

Supplementary Specification to IEC 60034-1 Low Voltage Three Phase Cage Induction Motors

Revision history

VERSION	DATE	PURPOSE
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Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2014).

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Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of low voltage three phase cage induction motors in accordance with IEC 60034-1, Edition 13.0, 2017, Rotating electrical machines – Part 1: Rating and performance, for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents Supplementary Technical Specification

This specification is to be applied in conjunction with the supporting data sheet, quality requirements specification (QRS) and information requirements specification (IRS) as follows.

IOGP S-703: Supplementary Specification to IEC 60034-1 Low Voltage Three Phase Cage Induction Motors

This specification defines the technical requirements for the supply of the equipment and is written as an overlay to IEC 60034-1, following the IEC 60034-1 clause structure. Clauses from IEC 60034-1 not amended by this specification apply as written to the extent applicable to the scope of supply.

Modifications to IEC 60034-1 defined in this specification are identified as *Add* (add to clause or add new clause), *Replace* (part of or entire clause) or *Delete*.

IOGP S-703D: Data Sheet for Low Voltage Three Phase Cage Induction Motors

The data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional

purchaser supplied documents may also be incorporated or referenced in the data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-703Q: Quality Requirements for Low Voltage Three Phase Cage Induction Motors

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

IOGP S-703L: Information Requirements for Low Voltage Three Phase Cage Induction Motors

The IRS defines the information requirements, including contents, format, timing and purpose, to be provided by the supplier. It may also define specific conditions which invoke information requirements.

The terminology used within this specification and the supporting data sheet, QRS and IRS follows that of IEC 60034-1 and is in accordance with ISO/IEC Directives, Part 2 as appropriate.

The data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The supplementary specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) purchaser defined requirements (data sheet, QRS, IRS);
- d) this specification;
- e) IEC 60034-1.

1 Scope

Add new subclause

1.1 General

This specification amends and supplements IEC 60034-1, Edition 13.0, 2017 for the design, materials, fabrication and testing of low voltage AC squirrel cage induction motors for petroleum, chemical and other severe-duty industry applications.

Add new subclause

1.2 Motors included in scope

Included in the scope of this specification are electric motors that:

- are of a wire-wound a.c. squirrel cage induction type;
- have a rated power from 0,12 kW to 500 kW;
- have a rated voltage above 50 V up to 1 kV;
- have 2, 4, 6 or 8 poles;
- are air cooled;
- are for single-speed use;
- are converter fed.

NOTE The values of rated voltage and the number of poles align with the ranges in IEC 60034-30.

Add new subclause

1.3 Motors excluded from scope

Excluded from the scope of this specification are electric motors that are:

- rated at a voltage exceeding 1 kV a.c.;
- rated at a power exceeding 1 000 kW.;
- fitted with sleeve bearings;
- submersible, sub-sea, canned or hermetically sealed motors;
- d.c. motors;
- single phase motors;
- synchronous motors;
- motor operated valve actuators.

Add new subclause

1.4 Extended use of this specification

This specification may be used as a basis for the purchase of electrical machines which are outside the immediate scope of this specification, with those clauses that remain relevant for motors of a similar construction and cooling method, such as:

- motors which have a rated power between 500 kW and 1000 kW;
- reluctance motors;
- permanent magnet motors;
- motors with 10 poles or more;
- induction generators;
- close-coupled motors;
- two speed motors.

Those parameters which are outside the scope of this specification are subject to agreement between the purchaser and the manufacturer.

2 Normative references

Add to clause

IEC 60034-7, *Rotating electrical machines - Part 7: Classification of types of construction, mounting arrangements and terminal box position (IM Code)*

IEC 60034-9: 2007, *Rotating electrical machines - Part 9: Noise limits*

IEC 60034-14: 2018, *Rotating electrical machines - Part 14: Mechanical vibration of certain machines with shaft heights 56 mm and higher - Measurement, evaluation and limits of vibration severity*

IEC TS 60034-30-2, *Rotating electrical machines - Part 30-2: Efficiency classes of variable speed AC motors (IE-code)*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60423: 2007, *Conduit systems for cable management – Outside diameters of conduits for electrical installations and threads for conduits and fittings*

IEC 61800-2:2015, *Adjustable speed electrical power drive systems – Part 2: General requirements – Rating specifications for low voltage adjustable speed a.c. power drive systems*

