



NATIONAL PETROCHEMICAL COMPANY
STANDARDS

MATERIAL STANDARD
FOR
3 PHASE SQUIRREL CAGE INDUCTION ELECTRIC MOTORS
NPCS-MS-EL-10
REVISION 0

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SCOPE

- 1.1 This standard covers the minimum technical requirements for design, manufacture, testing and supply of 3 phase squirrel cage electric induction motors upto 4000 KW for operation on systems upto and including 11 KV 3 Phase AC for use in petrochemical plants.
- 1.2 Electric motors shall comply with the requirements of the following documents and specifications listed in order of precedence:
- a) Purchase order.
 - b) The requisition with attached data sheets.
 - c) This standard.
 - d) Other specification and standards referred to.
- 1.3 All electric motors supplied in accordance with this standard shall meet the requirements of the area classification in which it is to be installed as defined by the latest applicable sections of the herein mentioned standards and codes. Any special requirements will be indicated on the motor data sheets.
- 1.4 In the reference numbers of this standard, "Purchaser" means National petrochemical Company of Iran (NPC).

STANDARDS & CODES

All motors shall be constructed and tested in accordance with all applicable sections of the latest listed standards and codes, as amended in this standard. Where reference is made in this standard to IEC standard and codes, it is understood that equipment standards and codes published by NEMA are also acceptable. The reference specifications are as follows:

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2.1 MOTORS MANUFACTURED IN EUROPE

2.1.1 IEC standard as listed below, including supplements and amendment

- IEC 34, Rotating Electrical Machines.
- IEC 72, Dimensions and Output Ratings for Rotating Electrical Machines. Frame numbers 56 to 400 and flange numbers f55 to f1080.
- IEC 72A, Dimensions and Output Ratings for Foot Mounted Electrical Machines with frame numbers 355 to 1000.
- IEC 79, Electrical Apparatus for Explosive Gas Atmospheres.

2.1.2 ISO Standards

- ISO R 281, Rolling Bearing-Dynamic Load Ratings and Life.
- ISO 1940/1, Mechanical "Vibration" Balance Quality Requirements of Rigid Rotors; Part 1, Determination of permissible residual unbalance.
- ISO 2373, Mechanical Vibration of Certain Rotating Electrical Machinery with Shaft Heights between 80 and 400 mm. Measurement and evaluation of vibration severity.

Motors specified in this standard basically comply with the relevant IEC standards. In case of conflicting requirements, the requirements of this standard shall apply.

2.2 MOTORS MANUFACTURED IN U.S.A.

National Electrical Manufacturer Association Standard, for Motors and Generators (NEUA).

2.3 For equipment manufactured outside of Europe and U.S.A. either Clause 2.1 or 2.2 above must be met.

2.4 For all motors, American Petroleum Institute (API) API specification RP 541, is only applicable for form wound motors above 150 kw.

2.5 When motors are offered according to IEC recommendations mechanical design features of API 541 which are specific related to NEHA MG-1 shall not apply.

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3 RESPONSIBILITY

- 3.1 The order of electric motor in accordance with this standard may be placed direct or through the manufacturer of the driven equipment, with the manufacturer of electric motor approved by purchaser.
- 3.2 The motor and driven equipment may **be** assembled either at the factory of the manufacturer of the driven equipment or on site in the country of destination.
- 3.3 When motors are furnished with the driven equipment as a package, the torque characteristics and speeds are the responsibility of the driven equipment vendor.
- 3.4 When motors **are** bought individually by the purchaser, the torque characteristics and speeds will be supplied with the "Request for quote" and "Purchase order".

4 DESIGN REQUIREMENTS

- 4.1 The motor and all individual items forming part of the motor, shall have an expected life time of 20 years; this includes e.g. the lubricating system with piping, heaters, protective and monitoring systems, wiring, fixing materials, terminals, etc., with the exception of **rolling element** bearings.
- 4.2 The motor shall be suitable for continuous operation at duty type **S1** for at least 4 years without maintenance requiring stopping of the motor. Lubrication if required, shall be possible with the motor in operation.
- 4.3 Minimum relubrication intervals shall be 4000 hr for horizontal motors and 2000 hr for vertical motors, irrespective of the actual number of running hours.
- 4.4 The electric motors shall be suitable for the load characteristics and the operational duty of the driven equipments and comply with the requisition, this standard and **the** IEC and ISO standards.

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1.5 The motors shall be earthquake proof in accordance with the local requirements which will be indicated in the requisition.

1.6 All equipments shall be of the highest quality standard for materials and workmanship.

1.7 ELECTRICAL SUPPLY SYSTEM

1.7.1 Unless otherwise specified in the data sheets, the motors shall meet the requirements tabulated below:

RATINGS	VOLTAGE (V)	PHASE	FREQUENCY I (HZ)	TYPE OF CONNECTION
Below 0.2 KW	220	1	50	--
0.2 KW (1/4 HP); through 150 KW (215 HP);	380	3	50	star
over 150 KW (215 HP)	6000	3	50	star

Fractional horsepower motors for critical service (compressor auxiliaries, lube oil systems, special pumps, etc.) shall be 380 volt, 3 phase. Deviation from the above limits may be considered in special case when justified by technical and economical reasons. The required motor rating and speed will be stated in the requisition.

