MATERIAL AND EQUIPMENT STANDARD FOR MEDIUM AND HIGH VOLTAGE INDUCTION MOTORS

SECOND REVISION
DECEMBER 2009
FOREWORD

The Iranian Petroleum Standards (IPS) reflect the views of the Iranian Ministry of Petroleum and are intended for use in the oil and gas production facilities, oil refineries, chemical and petrochemical plants, gas handling and processing installations and other such facilities.

IPS is based on internationally acceptable standards and includes selections from the items stipulated in the referenced standards. They are also supplemented by additional requirements and or modifications based on the experience acquired by the Iranian Petroleum Industry and the local market availability. The options which are not specified in the text of the standards are itemized in data sheet/s, so that, the user can select his appropriate preferences therein.

The IPS standards are therefore expected to be sufficiently flexible so that the users can adapt these standards to their requirements. However, they may not cover every requirement of each project. For such cases, an addendum to IPS Standard shall be prepared by the user which elaborates the particular requirements of the user. This addendum together with the relevant IPS shall form the job specification for the specific project or work.

The IPS is reviewed and up-dated approximately every five years. Each standards are subject to amendment or withdrawal, if required, thus the latest edition of IPS shall be applicable.

The users of IPS are therefore requested to send their views and comments, including any addendum prepared for particular cases to the following address. These comments and recommendations will be reviewed by the relevant technical committee and in case of approval will be incorporated in the next revision of the standard.

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General Definitions:
Throughout this Standard the following definitions shall apply.

Company:
Refers to one of the related and/or affiliated companies of the Iranian Ministry of Petroleum such as National Iranian Oil Company, National Iranian Gas Company, and National Petrochemical Company etc.

Purchaser:
Means the “Company” Where this standard is part of direct purchaser order by the “Company”, and the “Contractor” where this Standard is a part of contract documents.

Vendor And Supplier:
Refers to firm or person who will supply and/or fabricate the equipment or material.

Contractor:
Refers to the persons, firm or company whose tender has been accepted by the company.

Executor:
Executor is the party which carries out all or part of construction and/or commissioning for the project.

Inspector:
The Inspector referred to in this Standard is a person/persons or a body appointed in writing by the company for the inspection of fabrication and installation work

Shall:
Is used where a provision is mandatory.

Should:
Is used where a provision is advisory only.

Will:
Is normally used in connection with the action by the “Company” rather than by a contractor, supplier or vendor.

May:
Is used where a provision is completely discretionary.
MATERIAL AND EQUIPMENT STANDARD
FOR
MEDIUM AND HIGH VOLTAGE
INDUCTION MOTORS
SECOND REVISION
DECEMBER 2009
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1. SCOPE

1.1 This standard specification covers the minimum requirements for design, manufacture, and quality control of medium and high voltage squirrel cage induction motors.

1.2 The motors will be installed in oil, gas and petrochemical industries in Iran under the environmental and service conditions specified herein.

1.3 The general requirements are given in this specification; the specific requirements of individual cases will be given in request for quotation and / or purchase order.

Note 1:
The standard specification for three phase squirrel cage induction motors IPS-M-EL-132(0) is withdrawn, and replaced by the following two standard specifications which are issued as revision(1).

- IPS-M-EL-131(1) "Material and Equipment Standard for Low Voltage Induction Motors"

- IPS-M-EL-132(1) "Material and Equipment Standard for Medium and High Voltage Induction Motors"

Note 2:
This bilingual standard is a revised of the standard specification by the relevant technical committee on Dec 2009 which is issued as revision (2). Revision (1) of the said standard specification is withdrawn.

Note 3:
In case of conflict between Farsi and English languages, English language shall govern.

2. REFERENCES

Throughout this Standard, the following dated and undated standards / codes are referred to. These referenced documents shall to the extent specified herein, form a part of this Standard. For dated references, the edition cited applies. The applicability of changes in dated references that occur after the cited date shall be mutually agreed upon by the Company and the Vendor.

- IPS-M-EL-131(1) "Material and Equipment Standard for Low Voltage Induction Motors"

- IPS-M-EL-132(1) "Material and Equipment Standard for Medium and High Voltage Induction Motors"

2. مراجع

در این استاندارد به آین نامه ها و استانداردهای تاریخ دار و بدون تاریخ زیر اشاره گردیده است. این مراجع، تا حدی که در این استاندارد مورد استفاده قرار گرفته است، بخشی از این استاندارد محسوب می‌شود. در مراجع تاریخ دار و برای گلف شده ملاک می‌باشد. تغییراتی که بعد از تاریخ و برای در آنها داده شده، پس از توافق بین کارفرما و فروشنده قابل اجرا
undated references, the latest edition of the referenced documents (including any supplements and amendments) applies.

This standard specification is primarily based on IEC recommendations series 60034 and 60079. Selections from options given in IEC 60034 and additional requirements are specified herein.

IEC (INTERNATIONAL ELECTROTECHNICAL COMMISSION)

IEC 60034-1 "Rotating Electrical Machines Rating and Performance"

IEC 60034-2 "Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests"

IEC 60034-5 "Degrees of Protection Provided by the Integral Design of Rotating Electrical Machines (IP Code)"

IEC 60034-6 "Methods of Cooling (IC Code)"

IEC 60034-7 "Classification of Types of Construction, Mounting Arrangements and Terminal Box Position (IM Code)"

IEC 60034-8 "Terminal Markings and Direction of Rotation"

IEC 60034-9 "Noise Limits"

IEC 60034-14 "Mechanical Vibration of Certain Machines with Shaft Heights 56 mm and Higher. Measurement, Evaluation and Limits of Vibration"

IEC 60034-15 "Impulse Voltage Withstand Levels of Rotating A.C Machines with Form-Wound Stator Coils"

IEC60034-18 "Functional Evaluation of Insulation Systems for Rotating Electrical Machines".

