



*Design Specification:* **ED-**  
**P-02.01-04**

*Engineering Division*

*Technical Department*

ELECTRICITY

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**HIGH VOLTAGE ELECTRIC INDUCTION  
MOTORS  
(IEC 60034)**

## 1. GENERAL

### 1.1. Introduction

This document is part of the latest edition of Repsol technical specifications, and refers also to the latest edition of the Standards and Codes that are mentioned and / or applicable in it. Particular aspects for each project indicated in the "Basic Design Data (B.D.D.)" document shall be transcribed to the individual Material Requisition.

The completely or partially application of this specification will be confirmed in the specific B.D.D. of each project.

At points where in this specification reference to specific paragraphs or parts of codes or standards is done, apply the latest edition of the code or standard unless otherwise stated by Repsol. The indication in this specification of the standard or code edition in force at the time it was written is aimed to clearly identify the criteria to be applied in case in later editions have been moved or deleted. Repsol shall be informed in writing in case of discrepancies between the publication mentioned in this specification and the latest edition of the Code or Standard.

### 1.2. Scope

This specification, together with the project documentation (motor project documents and project specifications), establishes the standards to be followed for the design, selection of materials, manufacture, documentation, inspections, functional testing, painting, packaging and transport of three-phase totally enclosed fan cooled squirrel-cage induction motors for voltages equal or down to 1000V.



Equipment under this specification shall be designed and manufactured as per following Codes or Standards:

- IEC 60034 Rotating electrical machines.

Additionally, specifications listed in section "Standards and specifications of reference" shall be followed.

### 1.3. Priority order between documents

In case of conflict between documents, following order of priority shall prevail:

- Compulsory local laws and regulations (provided that in the rest of applicable documents are not more stringent criteria established)
- Project B.D.D.
- This specification
- Other referenced codes and standards.

Nevertheless, this discrepancy must be declared in writing to Repsol before continuing with the process of design / manufacturing.

### 1.4. Responsibility

Compliance with the rules and recommendations given in this Specification does not exempt partially or totally, the designers / supplier, their respective responsibilities and guarantees or any other contractual obligation.

### 1.5. Measurement units

The measurement units to be used shall be the International System (SI), or the Anglo-saxon system of units, to be established at the beginning of the Project.

## 2. DEFINITIONS

For other terms and abbreviations included in this specification, the definitions to consider shall be the ones established in the reference IEC standard 60034.

## 3. SERVICE CONDITIONS

### 3.1. Environmental conditions

The motor shall be suitable for continuous operation to nominal power respecting the limits of temperature indicated in IEC standard 60034 located outdoors, without protection and in the following conditions:

- Altitude lower than 1000 m (3281 ft)
- Maximum temperature 40 °C (104°F)
- Minimum temperature -5 °C (23°F)
- Maximum relative humidity (daily average) 90%
- Minimum relative humidity (daily average) 50%
- Chemically aggressive atmosphere, salty, dusty and corrosive, common to industrial facilities.

More restrictive conditions will be detailed in the BDD document and/or in the particular documentation of the project (data sheets, particular requisition, etc.)

### 3.2. Power supply

Unless indicated otherwise in the project documents, the motors will be suitable for continuous running at rated output (at ambient temperature and at the voltage and frequency values defined in the project documents) with variations of voltage and frequency within the limits of "zone A" (defined in the standard IEC 60034-1), without exceeding the temperature rise defined for the insulation systems of thermal class B (80K).

Furthermore, the motors will be suitable for continuous running at rated output (at ambient temperature and at the voltage and frequency values defined in the project documents) with voltage and frequency variations exceeding the limits of "zone A", within zone B, but without exceeding the temperature rise permitted by the insulation system of thermal class B by more than 10K.

### 3.3. Starting conditions

Unless otherwise specified in the project documentation, motors shall comply with the following requirements: **a)**

The motors shall be prepared on-line starting.

Based on the characteristics of the equipment being operated, the motor manufacturer shall specify any limitations and recommend the most appropriate motor for each specific case.

## 2 DEFINITIONS

In those cases in which the motors are driven by a speed-regulator and in which an on-line starting is not required, a motor that doesn't fulfill exactly the on-line starting condition could be acquired, previous Repsol authorization.

- b) During starting or the re-acceleration process the supply voltage may drop to 80% of the rated value defined in the project documents. In these conditions, the torque of the motor shall not be less than 130% of the load torque (without tolerances), at any speed between 0 and that corresponds to the maximum power torque. The resistant torque to be considered shall be the resistant torque of habitual starting's conditions of the driven machine.

The manufacturer of the driven equipment shall provide the torque-speed curve.

Care shall be given to special equipment (agitators, centrifuges, extruders, etc.) which require control of starting conditions and time.



