International Association of Oil & Gas Producers

SPECIFICATION
S-704

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Supplementary Specification to IEC 60034-1 High Voltage Three-phase Cage Induction Motors

JIP33
JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
1.0	January 2021	Issued for Use

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).

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 high 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-704: Supplementary Specification to IEC 60034-1 High 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-704D: Data Sheet for High Voltage Three-phase Cage Induction Motors (IEC)

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-704Q: Quality Requirements for High Voltage Three-phase Cage Induction Motors (IEC)

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-704L: Information Requirements for High Voltage Three-phase Cage Induction Motors (IEC)

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 high voltage three-phase 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 form-wound stator coil a.c. squirrel cage induction type;

– have a rated power 100 kW or greater;

– have a rated voltage above 1 kV;

– have 2, 4, 6 or 8 poles;

– are air- or water-cooled;

– have rolling element bearings, sleeve bearings or tilted pad thrust bearings;

– are for single-speed use or are converter-fed.

Add new subclause

1.3 Motors excluded from scope

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

– wire-wound motors rated at a voltage below 1 kV;

– submersible, subsea, canned or hermetically sealed motors;

– d.c. motors;

– synchronous motors, including permanent magnet motors.

Add new subclause

1.4 Extended use of this specification

This specification may be used as a basis for the purchase of electric motors that 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 with 10 poles or more;

– induction generators;

– form-wound motors with a rated voltage below 1 kV;

– multi-speed motors;

– reverse-speed motors;

– motors with magnetic bearings.

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

2 Normative references

Add to clause

ANSI/NEMA MG 1:2016, *Motors and Generators*

API Recommended Practice 686:2009, *Recommended Practice for Machinery Installation and Installation Design*

API Standard 541:2014, *Form-wound Squirrel Cage Induction Motors—375 kW (500 Horsepower) and Larger*

API Standard 670, *Machinery Protection Systems*

IEC 60034-2-1:2014, *Standard methods for determining losses and efficiency from tests (excluding machines for traction vehicles)*

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

IEC 60034-8:2014, *Terminal markings and direction of rotation*

IEC 60034-14, *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 60034-27-1, *Rotating electrical machines – Part 27-1: Off-line partial discharge measurements on the winding insulation*

IEC 60034-27-3, *Dielectric dissipation factor measurement on stator winding insulation of rotating electrical machines*

IEC 60034-27-4, *Measurement of insulation resistance and polarization index of winding insulation of rotating electrical machines*

IEC 60034-28:2012, *Rotating electrical machines – Part 28: Test methods for determining quantities of equivalent circuit diagrams for three-phase low-voltage cage induction motors*

IEC 60079 (all parts), *Explosive atmospheres*

IEC 60079-7:2017, *Explosive atmospheres – Part 7: Equipment protection by increased safety "e"*

IEC 60204-1:2016, *Safety of machinery – Electrical equipment of machines – Part 1: General requirements*

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

IEC 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

IEC 61800-4:2002, *Adjustable speed electrical power drive systems – Part 4: General requirements – Rating specifications for a.c. power drive systems above 1 000 V a.c. and not exceeding 35 kV*

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

IEC TS 60034-32, *IEEE Guide for Testing Turn Insulation of Form-Wound Stator Coils for Alternating-Current Electric Machines*

IEEE 112:2017, *IEEE Standard Test Procedure for Polyphase Induction Motors and Generators*

IEEE 522, *IEEE Guide for Testing Turn Insulation of Form-Wound Stator Coils for Alternating-Current Electric Machines*

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 5593:2019, *Rolling bearings — Vocabulary*

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*

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 21940-12, *Mechanical vibration — Rotor balancing — Part 12: Procedures and tolerances for rotors with flexible behaviour*

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 electric motor which is designed originally for main supply

[SOURCE: IEC TS 60034-25: 2014, 3.5, modified: removed "within the scope of IEC 60034-12" and replaced "electrical machine" with "electric motor"]

Add new term

3.35
D-end
drive end of a motor, that end of the motor connected to the driven equipment

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

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.

[SOURCE: IEC 60050-411: 1996, 411-43-37, modified: Note 1 to entry added and "machine" replaced with "motor"]

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

Add new term

3.39
form-wound winding
winding consisting of coils or bars which are preformed to shape, insulated and substantially completed before they are inserted into their final places

Note 1 to entry: Coils or bars are usually wound with rectangular conductors.

[Source IEC 60034-18-1:2010, 3.1.8]

Add new term

3.40
maximum continuous operating speed
highest rotational speed at which the motor, as-built and tested, is defined for continuous operation, expressed as revolutions per minute [min^{-1}]

Add new term

3.41
minimum continuous operating speed
lowest rotational speed at which the motor, as-built and tested, is defined for continuous operation, expressed as revolutions per minute [min^{-1}]

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

6.4 Minimum ambient air temperature

Replace subclause with

The ambient air temperature shall not be less than -15 °C.

Add new subclause

6.8 Degree of ingress protection

6.8.1

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

6.8.2

A condensation drain hole with a removable plug shall be provided at the motor enclosure low point(s).

Add new subclause

6.9 Degree of impact protection

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

7 Electrical operating conditions

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 at a supply voltage with harmonic content not exceeding the specified power supply quality.

Add to subclause

For converter-fed motors, the winding system qualification and tests shall comply with IEC 60034-18-42.