IEC (کمیسیون بین المللی الکترونکی)
IEC 60072-1 "Dimensions and Output Series for Rotating Electrical Machines"

Part 1: "Frame Numbers 56 to 400 and Flange Numbers 55 to 1080"

IEC 60072-2 "Dimensions and Output Series for Rotating Electrical Machines"

Part 2: "Frame Numbers 355 to 1000 and Flange Numbers 1180 to 2360."

IEC 60079-0 "Electrical Apparatus for Explosive Gas Atmospheres, General Requirements"

IEC 60079-1 "Electrical Apparatus for Explosive Gas Atmospheres, Flameproof Enclosures "d"

IEC 60079-4 "Electrical Apparatus for Explosive Gas Atmospheres, Method of Test for Ignition Temperature"

IEC 60079-7 "Electrical Apparatus for Explosive Gas Atmospheres, Type of Protection “e”"

IEC 60079-10 "Electrical Apparatus for Explosive Gas Atmospheres, Classification of Hazardous Areas"

IEC 60079-15 "Electrical Apparatus for Explosive Gas Atmospheres, Type of Protection “n”"

IEC 60085 "Thermal Evaluation and Classification of Electrical Insulation"

IEC 60423 "Conduits for Electrical Purposes- Outside Diameters of Conduits for Electrical Installations and Threads for Conduits and Fittings"

IEC 60445 "Identification of Equipment Terminals"
3. CONFLICTING REQUIREMENTS

In the case of conflict between documents relating to the inquiry or order, the following priority of documents shall apply:

- First Priority: Purchase order and variations thereto.
- Second Priority: Data sheets and drawings.
- Third Priority: This Standard.

All conflicting requirements shall be referred to

- First Priority: Purchase order and variations thereto.
- Second Priority: Data sheets and drawings.
- Third Priority: This Standard.
the Purchaser in writing. The Purchaser will issue confirmation document if needed for clarification.

4. UNITS

This standard is based on International System of Units (SI), as per IPS-E-GN-100 except where otherwise specified.

5. SERVICE CONDITIONS

5.1 The motor specified herein will generally be installed outdoor in areas where the presence of flammable gas or vapor is foreseen. In case where the motor will be installed indoor, it will be indicated in data sheet.

5.2 In order to permit the proper selection and installation of the electrical motors, the areas in which the motor will be installed are classified. The classification of areas shall be as per article 4 of this standard specification.

5.3 The electrical motor shall meet the requirements of the classified areas as specified in this specification and indicated in data sheet.

5.4 The maximum and minimum ambient air temperature, relative humidity and the elevation of the location in which the motor will be installed will be indicated in data sheet. The ambient air temperature shall in no case be assumed less than 40°C.

5.5 The conditions during transport and storage will be a temperature range of -25°C to 60°C and relative humidity of up to 98%. The equipment subjected to these extreme conditions without being operated shall not be damaged and shall operate normally under the specified conditions.

6. AREA CLASSIFICATION

6.1 The industrial areas in the Iranian Petroleum Industry shall be classified as zone 0, zone 1, zone 2 and non-hazardous area as defined in IEC 60079-10. The areas classified as zone 0, zone 1 and zone 2 are generally referred to as hazardous areas.

6.2 The extent of each hazardous area zone and the distance in any direction from the source of release of flammable substances to another zone or to non-hazardous area shall be estimated.
according to the guidelines and demonstrated examples outlined in API RP505.

6.3 The area classification zone and the gas group classification of the location in which the motor is to be installed will be indicated in data sheet/s. Unless otherwise indicated therein the gas group classification shall be assumed group IIB.

6.4 The type of motor enclosure suitable for installation in each zone and each gas group together with the temperature class of the motor shall be according to the requirements of article 6.1 of this standard specification and shall be stated by the motor supplier in data sheet/s.

6.5 Motors for use in classified areas shall be certified by recognized international or national certifying authorities. The certificate issued by Underwriters Laboratories Inc. (UL) of USA, the Ex Certification Bodies of IEC and the Notified Bodies of ATEX is acceptable. The certifying authority and the certificate number shall be stated in data sheet/s by the motor supplier.

7. GENERAL REQUIREMENTS

7.1 Voltages and Output Ratings

7.1.1 The voltage levels adapted in the oil, gas and petrochemical industries of Iran are based on the IEC recommendation No 60038.

7.1.2 The motors with nominal voltages of 6 kV are referred to as medium voltage (MV) motors.

7.1.3 The motors with nominal voltage of 10 kV and above are referred to as high voltage (HV) motors.

7.1.4 For special applications or existing facilities, other voltages may be specified. The nominal voltage of the motor will be indicated in data sheet.

7.1.5 Unless otherwise indicated in data sheet, the neutral point of medium voltage and high voltage systems are earthed through current limiting resistors.