The manufacturer shall check that the motors can start with 80% of the rated voltage and with the load torque of the driven machine, in the starting time of the motor and with the starting conditions

Lack of values of the driven machine, the motors' manufacturer shall assume the results, unless it is indicated in the offer as pending.

- c) Voltage during starting shall be 80% of rated value. In the conditions specified the motors shall support the following starting sequences:
- o Three consecutive cold start attempts (with return to the condition of zero speed before the next start attempt). It shall be possible to perform an additional start after running for 20 minutes or after 45 minutes - stopped once the motor has reached normal operating temperature.
  - o Two consecutive start attempts after continuous running at rated power. o Three start attempts at equal intervals during one hour, during continuous running at rated power.
  - o Motors of power greater than 1,000 kW, shall be capable of at least six (6) startings in one day without suffering damage, with 1000 startings per year as minimum.

The manufacturer shall specify the waiting time after finishing the above starting cycle before performing a new start.

During the above-mentioned starting sequences, the temperature of the stator coil shall not exceed more than 10% the insulation class limit; the rotor's squirrel-cage designed temperature must not be higher than 250 °C (482°F) or other more restrictive conditions required in the standards for Ex execution motors. These starts shall be considered at full load of the driven machine.

## 4. TECHNICAL CHARACTERISTICS

Unless otherwise specified in the project documentation, the technical characteristics shall comply with the following requirements:

### 4.1. Starting torque

At least, the conditions described in the bullet point "Starting Conditions" shall always be fulfilled.

The starting torque for motors with power up to 500 kW will never be less than 80% of rated torque. The starting torque for motors with power over 500 kW will never be less than 60%.

## 4.2. Starting current

The locked rotor current values at rated voltage and frequency, shall be less than 660% of rated current for motors rated up to 1000 kW and less than 550% for motors of more than 1000 kW. These are maximum values of current, in these values are already included the tolerances. Greater values require Repsol approval.

### 4 TECHNICAL CHARACTERISTICS

## 4.3. Noise level

The noise level, indicated as average pressure of sound at one meter from the surface of the motor and measured in dB(A) in accordance with the ISO 3744 recommendation, shall not exceed the limits specified in the technical specification ED-A-01.02 *Equipment noise control*. The maximum level admitted is 82dB.

If to fulfill this noise level, an acoustic protection is needed, it will be indicated in the data sheet and it will require the Repsol authorization.

If it is allowed, this acoustic protection will be removable, made of acoustic and fireproof insulation material and equipped with devices which rapid opening.

During the routine test if the required noise level is not fulfill, the manufacturer will propose to Repsol the changes to be made to the motor to fulfill it. These changes will have to be approved by Repsol, who will be able to request the repetition of the test that had been carried out before the measurement of the unfulfilled noise level.

## 4.4. Vibrations

Motor vibration shall be measured at the points specified in the IEC 60034-14 standard. For this purpose flat areas of approximately 30x30mm (1.2"x1.2") shall be available on the casings next to the bearing supports to fix the accelerometer.

Vibration shall be measured by putting the motor on a rigid workbench and with a half-key (unless otherwise indicated in the motor Data Sheet).

The vibrations will be measured at no-load at rated voltage and frequency.

The vibration speed limits (at no-load and at full load) are defined in the standard IEC 60034-14, depending on the rated speed, demanding degree B to all motors. In exceptional cases it could be required vibration levels even lower, following the code API 541, if required in the project BDD.

If vibrations in the driven machine are to be measured continuously, the motor shall include proximity measurement probes ("non contact" type). Unless otherwise specified, each bearing shall have two probes placed at 90°. The type of probes shall be the same as the ones used on the equipment being driven. The vibrations shall be measured as speed (mm/s).

## 4.5. Direction of rotation



Motors that turn only in one direction are acceptable although in these cases it shall be possible to change the direction only by changing the external fan

The direction of rotation of the motor shall be defined viewed from the coupling side and shall be directly related to the phase sequence U, V, W.

The direction of rotation required in the Data Sheet, shall be marked on the motor casing with an embossed single arrow or stainless steel screwed plate on the side opposite the coupling.

The name plate shall specify the possible direction of rotation CW, CCW, or CW-CCW. Sticky labels and painted signs are not acceptable.

#### 4.6. Pulsating current

Pulsating current in motors that drive alternative compressors shall not be greater than 40% of full load current.



If it is necessary to add a flywheel, the manufacturer of the motor shall supply the manufacturer of the driven machine with the necessary data so that the latter can produce the relevant calculations to limit the irregularity factor to lower than 1/100.



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### **4.7. Efficiency**

Manufacturer shall always offer the motors of the higher efficiency it can build, always in accordance with the technical requirement of this specification.

For the economical evaluation during purchasing process it shall be considered not only the initial cost but also the cost of the energy consumption during a period of life of 5 years for the specific working conditions of each project.

