grounding terminal.

The frame of each motor shall be provided with two separate and distinct grounding pads complete with tapped hole, GI bolts and washer.

The grounding connection shall be suitable for accommodation of ground conductors as follows :

- Motor above 90 KW : 75 x 10 mm GS Flat
- Motor above 30 KW up to 90 KW : 50 x 6 mm GS Flat
- Motor above 5 KW up to 30 KW : 25 x 3 mm GS Flat
- Motor up to 5 KW : 8 SWG GI Wire

3.21.0 Noise and Vibration

- Motors shall be selected with low noise levels in accordance with IS 12065.
- The peak amplitude of the vibration shall also be within the specified limits of IS: 12075.
- All HT motors shall be provided with vibration pads for mounting vibration detectors.

3.22.0 Name Plates

Motor shall have stainless steel nameplate(s) showing diagram of connections, all particulars as per IS: 325 / IS: 12615 and shall also have 'BEE' marking.

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

- Temperature rise in °C under rated condition and method of measurement.
- Degree of protection.
- Bearing identification no. and recommended lubricant.
- Location of insulated bearings.

3.23.0 Drain plug

Motor shall have drain plugs so located that they will drain the water, resulting from the condensation or other causes from all pockets of the motor casing.

3.24.0 Lifting provision

Motor weighing 25 Kg. or more shall be provided with eyebolt or other adequate provision of lifting.

3.25.0 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

4.0.0 INSTALLATION

Installation shall be carried out as per IS: 900.

5.0.0 PAINTING

Painting shall be carried out by an approved process. Pretreatment shall conform to applicable standard. The equipment shall be subject to a coat of red oxide primer paint. All inside and outside surface shall be painted with epoxy based paint. The final thickness of paint film on steel shall not be less than 100 microns. Paint Shade for the Motor shall be RAL 7032 (Siemens Grey). Sufficient quantity of touch-up paint shall be furnished for application at site.

6.0.0 TESTING AND INSPECTION

5.0.0 Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.

5.1.0 Routine and Type Tests are to be conducted for all HT motors and for LT motors above 60 KW rating in presence of customer's representative as per IS:325 and required copies of test certificates are to be furnished for approval.

5.2.0 Test certificates for Routine tests conducted as per IS-325 for motors of rating 60 KW and below shall be submitted for Mahagenco review, approval and dispatch clearance.

SECTION-3.2: ELECTRICAL ACTUATORS

1.0.0 INTENT OF SPECIFICATION

This section covers the requirements of motor operated electrical actuators.

2.0.0 CODES AND STANDARDS

The equipment to be furnished under this specification shall be in accordance with the applicable section of the latest edition (including amendments) of the applicable Indian Standards (IS), IEC publications and other codes except where modified and /or supplemented by this specification.

3.0.0 TECHNICAL REQUIREMENTS

Electric actuators shall be provided where specified/required. It shall be equipped with 3 phase induction motor, rated for intermittent duty S4-25%.

Motor shall be class F insulated with temperature rise limited to class B. Motor shall be of class H insulation with temperature limited to class B..

Motor shall be surface cooled designed for enclosure protection class of IP 68. Motor shall be suitable for starting direct on line.

For installation in potentially hazardous areas, the actuators shall have suitable explosion proof / flame proof type enclosure.

Actuators shall be suitable for operation at an ambient temperature of 50 degree C and relative humidity of 95%.

Motors shall be capable of operating under following supply variations without exceeding its guaranteed temperature limits.

- Frequency variation : (+) 3% and (-) 5% of 50 Hz
- Voltage variation for LT motors : ($\pm$) 10% of 415 V
- Combined variation of voltage and frequency: 10% (absolute sum)

All actuators shall be of integral type. Duty cycle of actuators shall suit the system requirement. The actuators shall be capable of giving the required torque at the output shaft. The actuators shall be designed to take the full thrust.

Actuators shall be of totally enclosed weather proof and dust proof construction with NEMA-6/IP 68 enclosure and shall be suitable for outdoor application without the necessity for a canopy. The actuator shall be suitable for mounting directly on the valve. The actuator shall be capable of giving the required torque, rpm and thrust without the help of any spur gear arrangement. The actuator shall be suitable for mounting in any position. Actuators shall be provided with integral starters.