7.1.6 The voltage of the motors shall be selected based on the kW rating of the motor. The voltage of the motors below 150 kW shall be 400 volt. For the specification of 400 volt motors refer to API RP 505.
The voltage of the motors rated 150 kW to 1000 kW shall be 6 kV. The voltage of the motors above 1000 kW can be selected as 6 kV or 10 kV. Selected voltage based on technical and economical considerations of the electrical power supply system, in particular the voltage drop during starting of the motor.

7.1.7 Motors shall be capable of operating continuously at rated torque at any frequency between -2% and +2% of the nominal frequency together with a voltage variation of ± 5%. The nominal frequency is 50Hz.

7.2 Motor Sizing

7.2.1 Frame sizes, dimensions and the kW ratings of the motors shall be in accordance with IEC 60072-1and/or IEC 60072-2.

7.2.2 Motors shall be sized, taking into consideration the appropriate multiplying factor/s related to each type and size of the driven equipment. The size of the motors versus the driven equipment shall be according to the recommendations of the driven equipment specifications.

7.3 Motor Application

7.3.1 Motors will generally be used to drive pumps, compressors, blowers, agitators and other constant speed equipment.

7.3.2 The type of driven load and the torque requirement will be specified in request for quotation and/or data sheet. Motors shall satisfy the speed-torque requirement of the driven equipment over its entire starting and operating range.

7.3.3 When motors are furnished with the driven equipment, verification of the torque - speed characteristic of the motor vs. the torque requirement of the load is the responsibility of the driven equipment supplier.

7.3.4 When motors are directly ordered by the purchaser, the torque requirement of the load will be indicated in data sheet.

7.4 Motor Starting

7.4.1 Unless otherwise specified in data sheet, motors shall be suitable for Direct On Line Starting.
7.4.2 Autotransformer reduced voltage starting (Korndorfer method) may be employed. Such requirement will be shown on single line diagram/s and/or data sheet/s.

7.4.3 For high voltage motors individual dedicated unit transformer directly connected to the motor may be used, which shall be shown on single line diagram/s. In such case the specification of the unit transformer shall be according to relevant IPS standard. Moreover the transformer shall withstand the thermal and dynamic stresses during repeated direct on line starting of the motor. The particulars of such transformer shall be shown in transformer data sheet.

7.4.4 Motors rated 150 kW to 1000 kW will be controlled by vacuum type contactors. Motors rated above 1000 kW will be controlled by vacuum type circuit breakers. MV and HV motors shall be designed to withstand the switching surges of vacuum interrupters.

7.4.5 The starting performance and pull up torque of the motor shall be coordinated with the driven equipment supplier.

7.4.6 The motor design shall allow without injurious heating of insulated windings, at least three successive starts from cold against full load torque and two successive starts with the motor initially at full load operating temperature.

7.4.7 Motors shall be able to overcome starting load inertia as well as accelerating the load to rated speed, when the applied voltage is 80% of the nominal voltage.

7.4.8 In case of power interruption during operation, the motor may be reconnected to the supply voltage at any time. The residual voltage magnitude and phase angle shall not have any detrimental effect on the motor.

7.5 Motor Duty

7.5.1 Unless otherwise indicated in data sheet/s the duty of the motor shall be duty type S1, continuous running duty, as defined in IEC 60034-1.
7.6 Method of Cooling

7.6.1 The motors up to and including 1000 kW shall be totally enclosed fan cooled designated by characteristic numerals IC 4A1A1 (or simplified IC411) as defined in IEC 60034-6 second edition. Internal and external cooling fans shall be provided.

7.6.2 The cooling method for motors above 1000 kW can be selected as IC 411, IC 511 or IC 611 as defined in IEC 60034-6 second edition, and shall be approved by company representative prior to manufacturing. Other cooling methods can be adopted based on prior agreement with company representative.

7.7 Direction of Rotation

7.7.1 The direction of rotation shall be coordinated with the driven equipment vendor and shall be indicated in data sheet. Otherwise, the direction of rotation shall be clockwise when viewed from the driving end of the motor.

7.7.2 The direction of rotation for motors shall be clearly indicated on the motor frame by means of an arrow in a durable and permanent manner.

7.8 Noise Level and Noise Reduction

7.8.1 The noise level of the motor shall not exceed the limits specified in IEC 60034-9. The noise level of the complete equipment consisting of the motor and the driven equipment shall be limited to the values specified in IPS-G-SF-900.

7.8.2 The noise limiting requirements shall be met without the use of noise reducing features, such as a secondary enclosure. In case where such features are to be employed, prior approval of the company representative shall be obtained.

7.8.3 Materials used for noise reduction for the motors to be installed in hazardous areas shall be fire resistant, antistatic and stable in the presence of hydrocarbon liquids and vapors. The application of noise reducing features shall be covered by the certification for use in hazardous areas.
7.9 Vibration

7.9.1 Vibration level of the motors shall conform to the requirements of IEC 60034-14.

7.9.2 For motors rated 1500 kW and above, vibration monitoring system shall be provided together with non-contacting vibration probes at each bearing of the motor in accordance with API 670.

7.9.3 The driven equipment vendor or the purchaser will perform torsional vibration analysis of the complete motor with the driven equipment. The motor manufacturer shall provide the required physical data for such analysis.

7.9.4 The motor manufacturer shall state on data sheet the first critical speed, and if applicable the second critical speed of the motor.

8. CONSTRUCTION REQUIREMENTS

8.1 Enclosure

8.1.1 The motor enclosure shall be suitable for the site climatic condition indicated in data sheet.

8.1.2 Motor frame, fan cover and bearing end shields shall be made of steel sheet or cast iron. Bolts and screws shall be made of corrosion resistant material.

