BS EN ISO 10439-3:2015

BSI Standards Publication

Petroleum, petrochemical and natural gas industries — Axial and centrifugal compressors and expander-compressors

Part 3: Integrally geared centrifugal compressors

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National foreword

This British Standard is the UK implementation of EN ISO 10439-3:2015. Together with BS EN ISO 10439-1:2015, BS EN ISO 10439-2:2015 and BS EN ISO 10439-4:2015, it supersedes BS EN ISO 10439:2002, which will be withdrawn upon publication of all parts of the series.

The UK participation in its preparation was entrusted by Technical Committee MCE/8, Compressors, pneumatic tools, pneumatic machines and vacuum technology, to Subcommittee MCE/8/-/1, Compressors - Safety.

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CEN-CENELEC Management Centre: Avenue Marnix 17, B-1000 Brussels

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Foreword

This document (EN ISO 10439-3:2015) has been prepared by Technical Committee ISO/TC 118 "Compressors and pneumatic tools, machines and equipment" in collaboration with Technical Committee CEN/TC 12 “Materials, equipment and offshore structures for petroleum, petrochemical and natural gas industries” the secretariat of which is held by AFNOR.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by August 2015, and conflicting national standards shall be withdrawn at the latest by August 2015.

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Endorsement notice

The text of ISO 10439-3:2015 has been approved by CEN as EN ISO 10439-3:2015 without any modification.

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Introduction

This International Standard is based on the 7th edition of the American Petroleum Institute standard API 617.

Users of this International Standard should be aware that further or differing requirements might be needed for individual applications. This International Standard is not intended to inhibit a supplier from offering or the purchaser from accepting alternative equipment or engineering solutions for the individual application. This can be particularly appropriate where there is innovative or developing technology. Where an alternative is offered, the supplier should identify any variations from this International Standard and provide details.

A asterisk (*) at the beginning of the paragraph of a clause or subclause indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on data sheets or stated in the enquiry or purchase order (see examples in Annex A, ISO 10439-2:2015, Annex A, and ISO 10439-4:2015, Annex A).

This International Standard includes the following annexes:

— Annex A: Datasheets

— Annex B: Vendor (Supplier) data and drawing requirements (VDDR)

— Annex C: Nomenclature

— Annex D: Typical materials for integrally geared compressors

— Annex E: Inspector's checklist

— Annex F: External forces and moments

— Annex G: Rating formulae for integral gearing

Annex A and Annex G form a normative part of this part of ISO 10439. Annexes B to F are for information only.

In this International Standard, where practical, US customary units are included in parentheses for information.

INTERNATIONAL STANDARD ISO 10439-3:2015(E)

Petroleum, petrochemical and natural gas industries — Axial and centrifugal compressors and expander-compressors —

Part 3: Integrally geared centrifugal compressors

1 Scope

This part of ISO 10439 specifies minimum requirements and gives recommendations for axial compressors, single-shaft and integrally geared process centrifugal compressors, and expander-compressors for special purpose applications that handle gas or process air in the petroleum, petrochemical, and natural gas industries. This part of ISO 10439 specifies integrally geared centrifugal compressors in conjunction with ISO 10439-1.

NOTE 1 See API 672 for packaged plant instrument air compressors.

NOTE 2 Expander stages are sometimes provided on these machines.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 5389, *Turbocompressors — Performance test code*

ISO 8068, *Lubricants, industrial oils and related products (class L) — Family T (Turbines) — Specification for lubricating oils for turbines*

ISO 10439-1, *Petroleum, petrochemical and natural gas industries — Axial and centrifugal compressors and expander-compressors — Part 1: General requirements*

API 670, *Machinery protection systems*

AGMA 2015-1-A01, *Accuracy classification system — Tangential measurements for cylindrical gears*

AGMA 2101-D04, *Fundamental rating factors and calculation methods for involute spur and helical gear teeth*

ASME PTC 10-1997, *Performance test code on compressors and exhausters*

3 Terms, abbreviated terms, and definitions

For the purposes of this document, the terms, abbreviated terms, and definitions given in ISO 10439-1 apply.

NOTE A cross-section showing nomenclature of an integrally geared centrifugal compressor is included in Annex C.

4 General

4.1 Dimensions and units

The dimensional and unit requirements shall be in accordance with ISO 10439-1.

4.2 Statutory requirements

The statutory requirements shall be in accordance with ISO 10439-1.

4.3 Unit responsibility

The unit responsibilities shall be in accordance with ISO 10439-1.

4.4 Basic design

4.4.1 Performance

4.4.1.1 The sectional head-capacity characteristic curve of each compressor section shall rise continuously from the rated point to predicted surge. The compressor, without the use of a bypass, shall be suitable for continuous operation at any capacity at least 10 % greater than the predicted surge capacity shown in the proposal.

4.4.1.2 Unless otherwise specified, the design lubricant shall be hydrocarbon oil of viscosity Grade 32 with an FZG load stage of 5, in accordance with ISO 8068. Viscosity Grade 46 with an FZG load stage of 5 can be used as a design lubricant, with the purchaser's approval. Oils with extreme pressure (EP) additives shall not be used.

NOTE Typical oil used in refineries and chemical plants has an FZG of 5 or higher. Requiring a higher FZG by design can require the need for special oil for this equipment.

4.5 Materials

Materials shall be in accordance with ISO 10439-1:2015, 4.5.

NOTE Refer to Annex D for typical materials.

4.6 Casings

Casings shall be in accordance with ISO 10439-1:2015, 4.6 and 4.6.1 to 4.6.6.

4.6.1 Pressure-containing casings

4.6.1.1 * The maximum allowable working pressure of each pressure casing shall be at least equal to the specified relief valve set pressure for that casing. The purchaser will specify the relief valve set pressure(s) for final discharge pressure and intermediate casing pressures, if applicable.

NOTE If only one relief valve pressure is specified, its set pressure does not usually apply to the intermediate pressure.

4.6.1.1.1 When a relief valve set pressure is not specified, each pressure casing shall be rated for at least 125 % of the maximum specified discharge pressure (gauge) of that pressure casing as determined by the supplier. System protection shall be furnished by the purchaser.

4.6.1.2 Socket-head or spanner-type bolting shall not be used externally unless specifically approved by the purchaser. For limited space locations, integrally flanged fasteners might be required.

4.6.2 Casing repair

Casings repairs shall be in accordance with ISO 10439-1:2015, 4.6.2.

4.6.3 Material inspection of pressure-containing parts

Casing material inspection of pressure-containing parts shall be in accordance with ISO 10439-1:2015, 4.6.3.