7.5 Voltage (peak and gradient) withstand levels

Replace fourth paragraph with

When sample coils have been specified, testing shall comply with IEC 60034-15.

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 for 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 for the motor rated output at maximum ambient air temperature, this may be provided.

Add to subclause

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

8.6 Determination of winding temperature

8.6.1 Choice of method

Delete second paragraph

Delete third paragraph

8.6.2 Determination by resistance method

8.6.2.3 Correction for stopping time

8.6.2.3.2 Short stopping time

Replace first paragraph with

Short stopping time shall be determined by the following steps.

a) Obtain initial resistance reading after stabilization of the measuring device and within 120 seconds of switching off power.

b) Take additional readings at 30 second intervals over a period of 5 minutes following the first reading.

c) Calculate the resistance value at the time of switching off power by means of extrapolation.

d) Use the resistance value at the time of switching off power to confirm the winding temperature.

e) Resistance measured between the same windings for all readings.

Table 6 – Time interval

Delete Table 6

8.6.2.3.3 Extended stopping time

Delete subclause 8.6.2.3.3

9 Other performance and tests

9.1 Routine tests

Replace subclause with

Add new subclause

9.1.1 General

9.1.1.1

Routine tests shall be performed at the factory of the manufacturer.

9.1.1.2

The motor shall be fully assembled with the exception of components that are not significant for testing.

9.1.1.3

Shims used for alignment shall be full-bearing in accordance with API Recommended Practice 686:2009, 5.4.2.4.

9.1.1.4

A "soft feet" check shall be made prior to running tests in accordance with API Standard 541:2014, 6.3.1.16.

Add new subclause

9.1.2 Motors with sleeve bearings

9.1.2.1

Factory tests shall be carried out with the specified lube oil grade at the specified lube oil temperature.

9.1.2.2

During vibration severity tests, the lube oil inlet temperature shall be adjusted to the maximum specified operating temperature.

9.1.2.3

Before and after the heat run and vibration severity tests, the following data shall be plotted during coastdown from maximum continuous operating speed to 10 % of rated speed:

– synchronous vibration amplitude, one per revolution;

– overall vibration amplitude;

– phase angle versus speed.

9.1.2.4

The contact between the shaft journal and the bearing bore shall be a minimum of 80 % of the axial length and symmetrical, with no edge loading or metal transfer between the shaft and the bearing.

NOTE When running tests have been completed, the shaft journals and bearings are inspected by completely removing both the top and bottom halves of each sleeve bearing.

9.1.2.5

When bearing modification or replacement is undertaken during testing, bearing related tests shall be repeated so that bearing performance is reassessed.

NOTE Cosmetic repairs, such as the removal of scratches which do not otherwise affect motor performance, are not a cause for retesting.

9.1.2.6

Shaft vibration displacement at filtered frequencies below the running-speed frequency shall not exceed 2,5 µm peak-to-peak or 20 % of the measured unfiltered vibration displacement, whichever is greater.

9.1.2.7

Shaft vibration displacement at filtered frequencies above the running-speed frequency shall not exceed 12,5 µm peak-to-peak.

9.1.2.8

Shaft vibration displacement filtered at the running-speed frequency with run-out compensated shall not exceed 80 % of the unfiltered specified limits.

9.1.2.9

The magnitude of the vectorial change in the 1X vibration on the shaft and bearing housings, when operated at running speed after the overspeed tests, shall not exceed 10 % of the unfiltered specified vibration limits.

NOTE 1X vibration is where vibration cycles per minute equals motor min^{-1}.

9.1.2.10

Single-speed motors shall be tested in accordance with Table 16A.

9.1.2.11

Converter-fed motors shall be tested in accordance with Table 16B.

9.1.2.12

Special testing shall be performed as specified and in accordance Table 16C.

Table 16 – Minimum routine tests for machines assembled and tested in the factory of the manufacturer

Replace Table 16 with Tables 16A, 16B and 16C

Add new Table 16A

Table 16A – Single-speed motor tests

Number	Test description	Reference standard	Motors with a rated power less than 400 kW	Motors with a rated power 400 kW and above
1	Air-gap measurement between stator and rotor [h]	API Std 541:2014, 4.4.7.2.4	No	Routine
2	Measurement of ohmic resistance of stator winding referred to 20 °C	IEC 60034-2-1:2014, 5.7.1	Routine	Routine
3	Insulation resistance pre-test	IEC 60034-27-4	Routine	Routine
4	Check of phase sequence, direction of rotation and terminal markings	IEC 60034-8:2014, 6.7	Routine	Routine
5	No-load losses and current test at rated frequency [b]	IEC 60034-2-1:2014, 6.1.3.2.4	Routine	Routine
6	No-load characteristic (saturation curve) at rated frequency [k]	IEC 60034-2-1:2014, 6.1.3.2.4	No	Enhanced routine [a]
7	Locked rotor current test [l]	IEC 60034-28:2012, 6.6.3	Routine	Routine
8	Locked rotor torque test	IEEE 112, 7.2.2	No	Enhanced routine [a]
9	Temperature rise test at full load	IEC 60034-1, Clause 8 or IEC 60034-29 [i]	Enhanced routine [a]	Enhanced routine [a]
10	Performance test at rated frequency at 100 %, 75 % and 50 % load [c]	IEC 60034-2-1:2014, 6.1.3.2.3	Enhanced routine [a]	Enhanced routine [a]
11	Vibration severity test at no-load (for the rated speed) [d e f]	9.1.2.3	Routine	Routine
12	Overspeed test	9.1.2.9 and IEC 60034-1:2017, 9.7	No	Routine
13	Measurements of shaft voltage at no-load	IEEE 112:2017, 8.3	Routine	Routine
14	Determination of magnetic centre (where sleeve bearings are provided)	API 541:2014, 4.4.9.3	N/A	Routine
15	Sleeve bearing inspection	9.1.2.4 and API Std 541:2014, 6.3.2.1	N/A	Routine
16	Bearing temperature rise at no load and rated speed	API Std 541:2014, 6.3.2	Routine	Routine
17	Shock pulse monitoring recording	Manufacturer's standard	Routine	N/A
18	Withstand voltage test	IEC 60034-1:2017, 9.2	Routine	Routine
19	Insulation resistance and polarization index of stator windings - post withstand voltage test	IEC 60034-27-4	Routine	Routine