8.1.3 The degree of protection of motors and auxiliaries shall be at least IP 54W according to IEC 60034-5. The degree of protection of terminal box and bearing housings shall be IP 55W.

8.1.4 For offshore installations, the degree of protection for the motor, auxiliaries, terminal box and bearing housings shall be IP 56W.

8.1.5 Motors installed outdoor which are directly exposed to sun radiation shall be protected by sun canopy.

8.1.6 In hazardous areas classified as zone 0 no electrical motor shall be installed.

8.1.7 In hazardous areas classified as zone 1, in addition to the requirements of paragraph 8.1.3 or 8.1.4 the motors shall be flameproof Ex d according to IEC 60079-1. The gas group classification of Ex d motors shall be at least the requirements of IEC 60079-1. The gas group classification of Ex d motors shall be at least the requirements of IEC 60079-1.

8.1.8 The motors shall be flameproof Ex d according to IEC 60079-1. The gas group classification of Ex d motors shall be at least the requirements of IEC 60079-1.

8.1.9 The driven system shall be performed by the motor manufacturer in accordance with API 670.

8.2 CONSTRUCTION REQUIREMENTS

8.2.1 The driven system shall be performed by the motor manufacturer in accordance with API 670.

8.2.2 For offshore installations, the degree of protection of the driven system shall be at least IP 54W according to IEC 60034-5.

8.2.3 The degree of protection of the driven system shall be at least IP 54W according to IEC 60034-5.

8.2.4 The driven system shall be performed by the motor manufacturer in accordance with API 670.

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8.2.52 The driven system shall be performed by the motor manufacturer in accordance with API 670.
group IIB if not indicated otherwise in data sheet. Where hydrogen is present, the gas group classification shall be group IIC. The temperature class of Ex d motors shall be suitable for the appropriate gas in the subject area and shall in no case be more than 200°C (T3) according to IEC 60079-8. The IEC designation for such motor is (Ex d IIBT3).

8.1.8 In hazardous areas classified as zone 2, in addition to the requirements of paragraph 8.1.3 or 8.1.4 the motors shall be increased safety Ex e type according to IEC 60079-7 or flame proof Ex d per paragraph 8.1.7. The temperature class of Exe motors shall be suitable for the appropriate gas in the subject area and shall in no case be more than 200°C (T3) according to IEC 60079-8. The IEC designation for such motor is (Ex e IICBT3).

8.1.9 In non-hazardous areas, the enclosure of the motors shall be as per paragraph 8.1.3 or 8.1.4. Exn type motors should not be used in zone 2 area. The use of Exn type motors in non-hazardous area is acceptable.

8.1.10 Certificate of conformity shall be supplied for all Ex e type motors. The certificate number and certifying authority shall be indicated in data sheet at quotation stage.

8.1.11 The enclosure of motors except Ex d types shall be equipped with a drain hole with the same degree of protection as of the motor enclosure.

8.1.12 Vertical motors with downward drive end shaft shall be provided with a rain cowl over the air inlets to prevent water entry into the motor. Precautions shall be taken to preclude water ingress through mechanical gaps.

8.1.13 Vertical motors with upward drive end shaft shall be provided with fitter rings on the motor shaft to prevent water ingress along the shaft of the motor under running and stop condition.

8.1.14 Earthing bolt/s shall be provided on the motor frame for connection to the earthing cable.

8.1.15 Exposed surfaces shall be given a coating of rust preventive to provide protection against rust. The motor frame shall be painted in rust. The motor frame shall be painted in
accordance with manufacturer standard practice. The finish shall be suitable for the environmental conditions indicated in data sheet.

8.1.16 Motors shall have jacking bolts to lift the motor in order to facilitate the alignment of the motor with the driven equipment.

8.2 Winding and Winding Connection

8.2.1 Stator windings of medium and high voltage motors shall be made of rectangular copper conductors insulated with mica tape or other insulation material specified in article 8.3 (wire windings are not acceptable).

8.2.2 The finish shall be suitable for the environmental conditions indicated in data sheet. The finish shall be based on class B temperature rise for all motors shall be made of rectangular copper conductors insulated with mica tape or other insulation material specified in article 8.3 (wire windings are not acceptable).

8.2.3 After installation of the windings and connection of the coils, the windings shall be fully impregnated according to manufacturer's standard method (Resin rich or vacuum pressure impregnation) in order to restrict the movement of the coils and to achieve adequate heat dissipation.

8.2.4 Curing of the stator coils after impregnation shall be performed at the appropriate elevated temperature. During the curing process the stator should be continuously rolled to avoid the formation of voids in the insulation.

8.2.5 Two speed motors shall have separate windings.

8.2.6 Windings shall be adequately braced to prevent any relative movement during operation.

8.2.7 Windings shall be able to withstand the dynamic forces from starting and re-starting against full opposite residual voltage.

8.3 Insulation

8.3.1 Insulation materials shall be class F as defined in IEC 60034-18. The rating of motor shall be based on class B temperature rise for all parts of the motor.

8.3.2 All insulated windings shall be non-}

طبق دستورالعمل استاندارد سازنده، رنگ‌آمیزی شود. سطح رنگ‌آمیزی شده نهایی باید برای شرایط محیطی ذکر شده در داده برگ مناسب باشد.

