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02	01/15/2024	Issued For Final				
01	05/12/2023	Issued For Approval				
00	18/10/2023	Issued For Review				
Rev.	Date	Description	Prepared	Checked	Approved	Authorized

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1. General

1.1.Introduction

The plant will be referred to as“ phase 3 ”in the rest of the report.

“Nominal” and “Design” capacity of the project is equal to 2340 dtph and 2700 dtph fresh ore feed conditions respectively. The plant is “Designed” to accommodate the “Maximum” conditions.

1.2.Definition of Terms

Throughout this document the following words and expressions shall have the meanings hereby assigned to them except where the context otherwise requires:

- **“CLIENT” &/OR OWNER**
- **“BUYER &/OR PURCHASER”**
- **"BUYER REPRESENTATIVE"**
- **“SUPPLIER &/OR CONTRACTOR &/OR VENDOR”** means the firm or company which the contract will be made with.
- **“SUB-SUPPLIER”** means any person or company (other than the supplier) named in the contract for any part of the works.
- **“WORKS”** means all obligations of the Contractor described in the "scope of works" of this document.
- **“PLANT”**
- **“APPROVE”** means approval in writing letter confirmed by buyer.

1.3.Document priority

In the event of conflict, actual or implied, among documents relating to an enquiry or order, following order of precedence shall govern, unless agreed in writing by Buyer.

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- 1. Material Requisition
- 2. Data sheet
- 3. Drawings
- 4. specification
- 5. Design Criteria
- 6. Code and standards
- 7. In any case the vendor shall inform purchaser and obtain clarification before proceeding with any work.

The Vendor shall notify the Buyer of any apparent conflict between this specification, the Codes and Standards and any other specification noted herein. Resolution and/or interpretation of precedence shall be obtained from the Buyer in writing before proceeding with the design/manufacture.

Alternatives proposed by the Supplier will receive careful consideration if they improve performance and reliability.

2.Site Condition and Utilities

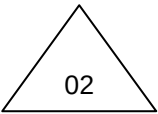
General Site Location

4-1-1 Site Location:

- Elevation: about 2500 meters above sea level.

4-1-2- Temperature:

- Max. (Summer): 35° C
- **Design Max (indoor and outdoor) 40 °C**
- Min. (Winter): -25° C
- **Design Min.(outdoor) -25° C**



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4-1-2- Relative Humidity:

- Humidity: 30 % @ 33°C
- Max.: 70 %
- Min.: 23 %

For specific indoor area (above open sumps and flotation cells and above thickeners) due to special condition (water evaporation and water spraying) relative humidity shall be considered 100 %.

4-1-3- Wind Condition:

- Max. Wind Velocity already recorded: 100 Km/h
- Prevailing Wind Direction:
- Winter: Between South and South West
- Summer: Between North and North East
- Stormy days per annum: 10

4-1-4- Rainfall:

- Average: 500 mm/a
- Design: 500 mm/a
- Rainfall Intensity: 76 mm/h

4-1-5- Snowfall:

- Average: 100 mm/a (as water)
- Design Intensity: 150 mm/a (as water)
- Frost Line: 1200 mm below grade

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Site description

4-2-1- Lithology:

The Site lithology consists of colluviums or slope wash overlying a deep volcanic weathering profile.

The Site lithology is summarized in below table:

Unit	Description	Top of Unit (m)	Approx. thickness (m)
1	Colluvium/ Slope wash	Surface	1-3
2	Residual Solids	3	5-10
3	Volcanic Rocks	10	>10

4-2-1- Seismicity:

SITE is classified as a high hazard zone and the above standard shall be considered during design of all foundation, structures and buildings.

3.Objective and Scope

This Specification covers the furnishing of all labor, material, equipment and services for the design, fabrication, supply, delivery erection, commissioning and guarantee of the low voltage induction motors as specified herein as required for the Plant (Phase.3).

The motors shall, in general, be 3 phase, 400, 690 or 6600 volt, 50 Hz, IEC metric frame squirrel cage induction motors.

It is intended that the Bidder shall provide complete and operable units, suitable for continuous operation, including all auxiliaries for complete operation of the plant.

All motors shall be adapted with site temperature and altitude.

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4.Codes and Standards

The equipment covered by this Specification, including all components and auxiliaries shall be designed, manufactured and tested in accordance with the latest IEC Standards wherever they may apply, and in particular: unless otherwise specified, the design, equipment, materials, installation, inspection and testing shall be conformed to the requirements of the latest edition of the followings:

- IEC60027: Letters, Symbols to be used in Electrical Technology
- IEC 60072: Dimensions and output rating for rotating electrical machines
- IEC 60034: Rotating electrical machines general requirements
- IEC 60034-1: Rotating electrical machines rating & performance
- IEC 60034-2: Rotating electrical machines losses calculation
- IEC 60034-5: Degree of protection minimum IP 55
- IEC 60034-6: Rotating electrical machines methods of cooling
- IEC 60034-7: Rotating electrical machines construction arrangement
- IEC 60034-8: Rotating electrical machines terminal marking
- IEC 60034-9: Rotating electrical machines noise limits
- IEC 60034-12: Rotating electrical machines starting performance
- IEC 60034-14: Rotating electrical machines Vibration
- IEC 60034-1 to 60034-18: Designed and manufactured in accordance with IEC Standards 60034-1 to 60034-18 as applicable
- IEC 60079: Electrical apparatus for explosive gas atmospheres
- IEC 60079-1:14: Electrical equipment selection for classified hazardous area
- IEC 60072-1: Dimensions and Output series for Rotating Electrical Machines 56 to 400 and flange numbers 55 to 1080
- IEC 60085: Thermal evaluation and classification of electrical insulation

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IEC60445: Identification of Equipment Terminals and of Terminations of System Certain Designated Conductors Including General Rules of an Alphanumeric

IEC 60529: Classification of Protection provided by Enclosures.

ISO-R-1680: Noise level Measurement

BS4999 General Requirement for Rotating Electrical Machines, Winding Termination

BS 5512 Dynamic Load Ratings and Rating Life of Rolling Bearing

BS 6121 Mechanical Cable Glands

NEMA MG1-1998 Motor and Generators

Note: Electrical equipment shall be designed, manufactured, erected, and installed according to the latest editions of the IEC (International Electro technical Commission) standards.

Minimum requirement for installation shall be follow local codes and norms. In lack of them normal European industrial practice is followed. Other standards that can use in reference, but shall be equivalent with IEC standard, are as below:

BS-IEEE-ANSI-VDE -DIN -ISO -NEMA-NFPA-NACE-API-ISA-NACE

5.OPERATION AND DUTY

The Motors shall be designed for continuous duty energized from D.O.L. (direct on line) starters, electronic soft starts or from VFDs on a 3 phase, nominal 400Vac, or 690Vac $\pm$ 5%, 50 Hz $\pm$ 2%, solidly grounded, power system with up to 40 kA RMS symmetrical fault capacity.

Motors shall be capable of producing full rated output at this elevation without exceeding the design temperature rise. This has already been considered in the dimensioning data given to the bidder. Motor kW ratings at name plated elevation must be confirmed against load kW requirements at new plant elevation.

