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Induction Motors**

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1.0 INTRODUCTION

This specification covers the minimum requirements for design, materials, manufacturing and inspection of medium voltage 3-phase cage induction motors for NIS - Pancevo Oil Refinery.

2.0 CODES AND STANDARDS

Unless otherwise specified in the requisition the electric motors shall be in accordance with the requirements of this specification and the latest edition of following codes, publications and standards:

IEC 60034	Rotating Electrical Machines
IEC 60072	Dimensions and Output Series for Rotating Electrical Machines
IEC 60079	Electrical apparatus for explosive gas atmospheres
IEC 60085	Electrical insulation – Thermal evaluation and designation
ISO 281	Rolling Bearings - Dynamic Load Ratings and Rating Life

2.1 CE MARKING

All electrical equipment, materials and components shall be CE certified, shall bear CE marking and shall be compliant to applicable EU directives.

2.2 SERBIAN AUTHORITY REQUIREMENTS

All equipment shall be in compliance with Serbian legislation and law requirements. Equipment vendors shall deliver all documentation requested by Serbian law (e.g. Serbian Ex Certificate) to be able to put equipment in operation in Serbia.

All electrical equipment for use in hazardous area will be certified according ATEX (2014/34/EU) directive.

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3.0 DESIGN

3.1 SERVICE CONDITIONS

- 3.1.1 The electric motor shall be suitable to operate under service conditions as specified on the site and utility data sheet attached to the requisition.

3.2 RATING AND PERFORMANCE

- 3.2.1 The output rating, supply voltage, system short-circuit capacity and equipment characteristics shall be as specified on the motor data sheets.
- 3.2.2 Stator windings shall be connected in star. If no differential protection is specified in the requisition, the star point may be concealed. In case current transformers have to be installed in the star point box, details will be given in the requisition.
- 3.2.3 Unless otherwise specified in the requisition, motors shall be suitable for continuous running duty, type S1 in accordance with IEC 60034.
- 3.2.4 If motors are destined to drive machines, which draw a continuous fluctuating load, the irregularity factor has to be taken into account.
- 3.2.5 Seller shall base his calculations on the tangential effort diagrams prepared by the driven equipment manufacturers.
- 3.2.6 In general, the starting current shall not exceed seven (7) times the rated current at nominal voltage. When special low starting currents are required, this will be specified in the requisition.
- 3.2.7 Motors shall be able to withstand the forces that may occur during restarting against full-phase opposition with full residual voltage.
- 3.2.8 Critical speeds of rotors shall not occur between 80% and 125% of the rated motor speed. Rigid rotor designs are preferred with the first critical speed over 125% of the rated speed.
- 3.2.9 Motors shall be suitable for three (3) consecutive starts from cold and two (2) consecutive starts from hot at 80% of the nominal voltage with the actual external inertia connected.
- 3.2.10 Torque characteristics shall be such, that motors are able to accelerate (reaccelerate) the load, even at a motor terminal voltage of 80% of the nominal voltage.
- 3.2.11 Vibration severity shall not exceed the values given in IEC 60034. Balancing and measurement shall be done with a half key fitted in the key way. Rotors and fans shall be individually balanced before the assembly is balanced.
- 3.2.12 Starting torque and locked rotor apparent power shall at least be in accordance with IEC 60034.

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3.3 NOISE REQUIREMENTS

- 3.3.1 If not specified otherwise in the requisition, the maximum sound pressure level as measured at 1 m from the equipment surface shall not exceed 82 dB(A).
- 3.3.2 In general, motors shall comply with the noise limits laid down in IEC 60034-9. However, the sound pressure level specified in paragraph 3.3.1 shall never be exceeded. If necessary, low-noise designs shall be supplied.
- 3.3.3 When the noise limit as specified in paragraph 3.3.1 cannot be met by using the low-noise design, seller shall quote a noise limiting cover/enclosure as an option for his standard noise limiting fan.
- 3.3.4 If specified in the requisition, air to water cooling may be applied. Coolers shall be designed conform the requirements of the requisition.

3.4 CONSTRUCTION

- 3.4.1 Unless otherwise specified motors shall be totally enclosed fan-cooled, designed in accordance with the relevant IEC standards and publications.
- 3.4.2 The minimum enclosure protection of motors shall be IP 55, conform IEC 60034. Terminal boxes and bearing houses, however, shall have an IP 55 enclosure.

The enclosure protection IP 65 is required where an explosive atmosphere of dust is present – zone 21 and zone 22.

Vertical motors (IM-V1) shall be equipped with a rain cap over the fan cover.

Motors specified for vertical installation with their shaft extension upwards (IM-V6 as per IEC 60034), shall have an end shield design, which prevents ingress of water into the motor, and/or bearing housing via the shaft or grease relief drains.

- 3.4.3 Motors for use in zone 1 and zone 2 hazardous area shall be flameproof with an increased safety terminal box, in accordance with IEC 60079, unless specified otherwise in the requisition.

Where flameproof construction (de) is impractical or undesirable pressurized enclosures may be quoted.

- 3.4.4 Equipment specified for use in hazardous areas shall have a certificate of conformity according to the type of protection issued by a Local testing authority (reatest).
- 3.4.5 Motors shall be suitable for rotation in the direction specified on the data sheet, however, it shall be possible to change direction of rotation by fitting another fan. Motors with a unidirectional fan shall have the arrow indicating the direction of rotation fitted on the end shield.