8-10 به منظور تسهیل در تراز کردن موتورهای سنگین جهت هم محورسازی آن ها به تجهیزات منصوب به پیچ های تراز کردن باشد.

2-8 سیم پیچ و اتصال سیم پیچ

8-2 8-1 سیم پیچ استاندارد موتورهای ولتاژ متوسط و فوق باید از سیم های مسی چهارگوش که با یوشش نوار طلق نسوز (میکا) یا سایر مواد عایق مشخص شده در زیریند 3-8 ساخته شوند. (سیم پیچ اسیم قابل قبول نیست).

8-2 8-2 شر سیم پیچ باید در جعبه ترمینال قابل استراقی باشد. سیم پیچ در کارخانه سازنده باید به صورت سازنده متصول شوند به ویژه برای اتصالات روشنامه‌های حفاظتی که از نوع دیفرانسیل مطابق زیریند 10-8 توجه شود.

8-2 8-3 پس از نصب سیم پیچ و سروندی کلاغها، سیم پیچ باید به طور کاملاً مطابق روشن استاندارد سازنده به مواد مربوطه آگشته گردد (روش زیرین غنی شده با فشار خلاء) نا حرکت کلاف ها محدود و دفع کافی حرارت حاصل گردد.

8-2 8-4 فرآیند حرارتی روی کلاف‌های استاندارد پس از روند آغشته سازی باید در یک دست دیافراگمی آفتاب مناسب صورت گیرد. در حالی فرآیند عملیات حرارتی به منظور جلوگیری از تشکیل حباب در عایق باید استاندارد دامنه حرارتی داشته باشد.

8-2 8-5 موتورهای دو سرعته باید سیم پیچ‌ها مجرا داشته باشند.

8-2 8-6 سیم پیچ‌ها باید به اندازه کافی مهار گردد تا حرکت اولیه آنها در طول کار جلوگیری شود.

8-2 8-7 سیم پیچ‌ها باید قادر به تحمل نیروهای دینامیکی ناشی از راهاندیز و رانندگی مجدد با حداکثر ولتاز پسماند باشند.

3-8 عایق بندی

3-8 3-8 مواد عایق بندی کلاس F طبق تعیین استاندارد باشد. توان نامی موتور باید براساس IEC 60034-18 افزایش دمای موتور تا سطح کلاس B بیاید. تمام قطعات آن باشد.

3-8 3-2 کلیه سیم پیچ‌ها عایق شده باید قابل جراح بود.
hygroscopic, oil resistant and the materials shall be resistant to flame propagation. Insulation shall comply with the requirements of IEC 60085.

8.3.3 Stator windings shall have identical insulation at star point and line side of the coils, graded insulation is not acceptable.

8.3.4 Stator coils shall have anti-corona protection on the part of the coils in the stator slots and shall have stress grading on the part of the coils out of the slots.

8.3.5 The insulation shall be sized based on restarting of the motor immediately after loss of power with residual voltage of any possible magnitude and phase angle. The restarting voltage shall be assumed 100% of the rated voltage.

8.4 Temperature Detectors

8.4.1 In order to monitor the temperature of the stator winding, embedded resistance temperature detectors (RTD) shall be provided for all medium voltage and high voltage motors.

8.4.2 Oil lubricated bearings and/or bearings of motors rated 1000 kW and above, and also the thrust bearings of all MV and HV vertical motors shall be equipped with resistance temperature detectors. The numbers of RTD’s for such purpose shall be agreed by company representative.

8.4.3 The winding temperature detectors shall be distributed at least two per phase totally six numbers on each motor.

8.4.4 Temperature detectors shall be according to IEC 60751. All detectors shall have the same characteristics. Type and numbers of temperature detectors shall be indicated in data sheet.

8.4.5 The temperature detectors shall be wired to a separate terminal box mounted on the motor frame.

8.4.6 The terminal box for temperature detectors shall be according to clause 8.9 of this specification.
8.5 Condensation Protection

8.5.1 Motors shall be designed to prevent the accumulation of moisture within the enclosure.

8.5.2 Anti-condensation heaters shall be provided for all medium voltage and high voltage motors.

8.5.3 The voltage of the anti-condensation heaters shall be 230 volt single phase for heaters of up to 3 kW. For heaters above 3 kW, 400 volt three phase and neutral shall be used. Anti-condensation heaters will be supplied by one power cable for each motor.

8.5.4 The maximum sheath temperature of anti condensation heater/s shall be limited to the temperature class of Ex motors and shall not exceed 200°C. Moreover the heaters shall be sized such that the allowable temperature rise of the winding insulation do not exceed.

8.5.5 The anti condensation heater/s shall be wired to a separate terminal box mounted on the motor frame. A warning label shall be provided to indicate that the circuit may be live when the motor is not energized.

8.5.6 Heater/s shall have the same degree of protection as the motor itself, and the associated terminal box shall have the same degree of protection as the main power terminal box.

8.5.7 The terminal box for anti condensation heater/s shall be according to clause 8.9 of this specification.

8.6 Bearing and Lubrication

8.6.1 Bearings can be grease lubricated rolling element type (ball and/or roller bearing) or oil lubricated sleeve bearing type as proposed by the motor manufacturer.

8.6.2 Rolling element bearings shall be in metric sizes with maximum interchangeability and shall comply with ISO recommendations (ISO 15 and ISO 1132).

8.6.3 Special attention shall be paid to ensure that dismantling of bearings shall be simple and free from risk of damage.