The actuator shall be complete with motor, reduction gears, change gears, terminal compartment, switch compartment with limit switches and torque switches, local position indicator, position transmitter for remote position indicator, thermistor, space heaters, cable glands, mechanical position indicator, hand wheel for manual operation, valve attachment etc.

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

Two number adjustable torque switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. It is required to have calibration for the torque switches so that the switches can be easily set to any value desired.

Two numbers of position limit switches (one for open and one for close) each with 2 NO and 2 NC potential free contacts shall be provided. Two auxiliary limit switches (one for open and one for close) with 2 NO and 2 NC potential free contacts shall also be provided. The limit switches shall be of independently adjustable type. Limit switches and actuating mechanism shall be rust proof suitable for damp atmospheres. Limit switch compartment shall be weather proof and spacious enough for easy setting. The limit switches shall be suitable for the following ratings, both 240 Volts AC, 10 A and 220 V DC, 0.5 Amps.

Each actuator shall have a space heater in the limit switch compartment suitable for 240 V AC 50 Hz single phase supply.

The wiring from the limit switches, torque switches etc. shall be brought out in a separate terminal box of adequate size, so as to easily terminate the control cables.

Each actuator shall have a hand wheel fitted on it for emergency operation. The hand wheel shall be designed such that it is declutched automatically when the power supply to the motor is restored. The material of the hand wheel shall be either malleable iron or steel. The hand wheel shall have adequate clearance from housing for each gripping and operation. Actuators offered shall be with self-locking worm.

Actuators shall be supplied with integral starter which shall have sophisticated electronic controls with field programming feature.

A three position selector switch (marked as LOCAL-OFF-REMOTE) and push buttons OPEN-STOP-CLOSE (for local operation) with indication lamps for running OPEN and running CLOSE shall be provided.

The Remote command signal (OPEN-STOP-CLOSE) from DCS/PLC/Control panel shall be isolated from control electronics through opto-isolator.

The following individual status annunciation LED's (Colour-Green) shall be provided locally (Integral to actuator) to annunciate the following for easy local monitoring.

- Actuator in local mode
- Actuator in remote mode
- Actuator running in OPEN direction
- Actuator running in CLOSE direction
- Actuator in inching mode.
- Actuator in self-retaining mode
- Limit switch OPEN trip
- Limit switch CLOSE trip
- Control voltage availability

View port shall be provided on integral starter unit to monitor the above status annunciation.

The following individual fault annunciation LED's (Colour-Red) shall be provided locally. (Integral to Actuator)

- Torque switch OPEN
- Torque switch CLOSE
- Thermo switch trip
- Electronic overload relay trip
- Motor single phasing
- Common fault (Inclusive of any one or combination of above fault)

View port shall be provided on integral starter unit to monitor the above status annunciation.

Electronic overload relay shall be provided to trip actuator in case of overload.

Plug in connections/design shall be provided between:-

- Integral starter unit and basic actuator
- Between external customer connections and actuator.

OPEN-CLOSE indication /LED shall be provided for indication of full open/close position.

Automatic phase correction facility and potential free contact for annunciation of power failure shall be provided.

The following individual potential free relay contacts shall be provided in the actuator for remote annunciation to facilitate continuous monitoring of the actuator.

- Actuator (valve) running in OPEN direction.
- Actuator (valve) running in CLOSE direction.
- Actuator in remote mode.
- Actuator in local mode.
- Actuator power switched off /single phasing.
- Torque switch trip, thermo switch trip and thermal overload relay trip

4.0.0 TESTING AND INSPECTION

Equipment offered shall be of type tested and proven type. Routine tests shall be carried out for all the equipment as per applicable standards.

Tests shall be performed in presence of Owner's representatives. Successful Bidder shall give atleast fifteen (15) days advance notice for witnessing the tests. Copies of certified reports of all tests carried out at the works shall be furnished. The equipment shall be dispatched from works, only after receipt of Owner's written approval of the test reports.