- 3.4.6 Motor insulation shall be minimum class F according to IEC 60085.

Temperature rise shall be limited to the limits of class B, unless specifically noted otherwise in the requisition.

- 3.4.7 All motors shall be in IE3 Efficiency class.

- 3.4.8 The maximum permissible temperature of motors and other equipment in the hazardous area must comply with EN/IEC 60079 and meet the requirements specified in the requisition.

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3.5 TERMINAL BOXES

- 3.5.1 The main terminal box location shall either be on top of the motor or the right hand side, facing the driving end of the motor. The terminal box shall be able to rotate 90 and 180 degrees. Request for rotation is valid as far as possible due to construction of motor.
- 3.5.2 In view of the maximum acceptable voltage drop, a large number of cables in the same trench and the short-circuit rating of the system, the prescribed cable size or the number of cables can be twice that considered normal by seller. Consequently a larger terminal box than standard may be required.
- 3.5.3 The terminals and the cable gland or pot head shall be sized for the supply cable specified on the motor data sheet.
- 3.5.4 Not used cable entries shall be closed with plugs, in compliance with the degree of protection specified.

3.6 BEARINGS AND LUBRICATION

- 3.6.1 Motors shall preferably be supplied with ball or roller bearings, however, when lubrication intervals given in paragraph 3.6.4 or service lifetimes cannot be met or, when specified in the requisition, sleeve bearings shall be supplied.
- 3.6.2 The L10 basic rating life of ball and roller bearings shall be in excess of 40,000 hours when calculated in accordance with ISO 281.

For motors having abnormal external force imposed to the shaft, a relaxation to 32,000 hours is allowed.

Based upon a maximum ambient temperature of 40 °C, the minimum service life of the bearings shall be 25,000 hours. Continuous operation shall be possible during this period and construction of bearing housing shall be such that relubrication, if required, can be carried out without stopping the motor.

- 3.6.3 Grease-lubricated motors with regressing facilities shall have a grease relief device to the outside of the motor.
- 3.6.4 The minimum lubrication intervals shall be 4,000 hours for horizontal motors and 2,000 hours for vertical motors. The regreasing interval calculations shall be based on an ambient temperature of 40°C whereby the actual bearing temperature at rated load should be considered.
- 3.6.5 Sleeve bearings shall preferably have oil ring lubrication. When bearings need forced cooling this system shall, if possible, be combined with the driven equipment lubrication system.

If a combined lubrication system is not possible, the motor manufacturer shall supply the lubrication unit required. Requirements for the lube oil system and temperature monitoring will be given in the requisition.
- 3.6.6 When the motor shaft voltage exceeds 250 mV, the bearings shall be insulated. The DE (Driving End) bearing shall be earthed via an earth lead.
- 3.6.7 For motors with sleeve bearings; the rotor float shall be indicated on the data sheet. The magnetic center position shall be indicated on the shaft.

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3.7 MISCELLANEOUS

- 3.7.1 Motors shall have an external earthing connection on the frame.
- 3.7.2 Motors shall have lifting facilities suitably dimensioned to carry the complete motor weight. When spreader bars or special lifting facilities are required, this shall be indicated in the proposal.
- 3.7.3 Motors shall be provided with drain holes at locations where water may collect. Special attention shall be given to the location of the drain hole for vertical motors. Drain holes shall be in compliance with the explosion protection requirements.
- 3.7.4 All motors shall have temperature detectors. It is necessary to provide motor bearing temperature sensors (Pt100) and motor winding temperature sensors (PTC) for all equipment in Scope of supply
- 3.7.5 Pt 100 elements shall be of the 3-wire connection system.
- 3.7.6 Temperature detectors shall be provided with surge diverters mounted in the auxiliary terminal box.
- 3.7.7 Motors shall be equipped with anticondensation heaters when deemed necessary by seller due to the service conditions as referred to in paragraph 3.1. Supply voltage shall be 230 V, single-phase and shall be specified on the data sheet. The space heater shall preferably have a separate terminal box.
- 3.7.8 For motors driven by VSD (Variable Speed Drive) it is necessary to provide:
- One insulated bearing
 - Temperature sensors for motor protection
 - Separate nameplate with data for VSD operation
 - S1 duty cycle in all frequency and power range

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4.0 INSPECTION AND TESTING

In general, all motors shall be routine tested in accordance with the applicable IEC standards.

When performance guarantees have been requested in the requisition, tolerances shall be in accordance with table 8 of IEC 60034.

The intention of witnessing the tests and eventual supplementary inspection items will be specified in the requisition.

5.0 CORROSION PROTECTION

All motor parts shall be adequately protected against corrosion, based upon the environmental conditions specified on the site and utility data sheet.

Surface preparation and painting shall be seller's standard for the applicable environmental conditions. Seller shall submit in his quotation his standard surface preparation and painting system for buyer's review.

Color of topcoat shall be seller's standard unless a specific color is specified on the motor data sheet.

6.0 MARKING

Marking shall be on stainless-steel rating plates securely fastened to a nonremovable part of the frame on a well visible and accessible place.

The rating plate shall show the appropriate information as required as per IEC 60034.

Motors suitable for use in hazardous areas shall bear the markings as required per IEC 60079.

7.0 SELLER DOCUMENTATION

Seller shall, as a minimum, provide all documentation as requested on the "Supplier Documents Requirements" forms, which are an integral part of the requisition.