4.6.4 Pressure casing connections

Pressure casing connections shall be in accordance with ISO 10439-1:2015, 4.6.4 and 4.6.4.1 and 4.6.4.2.

4.6.4.1 Main process connections

Main process connections shall be in accordance with ISO 10439-1:2015, 4.6.4.2.

4.6.4.2 Auxiliary connections

4.6.4.2.1 If flanged or machined and studded openings are impractical, threaded connections can be used where they do not come in contact with flammable or toxic gas, with the purchaser's approval as follows:

a) on non-weldable materials, such as cast iron;

b) where essential for maintenance (disassembly and assembly).

These threaded openings shall be as specified in ISO 10439-1:2015, 4.6.4.3.8.

4.6.4.2.2 Auxiliary connections shall be at least DN 20 (NPS 3/4-in). See 4.11.1.7 to 4.11.1.8 and Table 1 for auxiliary gearbox connections.

NOTE See ISO 10439-1:2015, 4.6.4.1.3 for allowable connection sizes.

4.6.4.2.3 Threaded connections for pipe sizes DN 20 (NPS 3/4-in) to DN 40 (NPS 1-1/2-in) size are permissible with the approval of the purchaser.

NOTE See ISO 10439-1:2015, 4.6.4.1.3 for allowable connection sizes.

4.6.5 Casing support structure

The mounting of the pressure casing (volute) to the gearbox shall be in accordance with ISO 10439-1:2015, 4.4.1.7. Bolting used to mount pressure casings shall be in accordance with ISO 10439-1:2015, 4.6.1.7.

4.6.6 External forces and moments

4.6.6.1 The supplier shall furnish the allowable forces and moments for each main process nozzle which has a customer connection in tabular form with the proposal. If nozzle loadings are not furnished, they shall be no less than NEMA SM23.

NOTE 1 Forces and moments allowed on integrally geared compressors are generally less than those allowed in ISO 10439-2 compressors (see Annex F).

NOTE 2 Piping system design needs to be rigorous in order to avoid piping expansion joints.

4.6.6.2 Pressure casing and supports shall be designed to have sufficient strength and rigidity to avoid adversely affecting impeller running clearances, gear contact pattern, seals, bearings, and coupling alignment.

4.6.7 Variable inlet and/or diffuser guide vanes

4.6.7.1 * Adjustable guide vanes shall be provided when specified or required by the supplier to meet specified operating conditions.

4.6.7.2 When provided, adjustable inlet guide vanes and operating mechanisms shall be suitable for all specified operating conditions, as well as start-up, shutdown, trip-out, settling-out, and momentary surge.

4.6.7.2.1 Guide vanes shall be mounted in replaceable bushings. Vanes can be positioned in the housing by replaceable permanently sealed rolling element bearings, if approved by the purchaser.

4.6.7.2.2 When adjustable guide vanes are used for toxic, flammable, or explosive process gas, then the linkage passing through the casing or enclosure shall be sealed to prevent leakage.

4.6.7.2.3 The inlet guide vanes shall be located sufficiently close to the eye of the impeller to be effective.

4.6.7.2.4 The vane foils shall have an aerodynamically smooth surface, especially where the shank enters the gas stream through the housing. A cantilevered design in lieu of a centre-supported vane design is preferred.

4.6.7.2.5 The vanes shall be designed such that the vanes will tend to open on loss of the control signal.

4.6.7.2.6 A vane control system consisting of a valve positioner with direct driven local position indicator shall be provided that will be visible during operation of the machine.

4.6.7.2.7 * Additional components to the vane control system in 4.6.7.2.6 shall be as specified.

4.6.7.3 * If specified, the actuation shaft seal shall be buffered using a barrier gas.

4.7 Rotating elements

4.7.1 Each impeller and shaft shall be clearly marked with a unique identification number. This number shall be on an accessible area that is not prone to maintenance damage.

4.7.2 Unless other shaft protection is approved by the purchaser, renewable components shall be furnished at close clearance points. Sleeves, spacers, or bushings shall be made of materials that are corrosion-resistant in the specified service (see ISO 10439-1:2015, 4.5.1.6 for limitations).

4.7.2.1 Shaft sleeves shall be provided under shaft end seals. Sleeves shall be treated to resist wear and sealed to prevent gas leakage between the shaft and sleeve.

4.7.3 Thrust loads from impellers and gears shall be absorbed by individual thrust bearings on pinions or transmitted to the bull gear thrust bearing by means of thrust rider rings fixed to the pinions and bull gear. All specified operating conditions and start-up conditions shall be evaluated for residual thrust loads.

NOTE Balance pistons are normally not used. Thrust balancing can be achieved by helix thrust force direction of the gearing and offsetting impeller aerodynamic thrust forces.

4.7.4 Impeller requirements shall be in accordance with ISO 10439-1:2015, 4.7.10.

4.8 Dynamics

Dynamics requirements shall be in accordance with ISO 10439-1.

4.8.1 For equipment covered in this part of ISO 14039, a lateral analysis shall be carried out for each shaft. For the bull gear, this shall consist only of an undamped critical speed map.

4.9 Bearings and bearing housings

Bearings and bearing housings shall be in accordance with 4.9.1 to 4.9.4 and ISO 10439-1:2015, 4.9.

4.9.1 General

4.9.1.1 Unless otherwise specified, radial and thrust bearings shall be of the hydrodynamic fluid film type.

4.9.1.2 Unless otherwise specified, thrust bearings and radial bearings shall be fitted with bearing-metal temperature sensors installed in accordance with API 670.

4.9.1.2.1 As design criteria, bearing metal temperatures shall not exceed 100 °C (212 °F) at specified operating conditions with a maximum oil inlet temperature of 50 °C (120 °F).

4.9.1.2.2 In the event the design criteria in 4.9.1.2.1 cannot be met, the purchaser and the supplier shall agree on acceptable bearing metal temperatures.

4.9.2 Hydrodynamic radial bearings

4.9.2.1 Sleeve or pad radial bearings shall be used and shall be split for ease of assembly. The use of non-split designs requires the purchaser's approval. The bearings shall be precision bored with steel, copper, cupro-nickel, or bronze-backed babbitted liners, pads, or shells. The bearings shall be equipped with anti-rotation pins and shall be positively secured in the axial direction.

4.9.2.2 * If specified, tilting pad bearing pads shall be copper-alloy backed.

4.9.2.3 * Unless otherwise specified, the liners, pads, or shells shall be in axially split housings. The bearing design shall not require removal of the coupling hub to permit replacement of the bearing liners, pads, or shells unless approved by the purchaser.