Table 16A *(continued)*

Number	Test description	Reference standard	Motors with a rated power less than 400 kW	Motors with a rated power 400 kW and above
Auxiliary devices				
20	Functional tests of all auxiliary devices	Manufacturer's standard	Routine	Routine
21	Withstand voltage tests on RTDs, space heaters and insulated bearings where applicable	IEC 60034-1:2017, 9.2	Routine	Routine
22	Insulation resistance tests on RTDs and space heaters where applicable	IEC 60204-1:2016, 18.3	Routine	Routine
23	Insulation resistance insulated bearings	IEEE 112:2017, 8.4	Routine	Routine
Air-to-water heat exchangers				
24	Hydrostatic pressure test of heat exchanger tubing [j]	As per design code [g]	Routine	Routine

[a] Where a number of identical motors are purchased as a batch, an enhanced routine test is performed on a single motor only.

[b] No stabilization of temperature required for measurement of no-load losses.

[c] Performance test to include determination of power factor, efficiency, current balance and slip.

[d] Contact vibration sensors shall be used, forming the basis for acceptance.

[e] For rolling element bearings, test facilities shall include the capability to continuously monitor, display, record, and print vibration speeds.

[f] For sleeve bearings, test facilities shall include the capability to continuously monitor, display, record, and print vibration displacements and phase, vibration spectra, bode plots and shaft orbits.

[g] Heat exchanger design code to be confirmed by the supplier.

[h] Ex db motors are exempt from this test and an air gap calculation shall be performed.

[i] IEC 60034-29 shall be used as the reference standard where testing to IEC 60034-1 is restricted due to the physical size of the motor.

[j] Air to water heat exchanger testing is performed at the heat exchanger manufacturer's premises.

[k] The no-load characteristic shall be measured up to a minimum of 125 % of rated voltage.

[l] A minimum of 3 measurement points shall be recorded.

Add new Table 16B

Table 16B – Converter-fed motor tests

Number	Test description	Reference standard	Motors with a rated power less than 400 kW	Motors with a rated power 400 kW and above
1	Air-gap measurement between stator and rotor [h]	API Std 541:2014, 4.4.7.2.4	No	Routine
2	Measurement of ohmic resistance of stator winding referred to 20 °C	IEC 60034-2-1:2014, 5.7.1	Routine	Routine
3	Insulation resistance pre-test	IEC 60034-27-4	Routine	Routine

Table 16B *(continued)*

Number	Test description	Reference standard	Motors with a rated power less than 400 kW	Motors with a rated power 400 kW and above
4	Check of phase sequence, direction of rotation and terminal markings	IEC 60034-8:2014, 6.7	Routine	Routine
5	No-load losses and current test at rated frequency [b]	IEC 60034-2-3	Routine	Routine
6	No-load losses and current test at minimum continuous operating speed	IEC 60034-2-3	Routine	Routine
7	No-load losses and current test at maximum continuous operating speed	IEC 60034-2-3	Routine	Routine
8	No-load characteristic (saturation curve) at rated frequency [k]	IEC 60034-2-1:2014, 6.1.3.2.4	No	Enhanced routine [a]
9	Temperature rise test at rated torque and rated frequency	IEC 60034-1:2017, Clause 8 or IEC 60034-29 [i]	Enhanced routine [a]	Enhanced routine [a]
10	Temperature rise at maximum torque at minimum continuous operating speed	IEC 60034-1:2017, Clause 8 or IEC 60034-29 [i]	No	Enhanced routine [a]
11	Temperature rise test at maximum torque at maximum continuous operating speed	IEC 60034-1:2017, Clause 8 or IEC 60034-29 [i]	No	Enhanced routine [a]
12	Performance test at rated frequency at 100 %, 75 % and 50 % load [c]	IEC 60034-2-3	Enhanced routine [a]	Enhanced routine [a]
13	Performance test at minimum continuous operating speed at 100 %, 75 % and 50 % of motor continuous torque capability for this speed [c]	IEC 60034-2-3	No	Enhanced routine [a]
14	Performance test at maximum continuous operating speed at 100 %, 75 % and 50 % of motor continuous torque capability for this speed [c]	IEC 60034-2-3	No	Enhanced routine [a]
15	Vibration severity test at no-load (for the whole operating speed range and during coast down) [d, e, f]	9.1.2.3	Routine	Routine
16	Overspeed test	9.1.2.9 and IEC 60034-1:2017, 9.7	No	Routine
17	Measurements of shaft voltage at no-load	IEEE 112:2017, 8.3	Routine	Routine
18	Determination of magnetic centre (where sleeve bearings are used)	API Std 541:2017, 4.4.9.3	No	Routine