1.7.2 The system voltage shall be assumed to be sinusoidal in accordance with IEC 34-1, article 12.

1.7.3 System Variations

Motors shall be capable of operating continuously at rated torque under the above conditions at any frequency between $\pm 5\%$ of the nominal frequency together with any voltage between $\pm 5\%$ of the nominal rating.

1.8 POWER RATINGS

The power rating given in the motor list and on the nameplate of the motor shall be for continuous operation and is the rated output on the shaft at rated voltage and frequency.



4.9 SITE CONDITIONS

Site conditions will be stated in the requisition.

4.10 ENCLOSURE

4.10.1 The degree of protection of the motors shall be at least:

- IPW 54 for motor and auxiliaries.
- IPW 55 for the terminal boxes and bearing housings.

4.10.2 For dusty areas depending on the location, the degree of protection of the motor, terminal boxes and bearing housings shall correspond to the above requirements.

Note: The degree of protection designed by the letter W refers to the site conditions.

4.10.3 The enclosure of the electric motor and of the terminal boxes shall be equipped with a normally open drain hole with a degree of protection IPW 4X.

Note: No condensation shall accumulate within the motor.

4.10.4 The top bearing construction of vertical motors with upward extended shaft shall prevent water collection around the shaft protrusion and water penetration into the bearing.

4.10.5 Vertical motors with downward shafts shall be provided with fully covering rain canopies.

4.10.6 Horizontal motors used in vertical service, e.g. air coolers shall be equipped with a shaft sealing device which will preclude entry of moisture. Adequate means of drainage through the lower end bell shall also be provided. Motors for such service will be identified by Purchaser.

4.10.7 All motors, unless otherwise specified, are for coupled service.

4.11 METHODS OF COOLING

4.11.1 The motor shall be totally enclosed fan cooled (IC 0141, IC 0151 or IC 0161).

4.11.2 Motors over 2000 kw may be totally enclosed separately fan air-cooled (IC 0166) or totally enclosed water-cooled (ICW 37A71), subject to the purchaser's approval.

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4.12 STARTING, RESTARTING

4.12.1 General

Electric motors shall be suitable for direct on-line starting and for restart with full opposite residual voltage under full load conditions and at any voltage between 80% and 110% of the rated voltage at the terminals of the motor. Motors shall be capable of recovering normal operation in the event of a system disturbance causing temporary loss of supply voltage for periods of up to 0.2 S (fault clearance time) followed by a sudden restoration, initially to 60% rated voltage for 3 S then followed by a sudden restoration to 80% voltage, from which voltage the motors shall then be capable of accelerating and ultimate recovery under the most arduous load conditions, e.g. open pump discharge valve.

4.12.2 Number of Sequential Starts

Electric motors shall be suitable for:

- 3 consecutive plus 1 after 30 minutes when starting from ambient temperature (cold motor).
- 2 consecutive plus 1 after 30 minutes when starting from operating temperature (hot motor).

Motors for intermittent periodic duty shall permit the number of starts defined in the relevant motor data sheet, issued by the purchaser.

4.12.3 Number of Starts Per Year

The electric motor, shall be suitable for one of the duties listed below:

- Normal : maximum 1000 starts per year.
- Heavy : maximum 3000 starts per year, e.g. conveyor systems, drain pumps, etc.
- Extra Heavy : maximum 20,000 starts per year, e.g. hoisting equipment, cranes, etc.

4.13 STARTING CHARACTERISTIC

4.13.1 The locked rotor torque characteristic shall be sufficient to meet the specified requirements of the driven load.

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1.13.2 The motors have to be capable to overcome the starting load inertia, as well as the acceleration of the load to rated speed at a voltage drop of 20%.

1.13.3 The rated torque should not be affected by fluctuation of the frequency by - 5% and +5% together with the voltage $\pm$ 5% of the nominal value.

1.13.4 The pull-out torque has to be definitely above the load torque of the driven machine. The following shows the required relation and limit for starting current and torque for direct on line starting mode. A tolerance of -5% on torque and +7.5% on starting current is allowed on followed datas. Design (A) will be preferred but values up to the data shown in design (B) are acceptable, provided that the starting torque is increased in the same proportion.

Alternative Designs		(A)	(B)
Max. starting current	% In :	500	700
Min. starting torque	% Mn :	100	140
Torque during running up	% Mn :	90	100
Pull out torque	% Mn :	200	200

1.13.5 The specific starting time will not exceed 1.7 times the locked rotor time. Starting time is the time required by the motor to reach the rated rpm coupled to the driven machine. Locked rotor time is the time during which, starting from the rated service temperature, the rotor may remain locked with the stator windings carrying the starting current without exceeding the maximum admitted temperature for anyone of the used materials.