8.6.4 Bearing temperature detectors shall be
The lubricating intervals, quantity and type of grease and/or oil shall be indicated on the motor nameplate or on an additional plate fixed on the motor frame.

Grease lubricated bearings shall have grease relief devices which ensures that the old grease will be forced out of the bearing when new grease is added. Re lubrication shall be possible with the motor in operation without dismantling parts.

The lubricated bearings shall be supplied with inside end caps to prevent grease from migrating into the motor.

Grease lubricated bearings shall be packed with grease before the motor is dispatched.

The sleeve bearings shall be of spherical seated, self aligning type.

The sleeve bearings housing design shall permit the replacement of bearing liners without disassembly of couplings or other machine parts.

Suitable lube oil system for sleeve bearings shall be provided by the motor manufacturer. When common lube oil system is to be adopted, the driven equipment manufacturer shall be responsible to supply the common lube oil system, based on the lubrication requirement to be adopted, the driven equipment manufacturer. When common lube oil system is provided according to the requirement of article 8.4.

Sleeve bearings shall be suitable for starting the motor without the aid of oil jacking. Means shall be included to assure adequate oil pressure to the motor bearings for start up.

Suitable monitoring devices such as a pressure switch in the lube oil pump discharge shall be provided to initiate an alarm in case of malfunction of the lube oil system.

Visual inspection of the lube oil system for sleeve bearings shall be possible. For non-forced malfunction of the lube oil system.
oil systems with oil reservoir, proper indication of oil level in the reservoir shall be provided.

8.6.16 Dial type temperature indicator shall be provided for each sleeve bearing to indicate the bearing oil temperature.

8.6.17 Bearing insulation shall be provided, if the shaft voltage measured across the ends of the shaft exceeds 250 mV (rms) for rolling element bearings or 400 mV (rms) for sleeve bearings.

8.6.18 When bearing insulations are to be provided, they shall be provided for all bearings of the motor.

8.6.19 The method of insulating the bearings shall be permanent and non-deteriorating during assembly and disassembly of the bearing.

8.6.20 An earthing connection, which shall be removable for test purposes shall be provided at the drive end bearing. Care shall be taken not to bridge the bearing insulation by any other connection.

8.6.21 For insulated bearings, insulating fittings shall be provided in the lube oil supply connections to prevent the oil supply lines from by passing the bearing insulation.

8.6.22 Vertical motors shall include suitable bearings to withstand the thrust of the rotor and the external thrusts from the driven equipment. The design of thrust bearing and the associated resistance temperature detectors for vertical motors shall be submitted for purchaser’s approval.

8.7 Rotor

8.7.1 The rotor core shall be made of high quality annealed insulated steel laminations similar to stator core laminations.

8.7.2 The shaft shall be made of one piece heat treated steel.

8.7.3 The rotor cage shall be made of copper and the end rings shall be brazed or welded.

8.7.4 The rotor and internal fan shall be dynamically balanced at nominal speed with half the key fitted in the key way.
8.7.5 The rotor design shall allow the addition of balancing weights which shall not be lead or similar ductile material.

8.7.6 Shaft extension shall be in accordance with IEC 60072-1 and IEC 60072-2. The design of the shaft end and coupling shall be in accordance with the instruction of the driven equipment manufacturer.

8.8 Cooling Fans

8.8.1 Cooling fan/s shall be made of non-sparking anti-static material.

8.8.2 Metallic fans made of aluminum, cast iron or steel is preferred.

8.8.3 The external fan and internal fan if separately mounted shall be individually balanced.

8.8.4 The external fan shall force the cooling air in the direction of the driving end.

8.8.5 Bidirectional fan is preferable. For motors fitted with unidirectional fans, a permanent arrow shall indicate the direction of rotation.

8.9 Terminal Box

8.9.1 Motor terminal box/s including removable covers shall be made of steel sheet.

8.9.2 Unless otherwise specified, the main power terminal box shall be positioned on the right hand side of the motor enclosure when looking at or facing the driving end. The star point terminal box, if any, shall be located opposite the main power terminal box. The cable/s to the main terminal box will rise from the floor. Other positions of main power terminal box shall be agreed by company representative prior to manufacturing.

8.9.3 The additional connections to the motor shall be terminated in boxes separate from the main terminal box.

8.9.4 The degree of protection of terminal boxes shall be at least IP55. Terminal boxes for motors in offshore installations shall be IP 56. The
design of the terminal boxes shall be such as to prevent small objects from dropping into the motor housing.

8.9.5 The main power terminal box and star point terminal box shall withstand the effects of short circuits inside the terminal boxes without being damaged and without emission of flame. The short circuit capability of the terminal boxes shall be as per IEC recommendations.

8.9.6 Terminal boxes for Ex motors shall be minimum with the same protection degree as the motor itself (Exd IIB T3 for Ex d motors and Ex e IIB T3 for Exe motors).

8.9.7 Terminal boxes shall have ISO metric threaded entry as per IEC 60423, complete with threaded plug (cable gland will be supplied by others).

8.9.8 Bushings of synthetic resin type shall be provided in the main power terminal box for termination of main cable/s. Porcelain bushings are not acceptable.

8.9.9 Terminal boxes shall be sized to have enough space for cable/s connections and to accommodate the differential protection current transformers as per article 8.10. The sizes of the power cable/s are indicated in data sheet.