IEC 62262, *Degrees of protection provided by enclosures for electrical equipment against external mechanical impacts (IK code)*

ISO 281, *Rolling bearings - Dynamic load ratings and rating life*

ISO 1680, *Acoustics - Test code for the measurement of airborne noise emitted by rotating electrical machines*

ISO 5753-1: 2009, *Rolling bearings — Internal clearance — Part 1: Radial internal clearance for radial bearings*

ISO 12944-1, *Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 1: General introduction*

ISO 12944-2, *Paints and varnishes – Corrosion protection of steel structures by protective paint systems – Part 2: Classification of environments*

ISO 21940-11, *Mechanical vibration - Rotor balancing - Part 11: Procedures and tolerances for rotors with rigid behaviour*

ISO 21940-32, *Mechanical vibration - Rotor balancing - Part 32: Shaft and fitment key convention*

3 Terms and definitions

Add new term

3.34

converter-fed motor

electric motor fed from a frequency converter independent of whether it is specifically designed for converter supply or whether it is an electrical machine within the scope of IEC 60034-12 which is designed originally for main supply

Note 1 to entry: This definition is taken from IEC TS 60034-25 and for the purposes of this specification, replaces the term "electrical machine" with the term "motor".

[SOURCE: IEC TS 60034-25: 2014, 3.5, modified: Note 1 to entry added and other modifications indicated in italics]

Add new term

3.35

D-end

drive end of a *motor*, that end of the *motor* which accommodates the shaft end

Note 1 to entry: This can also be expressed as DE.

Note 2 to entry: This definition is taken from IEC 60050-411 and for the purposes of this specification, replaces the term "machine" with the term "motor".

[SOURCE: IEC 60050-411: 1996, 411-43-36, modified: Note 1 to entry added and other modifications indicated in italics]

Add new term

3.36

N-end

non-drive end of a *motor*, that end of the *motor* opposite to the drive end

Note 1 to entry: This can also be expressed as NDE.

Note 2 to entry: This definition is taken from IEC 60050-411 and for the purposes of this specification, replaces the term machine with the term motor.

[SOURCE: IEC 60050-411: 1996, 411-43-37, modified: Note 1 to entry added and other modifications indicated in italics]

Add new term

3.37

notified body

organization designated by a European Union country to assess the conformity of equipment for use in potentially explosive atmospheres before being placed on the market

Note 1 to entry: These bodies carry out tasks related to conformity assessment procedures set out in the applicable legislation, when a third party is required.

Note 2 to entry: The European Commission publishes a list of such notified bodies.

Note 3 to entry: Notified bodies can certify to European Directive 2014/34/EU.

Add new term

3.38

certification body

organization having successfully completed the IECEx assessment process and approved to operate within the IECEx Certified Equipment Scheme

5 Rating

5.5 Rated output

5.5.3 Motors

Replace first sentence with

The motor rated output is the mechanical power available at the shaft and shall be expressed in kilowatts (kW).

6 Site conditions

Add new subclause heading

6.8 Degree of ingress protection

Add new subclause

6.8.1

For exterior locations, motors shall have a minimum degree of ingress protection of IP55, in accordance with IEC 60034-5.

NOTE For interior locations, the requirement for a degree of ingress protection lower than IP55 may be evaluated by the user.

Add new subclause

6.8.2

On frame sizes 160 and above, a condensation drain hole with a removable plug shall be provided at the motor enclosure low point, when mounted at the designated orientation.

Add new subclause

6.9 Degree of impact protection

The motor enclosure and terminal boxes shall have a minimum degree of protection against harmful external mechanical impacts of IK08 in accordance with IEC 62262.

7 Electrical operating conditions

7.1 Electrical supply

Replace second sentence of third paragraph with

In this case, the insulation system including terminal box terminals shall be suitable for IVIC C for phase-to-phase and IVIC B for phase-to-ground.

7.2 Form and symmetry of voltages and currents

7.2.1 AC motors

7.2.1.1

Add to subclause

Single-speed motors shall be rated to operate on a supply voltage having a power quality defined in the data sheet.

8 Thermal performance and tests

8.1 Thermal class

Replace first paragraph with

The motor insulation system shall be thermal class 155 (F) in accordance with IEC 60085 without exceeding thermal class 130 (B) temperature limits at the motor rated output at maximum ambient air temperature.