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The Motors shall be designed for installation in wet or dusty locations and may be subject to spillage of slurry and water sprays during equipment wash down. The motors may be mounted indoors or outdoors where they may be subject to direct sunlight, heavy rain and snow.

The motors shall be designed for the industry standard maximum indoor/outdoor 40°C ambient plant temperature. Motors shall also be designed for installation and operation at the design minimum outdoor temperature of minus 25°C. Particular attention shall be paid to bearing grease selection.

Motors shall be suitable for horizontal or vertical mounting as per the motor data sheet. Unless noted otherwise, motors shall be designed for foot mount.

Motor operating characteristics shall satisfy the requirements of the specified load. Where not specified, motors shall have an equivalent NEMA design B torque characteristics for normal operating conditions. For high starting torque applications motors shall have an equivalent NEMA Design C characteristic. Motors for use with variable frequency drives (VFDs) shall have NEMA Design B torque characteristics, unless specifically noted otherwise.

Motors shall be capable of operating continuously at full nameplate rating at site elevation of 2500 meters in an ambient temperature of up to industry standard 40°C without exceeding the specified temperature rise.

Note: The outdoor motors and also in concentrator hall motors shall equipped with heating element as anti-condensation.

Note: All the VFDs shall have harmonic filter (THD abatement) both on the input and output. The input THDV shall be considered 5% according to IEEE 60-519.

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6.DESIGN DATA (LV MOTOR)

6.1.General Characteristics

The motor design shall allow at least three consecutive starts from cold against full load torque without injurious heating of insulated windings.

Motors shall be able to overcome starting load inertia as well as accelerating the load to rated speed at 20% reduced voltage.

The minimum accelerating torque shall be at least 30% more than the torque required by the load, at starting and at pull up stage, when the applied voltage is 80% of the nominal voltage. The starting torque shall be at least 100% of the rated full load torque at 80% of the nominal voltage.

In any event, the motor starting torque at 100% rated voltage and at all speeds between standstill and the speed at the pullout torque point, it shall not be less than 1.7 times the torque obtained from a load curve which varies as the square of the speed and is equal to 1.0 P.U. motor rated torque tabulated in IEC 60034.12 Table 1.

Motors shall be capable of recovering normal operation in the event of a system disturbance causing temporary loss of supply voltage of periods of up to 200 milliseconds (fault clearance time) followed by a sudden restoration, initially to 60% rated voltage for 3 seconds, then followed by a sudden restoration to 80% rated voltage, from which voltage, then motors shall be capable to accelerating and ultimate recovery under the most arduous load conditions.

Manufacturers shall specify in their tenders the percentage value of residual voltage against which the motor may be reconnected to the supply immediately following loss of supply, however the motor shall withstand a residual voltage of at least 30% of rated supply voltage with 180° out of phase situation.

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The electric motor, including any associated unit transformer shall be suitable for one of the duties listed below:

- Normal: maximum 1000 start per year
- Heavy: maximum 3000 start per year

The Manufacturer shall assign "safe stalled rotor time(s)" for "cold" and "hot" conditions. It shall be the time(s) during which the motor may remain stalled without injurious effects to rotor and stator. The time for the "cold" condition shall assume that the motor is initially at the specified ambient temperature. The time for the "hot" condition shall assume that the motor is initially at the stabilized full load rating temperature.

Non-metallic materials, particularly those introduced for noise reduction, shall be fire resistant, antistatic (in compliance with the requirements of IEC 60079) and stable in the presence of hydrocarbon liquids and vapors or for other conditions that will be specified.

6.2.Motors for Hazardous Area

Motors to be used in hazardous areas shall be totally enclosed fan cooled (TEFC), IP65, explosion proof as per area classification. The devices used for temperature control, whether of the current dependent or temperature detector type shall be high quality and shall be regularly tested. Totally, it shall meet the requirements of IEC recommendation 60079-7 or equivalent standards.

On explosion proof motors, means shall be provided for withdrawing end plates and cartridges housing (where fitted) in a manner which shall avoid damage to explosion proof flanges.

Motor enclosures, which are specified explosion proof or increased safety, shall be certified by manufacturer or approved by equivalent internationally recognized certifying authorities.

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6.3.Motors to be Used in Non-Hazardous Area

Motors to be used in non-hazardous area, outdoor in non-process, shall be totally enclosed fan cooled (TEFC) with degree of protection IP55 according to IEC 60034-5.

In non-hazardous area, indoor in non-process area, standard industrial type motors, with degree of protection IP55 according to IEC 60034-5 shall be used.

6.4.Ratings and Performance

- a) Motors shall be rated 3 phase, 50 Hz, 400 or 690 volts.
- b) Motors shall have a 1.15 service factor (SF) if required.
- c) Motors shall have IEC “N” (equivalent to NEMA Design B) torque characteristics, unless specified otherwise on the Purchaser’s data sheets.
- d) Motors shall be capable of operating continuously at their nominated load ratings with a supply voltage of 400 Vac or 690 Vac $\pm$ 5%, and a frequency of 50 Hz $\pm$ 2%.
- e) All motors shall be suitable for direct across the line starting at full voltage.
- f) Motor direction of rotation shall be bi-directional, unless noted otherwise herein or on the data sheets herewith.
- g) Where noted on the Purchaser’s data sheets, motors shall be specifically designed for variable speed drive (VFD) service. Motor speed turn down shall be at least 3 to 1. Motor insulation shall be designed to withstand the voltage peaks associated with VFD applications. Motors for VFD service shall have IEC “N” (NEMA Design B) torque characteristics.
- h) Motors shall, as a minimum, meet IEC performance standards.
- i) Motors shall be designed for continuous S1 duty as per IEC 60034 1.
- j) The PT100 temperature sensor shall be connected to the control system.

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6.5.Temperature Rise

- The motors will be able to run at their Nominal rating, without that the temperature rise of their windings, measured via resistance at the ambient temperature, exceeding the indicated values in the IEC 60085 standard. The insulation of the windings shall be Class 'F',
- Motors shall be designed for Class B temperature rise of not more than 80°C temperature rise by resistance over an ambient temperature of 40°C, at full load, 1.15 service factor.
- The above temperature rise limits shall apply at the plant site elevation.

6.6.Efficiency

Motors shall be premium efficiency.

6.7.Stator Construction and Stator Windings

- Stator laminations shall be of high grade, insulated/coated, cold rolled, low loss, electrical grade, steel.
- Stator windings should be 6 lead, suitable for wye-delta starting. This is preferable but not a requirement.
- Stator windings shall be of copper.
- Stator winding insulation shall be of Class F or better.
- Stator winding leads shall be brought out to a terminal connection box.
- Wire insulation shall be high quality polyester enamel, or equivalent.
- Insulation shall be non-hydroscopic, meeting or exceeding IEC standards.
- Completed stator windings shall be double dipped with solvent free varnish and baked.

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- l) Motors for VFD service shall have insulation designed to withstand peaks of 1600 volts having a 0.1 microsecond rise time (400 V design), (as per NEMA Standard MG 1 Part 31.4).

Note: The VFD information will be sending to control system via serial link.