8.9.10 Means shall be included in the terminal boxes to prevent slackening of connections due to vibration.

8.9.11 Inside the main power terminal box an earthing terminal shall be provided for earthing the cable shields. Such terminal shall be clearly marked with earthing symbol.

8.9.12 The phase sequence associated with the direction of rotation of the motor shall be clearly indicated on the motor terminals. Terminal markings shall be made in a clear and permanent manner according to IEC 60034-8.

8.10 Motor Differential Protection
8.10.1 Differential protection current transformers shall be provided for motors above 1000 kW.
8.10.2 Unless otherwise indicated in data sheet, the differential protection scheme is the self balancing differential protection where three 50/5 ratio (or other ratios specified in data sheet) current transformers shall be mounted in the main power terminal box of the motor. Motor leads U₁ and U₂ shall pass through one CT, leads V₁ and V₂ through the second CT and W₁ and W₂ through the third CT. Lead ends U₂, V₂ and W₂ are then connected together as the star point of the motor. Terminals of current transformers shall be brought to a terminal strip located in the main power terminal box.

8.10.3 When specified by the purchaser in data sheet, conventional differential protection scheme can be adopted. For such case three appropriately sized current transformers shall be mounted in the star point terminal box of the motor. (Similar current transformers will be installed in the motor control gear by others). Secondary terminals of these current transformers shall be brought to a terminal strip located in the star point terminal box.

8.10.4 The purchaser will provide all necessary details of the current transformers to be supplied by motor manufacturer or will make such current transformers available for the manufacturer to install in the terminal box/s. The supplier of the current transformers will be indicated in data sheet.

8.10.5 Differential protection relay/s will be installed at the motor control gear by others.

8.11 Nameplate

8.11.1 Each motor shall be provided with nameplate/s securely fixed to the non-removable part of the motor frame.

8.11.2 The nameplate/s shall be made of stainless steel.

8.11.3 Nameplates shall be durably marked with the items specified in IEC 60034-1 as far as they apply, and shall also include the following items. The items need not all be on the same plate.
Maximum ambient air temperature, if other than 40°C.

Class of insulation

Degree of protection IP code of the motor enclosure, terminal box and auxiliary devices

Type and size of bearings

Type of lubricant, lubricating intervals and required oil pressure for force lubricated bearings

Explosion protection type of the machine, terminal box and auxiliary devices in accordance with the recommendations of IEC 60079 series

Gas group and temperature group of the motor in accordance with IEC 60079 series

When special features are embodied, a plate showing appropriate instructions shall be fixed to the motor frame.

In addition to motor nameplate/s, a separate identification plate engraved with the motor identification number given on data sheet shall be attached to the non-removable part of the frame. It shall be possible to replace such plate by a similar plate.

The equipment under this specification shall be factory tested. Certified copies of test reports and/or certificates shall be submitted to the purchaser. The numbers of certified copies required will be specified by the purchaser in the purchase order.

The purchaser’s inspectors shall be granted the right for inspection at any stage of manufacture and testing.

Purchaser will require the presence of his nominated representative to witness the final inspection and performance tests. For such purpose a type test on an identical machine is

Maximum ambient air temperature, if other than 40°C.

Class of insulation

Degree of protection IP code of the motor enclosure, terminal box and auxiliary devices

Type and size of bearings

Type of lubricant, lubricating intervals and required oil pressure for force lubricated bearings

Explosion protection type of the machine, terminal box and auxiliary devices in accordance with the recommendations of IEC 60079 series

Gas group and temperature group of the motor in accordance with IEC 60079 series

When special features are embodied, a plate showing appropriate instructions shall be fixed to the motor frame.

In addition to motor nameplate/s, a separate identification plate engraved with the motor identification number given on data sheet shall be attached to the non-removable part of the frame. It shall be possible to replace such plate by a similar plate.

The equipment under this specification shall be factory tested. Certified copies of test reports and/or certificates shall be submitted to the purchaser. The numbers of certified copies required will be specified by the purchaser in the purchase order.

The purchaser’s inspectors shall be granted the right for inspection at any stage of manufacture and testing.

Purchaser will require the presence of his nominated representative to witness the final inspection and performance tests. For such purpose a type test on an identical machine is
acceptable. The supplier shall inform the date of such tests at least four weeks in advance.

9.4 Type tests and routine tests shall be carried out according to the recommendations of IEC 60034-1 and the relevant IEC publications referred to therein. The final performance test shall include at least the following:

1. Insulation resistance test on windings, heaters, temperature detectors and bearing insulations
2. Measurement of winding resistance (cold)
3. Measurement of winding resistance (hot)
4. Bearing temperature rise
5. No load current
6. Current unbalance at full load
7. Locked rotor current (at full or reduced voltage)
8. Locked rotor torque (at full or reduced voltage)
9. Torque speed curve
10. No load losses
11. Direction of rotation
12. Slip and nominal speed and full load
13. Vibration severity
14. Noise test
15. bearings inspection

10. SPARE PARTS

10.1 Together with the supply of motors under this specification, a complete set of spare parts for commissioning shall be supplied for each motor. The supplied spare parts shall comply with the same specifications as the original parts and shall be fully interchangeable with the original parts without any modification. Spare parts shall be preserved to prevent deterioration during
transport and storage in a humid tropical atmosphere.

10.2 The vendor shall also supply a list of recommended spare parts for two years of operation.

11. DOCUMENTATION

11.1 The vendor shall supply the necessary information with the quotation to enable evaluation of the submitted proposal. General documents/drawings are not acceptable unless they are revised to show the equipment proposed.