NOTE Where the application requires motor insulation thermal class 180 (H) in accordance with IEC 60085 without exceeding class 155 (F) limits at the motor rated output at maximum ambient air temperature, this can be selected in the data sheet.

Add to subclause after first paragraph

For converter-fed motors, the total losses including additional losses within the operating envelope due to a non-sinusoidal power supply shall not cause thermal class 130 (B) temperature limits to be exceeded at the rated output.

8.6 Determination of winding temperature

8.6.1 Choice of method

Replace first paragraph with

For measuring motor winding temperature, the resistance method defined in 8.5.2 shall be applied (see also 8.6.2.3.3).

9 Other performance and tests

9.1 Routine tests

Replace third and fourth sentences of first paragraph with

The motor shall be fully assembled with the exception of parts to be removed to facilitate testing.

Add new subclause heading

9.12 Single-speed motor starting, re-starting and re-acceleration

Add new subclause heading

9.12.1 Starting

Add new subclause

9.12.1.1

Motor starting performance shall be in accordance with IEC 60034-12 design N designation.

NOTE Where locked rotor apparent power requirements in accordance with IEC 60034-12 Table 2 cannot be achieved, design NE may be provided.

Add new subclause

9.12.1.2

For motors with a rated power greater than 110 kW, the declared locked rotor current shall not exceed 7.5 times the rated current.

NOTE For motors rated 110 kW or less, the maximum locked rotor apparent power shall be in accordance with IEC 60034-12.

Add new subclause

9.12.1.3

At 80 % of rated voltage at the motor terminals, by means of direct-on-line starting, the motor shall achieve rated speed at rated load, without exceeding maximum temperature rise.

Add new subclause

9.12.2 Re-starting

Motors shall withstand the following, without exceeding the steady state temperature at rated load:

- three starts in succession from cold conditions, coasting to rest between starts;
- two starts from hot at rated conditions.

Add new subclause

9.12.3 Re-acceleration

Motors shall withstand re-acceleration with 100 % residual voltage and in total phase opposition to the supply voltage.

Add new subclause heading

9.13 Noise

Add new subclause

9.13.1

Without secondary noise abatement measures, the motor maximum A-weighted sound power level (LWA) at no-load and rated speed shall not exceed the values defined in IEC 60034-9, Table 2.

Add new subclause

9.13.2

Noise measurements shall be in accordance with ISO 1680.

Add new subclause heading

9.14 Motor efficiency

Add new subclause

9.14.1

All duty type S1 motors for single-speed use shall have a minimum rated efficiency class of IE3 in accordance with IEC 60034-30-1.

Add new subclause

9.14.2

All converter-fed motors shall have a minimum rated efficiency class of IE2 in accordance with IEC TS 60034-30-2.

10 Rating plates

10.1 General

Add new subclause

10.1.1

Rating and marking plates shall be made of 316L stainless steel.

Add new subclause

10.1.2

Rating and marking plates shall be attached to a non-removable part of the motor frame with stainless steel 316L fixings.

Add new subclause

10.1.3

Rating and marking plates shall have the required information (see 10.2) stamped or engraved.

10.2 Marking

Replace list item aa) with

aa) The total mass of the motor, if exceeding 25 kg.

Add new list item ee)

ee) D-end and N-end bearing type.

11 Miscellaneous requirements

11.1 Protective earthing of motors

Replace third paragraph with

Motors of all frame sizes shall have a terminal for the earthing conductor fitted internally within the terminal box.

Add to subclause after third paragraph

Motors of frame size greater than 71 shall have an ISO metric thread earthing terminal fitted externally on the frame body.

Add new subclause heading

11.3 Motor construction

Add new subclause heading

11.3.1 Housing

Add new subclause

11.3.1.1

For motors with a rated power greater than 0.55 kW, frames, stator end-shields and bearing housings shall be constructed from cast iron.

Add new subclause

11.3.1.2

Fan covers shall be constructed from ferrous metal.

Add new subclause

11.3.1.3

Motors with a fully assembled mass greater than 25 kg shall be provided with frame mounted lifting lugs or lifting eye bolts.

Add new subclause heading

11.3.2 Rotor

Add new subclause

11.3.2.1

Rotors shall be balanced with a half-key fitted in the shaft key-way in accordance with IEC 60034-14 and ISO 21940-32.