4.9.3 Hydrodynamic thrust bearings

4.9.3.1 Thrust bearings can be fixed-geometry (e.g. tapered-land) or tilting-pad type, steel-backed and babbitted, arranged for continuous pressurized lubrication to each side.

NOTE See 4.7.3 for thrust rider rings.

4.9.3.2 If specified, bearings shall be tilting pad on one or both sides.

4.9.3.3 Hydrodynamic thrust bearings shall be selected at no more than 50 % of the bearing manufacturer's ultimate load rating. In sizing thrust bearings, consider the following for each specified application:

a) the shaft speed;

b) the temperature of the bearing babbitt;

c) the deflection of the bearing pad;

d) the minimum oil film thickness;

e) the feed rate, viscosity, and supply conditions of the oil over the specified allowable oil supply condition range;

f) the design configuration of the bearing;

g) the babbitt or other bearing surface material alloy and pad material;

h) the turbulence of the oil film;

i) load changes due to process changes over the specified operating range.

NOTE See ISO 10439-1:2015, 3.1.60 for a definition of ultimate load rating for hydrodynamic thrust bearings.

4.9.3.4 Thrust bearings shall be sized for continuous operation under the most adverse specified operating conditions. Calculations of the thrust forces shall include, but shall not be limited to, the following factors:

a) seal maximum design internal clearances and twice the maximum design internal clearances;

b) pressurized rotor diameter step changes;

c) stage maximum differential pressures;

d) specified extreme variations in inlet, interstage, and discharge pressures;

e) the maximum thrust force that can be transmitted to the compressor thrust bearing by other equipment in the train (i.e. couplings, gears, or a motor without a thrust bearing);

f) the maximum thrust force from the sleeve bearing type drive if the motor or generator is directly connected.

4.9.4 Bearing housings

4.9.4.1 The term bearing housing refers to all bearing enclosures including the gearbox.

4.9.4.2 Bearing housings for pressure-lubricated hydrodynamic bearings shall be arranged to minimize foaming. The drain system shall be adequate to maintain the oil and foam level below shaft seals.

4.9.4.3 Oil reservoirs and housings that enclose moving lubricated parts (such as bearings and shaft seals), highly polished parts, instruments, and control elements shall be designed to minimize contamination by moisture, dust, and other foreign matter during periods of operation and idleness.

4.9.4.4 Provision shall be made in the bearing housings for the probes specified in 5.5.7.1.

4.10 Shaft end seals

4.10.1 Process seals and seal systems shall be in accordance with ISO 10439-1:2015, 4.10.

NOTE 1 Typical cross sections of various seal systems are given in ISO 10439-1:2015, Annex B.

NOTE 2 Equipment covered in this part can be available with any of the shaft end seal types covered in ISO 10439-1 or additional hybrid types are available.

4.10.2 * The purchaser shall specify the type of shaft end seal(s) to be provided and all operating conditions including start-up, shutdown, and settling-out conditions.

4.11 Integral gearing

4.11.1 The supplier shall dowel or key the gearbox to the mounting plate to maintain alignment.

NOTE Integrally geared compressors are fixed to the mounting plate and are not to be moved for alignment (to avoid distortion of the gearbox).

4.11.1.1 To the maximum extent practical, gearboxes shall be designed with internal oil passages to minimize external piping. External piping connections shall conform to the requirements of ISO 10439-1:2015, 4.6.4.3.

4.11.1.2 The design of internal piping and tubing shall achieve proper support and protection to prevent damage from vibration or from shipment, operation, and maintenance. Cantilevered piping in excess of 10 pipe diameters shall include reinforcing gussets in two planes at all pipe-to-flange connections.

4.11.1.3 The gearbox shall be designed to permit rapid drainage of lube oil and to minimize oil foaming (which could lead to excessive heating of the oil). For gears with pitch line velocities of more than 125 m/s (25 000 ft/min), consideration should be given to design features such as windage baffles, false bottoms, adequate sump depth, and an additional full-size drain connection.

4.11.1.4 A removable and gasketed inspection cover or covers shall be provided in the gearbox to permit direct visual inspection of the full-face width of the pinion(s) and gear. The inspection opening or openings shall be at least one-half the width of the gear face.

4.11.1.5 Permanent coatings or paint shall not be applied to the interior of the casing, unless the purchaser approves in advance the material and method of application.

4.11.1.6 A single lube-oil supply connection is preferred.

4.11.1.7 A single lube-oil drain connection from the gear casing is preferred. The minimum drainpipe size shall be sized to be no more than half full and shall be based on the total inlet flow to the gear casing, as shown in Table 1.

Table 1 — Drain pipe sizes

Inlet flow rate		**Minimum drain size**[a]	
Litres per minute	US Gallons per minute	Millimetres	Inch
74	19	50	2
176	46	75	3
370	97	100	4
1 146	302	150	6

[a] Nominal pipe size.

4.11.1.8 Gearboxes shall be provided with a plugged or flanged-and-blinded purge gas connection.

4.11.2 Gearbox split lines shall use a metal-to-metal joint. Adequate sealing shall be provided with a suitable joint compound or groove-type seals. Gaskets (including string type) shall not be used on the gearbox split lines.

4.11.3 Gear rating

4.11.3.1 When a gearbox has a gear mesh with a ratio of 7:1 or greater, all of the gearing in that gearbox shall be rated in accordance with Annex G. All other gear sets shall be rated per API 613.

4.11.3.2 The rated power of the gearing shall not be less than the driver nameplate rating multiplied by the driver service factor. When there are multiple pinions, the power rating of the gear sets shall not be less than the following:

a) 110 % of the maximum power transmitted by the gear set.

b) The maximum power of the driver (including service factor) prorated between all the gear sets, based on normal power demands. If the maximum transmitted torque occurs at a continuous operating speed other than the maximum continuous speed, this torque and its corresponding speed shall be the basis for sizing the gear set.

4.11.3.3 The power rating based upon both pitting resistance and bending strength shall be calculated for each member of each gear set in the unit. The pinion and bull gear teeth can have different ratings due to differences in material properties, geometry factors, and number of cycles under load. The lowest of the four ratings (pinion bending, pinion pitting, bull gear bending, bull gear pitting) shall be used as the gear rating (see Annex G). Wherever possible, gear sets shall be designed such that failure will occur due to pitting rather than bending (i.e. wear out before breaking).

NOTE Higher gear ratios require a large number of teeth; therefore, it might not be possible to provide tooth design (which will fail in pitting rather than bending) without compromising other aspects of the gear design (i.e. higher pitchline velocities).

4.11.3.4 Gearing shall be designed and manufactured to meet the requirements of AGMA 2015-1-A01, accuracy Grade 4.

NOTE For equivalent loading conditions, gearing produced to higher quality levels will always result in longer service life and reduced bearing loads.