Table 16B *(continued)*

Number	Test description	Reference standard	Motors with a rated power less than 400 kW	Motors with a rated power 400 kW and above
19	Sleeve bearing inspection (where sleeve bearings are used)	9.1.2.4 and API Std 541:2017, 6.3.2.1	Routine	Routine
20	Bearing temperature rise at no load and rated speed	API Std 541:2017, 6.1.2	Routine	Routine
21	SPM recording (where rolling element bearings are provided)	Manufacturer's standard	Routine	N/A
22	Withstand voltage test	IEC 60034-1:2017, 9.2	Routine	Routine
23	Insulation resistance and polarization index of stator windings – post withstand voltage test	IEC 60034-27-4	Routine	Routine
Auxiliary devices				
24	Functional tests of all auxiliary devices	Manufacturer's standard	Routine	Routine
25	Withstand voltage tests on RTDs, space heaters and insulated bearings where applicable	IEC 60034-1:2017, 9.2	Routine	Routine
26	Insulation resistance tests on RTDs and space heaters where applicable	IEC 60204-1:2017, 18.3	Routine	Routine
27	Insulation resistance insulated bearings	IEEE 112:2017, 8.4	Routine	Routine
Air-to-water heat exchangers				
28	Hydrostatic pressure test of heat exchanger tubing [j]	As per design code [g]	Routine	Routine

[a] Where a number of identical motors are purchased as a batch, an enhanced routine test is performed on a single motor only.

[b] No stabilization of temperature required for measurement of no-load losses.

[c] Performance test to include determination of power factor, efficiency, current balance and slip.

[d] Contact vibration sensors shall be used, forming the basis for acceptance.

[e] For rolling element bearings, test facilities shall include the capability to continuously monitor, display, record, and print vibration speeds.

[f] For sleeve bearings, test facilities shall include the capability to continuously monitor, display, record, and print vibration displacements and phase, vibration spectra, bode plots and shaft orbits.

[g] Heat exchanger design code to be confirmed by the supplier.

[h] Ex db motors are exempt from this test and an air gap calculation shall be performed.

[i] IEC 60034-29 shall be used as the reference standard where testing to IEC 60034-1 is restricted due to the physical size of the motor.

[j] Air to water heat exchanger testing may be performed at the heat exchanger manufacturer's premises.

[k] The no-load characteristic shall be measured up to a minimum of 125 % of rated voltage.

Add new Table 16C

Table 16C – Special tests

Number	Test description (selected in data sheet where required)	Reference standard
1	Noise level at no load	9.16
2	Measurement of moment of inertia	Manufacturer's standard
3	Measurement of torque and current as function of speed from standstill to synchronous speed (for single-speed motors)	IEEE 112:2017, 7.3.2
4	Measurement of axial shaft displacement	Manufacturer's standard
5	Dielectric dissipation test (tan δ) on stator windings	IEC 60034-27-3
6	Partial discharge test on complete stator	IEC 60034-27-1
7	Sealed winding conformance test	ANSI/NEMA MG 1:2016, Part 20
8	Unbalanced response test	API Std 541:2017, 6.3.5.3
9	Bearing housing natural frequency test	API Std 541:2017, 6.3.5.4
10	Stator core test	API Std 541:2017, 6.3.4.1
11	Surge test	IEEE 522
12	Measurement of stator end-winding structural dynamics at standstill	IEC TS 60034-32
Sample coils		
13	Impulse voltage withstand tests of sample coils	IEC 60034-15
14	Dielectric dissipation tests (tan δ) of sample coils	IEC 60034-27-3
15	Partial discharge test of sample coils	IEC 60034-27-1
NOTE Tests are performed at rated frequency, voltage and speed where applicable.		

9.4 Momentary excess torque for motors

9.4.1 Polyphase induction motors and d.c. motors

Delete seventh paragraph

Table 19 – Overspeeds

In Table 19 header row, replace "Machine" with "Motor"

Add row 1e) to Table 19

Item	Motor type	Overspeed
1e)	Converter-fed three-phase cage induction motor > 1 000 V	1,2 times rated speed or 1,05 times maximum continuous operating speed, whichever is greater

Add new subclause

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

9.12.1 Starting

9.12.1.1

For motors without specific starting requirements, the declared locked-rotor current shall be between 4 and 6,5 times the rated current.

NOTE Motors with locked-rotor currents of less than 4 times the rated current may compromise performance characteristics such as efficiency, breakdown torque and rotor thermal stability. Caution should be applied when specifying a motor with a locked-rotor current less than 4 times the rated current.

9.12.1.2

The motor shall be designed to start and accelerate the connected load to running speed with 80 % of rated voltage at the motor terminals.

9.12.1.3

The torque-speed characteristic of the motor at rated frequency with 80 % rated voltage applied at the motor terminals shall have an accelerating torque margin above the load torque-speed curve of at least 10 % of the motor torque curve.

9.12.1.4

Running-up times shall be calculated using inertia values and torque-speed characteristics of the driven equipment.