6.8. Rotors and Shaft

- Rotors shall be constructed by pressure die casting high conductivity aluminum or copper including integral end rings and fan blades.
- All rotors shall be dynamically balanced to IEC standards or better.
- Motors shall be equipped with standard metric single ended shaft and keyway, complete with key.
- Shafts shall be of ANSI 1045 steel, ISO equivalent, or better.

6.9. Bearings and Shaft Seals

- Motor bearings shall be re-greaseable, with grease release plugs provided (to allow escape of old grease during greasing).

Note: Bidders may propose small frame size motors (below 7.5 kW) with sealed bearings if they do not have re-greaseable bearings available. However, proposals including re-greaseable bearings for small frame size motors will be favored.

- Motor bearings shall be of the anti-friction type, made of vacuum degassed steel and shall be generously sized for the application. It is expected that motor bearings shall have C3 clearance.
- Ball bearings shall be of the deep groove rolling element carriage type.
- Motor bearings for motors used with variable frequency drives (VFDs) shall be protected against circulating shaft currents by the use of insulated housings or other design features.

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- e) Motors (horizontal mount) over 75 kW shall have cylindrical roller bearings on drive end for belt drive applications.
- f) Motors shall have an inner bearing cap or slinger which keeps the grease from entering the inside of the motor while allowing the grease to be exchanged from both sides of the bearing.
- g) Motors shall be greased in the factory with premium grade grease having extra additives to prevent oxidation.
- h) For out of doors operation, grease shall be selected based on the minimum ambient temperatures specified.
- i) Motors shall be provided with shaft seals and slingers designed to prevent water, dust and moisture entry during operation and during equipment wash down or process (slurry) spills. Note, in addition to any standard labyrinth seal, a lip seal or similar additional protection is required, plus a shaft slinger or similar as specified above.
- j) Bearing life, in belt drive applications, with loading in accordance with the data provided, shall be rated for 50,000 hours and 100,000 hours for direct drive applications.
- k) Motor shafts shall be suitably locked/blocked during shipment to prevent vibration damage to the bearings (false brinelling) during transportation.

6.10.Ventilation

- a) Motors shall have IC410 or IC411 method of cooling in accordance with IEC standards. The cooling of constant speed motors shall be taken from shaft-driven fan, suitable for bi-directional rotation. Where it is necessary to furnish a uni-directional fan, it has to be stated on the motor drawings and data sheet.

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- b) Variable speed motors may have independent motor driven fans, if required.
A separate constant speed fan is recommended to increase cooling capacity and load capacity at low speeds.
- c) Cooling fan material shall be of non-sparking material.
- d) Fans for motors shall be of corrosion resistant material such as brass, bronze, and aluminum alloy. aluminum alloy fans should not contain more than 0.2% copper. Fans shall be balanced before assembly on shaft. Plastic or non-metallic fan housing is not acceptable.
- e) Fans shall be inherently balanced and shall be located so that it is impossible to assemble them incorrectly. They shall force the cooling air in the direction of the driving end and preferably be suitable for rotation in either direction.
- f) In the case of motors supplied with unidirectional fans, the direction of rotation for which the motor is arranged shall be clearly indicated by means of a permanent arrow on the non-driving end, preferably on the stator body and not on a removable end shield. A painted arrow only is not acceptable. Fan shall be non-sparking.
Note: For motor that feed by VFD, cooling fan shall be driven by separate motor.
- g) Motor cooling fans shall be of corrosion resistant, non-sparking design.
- h) Cooling fans shall be bi-directional.

6.11.Enclosures/Frames

- a) Motors shall have IEC metric frames.
- b) Motor enclosures shall be totally enclosed fan cooled (TEFC) unless specified otherwise herein.
- c) Enclosures shall meet IEC 60034-1 and 60034-5 requirements.

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- d) Motors shall be weatherproof the degree of motor protection shall be IP55 or better.
- e) Motor housings, end bells (bearing end shields) and fan housings shall be constructed of high-grade cast iron or die cast aluminum (for small frame sizes where cast iron is not available).
- f) All motors of frame size 132 and above shall have a forged lifting eye, this type of motor will be equipped with bearing temperature measurement.
- g) Motors shall be equipped with .
- h) Motors shall protection IP 54 (for indoors) and IP 55 (for outdoors). Motor housings, end bells (bearing) degree of motor protection shall be IP55 or better.

6.12.Mounting

- a) Mounting shall be rigid base foot mount, B3 (IM1001) unless noted otherwise.
- b) Where specified motors shall be C-Face F2 mount.

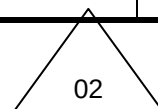
6.13.Hardware

- a) All hardware shall be corrosion resistant, zinc plated or stainless steel.
- b) Threaded fasteners shall be ISO course pitch.

6.14.Nameplates

- a) Information on motor parameters shall be given according to IEC-60034.
- b) Each item of equipment shall be fitted with a permanent stainless steel identification plate, securely mounted with permanent fixing screws, in a prominent position and neatly, clearly and indelibly engraved to display as per standard.

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6.15. Terminal Connection Boxes

- a) Motor terminal boxes shall be water tight, IP55 or better, for powers and signals
- b) Motor terminal boxes shall be located on the right side of the motor when viewed from the drive end, unless otherwise specified.
- c) Motor connection boxes shall be “oversized” relative to the standards and shall be designed to allow generous space for conductor terminations.
- d) Motor terminal boxes shall have threaded hubs, size to be confirmed for each motor frame size.
- e) Motor terminal boxes shall be provided with stud terminals for the motor leads. Links shall be provided to achieve the required motor connection configuration. Terminals shall be complete with lock nuts.
- f) Motor terminal boxes shall have an internal ground stud.
- g) The terminal box shall be turned by $4 \times 90^\circ$ degrees on the terminal base of the machine housing in the case of a terminal board with 6 terminal studs.
- h) The connection box shall have a gasket between the box and the motor frame and shall have a suitable cover gasket.

6.16. Noise Levels

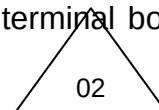
- a) Noise levels shall meet IEC standards and in no case shall be greater than 85 dBA at 1 meter.
- b) Suppliers shall provide sound level data with their proposals.

6.17. Over Temperature Sensors

- c) Over temperature protection is not required unless specifically requested on the motor data sheets or elsewhere herein. Typically, they will be required on motors with a power rating of greater than 400 kW.

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- d) For over than 132 KW motor, six stator resistance temperature detectors (RTD5) shall be provided for each motor. The RTDs shall be embedded in the stator windings and terminated in a separate (IP55) terminal box. The RTDs shall be 100 ohms, three lead, and platinum.
- e) Provide bearing RTDs (100-ohm platinum) where specifically requested. Terminate in stator RTD terminal box, if practical.
- f) Six stator thermistor devices (PTC) shall be provided for each VFD motor where specifically requested.
- g) The V.F.D panel shall be equipped with anti-condensate heater with thermostat control.



6.18.Starts per Hour

- a) Motors shall be designed for at least the number of direct on line starts per hour as specified in the IEC Standards. Motors with the capability of at least 5 starts per hour, direct on line, are preferred.
- b) Bidders shall include starts per hour information for all motors in the proposal, and include in motor protection.