4.11.3.5 The manufacturer shall provide documentation showing that the required quality levels in 4.11.3.4 have been met.

4.11.3.6 The pinion face width to working pitch diameter ratio (L/d ratio) shall be limited based on pinion tooth hardness, as follows:

4.11.3.6.1 For pinion hardness equal to or less than 38 Rc (BHN 354), L/d shall be limited to 2,0 maximum.

4.11.3.6.2 For pinion hardness equal to or greater than 58 Rc (BHN 615), L/d shall be limited to 1,6 maximum.

4.11.3.6.3 For pinion hardness between 38 and 58 Rc (BHN 354 and BHN 615), L/d shall be limited to $L/d = 2{,}76 - 0{,}02 \times H$ (see Figure 1), where H is the hardness in Rockwell C.

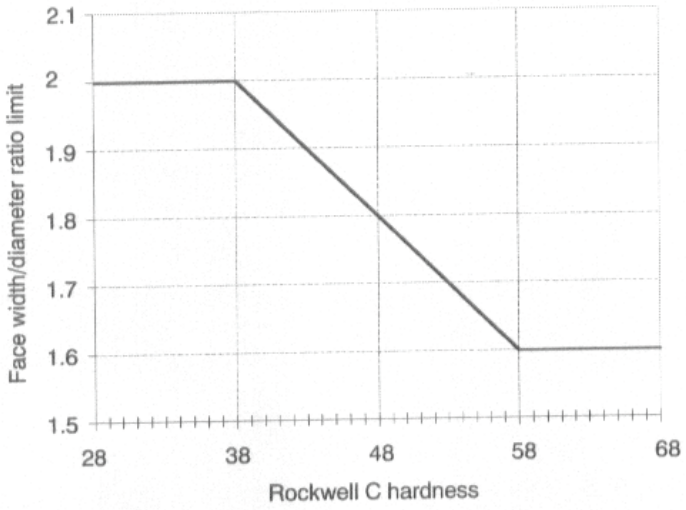

Figure 1 — Face width limit

4.11.3.7 The material used for gearing shall meet the specifications for AGMA 2101 Grade 2 material, as a minimum. If a superior grade of material is used, credit for the better material shall not be taken in the gear rating.

4.11.3.8 The tooth portion of pinions shall be integral with their shafts.

4.11.3.9 The bull gear can be integral with or separate from its shaft. Separate shafts shall be assembled into the bull gear with an interference fit suitable for all torque requirements including pulsations.

4.11.3.10 Shafts shall be made of one-piece, heat-treated steel that is suitably machined. Shafts that have a finished diameter larger than 200 mm (8 in) shall be forged steel. Shafts that have a finished diameter of 200 mm (8 in) or less shall be forged steel or hot rolled barstock, providing such barstock meets all quality and heat treatment criteria established for shaft forgings.

4.11.3.11 Gearboxes shall not require a break-in period.

4.11.3.12 The gearing shall be designed to withstand all internal and external loads inherent to geared, rotating machinery systems to the limit of the installed driver.

4.11.3.13 The unplated tooth surface on loaded faces of completed gears shall have a finish, as measured along the pitch line, of 0,8 µm (32 µin) Ra or better.

4.11.3.14 Hunting tooth combinations are preferred. To achieve this, it can be necessary for the manufacturer to adjust the exact gear ratio. If such adjustment is impractical, the purchaser and the supplier shall negotiate a solution. At least one mesh shall be hunting tooth.

NOTE A hunting tooth combination is preferred because the intent is for every tooth on a pinion to mesh with as many teeth as possible on the mating gear before the same teeth mesh again or repeat. However, with multiple pinion units, a hunting tooth combination is not as critical because the gear wheel meshes with multiple pinions and is, therefore, not as susceptible to the problems of non-hunting tooth designs.

4.11.3.15 Each gear and each pinion shall be supported between two bearings. Overhung designs are not permitted.

4.12 Nameplates and rotation arrows

4.12.1 Nameplates and rotation arrows shall be in accordance with 4.12.2 and 4.12.3 and ISO 10439-1:2015, 4.12.

4.12.2 The following data shall be clearly stamped or engraved on the nameplate(s):

a) supplier's name;

b) serial number;

c) size, type, and model;

d) rated capacity;

e) rated power;

f) gear ratio;

g) rated input speed or speed range for variable speed driver;

h) purchaser item number;

i) maximum allowable working pressure of each pressure-containing casing;

j) maximum and minimum allowable working temperature of each pressure-containing casing;

k) hydrostatic test pressure for each pressure-containing casing;

l) maximum sealing pressure of each pressure-containing casing.

NOTE Normally, multiple nameplates are provided.

4.12.3 Rotation arrows shall be cast-in or attached for the bull gear rotation at a readily visible location.

NOTE See ISO 10439-1:2015, 4.12.

5 Accessories

Accessories shall be in accordance with ISO 10439-1:2015, Clause 5.

5.1 Drivers

Drivers shall be in accordance with ISO 10439-1:2015, 5.1.

5.2 Couplings and guards

Couplings and guards shall be in accordance with ISO 10439-1:2015, 5.2.

5.3 Lubrication and sealing systems

Lubrication and sealing systems shall be in accordance with ISO 10439-1:2015, 5.3.

5.4 Mounting plates

Mounting plates shall be in accordance with ISO 10439-1:2015, 5.4.

5.4.1 * If specified or approved by the purchaser, the oil reservoir shall be integral with the baseplate.

5.4.2 * If specified, the baseplate shall have a series of machined mounting pads suitable for mating to field-installed soleplates to facilitate installation.

NOTE See API RP 686 2nd edition, Annex C, Figure C.1.

5.4.3 * If specified, when machined mounting pads as indicated in 5.4.2 have been specified, the supplier shall also supply the soleplates needed for field installation.

5.5 Controls and instrumentation

5.5.1 Controls and instrumentation shall be in accordance with ISO 10439-1:2015, 5.5.

5.5.2 Control systems

5.5.2.1 * For a constant-speed centrifugal compressor, the control signal shall actuate either a purchaser-furnished control valve in the compressor inlet piping or the adjustable inlet guide vanes or variable diffuser vanes furnished by the supplier as an integral part of the compressor, as specified.

5.5.2.2 If adjustable inlet guide vanes or variable diffuser vanes are specified, the supplier shall also furnish a guide-vane positioner compatible with the type of control signal specified by the purchaser.

5.5.2.3 * If specified, the guide vane positioner shall include a local manual override. A direct-driven vane position indicator that will be visible during operation of the machine shall be provided.