The documents to be supplied with the quotation shall at least include the following:

a) Completed enquiry data sheet/s.

b) Summary of exceptions/deviations to this standard specification.

c) Brochures and catalogues containing description of typical motors.

d) Torque-speed curves.

e) Preliminary dimensional drawings.

f) Approximate shipping weights and sizes.

g) Copies of relevant certification documents.

11.2 The documents which shall be supplied together with the equipment shall at least include the following:

a) Updated and completed enquiry data sheet/s.

b) General arrangement drawings showing main dimensions, arrangement of components and terminal boxes, jacking points, and cable entry positions.

c) Windings connection diagrams.

d) List of components, showing complete reordering information for all replaceable parts.
e) Bearing arrangement drawing with bearing replacement procedure.

f) Installation, operation and maintenance instruction/s.

g) Recommended spare parts list for two years of operation.

h) Test reports for type tests and routine tests.

i) Certificates of conformity for Ex type motors.

12. SHIPMENT

12.1 The supplier of the equipment under this specification is the sole responsible for packaging and preparation for shipment.

12.2 The packaging and preparation for shipment shall be adequate to avoid mechanical damage during transport and handling.

12.3 Motors shall be shipped with bearing lubricate.

12.4 Rotors shall be locked during shipping, to avoid damage to the bearings.

12.5 Depending on motor size and weight, motors shall be securely fastened to a hardwood skid or pallet suitable for fork truck handling, and shall be covered for protection against dirt and moisture during transport and outdoor storage.

12.6 Open cable entries on motor terminal box shall be adequately sealed before the motor is dispatched from the manufacturer's works.

12.7 Each motor package/container shall be provided with permanently attached identification tag containing necessary information together with the motor identification number indicated in data sheet Appendix A.

12.8 Silica gel or similar dehydrating compound shall be enclosed in each motor package/container.

12.9 Shipping documents with exact description
of equipment for custom release shall be supplied, with the equipment.

13. GUARANTEE

13.1 The supplier of the equipment under this specification shall guarantee the equipment and shall replace any damaged equipment/parts resulting from poor workmanship and/or faulty design.

13.2 The supplier shall replace any equipment/part failed under the following condition:

- Failure under startup and commissioning tests performed according to IEC recommendations.

- Failure under normal usage for a period of 12 months, not exceeding 18 months from the date of dispatch from the manufacturers works.
APPENDICES

APPENDIX A

MEDIUM AND HIGH VOLTAGE
INDUCTION MOTOR DATA SHEET

The vendor shall complete and submit this data sheet with his proposal.

* Items marked with asterisk will be specified by purchaser.

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<td>نام پروژه یا واحد</td>
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<td>Motor identification No</td>
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<td>3.</td>
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<td>5.</td>
<td>Minimum outdoor ambient temperature</td>
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<td>بار متصله (توماس، کمپرسور، دموده و غیره)</td>
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<tr>
<td>18.</td>
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<td>Pull out torque (the highest torque in % of full load torque)</td>
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<td>43</td>
<td>Acceleration time, with load (by driven equipment supplier)</td>
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<td>44</td>
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<td>45</td>
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<td>46</td>
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<td>47</td>
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<td>درجه حفاظت محفظه (کد IP)</td>
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<td>48</td>
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<td>49</td>
<td>Motor classification (Ex d, Ex e, Ex n, etc)</td>
<td>طبقه بندی موتور (Ex n, Ex e, Ex d و غیره)</td>
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<td>Enclosure gas group suitability (Group II A, IIB, IIC)</td>
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<td>51</td>
<td>Temperature class of the motor</td>
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<td>52</td>
<td>Stator winding insulation material</td>
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<td>55</td>
<td>Stator connection (star/delta)</td>
<td>اتصال استاندارد (ستاره/ مثلث)</td>
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<td>56</td>
<td>Differential protection scheme (self balancing/conventional)</td>
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<td>نوع ترانسفورماتور جریان و نسبت سیم پیچ برای حفاظت دیفرانسیل</td>
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<td>58</td>
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<td>نوع یافتن، ساخت و اندازه</td>
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<td>No.</td>
<td>Specification</td>
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<td>67.</td>
<td>Method of lubrication of bearings</td>
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<td>68.</td>
<td>Bearing lube oil system, included or not (paragraph 8.6.11)</td>
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<td>69.</td>
<td>Numbers and type of bearing temperature detectors</td>
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<td>Noise level (off load)</td>
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<td>71.</td>
<td>Over speed capability</td>
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<td>72.</td>
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<td>73.</td>
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<tr>
<td>74.</td>
<td>Motor manufacturer</td>
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<td>75.</td>
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<tr>
<td>76.</td>
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<td>77.</td>
<td>Motor serial number</td>
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<td>78.</td>
<td>Frame size</td>
<td></td>
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<td>79.</td>
<td>Wight of the motor</td>
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<td>80.</td>
<td>Type test certificate/s</td>
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<td>83.</td>
<td>Accessories</td>
<td></td>
</tr>
<tr>
<td>84.</td>
<td>Deviation from this specification if any</td>
<td></td>
</tr>
</tbody>
</table>

**To be attached:**
- Type test certificate/s
- Certificate of conformity for Ex type motors
- Certifying authority and certificate number/s
- Accessories
- Deviation from this specification if any

**Attach list:**
- Motors
- Accessories
- Certifying authority and certificate number/s