9.12.1.5

At 80 % of rated voltage at the motor terminals, the minimum hot locked-rotor time shall be at least 5 seconds more than the time required to accelerate the specified driven load.

9.12.2 Re-starting

9.12.2.1

Motors shall withstand three starts in succession, coasting to rest between starts, from cold conditions.

9.12.2.2

Motors shall withstand two starts in succession, coasting to rest between starts, from hot conditions.

9.12.2.3

Motors driving a quadratic torque-speed characteristic load shall be capable of re-acceleration under rated conditions following a power interruption not exceeding 0,2 seconds.

9.12.2.4

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

9.12.2.5

Motors shall be designed for a minimum of 1 000 starts per year.

9.12.3 Transient air-gap torques

9.12.3.1

The bracing of end windings shall withstand a three-phase short-circuit current for 0,2 seconds at the motor terminals.

9.12.3.2

The rotor shaft and active iron core systems shall withstand a two-phase short-circuit current for 0,2 seconds.

Add new subclause

9.13 Pulsating stator current

Driven loads requiring variable torque during each revolution shall have a combined inertia of rotating parts to limit the stator current variation to 40 % of the motor rated current.

Add new subclause

9.14 Critical speeds

9.14.1

Rigid-shaft rotors shall incur the first bending critical speed at least 15 % above the rated speed or maximum continuous operating speed for converter-fed motors.

9.14.2

Flexible-shaft rotors shall incur a critical speed separation margin of at least 15 % below minimum continuous operating speed and 15 % above the maximum continuous operating speed.

Add new subclause

9.15 Motor efficiency

For 2 pole and 4 pole motors, compliance with Table 22 shall be confirmed at the rated voltage and frequency in accordance with IEC 60034-2-1:2014, Table 2.

NOTE 6 pole and 8 pole motor efficiency is declared by the manufacturer.

Add new Table 22

Table 22 – Motor efficiency

Power rating in kW	2 pole motor efficiency %	4 pole motor efficiency %
185	94.2	94.6
200	94.5	94.7
220	94.7	95.1
250	95.1	95.2
280	95.3	95.4
300	95.4	95.5
315	95.5	95.5
335	95.6	95.6
355	95.7	95.7
375	95.8	95.8
400-500	96.0	96.0
530-570	96.2	96.2
800-950	96.4	96.4
≥1 000	96.5	96.5

Add new subclause

9.16 Noise

9.16.1

Secondary noise abatement measures shall not be used for compliance with the specified maximum permissible sound pressure level.

9.16.2

Noise measurements shall be in accordance with ISO 1680.

10 Rating plates

10.1 General

Add new subclause

10.1.1

Rating and marking plates shall be 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 information stamped or engraved.

10.2 Marking

Replace list item aa) with

aa) The total mass of the motor.

Add new list item ee)

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

Add new list item ff)

ff) Equipment tag number.

Add new list item gg)

gg) Bearing lubricant specification.

11 Miscellaneous requirements

11.1 Protective earthing of motors

Replace fourth paragraph with

Motors shall have at least one ISO metric thread earthing terminal fitted externally on the frame and a means inside each terminal box for connecting a conducting cable sheath.

Add new subclause

11.3 Motor construction

11.3.1 General

11.3.1.1

The motor shall be constructed with components and materials of a proven design with a minimum service of two years.

11.3.1.2

Obsolete components or those scheduled for discontinuation within ten years shall not be provided.

11.3.2 Enclosure

11.3.2.1

Motor enclosures shall be constructed from cast iron or fabricated steel.

11.3.2.2

Motor frame dimensions shall be in accordance with IEC 60072.

11.3.2.3

Fan covers shall be constructed from ferrous metal.

11.3.2.4

Motors shall be provided with frame mounted lifting lugs or lifting eyebolts.

11.3.2.5

Foot-mounted motors of frame size 400 and above shall be provided with jacking facilities to align the motor with the driven equipment.

11.3.2.6

When a corrosivity category of C4 or greater has been specified, external screws, bolts, nuts and washers of a thread diameter 10 mm or less shall be 316L stainless steel.

11.3.2.7

When a corrosivity category of C4 or greater has been specified, external screws, bolts, nuts and washers with a thread diameter greater than 10 mm shall be hot-dip galvanized.

11.3.2.8

When a corrosivity category of C4 or greater has been specified, grease nipples shall be 316L stainless steel.

11.3.2.9

Non-Ex db motors with a frame size 630 and above shall have removable covers for inspection of the air gap in a minimum of three positions, at least 90° apart.

11.3.2.10

Motors shall be free of structural resonances on their permanent foundations with a safety margin of at least 15 % within the operating speed range for one and two times electrical motor power frequency.

11.3.2.11

Motors shall be free of structural resonances on their permanent foundations with a safety margin of at least 15 % within the operating speed range for one and two times mechanical rotating frequency.

11.3.2.12

For motors with sleeve bearings, there shall be no structural resonances between 40 % and 60 % of the operating speed range.

11.3.3 Windings

11.3.3.1

Windings shall be of a form-wound global fully vacuum pressure impregnated (VPI) construction.

11.3.3.2

The stator winding system, including connections and terminal lead extensions, shall be supported, wedged or braced to prevent insulation cracking.

11.3.3.3

Conductors connected between stator coils and terminals bushings shall permit movement of the stator during start up and thermal expansion.

11.3.3.4

Winding connections except those completed in the main terminal box shall be brazed using a silver-based brazing material.