5.5.3 Instrument and control panels, when supplied, shall be in accordance with ISO 10439-1:2015, 5.5.3.

5.5.4 Instrumentation, when supplied, shall be in accordance with ISO 10439-1:2015, 5.5.4.

5.5.5 Alarms and shutdowns, when supplied, shall be in accordance with ISO 10439-1:2015, 5.5.5.

5.5.6 Electrical systems, when supplied, shall be in accordance with ISO 10439-1:2015, 5.5.6.

5.5.7 Vibration, position, and bearing temperature.

5.5.7.1 Unless otherwise specified, the following transducers shall be provided: two radial-vibration probes adjacent to each radial bearing, two axial-position probes for each shaft equipped with a thrust bearing, and a one-event-per-revolution probe for each shaft.

5.5.7.2 Vibration and axial position transducers shall be supplied, installed, and calibrated in accordance with API 670.

5.5.7.3 * If specified, radial shaft vibration and axial position monitors shall be supplied and calibrated in accordance with API 670.

5.5.7.4 Two bearing temperature sensors shall be supplied, installed, and calibrated for each radial and thrust bearing in accordance with API 670.

NOTE The second sensor can be used as a spare.

5.5.7.5 * The purchaser shall specify the type of temperature sensors required per API 670.

5.5.7.6 * If specified, a bearing temperature monitor shall be supplied and calibrated in accordance with API 670.

5.5.7.7 * If specified, an accelerometer shall be supplied, installed at the shaft on the gearbox, and calibrated in accordance with API 670.

NOTE Commercially available accelerometers that have hazardous area certifications have difficulty reaching high gear mesh frequencies.

5.5.7.8 * If specified, an accelerometer monitor shall be supplied, installed, and calibrated in accordance with API 670.

5.6 Piping and appurtenances

5.6.1 General

Piping and appurtenances furnished shall be in accordance with 5.6.1.1 to 5.6.2.3 and ISO 10439-1:2015, 5.6.

5.6.1.1 When a baseplate has been specified, the supplier shall furnish all piping systems, including mounted appurtenances, located within its confines. The piping shall terminate with flanged connections at the edge of the baseplate. The purchaser will furnish only interconnecting piping between equipment groupings and off base facilities.

NOTE The oil reservoir and oil system can be combined in the baseplate (see 5.4.1).

5.6.1.2 * If specified, a liquid injection manifold shall be supplied. It shall include a throttle valve, an armoured flow meter, a check valve, a pressure indicator, and a block valve for each injection point.

5.6.2 Process piping and accessories

5.6.2.1 Unless otherwise specified, process piping, if furnished, shall be in accordance with ISO 10438-1, ISO 10438-2, and ISO 10438-4.

NOTE API 614 5th edition is identical to ISO 10438 (all parts):2007.

5.6.2.2 * If specified, the purchaser shall furnish piping specifications for supplier furnished process piping.

5.6.2.3 * If specified, the supplier shall provide process gas heat exchangers in accordance with purchaser-provided specifications.

NOTE 1 Refer to ISO 10438-1 for process heat exchanger requirements.

NOTE 2 API 614 5th edition is identical to ISO 10438 (all parts):2007.

5.7 Special tools

Special tools shall be in accordance with ISO 10439-1:2015, 5.7.

6 Inspection, testing, and preparation for shipment

6.1 General

General requirements for inspection, testing, and preparation for shipment shall be in accordance with ISO 10439-1:2015, 6.1. Also refer to Annex E for inspector's checklist.

6.2 Inspection

Requirements for inspection shall be in accordance with 6.2.1.1 to 6.2.1.2 and ISO 10439-1:2015, 6.2.

6.2.1 Gear contact checks

6.2.1.1 Each set of installed gears shall be checked for contact in the job gearbox at the supplier's shop.

6.2.1.2 A thin coating of colour transfer material (such as Prussian blue) shall be applied at three locations, 120 degrees apart, to four or more teeth of the dry degreased gear. (Layout dye shall not be used for the assembly contact check.) With the gear held firmly, the coated teeth shall be rotated through the mesh with a moderate drag torque applied in a direction that will cause the teeth to contact on the normally loaded faces. The colour transfer shall show evidence of contact distributed across each helix, as prescribed by the supplier. Prior to the contact tests, the supplier shall make available to the purchaser a contact drawing or supplier engineering specification that defines the acceptable contact. The results of the contact check shall be preserved by lifting the contrasting colours from a tooth by applying and peeling off a strip of clear adhesive tape and then applying the tape to a notated sheet of white paper. The drawing or specification and the results of the contact checks shall be preserved for at least 20 years and shall be available to the purchaser on request.

NOTE Unmodified leads generally show about 80 % contact across the tooth length.

6.3 Testing

In addition to the requirements of ISO 10439-1:2015, 6.3, the compressor shall be tested in accordance with 6.3.1 and 6.3.2. Other tests that can be specified are described in 6.3.3.

6.3.1 Mechanical running test

6.3.1.1 The requirements of 6.3.1.1.1 to 6.3.1.1.5 shall be met before the mechanical running test is performed.

6.3.1.1.1 The contract shaft seals and bearings shall be used in the machine for the mechanical running test.

6.3.1.1.2 Compressors covered in this part generally do not use oil-injected seals or seal-oil systems. When these are specified, testing shall be as agreed between user and supplier.

NOTE For guidance, see ISO 10439-1:2015, 6.3.2.

6.3.1.1.3 Oil viscosity, pressures, temperatures, and filtration shall be within the range of operating values recommended in the supplier's operating instructions for the specific unit being tested. Overall oil flow rates for each oil supply line shall be measured.

6.3.1.1.4 Following the mechanical running test, the requirements of ISO 10439-1:2015, 6.3.5.10 shall be met, as well as the requirements of 6.3.1.4.1 and 6.3.1.4.2.

NOTE API 614 5th edition is identical to ISO 10438 (all parts):2007.

6.3.1.1.5 Facilities shall be installed to prevent the entrance of oil into the compressor during the mechanical running test. These facilities shall be in operation throughout the test.

6.3.1.2 The mechanical running test of the equipment shall be conducted as specified in 6.3.1.2.1 to 6.3.1.2.4.

NOTE Testing with the contract coupling(s) is preferred.

6.3.1.2.1 The equipment shall be accelerated to the maximum continuous speed and run until bearings, lube-oil temperatures, and shaft vibrations have stabilized.

NOTE Operating equipment at or near-critical speeds is normally avoided.

6.3.1.2.2 For variable speed machines, the speed shall be increased to trip speed and the equipment shall be run for a minimum of 15 min.

6.3.1.2.3 The speed shall be reduced to the maximum continuous speed, and the equipment shall be run for 4 h continuous operation.