## **5. CONSTRUCTIONAL CHARACTERISTICS**

### **5.1. External dimensions**

The frame and main external dimensions shall correspond to the values specified in the IEC standard 60034.

### **5.2. Construction type**

The construction type and assembly requested in the Data Sheet shall be defined in accordance with the IEC standard 60034.

### **5.3. Degree of Protection**

Motors will be enclosed. The degree of protection of frame and the terminal box against external agents shall be IP55 and IP65, respectively.

The motor shall have one of the following cooling systems while maintaining the required degree of protection:

- a) Totally enclosed type, fan outer surface cooled with finned frame
- b) Totally enclosed type, with external and internal fans and with frame with tubes
- c) Totally enclosed type, with external and internal fans and with built on air-to-air heat exchanger
- d) Totally enclosed type, with external and internal fans and with built on air-to-water heat exchanger

### **5.4. Frame**

The motor frame shall withstand all possible forces during normal starting, short-circuits and counter-phase connections and in the event of re-acceleration due to supply voltage momentary interruptions.



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Unless otherwise specified in the project documentation, the frame shall be made of cast iron or corrosionresistant steel appropriate for the most adverse environmental conditions.

### 5.5. Rotor

The Rotors shall be made laminated

The rotor squirrel-cages shall be made of copper.

The axial force, if any, shall be absorbed by the motor bearings.

Rotors and fans shall be separately and dynamically balanced with a half-key inserted (verify with the manufacturer of the equipment being driven).

The quality of balancing shall be at least grade G2.5 according to ISO 1940

The manufacturer must specify in its quotation the type of the cage (single or double cage, deep bars, etc.).

The rotor will be determine to allow the indicated starting conditions, even the re-start of the motor with a residual voltage of 40% and with a phase displacement of 180°.

The rotor will be free of its own axial forces.

### 5.6. Fans

In all cases the fans will be non-sparking, made of corrosion-resistant materials such as: bronze, fiberglass brass, aluminium (with cooper content < 0.2%), etc..., and they will have a thermo-stable composition, according to manufacturers' Standard.

The fan shall be uni-directional (where possible) and installed on the side opposite the coupling so that it sends air towards the coupling.

All the fans will be mounted on the motor's shaft. The cases where fans with auxiliary motors are needed require the Repsol's authorization.

The fan cover and grid shall be made of steel plate.

### 5.7. Shafts

The shaft shall be made of steel and machined (in compliance with existing standards) to receive half of the coupling.

The shaft shall be supplied complete with the corresponding key.



When the motor drives an alternative machine, the flywheel shall be calculated and supplied by the manufacturer of the driven equipment, to obtain a degree of irregularity 1/100 or lower. In these conditions, the new PD<sup>2</sup> for the complete group



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must be considered and whether its modification (due to the installation of these devices) changes the starting time and other conditions.

The centre holes located on the shaft ends (used during construction), shall be of adequate design to ensure their protection and avoid deterioration and conserve them in best working conditions in future eccentricity verifications.

The maximum allowed deflection, shall be established so that critical speed is reached at more than 120% of maximum operation.

- The end of the shaft shall be marked with the letter H or F, depending on whether it was balanced with half or full key.
- The shaft shall be permanently marked at the magnetic centre working with the fan installed and for the specified direction of rotation and revolutions. According to standard API 541.

### 5.8. Couplings

When required direct rigid couplings, (for example line pumps and vertical motors) then the ends of the shaft shall be made according to the instructions of the manufacturer of the driven equipment.

When required rigid coupling with flange then mechanized, drill holes and tolerances shall be made according to the instructions of the manufacturer.

Vertical motors used to drive pumps located in deep wells shall have couplings bolted to the motor shaft with an anti-turning device to avoid defects to the unit.

### 5.9. Windings and insulation

The windings shall be made of copper form-wound coils and insulated with epoxy resin and vacuum impregnated.

The installation shall guarantee that movement or distortions will not occur if there is a short-circuit between the coils and the supply leads.

The winding insulation shall be adequate for the rated voltage specified in the project documents.

The winding terminals shall be insulated with fireproof, non-hygroscopic material.

Insulation shall be designed to support a motor re-start or re-acceleration with a phase displacement of 180° and a residual voltage of up to 40% of rated voltage (re-starting voltage value 140% of rated voltage).

Insulation system shall be class F, with temperature rise of class B.

The insulation temperatures allowed are those specified in IEC standard 60034, measured with the resistance method in relation to altitude and temperature conditions at the plant.



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### 5.10. Terminal boxes

Independent terminal boxes will be provided for:

- Main power terminals.
- Terminals for connecting the centre of the star (when necessary). (It can be the same)



• Terminals for differential protection connections (They will be located in the main power terminal box).

- Space heaters
- Transformers secondary circuits for the differential protection.
- Temperature detectors.
- Level instruments, water leakage, etc.