11.3.3.5

Coils shall be insulated by mica tape.

11.3.3.6

Stator coils and terminals shall have uniform insulation levels throughout the winding length.

11.3.3.7

For motors with a rated voltage of 3 kV and above, windings shall be provided with an anti-corona protection system in the slot of the coil.

11.3.3.8

For motors with a rated voltage of 4 kV and above, field stress grading tape shall also be used for anti-corona protection.

11.3.4 Rotor

11.3.4.1

The shaft shall be made from one of the following:

– hot-rolled and normalized steel;

– cold-rolled steel;

– a single billet of heat-treated forged steel.

11.3.4.2

Where shaft keys are provided, rotors shall be balanced with a half-key fitted in the shaft keyway in accordance with IEC 60034-14 and ISO 21940-32.

11.3.4.3

Rotors with rigid shaft characteristics shall be balanced in accordance with ISO 21940-11 to meet the limits of the maximum vibration magnitude specified.

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

11.3.4.4

Rotors with flexible shaft characteristics shall be balanced in accordance with ISO 21940-12 to meet the limits of the maximum vibration magnitude specified.

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

11.3.4.5

Rotor shaft ends shall be provided with an ISO metric threaded hole to facilitate coupling and rolling element bearing removal.

11.3.5 Fan

11.3.5.1

When a corrosivity category greater than C3 has been specified, fan impellers external to the stator end shields shall not be aluminium.

11.3.5.2

When fan balancing is required, fans external to the stator end shields shall be balanced independently to the rotor shaft.

11.3.5.3

Fan impellers external to the stator end shields shall be keyed or shrink fitted to the rotor shaft.

11.3.5.4

Unidirectional fans shall be provided with an engraved arrow indicating the direction of rotation.

11.3.6 Terminal boxes

11.3.6.1

Line conductor terminal boxes shall be constructed from steel with a minimum nominal thickness of 3 mm.

11.3.6.2

Threaded cable glands shall have a metric thread in accordance with IEC 60423:2007, Table 1.

11.3.6.3

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

11.3.6.4

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

11.3.6.5

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

11.3.6.6

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

11.3.6.7

When winding partial discharge monitoring is specified, the partial discharge sensing elements shall be located in the line conductor terminal box.

11.3.6.8

When winding partial discharge monitoring is specified, a dedicated terminal box shall be provided for partial discharge sensing element cable termination.

11.3.6.9

When a star point terminal box is specified, it shall be located on the opposite side of the motor from the line conductor terminal box.

11.3.6.10

When a star point terminal box is specified, disconnecting links between phases shall be provided to facilitate testing of individual phase windings.

11.3.6.11

For non-Ex db line conductor terminal boxes, a diaphragm shall be incorporated in the terminal box to relieve pressure caused by an electrical fault.

11.3.6.12

Pressure relief diaphragm discharge shall be directed away from locations where personnel may be present.

11.3.6.13

Pressure relief diaphragms shall be made from one of the following:

– corrosion-resistant material;

– material with corrosion-resistant plating;

– material treated for the specified environmental conditions.

NOTE It is expected that the corrosion resistance is comparable to the motor enclosure surface protection system.

11.3.6.14

When the termination system is not fully insulated, a connection point on each phase and earth terminal shall be provided for the attachment of the portable earthing device specified.

11.3.6.15

Terminal box covers weighing more than 25 kg shall be provided with hoisting attachments or be vertically hinged.

11.3.6.16

Terminal boxes shall not be provided with top entries.

11.3.7 Bushings and terminations

11.3.7.1

Line conductor bushings and post insulators shall be polyurethane resin or epoxy casting resin.

11.3.7.2

Single-speed motor bushings and insulators shall withstand the dynamic and thermal effects of the specified maximum prospective short-circuit current for at least 0,2 seconds.

11.3.8 Bearings

11.3.8.1 General

11.3.8.1.1

Bearings shall be one of the following type:

– grease-lubricated rolling element bearings;

– oil-lubricated sleeve bearings;

– oil lubricated tilted pad thrust bearings.

11.3.8.1.2

Rolling element bearings shall not be used for 2 pole motors when the rated power is greater than 750 kW.

11.3.8.1.3

Rolling element bearings shall not be used for 4 pole motors when the rated power is greater than 1 000 kW.

11.3.8.1.4

At least one 3-wire Pt-100 temperature detector shall be provided per bearing.

11.3.8.2 Bearing insulation

11.3.8.2.1

The N-end bearing shall be electrically insulated from the rotor shaft.

11.3.8.2.2

When the D-end and N-end bearings are insulated, a shaft grounding system shall be provided at the D-end of the rotor shaft.

NOTE A shaft grounding system may be provided at the N-end of the rotor shaft if an insulated coupling has been specified.

11.3.8.3 Sleeve bearings

11.3.8.3.1

Sleeve bearing liner replacement shall be possible without disassembly of the coupling or the motor.

11.3.8.3.2

Sleeve bearings shall be of a split construction for ease of assembly.

11.3.8.3.3

Self-lubricated sleeve bearings shall be provided with an oil level indicator.

11.3.8.3.4

When a lube oil re-circulation system is within the scope of supply, an oil flow indicator shall be provided.

11.3.8.3.5

Sleeve bearings with a ring lubricating system shall allow visual inspection of the oil ring operation while the motor is running.