6.3.1.2.4 The following seal flow data shall be taken during the mechanical running test to ensure that the seals are installed and operating properly:

a) for single dry gas seals, flow in the vent line from each seal shall be measured;

b) for tandem dry gas seals, flow in the primary and secondary vent line from each seal shall be measured;

c) for double dry gas seals, the total seal gas flow to each seal shall be measured.

NOTE 1 Seal performance at contract conditions is normally determined in separate tests by the seal manufacturer (see ISO 10439-1:2015, 4.10 for the requirements).

NOTE 2 Flow in the vents of single or tandem seals can include buffer or separation gas in addition to process gas leakage through the seal.

6.3.1.3 During the mechanical running test, the requirements of 6.3.1.3.1 to 6.3.1.3.7 shall be met.

6.3.1.3.1 During the mechanical running test, the mechanical operation of all equipment being tested and the operation of the test instrumentation shall be satisfactory. The equipment measured unfiltered vibration shall not exceed the limits of ISO 10439-1:2015, 4.8.8.8 and shall be recorded at the operating speed. Any other test acceptance criteria shall be agreed and stated in the test agenda.

6.3.1.3.2 Casing vibration shall not exceed an overall level of 4 Gs peak at gear mesh frequency.

6.3.1.3.3 While the equipment is operating at maximum continuous speed or other speeds, vibration data shall be acquired to determine amplitudes at frequencies other than synchronous. This data shall cover a frequency range from 0,25 times to 8 times the maximum continuous speed. If the amplitude of any discrete, nonsynchronous vibration exceeds 20 % of the allowable vibration as defined in ISO 10439-1:2015, 4.8.8.8, the purchaser and the supplier shall agree on the requirements for any additional testing and on the equipment acceptability.

6.3.1.3.4 The mechanical running test shall verify that lateral critical speeds below running speed conform to the requirements of ISO 10439-1:2015, 4.8.2.

6.3.1.3.5 * If specified, shop verification of the unbalanced response analysis shall be performed in accordance with ISO 10439-1:2015, 4.8.3.

6.3.1.3.6 * If specified, all real-time vibration data as agreed by the purchaser and the supplier shall be recorded and a copy provided to the purchaser.

6.3.1.3.7 * If specified, the user can bring in vibration equipment to record baseline readings.

6.3.1.4 Following the mechanical running test, the requirements of ISO 10439-1:2015, 6.3.7.2 shall be met, as well as the requirements of 6.3.1.4.1 and 6.3.1.4.2.

6.3.1.4.1 The tooth mesh shall be inspected for proper contact and for surface damage resulting from the test.

6.3.1.4.2 Spare rotor sets ordered to permit concurrent manufacture shall also be given a mechanical running test in accordance with the requirements of this standard. Complete spare set shall be run as a unit.

6.3.2 Assembled compressor gas leakage test

6.3.2.1 After the mechanical running test is completed, each completely assembled compressor casing intended for toxic, hazardous, or flammable service shall be tested as required in 6.3.2.2 and/or, if specified, 6.3.2.3.

NOTE These tests are intended to verify the integrity of the casing joint. Some shaft seal designs are not gas tight. Therefore, leakage from these seals during this test is acceptable.

6.3.2.2 The assembled compressor (including end seals) shall be pressurized, with an inert gas, to the maximum sealing pressure or the maximum seal design pressure, as agreed by the purchaser and the supplier; held at no less than this pressure for a minimum of 30 min and subjected to a soap-bubble test, or alternate method, to check for gas leaks. The test shall be considered satisfactory when no casing or casing joint leaks are observed. If design mole weight is less than 12, the test gas shall be helium.

NOTE The test gas mole weight will approximate or be less than the contract gas mole weight.

6.3.2.3 * If specified, the assembled compressor (with or without end seals installed) shall be pressurized with an inert gas to the maximum specified discharge pressure, held at this pressure for a minimum of 30 min, and subjected to a soap-bubble test, or alternate method, to check for gas leaks. The test shall be considered satisfactory when no casing or casing joint leaks are observed.

NOTE The requirements of 6.3.2.2 and 6.3.2.3 can necessitate two separate tests.

6.3.3 * Optional tests

The purchaser should specify whether any of the following shop tests shall be performed. The purchaser and the supplier shall agree upon test details prior to the test.

6.3.3.1 Performance test

6.3.3.1.1 The compressor shall be performance tested in accordance with ASME PTC 10-1997 or ISO 5389, as specified. A minimum of five points, including surge and overload, shall be taken at normal speed and vane setting. For variable speed or variable vane machines, additional points can be specified.

NOTE Refer to the applicable test code for general instructions. ASME PTC 10–1997 does not apply to some low-pressure ratio compressors. Refer to PTC 10–1997, 1.2.2 for the selection of the appropriate test code to be used.

6.3.3.1.2 For variable speed or variable vane machines, head and capacity shall have zero negative tolerance at the normal operating point (or other point as specified), and the power at this point shall not exceed 104 % of the supplier-predicted shaft power value. This tolerance shall be inclusive of all test tolerances. Surge shall comply with provisions of 4.4.1.1.

NOTE Both of the performance test codes referred to have provision for calculating inaccuracy based on instrumentation and procedures. These test inaccuracies are already included in the above tolerance and, therefore, are not to be further added.

6.3.3.1.3 For constant-speed compressors, the capacity shall be as specified in 6.3.3.1.2. The head shall be within the range of 100 % to 105 % of the normal head. The horsepower, based on measured head at normal capacity, shall not exceed 107 % of the value at the specified normal operating point. If the power required at this point exceeds 107 %, excess head can be removed by trimming impellers at the purchaser's option.

6.3.3.1.4 The performance test shall be conducted using only one contract rotor set, unless additional performance testing is specified.

6.3.3.1.5 Compressors with intermediate specified process pressures shall have individual sectional head (pressure) tolerances as agreed.

6.3.3.2 Complete unit test

Such components as compressors, gears, drivers, and auxiliaries that make up a complete unit shall be tested together during the mechanical running test. A separate auxiliary test can be performed with the purchaser's approval. The complete unit test can be performed in place of or in addition to separate tests of individual components specified by the purchaser. If specified, torsional vibration measurements shall be made to verify the supplier's analysis.

6.4 Preparation for shipment

6.4.1 Preparation for shipment shall be in accordance with 6.4.1.1 and ISO 10439-1:2015, 6.4.

6.4.1.1 * If specified, the fit-up and assembly of machine-mounted piping, intercoolers, etc. shall be completed in the supplier's shop prior to shipment.

7 Supplier's data

Supplier's data shall be in accordance with ISO 10439-1:2015, Clause 7.