Add new subclause

11.3.2.2

Rotors shall be balanced in accordance with ISO 21940-11 to meet the limits of maximum vibration magnitude specified in the data sheet, in accordance with IEC 60034-14, Table 1.

NOTE For converter-fed motors, maximum vibration magnitude is applicable throughout the speed range defined in the data sheet.

Add new subclause

11.3.2.3

Both rotor shaft ends shall be provided with an ISO metric threaded hole to facilitate removal of couplings and bearing races.

Add new subclause heading

11.3.3 Fan

Add new subclause

11.3.3.1

Where a corrosivity category of CX has been specified in the data sheet, fan impellers shall not be constructed from aluminium.

Add new subclause

11.3.3.2

Where fan balancing is required, fans external to the stator frame end shields shall be individually balanced prior to fitting to the rotor shaft.

Add new subclause

11.3.3.3

Fan impellers external to the stator frame shall be keyed to the rotor shaft.

Add new subclause heading

11.3.4 Terminal box

Add new subclause

11.3.4.1

The line conductor terminal box shall permit cable entry from at least three directions, 90° apart, excluding the motor drive end.

Add new subclause

11.3.4.2

Terminal boxes shall be of the same material as the motor frame.

Add new subclause

11.3.4.3

Threaded gland entries shall have a metric thread in accordance with IEC 60423, Table 1.

Add new subclause

11.3.4.4

Gland entries shall be fitted with blanking plugs to maintain the ingress protection rating of the motor during transportation and storage.

Add new subclause

11.3.4.5

Where single core line conductor cable entries have been specified, gland plates shall be of a non-magnetic material.

Add new subclause

11.3.4.6

For converter-fed motors, provisions for 360° high frequency earthing shall be provided where cables enter the terminal box.

Add new subclause

11.3.4.7

For converter-fed motors, conductive gaskets shall be provided.

Add new subclause heading

11.3.5 Bearings

Add new subclause

11.3.5.1

Motors with a frame size 132 or less shall have grease lubricated anti-friction bearings, packed and sealed for life.

Add new subclause

11.3.5.2

Bearings shall be C3 type in accordance with ISO 5753-1, Table 1, Group 3.

Add new subclause

11.3.5.3

Horizontally mounted motor bearings shall have a minimum L_{10h} bearing design lifetime of 50 000 hours in accordance with ISO 281 when the radial and axial load values defined in the data sheet are not exceeded.

Add new subclause

11.3.5.4

Vertically mounted motor bearings shall have a minimum L_{10h} bearing design lifetime of 40 000 hours in accordance with ISO 281 when the radial and axial load values defined in the data sheet are not exceeded.

Add new subclause

11.3.5.5

Where specified in the data sheet, stainless steel SPM (shock pulse monitoring) nipples shall be provided on the D-end and N-end of the motor.

Add new subclause

11.3.5.6

For converter-fed motors with a frame size of 160 or greater, the N-end bearing shall be insulated from the rotor shaft to prevent circulating currents.

Add new subclause heading

11.3.6 Space heaters

Add new subclause

11.3.6.1

Motors shall only be provided with space heaters where specified in the data sheet.

NOTE When advised by the manufacturer that space heaters are necessary for the specified site conditions, motors may be provided with space heaters.

Add new subclause

11.3.6.2

Space heaters shall be rated for operation at the heater supply a.c. voltage specified in the data sheet.

Add new subclause

11.3.6.3

Space heaters shall maintain the surface temperature of the stator windings at not less than 5 K above ambient air temperature to maintain the integrity of the insulation system at minimum ambient air temperature.

Add new subclause

11.3.6.4

Where space heater terminals are incorporated in the motor line conductor terminal box, a dedicated separate space heater earth terminal shall be provided within the terminal box.

Add new subclause

11.3.6.5

A label shall be fixed externally to the terminal box containing the heater terminals, warning that heater terminals may be live when the motor is isolated.

Add new subclause

11.3.6.6

Where space heater terminals are incorporated in the motor line conductor terminal box, the space heater terminals shall be rated a minimum of IP2X.