6.19.Space heaters and Condensation Protection

- a) Motors shall be designed to prevent the accumulation of moisture within the enclosure. Space heaters shall be considered for motors with rated power more than 132kW.
- a) Where specified they shall be 230 volts, single phase, supplied from emergency bus bar.
- b) Space heater leads shall be brought out to a terminal box separate from the main terminal box. Heater and its terminal box shall be suitable for the area classification in which the motor will be installed.

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6.20.Finish (Painting)

- Motor interiors shall be cleaned and receive a rust proof coating.
- Exterior surface finish shall be manufacturer's standard corrosion resistant paint system.
- Finishing paint shall be RAL7035, or manufacturer's standard and in accordance with the painting schedule which shall be prepared by manufacturer and shall be sent to the buyer for approval.
- For painting, please see Painting specification no. 12002-D-PI-SPC-303-GNL-004.

7.QUALITY CONTROL AND TESTING

Standard (routine) commercial tests shall be carried out on all motors, in accordance with IEC Standards. Complete certified type test results shall be provided as specified in IEC-60034 standards. Tests shall include, as a minimum:

- No load running current and power.
- Check of current balance.
- Measure winding resistance.
- High potential test.
- Vibration test.
- Test of instruments and sensor element.

8.DESIGN DATA (MV MOTOR)

8.1.Type

Motors shall be IEC metric frame, synchronous or squirrel cage (cage rotor)

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induction motors, except as specifically noted otherwise. Where so noted, synchronous motors shall have power factor correction mode.

All synchronous motor will be start as induction motor and has lead P.F, normally %80.

8.2.Motors for Hazardous Area

Motors to be used in hazardous areas shall be totally enclosed fan cooled (TEFC), IP65, explosion proof as per area classification. The devices used for temperature control, whether of the current dependent or temperature detector type shall be high quality and shall be regularly tested. Totally, it shall meet the requirements of IEC recommendation 60079-7 or equivalent standards.

On explosion proof motors, means shall be provided for withdrawing end plates and cartridges housing (where fitted) in a manner which shall avoid damage to explosion proof flanges.

Motor enclosures, which are specified explosion proof or increased safety, shall be certified by manufacturer or approved by equivalent internationally recognized certifying authorities.

8.3.Motors to be used in Non-Hazardous Area

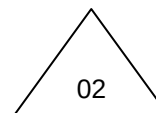
Motors to be used in non-hazardous area, outdoor in non-process, shall be totally enclosed fan cooled (TEFC) with degree of protection IP55 according to IEC 60034-5.

In non-hazardous area, indoor in non-process area, standard industrial type motors, with degree of protection IP55 according to IEC 60034-5 shall be used.

Motors, which used in non-hazardous are, indoor and outdoor in process area, shall be TEFC with degree of protection IP65.

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8.4. Ratings and Performance



- a) Motors shall be rated 3 phases, 50 Hz, 6600/11000 volts.
- b) Motors shall have a 1.0 service factor (SF).
- c) Motors shall have equivalent NEMA Design B torque characteristics, unless specified otherwise on the Owner's data sheets.
- d) Motors shall be capable of operating continuously at their nominated load ratings with a supply voltage of 6.6 kV ac $\pm 5\%$ and a frequency of 50 Hz $\pm 2\%$,
- e) All motors shall be suitable for direct across the line starting at full voltage by means of fused vacuum contactors or breaker.
- f) Motor direction of rotation shall be bi-directional, unless noted otherwise herein or on the data sheets herewith.
- g) Where noted on the Process data sheets, motors shall be specifically designed for variable speed drive (VFD) service. Motor speed turn down shall be at least 3 to 1. Motors for VFD service shall have NEMA Design B torque characteristics.
- h) Motors shall, as a minimum, meet IEC performance standards.
- i) Motors shall be designed for continuous S1 duty as per IEC 60034-1.
- j) Acc. To IEC60034-15, Lightning-impulse withstand voltage (BIL) kV, peak for MV Motor is 31kV and Power-frequency withstand voltage kV, rms is 14.2kV.

8.5. Temperature Rise

- a) The motors will be able to run at their Nominal rating, without that the temperature rise of their windings, measured via resistance at the ambient temperature, exceeding the indicated values in the IEC 60085 standard. The insulation of the windings shall be Class 'F',

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- b) Motors shall be designed for Class B temperature rise of not more than 80°C temperature rise by resistance over an ambient temperature of 40°C, at full load, 1.15 service factor.
- c) The above temperature rise limits shall apply at the plant site elevation.

8.6.Efficiency

Motors shall be premium efficiency.

- a) Stator Construction and Stator winding and Stator laminations shall be of high grade, insulated/coated, cold rolled, low loss, electrical grade steel..
- b) Stator windings shall be of copper. Stator winding insulation shall be of Class F or better. Stator coils shall be of the form wound type using high-grade, rectangular copper wire. Individual turns shall be enameled and continuously insulated with a polymer/glass cloth, and then the completed individual coils shall be further wrapped with a mica mat or similar composite covering in the slot portions. Provide an outer covering of over lapped glass tape on turn ends.
- c) Assembled stator windings shall be wedged, braced, connected and then vacuum pressure impregnated using solvent free epoxy type varnish and shall be subjected to several alternating cycles of vacuum and pressure (VPI) to ensure all voids are filled with solvent less epoxy resin.
- d) Additional winding protection (mica mat composite sheet) shall be provided in the stator slots (ground wall insulation). Anti-corona treatment shall also be applied.
- e) The ends of the stator coils shall be securely bonded to insulated steel support rings or similar which in turn shall be anchored to the stator frame.
- f) Wound stator assemblies shall receive a final curing bake.

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- g) Stator winding leads shall be brought out to a terminal connection box.
- h) Wire insulation shall be high grade polyester enamel, or equivalent.
- i) Insulation shall be non-hydroscopic, meeting or exceeding IEC standards.
- j) Provide anti-abrasive moisture resistant winding finish suitable for the stated ambient conditions (where open type motors are approved).
- k) Stator coils shall all receive production tests as specified by the IEC Standards, or as per IEEE standards. Completed stator windings shall be tested as per IEC standards, or as per IEEE Standard 429.
- l) Bidders shall provide complete surge withstand data of their proposed motor insulation with their bids.
- m) Motors for VFD service shall have insulation designed to withstand voltage peaks and line to ground voltages.
- n) For each phase of motor one R.T.D sensor shall be provided.

Note: The VFD information will be sending to control system via serial link.

8.7. Rotors and Shaft

- a) Rotors shall be constructed of insulated electrical grade steel laminations held together by through bolts and end plates.
- b) Rotor bars and end rings shall be of copper or copper alloy. Connections shall be brazed or inert gas welded.
- c) All rotors shall be dynamically balanced to IEC standards or better.
- d) Motors shall be equipped with standard metric single ended shaft and keyway, complete with key.
- e) Shafts shall be of ANSI 1045 steel, ISO equivalent, or better.