7.1 General

7.1.1 The information to be furnished by the supplier is specified in Annex B and ISO 10439-1:2015, Clause 7. The supplier shall complete and forward the VDDR form in Annex B to the address or addresses noted on the inquiry or order. This form shall detail the schedule for transmission of drawings, curves, and data as agreed to at the time of the order, as well as the number and type of copies required by the purchaser.

7.1.2 On the data sheets and in drawings and tables, the shaft rotational direction shall be designated by the abbreviations CW or CCW (see 4.12.3).

7.1.3 Suppliers shall provide bearing temperature alarm and shutdown limits.

7.2 Proposals

Proposals shall be in accordance with ISO 10439-1:2015, 7.2.

7.3 Contract data

Contract data shall be in accordance with ISO 10439-1:2015, 7.3.

Annex A
(normative)

Datasheets

The datasheets are also available in electronic format via http://standards.iso.org/iso/.

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	BY					
INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3) **SI UNITS (bar)**	REV/APPR					

JOB NO. _____ ITEM NO. _____

PAGE 1 OF 12 REQ'N NO. _____

APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR _____ UNIT _____

SITE _____ SERIAL NO. _____

SERVICE _____ NO. REQUIRED _____

MANUFACTURER _____ DRIVER TYPE (1-3.1.1) _____

MODEL _____ DRIVER ITEM NO. _____

APPLICABLE STANDARD: ○ US ○ ISO

NOTE: INFORMATION TO BE COMPLETED BY: ○ PURCHASER □ MANUFACTURER △ PURCHASER OR MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)

	NORMAL (1-2.1.1.2)	OTHER CONDITIONS (1-2.1.1.1)				
	(NOTE 1)	RATED	B	C	D	E
○ GAS HANDLED (ALSO SEE PAGE ____)						
△ GAS PROPERTIES (1-2.1.1.4)						
□ N(m³/h) (1013 barA & 0°C DRY)						
○ WEIGHT FLOW (lb/min) ○ WET ○ DRY						
INLET CONDITIONS						
○ PRESSURE (barA)						
○ TEMPERATURE (°C)						
○ RELATIVE HUMIDITY %						
○ MOLECULAR WEIGHT						
□ Cp/Cv (K_1) OR (K_{AVG})						
□ COMPRESSIBILITY (Z_1) OR (Z_{AVG})						
□ INLET VOLUME (m³/h) ○ WET ○ DRY						
DISCHARGE CONDITIONS						
○ PRESSURE (barA)						
□ TEMPERATURE (°C) **(ESTIMATED)**						
□ Cp/Cv (K_2) OR (K_{AVG})						
□ COMPRESSIBILITY (Z_2) OR (Z_{AVG})						
□ GHP REQUIRED (kW)						
□ TRAIN (BkW) REQUIRED						
□ (BkW) REQUIRED AT DRIVER INCL. EXT. LOSSES (GEAR, ETC.)						
□ SPEED of driver (rpm)						
□ TURNDOWN (%)						
□ POLYTROPIC HEAD (N-m/kg)						
□ POLYTROPIC EFFICIENCY (%)						
○ CERTIFIED POINT						
□ PERFORMANCE CURVE NUMBER						

PROCESS CONTROL (1-3.4.2.1)

○ METHOD ○ SUCTION THROTTLING FROM ____ (barA) TO ____ (barA) ○ VARIABLE INLET GUIDE VANES (3-2.4) ○ SPEED VARIATION FROM ____ % TO ____ % ○ DISCHARGE BLOWOFF OR RECIRCULATION ○ VARIABLE DIFFUSER GUIDE VANES (3-2.4)

SIGNAL ○ SOURCE (1-3.4.2.1) _____

TYPE ○ ELECTRONIC ○ PNEUMATIC ○ OTHER _____

RANGE _____ MA _____ (barG) _____

REMARKS: Note 1: IF GAS ANALYSIS IS GIVEN, MANUFACTURER SHALL SUPPLY GAS PROPERTIES, OTHERWISE DATA SHALL BE SUPPLIED BY USER

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INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
PAGE 2 OF 12 REQ'N NO. _____

OPERATING CONDITIONS (Continued) (1-2.1.1.1) (1-3.1.2) (1-3.1.3)

GAS ANALYSIS: ○ MOL %	MW	NORMAL	OTHER CONDITIONS RATED	B	C	D	E	REMARKS:
AIR	28,966							
OXYGEN	32.000							
NITROGEN	28,016							
WATER VAPOR	18,016							
CARBON MONOXIDE	28.010							
CARBON DIOXIDE	44.010							
HYDROGEN SULFIDE	34,076							(1-2.2.16)
HYDROGEN	2,016							(1-2.2.19)
METHANE	16,042							
ETHYLENE	28,052							
ETHANE	30,068							
PROPYLENE	42,078							
PROPANE	44,094							
I-BUTANE	58.120							
n-BUTANE	58.120							
I-PENTANE	72,146							
n-PENTANE	72,146							
HEXANE PLUS								
CORROSIVE AGENTS								(1-2.2.13)
TOTAL								
AVG. MOL. WT.								

LOCATION: (1-2.1.8)
○ INDOOR ○ OUTDOOR ○ GRADE
○ HEATED ○ UNDER ROOF ○ MEZZANINE
○ UNHEATED ○ PARTIAL SIDES ○ _____

SITE DATA (1-2.1.8)
○ ELEVATION _____ (m) BAROMETER _____ (barA)
○ RANGE OF AMBIENT TEMPS:

		DRY BULB	WET BULB
NORMAL	(°C)		
MAXIMUM	(°C)		
MINIMUM	(°C)		
	(°C)		

UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER (1-2.1.8) _____
○ COPPER AND COPPER ALLOYS PROHIBITED (1-2.2.1.14)

COATING: (1-2.2.1.16)
○ ROTATING COMPONENTS _____
○ STATIONARY COMPONENTS _____

REMARKS: _____

NOISE SPECIFICATIONS: (1-2.1.9)
○ APPLICABLE TO MACHINE:
SEE SPECIFICATION _____
○ APPLICABLE TO NEIGHBORHOOD:
SEE SPECIFICATION _____
ACOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:
API 617, 7TH CHAPTER 1&3
○ VENDOR HAVING UNIT RESPONSIBILITY (1-1.5.5.3) (1-1.8) (1-2.1.3)
_____
○ GOVERNING SPECIFICATION (IF DIFFERENT)
_____
○ ELEC. AREA CLASS. (1-2.1.1.4) ○ NEC ○ IEC
EQUIPMENT
CLASS _____ GROUP _____ DIV. _____
ZONE _____ GROUP _____ TEMP CLASS _____
CONTROL PANNELS
CLASS _____ GROUP _____ DIV. _____
ZONE _____ GROUP _____ TEMP CLASS _____
INSTRUMENT AND CONTROLS
STANDARD ○ NEMA ○ IEC