11.3.8.3.6

Sleeve bearings shall be spherical seated and self-aligning.

11.3.8.3.7

The magnetic centre and the limits of permissible shaft axial movement shall be permanently marked on the rotor to facilitate observation of the rotor position relative to these marks at all times.

11.3.8.3.8

Each sleeve bearing shall have two permanently installed non-contacting proximity probes in accordance with API Standard 670.

11.3.8.3.9

The sleeve bearing metal temperature shall not exceed 93 °C.

11.3.8.3.10

For force lubricated systems with an oil outlet temperature of 50 °C or below, the oil passing through the bearing shall not exceed a temperature rise of 20 °C.

11.3.8.3.11

The self-lubricated sleeve bearing oil sump temperature shall not exceed 80 °C.

11.3.8.3.12

Sleeve bearings shall not require jacking oil prior to the motor starting.

11.3.8.4 Rolling element bearings

11.3.8.4.1

Grease lubricated rolling element bearings lubrication intervals shall be 4 000 hours or greater for horizontal motors and 2 000 hours or greater for vertical motors.

11.3.8.4.2

Rolling element bearings shall be C3 type in accordance with ISO 5753-1:2009, Table 1, Group 3.

11.3.8.4.3

Horizontally mounted motor bearings shall have a minimum L10h bearing design lifetime of 50 000 hours in accordance with ISO 281.

11.3.8.4.4

Vertically mounted motor bearings shall have a minimum L10h bearing design lifetime of 40 000 hours in accordance with ISO 281.

11.3.8.4.5

Motors with rolling element bearings and a rated power of less than 400 kW shall be provided with one stainless steel SPM (shock pulse monitoring) nipple per bearing.

11.3.8.4.6

Motors with rolling element bearings and a rated power equal to or greater than 400 kW shall be provided with one permanently installed accelerometer per bearing.

11.3.8.4.7

Where accelerometers are not provided, the motors shall have two clearly marked positions, X and Y, at each bearing housing with a flat surface for mounting of a magnetic portable accelerometer.

11.3.8.4.8

Non-regreaseable rolling element bearings shall be greased, packed and equipped with double metallic shields or double rubber seals according to ISO 5593:2019, Figure 2, Figure 8 or Figure 44.

11.3.8.4.9

Re-lubrication of regreaseable bearings shall be possible while the motor is running.

11.3.8.4.10

A synthetic base oil grease with structural stability in the presence of water shall be used in rolling element bearings.

11.3.9 Space heaters

11.3.9.1

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

11.3.9.2

A dedicated space heater terminal box shall be provided for space heater terminals.

11.3.9.3

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

11.4 Mounting

11.4.1 Mounting arrangement

Motor mounting arrangements shall be in accordance with IEC 60034-7.

11.4.2 Vertically mounted motors

11.4.2.1

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

11.4.2.2

Vertically mounted motors with an upward facing D-end shaft shall be provided with a seal in addition to the bearing seal to prevent moisture ingress through the D-end bearing.

11.4.3 Mounting surfaces and alignment

11.4.3.1

Mounting surfaces shall be machined to a finish of at least 6,3 µm arithmetic average roughness (Ra).

11.4.3.2

Mounting surfaces shall be machined within a flatness of 40 µm per linear meter of mounting surface.

11.4.3.3

Mounting surfaces shall be in the same horizontal plane within 125 µm.

11.4.3.4

The upper machined or spot faced surface shall be parallel to the mounting surface.

11.4.3.5

Different mounting planes shall be parallel to each other within 0,17 mm per metre.

11.4.3.6

Horizontal motor mounting planes shall be parallel to the horizontal plane through the bearing centreline within 0,17 mm per metre.

11.4.3.7

The mounting surface on a vertical motor shall be machined perpendicular to the centreline of the motor.

11.4.3.8

The mounting surface on a vertical motor shall not deviate from the perpendicular plane by more than 0,17 mm per metre.

11.4.3.9

Hold-down bolt holes shall be drilled perpendicular to the mounting surfaces of the motor.

11.4.3.10

Hold-down bolt holes shall be machined or spot faced to a diameter of at least two times that of the bolt hole.

11.4.3.11

Hold-down bolt holes shall be 13 mm larger in diameter than the hold-down bolt.

11.4.3.12

Load-bearing washers shall remain in 360° contact with the mounting faces when the machine is aligned in its extreme position where the bolt is touching one side of its clearance hole.

11.4.3.13

Frame supports shall be provided with two vertical pilot holes for the installation of alignment dowels.

Add new subclause

11.5 Methods of cooling

11.5.1 Cooling method

Motors shall have one of the cooling methods listed in Table 23, in accordance with IEC 60034-6.

Add new Table 23

Table 23 – Cooling method

Cooling method	Code
Frame surface cooled motors using surrounding medium with self-circulation of secondary coolant	IC4A1A1
Motors with an integral heat exchanger using surrounding medium with self-circulation of secondary coolant	IC5A1A1
Motors with a machine mounted heat exchanger using surrounding medium with self-circulation of secondary coolant	IC6A1A1
Motors with a machine mounted heat exchanger using remote medium with self-circulation of primary coolant	IC7A1W7
Motors with a machine mounted heat exchanger using surrounding medium with self-circulation of primary coolant	IC8A1W7

11.5.2 Cooling enclosure

When provided, motor-mounted heat exchanger enclosures shall be of steel construction.