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8.8.Bearings and Shaft Seals

- a) Motor bearings shall be equipped with grease nipples and release plugs.
- b) Motors shall have extended grease fittings installed for the drive end bearing.
- c) Unless specified otherwise herein, motor bearings shall be of the anti-friction type, made of vacuum degassed steel and shall be generously sized for the application. It is expected that motor bearings shall have C3 clearance.
- d) Ball bearings shall be of the deep groove rolling element carriage type.
- e) Motor bearings for motors used with variable frequency drives (VFDs) shall be protected against circulating shaft currents by the use of insulated housings or other design features.
- f) All motors used for V-belt drive shall have cylindrical roller bearings on the drive end.
- g) The Vendor performs design calculations, based on load data available from the Owner, and shall design and provide appropriate bearings to meet the bearing life expectancy specified herein.
- h) Motors shall have an inner bearing cap or slinger which keeps the grease from entering the inside of the motor while allowing the grease to be exchanged from both sides of the bearing.
- i) Motors shall be greased in the factory with premium grade grease having extra additives to prevent oxidation.
- j) Where specified, motor bearings shall be sleeve type, either lubricated by bronze oil rings or flood lubricated by a supplied pump and lubrication system. Sleeve bearings shall be split type. They shall be spherically seated and self-aligning. To facilitate inspection and disassembly, the end shield of motors with sleeve bearings shall be of a split design. Insulation shall be

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provided if the motor is to be used with a VFD and as may otherwise be necessary.

- k) For out of doors operation, grease shall be selected based on the minimum ambient temperatures specified.
- l) Motors shall be provided with shaft seals and slingers designed to prevent water, dust and moisture entry during operation and during equipment wash down or process (slurry) spills. Note, in addition to any standard labyrinth seal, a lip seal or similar additional protection is required, plus a shaft slinger or similar as specified above.
- m) Bearing life, in belt drive applications, with loading in accordance with the data provided, shall be rated for 50,000 hours and 100,000 hours for direct drive applications.
- n) Motor shafts shall be suitably locked/blocked during shipment to prevent vibration damage to the bearings (false brinelling) during transportation.
- o) The bearing shall be equipped with remote and local temperature measurement.

8.9. Ventilation

- a) Motors shall be (a) totally enclosed fan cooled (TEFC) with shaft mounted external cooling fan or (b) totally enclosed with air-to-air heat exchanger (TEAAC) or (c) equipped with forced – ventilating centrifugal fans unless specifically noted otherwise. Where so specified, motors may be open drip proof or similar. These will be for use in indoor, dry, locations.
- b) Motor cooling fans shall be of corrosion resistant, non-sparking design. Cooling fans shall be bi-directional.

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- c) Fans for motors shall be of corrosion resistant material such as brass, bronze, and aluminum. Aluminum alloy fans should not contain more than 0.2% copper. Fans shall be balanced before assembly on shaft. Plastic or non-metallic fan housing is not acceptable.
- d) Fans shall be inherently balanced and shall be located so that it is impossible to assemble them incorrectly. They shall force the cooling air in the direction of the driving end and preferably be suitable for rotation in either direction.
- e) In the case of motors supplied with unidirectional fans, the direction of rotation for which the motor is arranged shall be clearly indicated by means of a permanent arrow on the non-driving end, preferably on the stator body and not on a removable end shield. A painted arrow only is not acceptable. Fan shall be non-sparking.
- f) For motor that feed by VFD, cooling fan shall be driven by separate motor.

8.10. Enclosures/Frames

- a) Motors shall have IEC metric frames.
- b) Motor enclosures shall be
 - Totally enclosed fan cooled (TEFC), or
 - Totally enclosed air to air cooled (TEAAC) unless specified otherwise herein. Where TEAC motors are provided it is important that vendors include complete dimensional data with their proposals, as the large top mounted air to air heat exchanger may interfere with driven equipment.
- c) Enclosures shall meet IEC 60034-1 and 60034-5 requirements.
- d) Motors shall be weatherproof unless specified otherwise herein. The degree of motor protection shall be IP 55 or better.

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- e) Motor housings, end bells (bearing end shields) and fan housings shall be constructed of high-grade cast iron or heavy fabricated steel.
- f) All motors shall have forged lifting eyes or lugs.
- g) Motors shall be equipped with drains.
- h) Motor shall be equipped with anti-condensate heater.
- i) Motors shall be equipped with cooling media temperature indicator.
- j) The motor shaft shall be protected for H.S.E requirement after completion.

8.11.Mounting

- a) Mounting shall be rigid base foot mount, B3 (IM1001) unless noted otherwise.
- b) Where specified motors shall be C-Face F2 mount.
- c) Slide rails shall be provided where specified on motor data sheets. Price separately.

8.12.Hardware

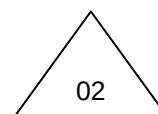
- a) All hardware shall be corrosion resistant, zinc plated or stainless steel.
- b) Threaded fasteners shall be ISO course pitch.

8.13.Nameplates

- c) Nameplates shall be of stainless steel.
- d) Information on motor parameters shall be given according to IEC-60034.

8.14.Terminal Connection Boxes

- a) Motor terminal boxes shall be water tight, IP55 or better.
- b) Motor terminal boxes shall be located on the right side of the motor when viewed from the drive end, unless otherwise specified.



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- c) Motor terminal boxes shall be of heavy gauge sheet steel or cast-iron construction. Sheet steel boxes shall have an epoxy type, corrosion resistant finish.
- d) Motor connection boxes shall be “oversized” relative to the standards and shall be designed to allow generous space for conductor terminations and stress cone installation.
- e) Motor terminal boxes shall have threaded hubs, size to be confirmed for each motor frame size. Alternatively, boxes may be provided with removable, gasketed cable gland plates which may be removed in the field and punched as required for cable entry.
- f) Motor terminal boxes shall be provided with stud terminals for the motor leads. Links shall be provided to achieve the required motor connection configuration. Terminals shall be complete with lock nuts.
- g) Motor terminal boxes shall have an internal ground stud.
- h) The motor connection box shall be rotatable in 90° increments. Boxes shall be designed for easy removal from the motor.
- i) The connection box shall have a gasket between the box and the motor frame and shall have a suitable cover gasket.
- j) Control signals of motors shall have separate terminal boxes for interface to control system.
- k) Motors over 1000 kW shall have the stator winding leads extended to a conduit box containing three CTs on each phase for motor differential relay (87) on 6.6kV switchgear.
- l) Separate terminal box for secondary windings of current transformers shall be provided.

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8.15. Surge Protection

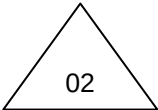
Motor terminal boxes shall be complete with surge arresters and surge capacitors where required. These devices shall have a working voltage of at least 6.6 kV plus 5 %. Alternately these devices may be supplied in separate IP55 enclosures for field installation adjacent to the motor. The surge protection requirement will be approved during design stage.

8.16. Noise Levels

- a) Noise levels shall meet IEC standards and in no case shall be greater than 85 dB at 1 meter.
- b) Vendors shall provide sound level data with their proposals, during selection for client approved.

8.17.Over Temperature Sensors

- a) Over temperature protection is required unless excluded specifically. Typically, they will be required on motors with a power rating of greater than 400 kW.
- b) Six stator resistance temperature detectors (RTDs) shall be provided for each motor. The RTDs shall be embedded in the stator windings and terminated in a separate (IP55) terminal box. The RTDs shall be 100 ohm, three lead and platinum.
- c) Provide bearing RTDs (100 ohm platinum) where specifically requested. Terminate in stator RTD terminal box, if practical.
- d) Bearing temperature sensor shall be provided
- e) For air cooling motor the hot air temperature indicator or sensor shall be installed.