Add new subclause heading

11.4 Mounting

Add new subclause

11.4.1 Mounting arrangement

Motors shall have a mounting arrangement in accordance with one of the following, defined in IEC 60034-7:

- for horizontal shaft, foot mounted motors with one cylindrical shaft extension: IM B3 (IM 1001);
- for horizontal shaft, flange mounted motors with one cylindrical shaft extension: IM B5 (IM 3001);
- for vertical shaft, foot mounted motors with one cylindrical shaft extension: IM V6 (IM 1031);
- for vertical shaft, flange mounted motors with one cylindrical shaft extension: IM V1 (IM 3011);
- for vertical shaft, foot mounted motors with one flanged shaft extension: IM V6 (IM 1035);
- for vertical shaft, flange mounted motors with one flanged shaft extension: IM V1 (IM 3015).

NOTE For applications not described above, other mounting arrangements may be specified.

Add new subclause

11.4.2 Vertically mounted motors

Vertically mounted motors with a downward facing drive-end shaft shall be provided with a canopy over any upward facing air inlets.

Add new subclause

11.5 Methods of cooling

Motors intended for outdoor use shall be of a totally enclosed fan-cooled design.

Add new subclause heading

11.6 Surface finish

Add new subclause

11.6.1

For onshore applications, the protective paint system corrosivity category shall be a minimum of C3 in accordance with ISO 12944-2.

Add new subclause

11.6.2

For offshore exterior applications, the protective paint system corrosivity category shall be CX in accordance with ISO 12944-2.

Add new subclause

11.6.3

The protective paint system durability category shall be a minimum of “medium” in accordance with ISO 12944-1.

Add new subclause heading

11.7 Temperature monitoring

Add new subclause

11.7.1

For single-speed motors with a frame size greater than 315 and all converter-fed motors, one PTC thermistor shall be embedded in each stator phase winding hot spot.

NOTE For single-speed motors with a frame size greater than 315, where the user has evaluated that temperature monitoring is not required, this may be specified.

Add new subclause

11.7.2

For motors with a frame size of 160 or greater, temperature monitoring devices shall be wired to a separate terminal box mounted on the motor frame.

Add new subclause heading

11.8 Additional requirements for converter-fed motors

Add new subclause

11.8.1

Where a converter-fed motor is required the motor shall comply with IEC TS 60034-25.

Add new subclause

11.8.2

For converter-fed motors the stated continuous motor output ratings shall be in accordance with IEC 61800-2, 4.3.3.2.

Add new clause heading

15 Motors intended for use in potentially explosive atmospheres

Add new subclause heading

15.1 General

Add new subclause

15.1.1

Motors for use in potentially explosive atmospheres shall be in accordance with IEC 60079 series.

Add new subclause

15.1.2

Motors with a defined equipment protection level of EPL Ga, EPL Gb or EPL Gc shall be supported with an equipment certificate issued by a notified body or certification body, to the scheme specified in the data sheet.

Add new subclause

15.1.3

Motors shall be certified for use in gaseous atmospheres for temperature group T3 as a minimum and for gases in group IIB as a minimum.

Add new subclause

15.1.4

Motors shall be designed, constructed, tested and marked to one of the following:

- Ex db the motor shall comply with IEC 60079-1;
- Ex db eb the motor shall comply with IEC 60079-1 and IEC 60079-7;
- Ex eb the motor shall comply with IEC 60079-7;
- Ex ec the motor shall comply with IEC 60079-7.

Add new subclause heading

15.2 Flameproof (type Ex db)

Add new subclause

15.2.1

On motors with a defined equipment protection level of Ex db eb, all terminal boxes shall have an equipment protection level of Ex eb.

Add new subclause

15.2.2

A drain fitted with a certified drain plug shall be provided at the motor enclosure low points when mounted at the designated IM orientation.

Add new subclause

15.3 Converter-fed motors

Where type test certification is unavailable for the duty of a converter-fed motor, means of temperature control by embedded temperature sensors for limiting the surface temperature of the motor housing shall be provided.

Registered Office

City Tower
40 Basinghall Street
14th Floor
London EC2V 5DE
United Kingdom

T +44 (0)20 3763 9700
F +44 (0)20 3763 9701
reception@iogp.org

Brussels Office

Bd du Souverain,165
4th Floor
B-1160 Brussels
Belgium

T +32 (0)2 566 9150
F +32 (0)2 566 9159
reception@iogp.org

Houston Office

10777 Westheimer Road
Suite 1100
Houston, Texas 77042
United States

T +1 (713) 470 0315
reception@iogp.org

| www.iogp.org