11.5.3 Air to air heat exchangers

A Pt-100 temperature detector shall be provided to monitor heat exchanger outlet air temperature.

11.5.4 Air to water cooling

11.5.4.1

Facilities for high point bleeding and low point draining of the cooling system shall be provided.

11.5.4.2

The heat exchanger shall prevent the entry of water into the motor components, whether by leakage or condensation.

11.5.4.3

A minimum of 20 % spare tubes shall be installed to permit plugging of leaking tubes.

11.5.4.4

A cooling water leakage detection system shall be provided.

11.5.4.5

A facility for the collection of coolant leakage with drainage shall be provided.

11.5.4.6

3-wire Pt-100 temperature detectors shall be provided to monitor the heat exchanger inlet and outlet air temperatures.

11.5.4.7

When a water cooling medium other than sea water has been specified, as a minimum, single copper-nickel tubing shall be provided.

11.5.4.8

When sea water cooling medium has been specified, double copper-nickel tubing or single titanium tubing shall be provided.

11.5.5 Inlet protection

When a corrosivity category of C4 or greater has been specified, the cooling-air inlet protection mesh shall be 316L stainless steel.

Add new subclause

11.6 Surface finish

11.6.1

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

11.6.2

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

11.6.3

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

Add new subclause

11.7 Temperature detection

11.7.1

At least two 3-wire Pt-100 temperature detectors in accordance with IEC 60751 shall be embedded at the anticipated hot spot in each stator phase winding.

11.7.2

Temperature detectors shall be wired to a separate terminal box mounted on the motor frame.

11.7.3

When temperature detector surge arrestors are provided, they shall be installed in the temperature detector terminal box.

Add new subclause

11.8 Differential protection

When specified, differential current transformers shall be wired to a separate terminal box mounted on the motor frame.

Add new subclause

11.9 Bonding

Motors shall have bonding straps across joints within or between the steel main enclosure, including the bed plate and heat exchanger, when provided.

Add new subclause

11.10 Additional requirements for converter-fed motors

11.10.1 General

Converter-fed motors shall comply with IEC TS 60034-25.

11.10.2

The stated continuous motor output ratings for converter-fed motors shall be in accordance with IEC 61800-4:2002, 6.1.3.

Add new subclause

11.11 Lateral analysis

When specified, lateral analysis shall be carried out for FAT (rigid workshop floor) and final site conditions (flexible skid or foundation) in accordance with API Standard 541:2014, 4.4.6.2.1.

Add new subclause

11.12 Torsional analysis

11.12.1

When specified, torsional analysis shall be performed in accordance with API Standard 541:2014, 4.4.6.2.2.

11.12.2

When specified, torsional analysis of converter-fed motors shall be performed in accordance with API Standard 541:2014, 4.4.6.2.2 and IEC 61800-4:2002, 9.4.

Add new clause

15 Motors intended for use in potentially explosive atmospheres

15.1 General

15.1.1

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

15.1.2

Motors with an equipment level of Gc or Dc shall be provided with a certificate issued by a notified body or a certification body.

NOTE A manufacturer's certificate of conformity alone does not satisfy this requirement.

15.1.3

Motors for use in potentially explosive atmospheres shall be certified for temperature class T3 as a minimum.

15.1.4

Motors for use in potentially explosive atmospheres shall be certified for gases in group IIB as a minimum.

15.1.5

Motors shall have one of the protection systems in Table 24.

Add new Table 24

Table 24 – Protection system

Protection system	International standard
Ex db	IEC 60079-1
Ex db eb	IEC 60079-1 and IEC 60079-7
Ex eb	IEC 60079-7
Ex ec	IEC 60079-7
Ex pxb	IEC 60079-2
Ex pzc	IEC 60079-2
Ex pxb eb	IEC 60079-2 and IEC 60079-7

15.1.6

Motor electrical subcomponents shall be certified for an explosion protection level and explosive atmosphere conditions no less onerous than those specified for the motor.

15.2 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.

15.3 Flameproof (type Ex db)

15.3.1

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

15.3.2

A drain fitted with a certified drain plug shall be provided at the motor enclosure low point(s).

15.4 Pressurized (type Ex pxb and Ex pzc)

15.4.1

The motor pressurization control system shall be certified to an EPL equal to the motor.

15.4.2

The purge and pressurization system shall provide a remote indication output for connection to the end user's integrated system for the "purge complete" condition.

15.4.3

The purge and pressurization system shall provide a remote indication output for connection to the end user's integrated system for the "pressurized" condition.

15.4.4

The purge and pressurization system shall provide a remote indication output for connection to the end user's integrated system for the "pressure fail" condition.

15.5 Increased Safety (type Ex eb and Ex ec)

When the motor air gap sparking assessment as defined in IEC 60079-7:2017, 5.2.7.3 has a total sum of determining factors greater than 6, the motor or a representative sample shall be tested in accordance with IEC 60079-7:2017, 6.2.3.2.

Registered Office
City Tower
Level 14
40 Basinghall Street
London EC2V 5DE
United Kingdom

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

Brussels Office
Avenue de Tervuren 188A
B-1150 Brussels
Belgium

T +32 (0)2 790 7762
reception-europe@iogp.org

Houston Office
15377 Memorial Drive
Suite 250
Houston, TX 77079
USA

T +1 (713) 261 0411
reception-americas@iogp.org

www.iogp.org