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8.18.Slip Ring Motors (If Applicable)

- a) Where so specified in detail design, including on the enclosed data sheets, wound rotor, slip ring type and motors shall be proposed.
- b) Slip rings shall be high quality brass or equal.
- c) Brush holders shall be of the constant force type, designed so that current does not pass through the springs.
- d) Brushes shall be provided which are suitable for the motor ambient conditions.
- e) Brushes and slip rings shall be enclosed. There shall be ready access for brush inspection. The enclosure shall be separate from the motor cooling circuit and arranged so that carbon from the brushes cannot contaminate the motor windings. Provide filtering as required. Generous electrical clearances shall be provided. A suitable water tight connection box shall be provided.

8.19.Starts per Hour

- f) Motors shall be designed for at least the number of direct on line starts per hour as specified in the IEC Standards. Motors with the capability of at least 5 starts per hour, direct on line, are preferred, for exceeding start per hour the protection device is required.
- g) Bidders shall include starts per hour information for all motors in the proposal.
- h) The protection shall be provided for No. of cold or hot start of motors.

8.20.Space heaters and Condensation Protection

- a) Motors shall be designed to prevent the accumulation of moisture within the enclosure. Space heaters shall be provided for all M.V motors (6.6 KV).
- b) Space heater voltages are to be as follows:

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- 3000 watts or fewer 230 volts, single phase, from emergency bus bar.
- Over 3000 watts 400 volts, 3 phase, from emergency bus bar.

Space heater shall have maximum sheath temperature of 200oC or as specified.

- c) Space heaters leads shall be brought out to junction box separate from the main power terminal box.
- d) Heater and its terminal box shall be suitable for the area classification in which the motor will be installed.

8.21.Finish (Painting)

- a) Motor interiors shall be cleaned and receive a rust proof coating.
- b) Exterior surface finish shall be manufacturer's standard corrosion resistant paint system.
- c) Painting shall be unified for phase 1 and 2 as much as possible.
- d) Finishing paint shall be RAL7035 or manufacturer's standard and in accordance with the painting schedule which shall be prepared by manufacturer and shall be sent to the buyer for approval.
- e) For painting, please see Painting specification no. 12002-D-PI-SPC-303-GNL-004.

9. SYNCHRONOUS

The motors shall, in general, be 3 phase, 6.6 kV, 50 Hz, IEC metric frame synchronous or squirrel cage induction motors. Where specifically indicated, motors shall be of the synchronous type, with capability for power factor correction mode of operation.

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It is intended that the E.P.C Bidder shall provide complete and operable units, suitable for continuous operation, including all auxiliaries for complete operation for the specified function.

The synchronize motor shall be equipped with starting system as induction motor.

All standard protection with lockout relays shall be provided for motors.

The synchronous motor will be started as Asynchronous motor.

All synchronous motor will be start as induction motor and has lead P.F, normally %80.

9.1.Frame

The frame function is supporting and protecting the motor, also housing the lamination core and the stator windings. It can be built considering horizontal or vertical construction and with protection degree adjusted in accordance with the environment requirements. The frame is built in welded steel profiles and sheets, forming a solid and robust structure that is the structural base of the machine. This kind of construction provides excellent structural strength to withstand mechanical stresses arising from potential short circuits and vibration, enabling the motor to meet the severest conditions.

9.2.Stator

The stator consists of a core of high-quality silicon steel laminations with slots to fit the stator winding, which operates with alternating current power supply in order to generate the rotating magnetic field.

9.3.Rotor

The rotor can be designed with cylindrical poles, laminated salient poles or solid salient poles, depending on the construction characteristics of the motor and its

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application. The complete rotor is formed by the structure that composes or supports the poles, the field windings and the starting cage, in case of laminated salient poles and cylindrical poles, which are the active rotating parts of the synchronous motor. The field poles are magnetized through the direct current coming from the exciter rotor or directly by slip rings and brushes. In operation, the poles are aligned magnetically by the air gap, and they spin in synchronism with the stator rotating field. The shaft is made of forged steel and machined according to each specification. The shaft end is normally cylindrical or flanged.

9.4.Bearings

Depending on the application, the synchronous motors can be supplied with rolling bearings or sleeve bearings.

9.5.Rolling Bearings

These bearings are normally composed of ball roller bearings or cylindrical roller bearings, depending on the speed and axial and radial loads to which they are subject, and special bearings can be used in some applications. The rolling bearings can be lubricated with oil or grease.

9.6.Sleeve Bearings

The sleeve bearings can have natural lubrication (self-lubrication) or forced lubrication (external lubrication).

9.7.Type of Excitation

Synchronous motors require a source of direct current in order to supply the necessary power to the field winding (rotor winding), which is usually provided by a rotating brushless exciter or by slip rings and brushes (static exciter).

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9.7.1.Brushless Exciter

Synchronous motors with brushless excitation system present a rotating exciter, normally located in a compartment in the back of the motor. Depending on the motor operation, the exciter is composed by:

- Exciter with direct current supply on the stator
- Exciter with alternating current supply on the stator
- The exciter rotor supplies the necessary power to the motor excitation winding through a rotating, three-phase rectifier bridge.

9.7.2.Static Exciter (with Brushes)

Synchronous motors with static exciter are designed with slip rings and brushes that allow the current supply to reach the rotor poles by means of sliding contact. The direct current must come from an AC/DC static controller and converter located outside the motor. Synchronous motors with static exciter are more often used in applications with variable speed with a frequency drive operation or in applications where the system dynamic response must be extremely fast.

9.7.3.Exciter Rectification Circuit for Brushless Motors

The field application control circuit of the rectification system uses microprocessors to determine the best angle and phase for field application. The Sync-Rite system is a high-performance, digitally controlled module.

9.8.Types of Cooling and Degrees of Protection

The most widely used types of cooling / protection in synchronous motors are:

- IC01 - self-ventilated, degree of protection IP23 to IP24
- IC611 or IC511 - air-air heat exchanger, degree of protection IP54 to IP65

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- IC81W - air-water heat exchanger, degree of protection IP54 to IP65

Besides the types of cooling methods aforementioned, the motors can be supplied with forced ventilation, air inlet and outlet by ducts, and other cooling systems, meeting the requirements of the application and environment where they are installed in the most efficient way.

9.9.Accessories

Synchronous motors are supplied with standard accessories required for their proper operation and monitoring.