1.14 CRITICAL SPEEDS

The first critical speed of s-tiff rotors shall be at least 125% of the synchronous speed. For flexible rotors, the first critical speed shall be between 60% and 80% of the synchronous speed and the second critical speed shall be at least 125% of the synchronous speed. These figures shall apply to the machine under operating conditions on site,

1.15 VIBRATION

On the test bed the vibration severity of the electric motor shall not exceed 2 mm/s. The manufacturer shall guarantee a vibration severity of 2.8 mm/s with the motor mounted on a stiff rigid foundation.

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4.16

NOISE

Noise level shall be to the Purchaser's stated requirements but in the event of no requirement being stated then the vendor shall state the mean sound pressure level at 1m, should not normally exceed 80 dB(A) in the no load running condition. Vendor shall state in the quotation the sound pressure level in octave bands in dB(A).

5

GENERAL CONSTRUCTION REQUIREMENTS

5.1

Motor frames and end shields shall be constructed of ferrous metals. For motors below 22 kw Aluminium alloys may be used, subject to purchaser's prior confirmation. With fibre-reinforced non-metallic fan covers, Aluminium alloys shall not contain more than 6% of magnesium by weight.

5.2

Motors heavier than 25 kg shall have eye bolts, lugs or extension pieces, clearly marked for "hoisting".

Note: Lifting points which are an integral part of the frame, are preferred.

5.3

Motors weighting over 200 kg shall have jacking bolts or facilities to lift the motor with the aid of e.g. a hydraulic jack to facilitate lining-up of the motor with the driven equipment.

5.4

The materials shall be selected to prevent contact corrosion. All screws, bolts and nuts shall be corrosion-resistant. Self tapping screws shall not be used.

5.5

Corrosion-resistant screens or louvers shall be provided on high voltage motors.

5.6

All welding and welding inspection, shall comply with international standards and codes.

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The motors shall be provided with external earthing facilities by means of a suitable clamp or a bolt tapped into the frame on the side of the main cable connection box. The minimum size of earthing conductor to be connected shall be 25 mm² for smallest LV motor and up to 70 mm² for large LV and HV motors.

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6 CONDENSATION PROTECTION

- 6.1 With the exception of fractional horsepower motors, all totally enclosed motors should be provided with a means of preventing the accumulation of moisture inside the motor.
- 6.2 All high voltage motors shall be equipped with space heaters. Space heater voltages are to be as follows:
- 3000 watts or less 220 volt, single phase.
 - over 3000 watts 380 volt, 3 phase.
- 6.3 Neither the anti condensation heater nor any part thereof within the motor, shall exceed the temperature limitation, nor shall be expected life time of the motor be endangered.
- 6.4 For motors installed in classified areas, the sheath temperature will not exceed the ignition temperature of vapours and gases.
- 6.5 No joints in heater leads or looped-through connections inside the motor, are allowed.
- 6.6 Space heater leads shall be brought out to a junction box separate from the main power leads junction box, mounted on the motor frame at the same side as the motor main terminal box.

7 WINDINGS

- 7.1 Random wound open drip-proof motors shall have a scaled insulation system consisting of a complete encapsulation in an epoxy resin of the vacuum impregnated, molded or cast type.
- 7.2 Form wound motors shall have a sealed insulation system consisting of a complete encapsulation in an epoxy resin-mica compound impervious to moisture.
- 7.3 All motors shall be designed to operate under unusual conditions of high temperature, high humidity, fungus, salt air, and corrosive vapors. Vendor is advised to quote motors manufactured for operation under these conditions. All motors shall have class F insulation with a temperature rise limited to 80°C.

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- 7.4 The insulation level. of motors: that are required to operate on unearthed neutral. systems with one line at earth potential for prolonged periods must be agreed with the purchaser.
- 7.5 Adequate insulation shall be provided between coils of different phases which lie together.
- 7.6 The winding of HV motors shall have anti-corona protection and stress grading.
- 7.7 Motor winding shall. be suitable for switching with all normal switching device;;, e.g. air, SF6 and vacuum break-type contactor and breakers.
- Note: 'The life expectancy shall not be less than the minimum required in this standard, irrespective of the type and manufacture of the switching device used.
- 7.8 The end windings shall be adequately braced to prevent movement and consequent cracking of the insulation at the slot exits.
- 7.9 No resonance vibration shall occur within or with any part of the windings and interconnection, connecting leads at any load and between zero and the rated speed of the motor.
- 7.10 The connections inside the motor shall not be mechanically over-stressed during starting.

8 TERMINALS AND TERMINAL BOXES

8.1 TERMINALS

- 8.1.1 All terminals shall be substantially designed. Line terminals shall be thoroughly insulated from the frame with material resistant to tracking.
- 8.1.2 Natural rubber insulation shall not be used for terminal leads.
- 8.1.3 Means shall. be provided to prevent accidental reduction of clearances at terminals.
- 8.1.4 Terminal markings shall be U-V-W and provided in a clear and permanent manner.