During motor specification, additional accessories can be requested and then included in the motor design and manufacturing processes such as below:

Standard Accessories

- Temperature sensors, type Pt-100, on stator windings
- Temperature sensors, type Pt-100, on the bearings
- Space heaters
- Shaft grounding brush for motors driven by frequency inverters
- Magnetic center indicator (sleeve bearings)

Special Accessories

- Capacitors for surges protection
- synchronism controller (brushless machines)
- Lightning arrester for surges protection
- Current transformers (CT) for differential protection
- Vibration sensors
- Flow switch for water and/or oil
- Hydraulic unit for bearing lubrication
- High pressure injection system for oil to be used during start and stop the motor (hydrostatic jacking)

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- Oil thermometer (bearings)
- Water thermometer (heat exchanger)
- Air thermometer (ventilation)
- Pressurization system (Ex-p motors)
- Couplers and meters for partial discharges monitoring

10.QUALITY CONTROL AND TESTING

Standard (routine) commercial tests shall be carried out on all motors, in accordance with IEC Standards. Complete certified test results shall be provided as specified in IEC-60034 standards. Tests shall include, as a minimum:

- a) No load running current and power,
- b) Check of current balance,
- c) Measure winding resistance,
- e) High potential test,
- f) Vibration test.
- g) Voltage ratio stator/rotor test for wound rotor motors

11.Accessories

Motors above 20kg weight shall be provided with lifting lugs or hooks or in special cases, lifting equipment set.

Motors shall be provided with anchoring bolts suitable to withstand the stresses caused by the short circuit and starting conditions.

The motors frames shall be provided with corrosion resistant earthing terminals, one on each side of the motor. Earthing terminals and bolts shall be marked with the earthing symbol.

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Vertical motors shall always be provided with protection against the entry of water from the fans side. The following precautions shall also be taken to account to preclude water ingress through mechanical gaps, motor shaft etc.

Flinger ring with adequate diameter and tightness shall be provided on the motor shaft directly above the motor housing. The flinger ring shall be designed to direct water away from the bearing housing and to prevent water ingress, along the shaft under running and stop conditions of the motor.

Component parts of the frame shall be adequately bonded together and to the earth terminal in order to prevent arcing and sparking in service.

12.Nameplate

The nameplates shall be of stainless steel and shall be mounted on a fixed part of the frame.

The serial number shall always be different, even when the motors are identical.

On the nameplates the following data shall be shown in according to section 9 of IEC 60034-1:

- The manufacturer's name and manufacturer's code number
- The manufacturer's serial number and year of manufacture
- The purchaser name and purchase tag number (in a separate name plate)
- Number of phases and number of poles
- Frame size
- Degree of protection (IP code) for motor and terminal boxes

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- Stator winding connection
- The limit of temperature rise and class of insulation
- Altitude if in excess of 1000m above sea level
- The rated output power (kW)
- The rated voltage (V)
- The rated frequency (Hz)
- The rated current and locked rotor current (A)
- The rated speed (R.P.M.)
- The rated torque and locked rotor torque (N.m)
- Power factor and efficiency at rated output
- The Maximum/Minimum ambient air temperature
- Liquid coolant quality/pressure/temperature (if applicable)
- Net weight (Kg)

Where applicable the following additional information shall be provided:

- The symbol for explosion proofing (e.g. Ex)
- The symbol for type of protection (e.g. d or e)
- Temperature classification (e.g. T3)
- Apparatus gas group and subdivision (e.g. IIB)
- Certifying authority and certificate number
- Type and size of the bearings, life of the bearings

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- Type of lubrication and lubrication interval
- Indication of the axial play limitation to be kept by the joint
- Indication of the magnetic balance and of the tolerance range allowed by the joint with reference to a fixed point in order to check the coupling position .

13.SPARE PARTS AND SPECIAL TOOLS

Spare parts shall be interchangeable as far as possible between motors and be suitable for use in place of the original parts, and comply with the same specification and tests. They shall be marked and numbered for easy identification, and preserved to prevent deterioration during transport and storage in a humid tropical atmosphere.

Commissioning and start up spare parts shall be proposed and supplied according to order.

A full set of class F stator winding coils (note 1/3 set), and all other necessary materials for hazardous (If applicable) cage motors if of barrel type construction or a class F stator 'pack' if the type of motor construction is suitable for stator pack replacement shall be considered. Coils or stator "pack" to be boxed for long term dry storage in site and to be arranged so that the insulation can be checked periodically without having to disturb the box or packing.

The vendor shall also undertake which those parts could be available or be provided for duration of ten years time.

Vendor shall provide all special tools such as shaft extension etc. for rotor withdrawal and shall submit full rotor withdrawal procedure to Purchaser, for

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approval. For identical machines from the same manufacture, one set of special tools should be provided.

All necessary spare parts for commissioning period shall be provided by seller.

All spare parts for utilization period shall be provided by seller according to contracts annexes.

14.TEST AND INSPECTION

Test shall be carried out in the factories of the manufacturer with his care and expense. The purchaser's inspector or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment to carry out necessary inspection at any stage of work.

Manufacturer shall prepare test procedure prior to final test and it shall be sent to the purchaser for approval. Approval by the purchaser's inspector or representative shall not relieve the vendor of his commitments under the turns of this specification for any associated order.

Even if Purchaser's inspector waives to witness the tests, the manufacturer shall issue certificates of the carried-out tests, with all necessary information and the result of the measurements, the tests shall include but not limited to the following items.

14.1.Abbreviated Tests

The abbreviated tests shall consist of but not limited to the following:

- Measurement of winding resistance (cold)

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- Measurement of no load losses and current
- Measurement to allow calculation of locked rotor current
- High voltage test plus insulation resistance test
- Inspection (at no load) of bearings and mechanical operation of the motor
- Vibration check
- High voltage and insulation tests on built in temperature detectors
- Direction of rotation and phase sequence checks
- Determination of polarization index for motors rated above 1000 V
- Space heater power frequency voltage test (2500 V)
- Painting test (Adhesion and thickness)
- Over speed test

14.2.Complete Test

- Measurement of winding resistance (hot and cold)
- Measurement of no load losses and current
- Measurement to allow calculation of locked rotor current
- High voltage insulation resistance before and after heat run
- Inspection (at full load) of bearings and mechanical operation of the

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motor

- Full load heat run
- Measurement of slip at full load
- Measurement to allow calculation of pull out torque
- Measurement to allow calculation of starting torque characteristic
- Momentary overload capability
- Measurement to allow calculation of efficiency at full load, three-quarters, and half load
- Measurement to allow calculation of power factor at full load, three-quarters, and half load
- Measurement of vibration
- Measurement of noise
- High voltage and continuity tests on built in temperature detectors with tests to demonstrate satisfactory operation and compliance with stated characteristics
- Direction of rotation and phase sequence tests
- Unless otherwise agreed, for machines above 1000 V, determination of the polarization index
- Dielectric test

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- Space heater power frequency voltage test (2500V)
- Temperature rise test

Complete tests will not normally be required if evidence of type tests on identical motors is produced at the time of tender. Abbreviated test shall be made on the remaining motors of each group and certified test reports of all these tests shall be provided.

Purchaser and/or appointed inspectors reserve the right for inspection at any stage of manufacture, testing or preparation for shipment. Inspection may also be relevant to all accessory materials. The vendor shall allow free access of Purchaser's inspectors to its factories and supply all information requested as well as make available all copies of internal orders and of orders to sub-suppliers.

The Purchaser reserves the right to demand complete test on all motors on vendor's care and expense, should the motor fail abbreviated or complete test.

15.PREPARATION FOR SHIPMENT

Electric motors equipped with bearings shall be shipped with bearings lubricated. Rotors shall be locked during shipping.

Silica gel or similar dehydrating compound shall be enclosed in each motor package and terminal/junction boxes, vents shall be waterproof sealed. Preservation for exposed parts shall be provided.

Preparation for shipment shall be in accordance with Manufacturer's standards, unless otherwise noted on the request for quotation and/or purchase order. The Manufacturer shall be solely responsible for the adequacy of the preparation for shipment. Preservation for exposed parts shall be provided and silica gel or similar material shall be provided

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inside of terminal boxes and connection boxes.

16.GUARANTEEE

The supplier shall replace any damaged equipment resulting from poor workmanship and/or faulty design. The supplier shall also replace any equipment failed under the following conditions:

- Failure under startup and commissioning tests performed according to IEC recommendations.
- Satisfactory and trouble-free operation of equipment under specified conditions generally shall be guaranteed for a period of 12 months from starting to operation.

The supplier shall guarantee to support any spare parts for a period of 10 years.

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LV Motors' TEST

- 1) The supplier shall supply type test certification of tests carried out in accordance with IEC publications, along with his proposal. The test shall be of the type test already carried out on LV Motors with the same characteristics.
- 2) The supplier shall include in his bid the cost of carrying out witnessed inspection and testing of all LV Motors, in accordance with the requirements of the requisition. The supplier shall provide all test equipment and any specialized test rig required.
- 3) For proven designs, the following tests in accordance with IEC 60034 shall be carried out at the supplier's works.
 - Motors of 150kW and above are to be given "Basic Tests". Such tests will normally apply only to one machine where more than one of the same size and type has been ordered.
 - Motors below 150kW together with duplicated motors above 150kW shall be given 'Duplicate Tests'. In all cases certified 'Type Test' certificates are required.
 - When tests are to be carried out on any of the motors, then the SUPPLIER shall advise the Buyer in order that the Buyer shall have the option of witnessing these tests. If the results of the type tests on the selected motor are not fully satisfactory, Buyer shall have the option of insisting that the type tests be carried out on all motors at the supplier's expense.
- 4) Each motor shall be tested in accordance with IEC60034, Tests shall be a minimum:
 - Visual inspection and dimensional check,
 - No load running current and power.

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- Check of current balance.
- Measure winding resistance.
- High potential test.
- Test of instruments and sensor element.
- Dielectric tests,
- High voltage tests,
- Insulation resistance tests.
- Stator winding resistance measurement (hot and cold),
- Measurement of efficiencies at different load,
- Measurement of locked rotor current,
- Vibration measurements,
- Measurements of noise level.

5) Equipment and materials will be subject to inspection during the process of manufacture and upon completion.

6) The supplier shall afford the Buyer reasonable opportunity and facility to establish that the design, materials and construction of the equipment are in accordance with the specified requirements and approved methods.

7) Equipment and materials may be inspected at the supplier's facility in accordance with the requirements of this specification. Qualitative and quantitative checks on contractual technical file supplied with LV Motors, as follows:

- Visual examination (appearance, paintwork, finish, welding, sheet metal, lifting rings, assembly bolt tightness, wiring and internal cabling

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appearance, lining up of measurement instruments, handling devices, remote-control and signalling, indicator devices and name plate).

- Size checks (terminals, leakage path and isolation distance, fixation axis, overall sizes, and materials).
- Check for conformity in equipment and accessories supplied with particular specifications.
- Check for conformity and existence of rating plates, identification and name plates, warning notices, identification of wiring, identification of terminals and terminal boxes, identification for earths, identification of phases by colors and any supplementary identification depending on specification stipulations.
- Inspection by the Buyer shall not relieve the SUPPLIER of any guarantees, responsibilities or obligations to furnish equipment and materials to specification.

8) A pro-forma test report shall be presented to Buyer for approval before placing the order.

9) All flameproof and non-sparking motors for installation in hazardous area must be suitably certified and carry a certificate accordingly.

10) The test reports shall, at least, detail:

- The expected theoretical values
- The tolerances
- The result of measurements, including if applicable, any intermediate value which has caused a temporary rejection.

11) The test reports shall be included in the contractual technical documents, and shall be considered as an integral part of them.

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12) Prior to dispatch, SUPPLIER shall verify by test that the operation of the assembled LV Motors complies with the requirements specified on the purchase order documents, and shall submit to the Client a report incorporating measurements and results of all tests performed.

MV Motors' TEST

- 1) Test shall be carried out in the factories of the manufacturer with his care and expense. The purchaser's inspector or his authorized representative shall have free access to the manufacturing plant engaged in the manufacture of the equipment to carry out necessary inspection at any stage of work.
- 2) Complete tests will not normally be required if evidence of type tests on identical motors is produced at the time of tender.

Routine(abbreviated) test shall be made on the remaining motors of each group and certified test reports of all these tests shall be provided.

Complete test list:

- Measurement of winding resistance (hot and cold)
- Measurement of no-load losses and current
- Measurement to allow calculation of locked rotor current
- High voltage insulation resistance before and after heat run
- Inspection (at full load) of bearings and mechanical operation of the motor
- Full load heat run
- Withstand voltage test
- Measurement of slip at full load
- Measurement to allow calculation of pull-out torque
- Measurement to allow calculation of starting torque characteristic
- Momentary overload capability

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- Measurement to allow calculation of efficiency at full load, three-quarters, and half load
- Measurement to allow calculation of power factor at full load, three-quarters, and half load
- Measurement of vibration
- Measurement of noise
- High voltage and continuity tests on built in temperature detectors with tests to demonstrate satisfactory operation and compliance with stated characteristics
- Direction of rotation and phase sequence tests
- Unless otherwise agreed, for machines above 1000 V, determination of the polarization index
- Dielectric test
- Space heater power frequency voltage test (2500V)
- Temperature rise test

Routine (Abbreviated) test list:

- Visual inspection and dimensional check,
- Measurement to allow calculation of locked rotor current
- High voltage test plus insulation resistance test
- Inspection (at no load) of bearings and mechanical operation of the motor
- Vibration check
- Dielectric tests,
- Measurement of efficiencies at different load,
- Measurements of noise level
- High voltage and insulation tests on built in temperature detectors

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- Direction of rotation and phase sequence checks
 - Determination of polarization index for motors rated above 1000 V
 - Space heater power frequency voltage test (2500 V)
 - Painting test (Adhesion and thickness)
 - Over speed test
- 3) Manufacturer shall prepare test procedure prior to final test and it shall be sent to the purchaser for approval. Approval by the purchaser's inspector or representative shall not relieve the vendor of his commitments under the terms of this specification for any associated order.
 - 4) Even if Purchaser's inspector waives to witness the tests, the manufacturer shall issue certificates of the carried-out tests, with all necessary information and the result of the measurements, the tests shall include but not limited to the following items. Tests shall be in accordance with IEC standards.
 - 5) Routine (Abbreviated) test mentioned tests will be witnessed if so, decided by the buyer. As for type tests certificates for identical motors will be accepted. If the results of the type tests on the selected motor are not fully satisfactory, Client shall have the option of insisting that the type tests be carried out on all motors at the supplier's expense.
 - 6) The supplier shall provide all test equipment.