	INDOOR	OUTDOOR
CONTROL ENCLOSURE		
TERMINAL BOX		

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	INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3) **SI UNITS (bar)**	JOB NO.		ITEM NO.			
		PAGE 3 OF 12		REQ'N NO.			
1	**CONSTRUCTION FEATURES (1 COLUMN PER STAGE, USE ADDITIONAL SHEETS IF NEEDED)**						
2	**Rotor**	Rotor 1					
3	**Stage**	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
4	☐ **CASING:**						
5	MODEL						
6	CASING SPLIT						
7	MATERIAL						
8	THICKNESS (mm)						
9	CORROSION ALLOWANCE (mm)						
10	MAX. ALLOWABLE PRESS (barG)						
11	TEST PRESS (barG)						
12	MAX. ALLOWABLE TEMP. (°C)						
13	MAX. OPERATING TEMP (°C)						
14	MIN. OPERATING TEMPERATURE (°C)						
15	MAX CASING CAPACITY (m^3/h)						
16	☐ **INLET CONNECTIONS** (1-2.3.2.2.1, 1-2.3.2.2.7)						
17	TYPE						
18	ORIENTATION						
19	FLANGED OR STUDDED?						
20	MATING FLG & GASKET BY VENDOR?						
21	GAS VELOCITY (m/s)						
22	☐ **DISCHARGE CONNECTIONS** (1-2.3.2.2.1, 1-2.3.2.2.7)						
23	TYPE						
24	ORIENTATION						
25	FLANGED OR STUDDED?						
26	MATING FLG & GASKET BY VENDOR?						
27	GAS VELOCITY (m/s)						
28	○ **INTERMEDIATE MAIN PROCESS CONNECTIONS (2-2.4.5)**						
29	DISCH. PRESSURE (barG)						
30	INLET PRESSURE (barG)						
31	☐ **ADJUSTABLE INLET GUIDE VANES**						
32	MATERIAL _____						
33	NO. INLET GUIDE VANES						
34	☐ **IMPELLER:**						
35	DIAMETER						
36	Number of VANES						
37	TYPE (OPEN, ENCLOSED, ETC.)						
38	TYPE FABRICATION						
39	MATERIAL						
40	MIN. YIELD STRENGTH (MPa)						
41	HARDNESS: (Rc) (BRINNEL)						
42	SMALLEST TIP INTERNAL WIDTH (mm)						
43	MAX. MACH. NO. @ IMPELLER EYE						
44	MAX. IMPELLER HEAD @ 100% SPEED (m)						
45	MAX. IMPELLER TIP SPEED (m/s)						
46	☐ **DIFFUSER GUIDE VANES**						
47	ADJUSTABLE?						
48	MATERIAL						
49	NO. GUIDE VANES						
50	**REMARKS:**						
51							
52							
53							
54							
55							
56							

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INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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CONSTRUCTION FEATURES, continued (1 COLUMN PER STAGE, USE ADDITIONAL SHEETS IF NEEDED)

	Stage 1	Stage 2	Stage 3	Stage 4	Stage 5	Stage 6
☐ **SHAFT SLEEVES:**						
MATERIAL						
AT SHAFT SEALS?						
OTHER LOCATIONS?						
SHAFT SEALS: (1-2.8.11, 1-2.8.15)						
○ SEAL TYPE (1-2.8.13)						
○ SETTLING OUT PRESSURE (barG)						
○ MINIMUM SEALING PRESSURE (barG)						
○ TYPE BUFFER GAS, PRIMARY						
☐ PRESSURE (barG) (1-2.8.16)						
☐ FLOWRATE (kg/h) (1-2.8.16)						
☐ FILTRATION (1-2.8.16)						
○ TYPE BUFFER GAS, SECONDARY						
☐ PRESSURE (barG) (1-2.8.16)						
☐ FLOWRATE (kg/h) (1-2.8.16)						
☐ FILTRATION (1-2.8.16)						
☐ FLOWRATE TO PROCESS						

○ BUFFER GAS SYSTEM REQUIRED
○ MANIFOLD (1-3.5.14)
○ METHOD OF CONTROL (1-2.8.15) _____
○ BUFFER GAS CONTROL SYSTEM SCHEMATIC BY VENDOR
○ PRESSURIZING GAS FOR SUBATMOSPHERIC SEALS (1-2.8.2.4) ○ EDUCTOR ○ INJECTION (1-2.8.2.3)
☐ SEAL MANUFACTURER _____ ○ SYSTEM RELIEF VALVE SET PT. _____

BEARING TEMPERATURE DETECTORS (2-3.4.7)
○ SEE ATTACHED API-670 DATASHEET
○ THERMOCOUPLES TYPE _____
○ RESISTANCE TEMP DETECTORS
○ RESISTANCE MATERIAL _____ ○ _____ (ohm)
☐ ALARM TEMPERATURE (C) _____
☐ SHUTDOWN TEMPERATURE (C) _____
○ PROVISION FOR LOCAL DISCONNECT (1-2.7.4.6)
○ LOCATION-JOURNAL BEARING
NO. ____ EA PAD _____ EVERY OTHER PAD ____ PER BEARING
OTHER _____
○ LOCATION-THRUST BEARING
NO. ____ EA PAD _____ EVERY OTHER PAD ____ PER BEARING
OTHER _____
NO. (INACT) ____ EA PAD ____ EVERY OTHER PAD ____ PER BEARING
OTHER _____
○ LOCAL DISCONNECTION (1-2.7.4.6)
○ MONITOR SUPPLIED BY (2-3.4.7.4) _____
○ LOCATION _____ ENCLOSURE _____
○ MFR. _____ ☐ MODEL _____
☐ SCALE RANGE _____ ALARM _____ ☐ SET @ _____ (C)
○ SHUTDOWN: ☐ SET @ _____ (C) ○ TIME DELAY _____ (sec)

KEY PHASOR REQUIRED
○ COMPRESSOR ○ GEAR H.S. ○ GEAR L.S.

VIBRATION DETECTORS: ○ SEE ATTACHED API-670 DATA SHEET
○ TYPE _____ ☐ MODEL _____
○ MFR _____
○ NO. AT EA SHAFT BEARING _____ TOTAL NO. _____
○ OSCILLATOR-DETECTORS SUPPLIED BY _____
○ MFR _____ ☐ MODEL _____
○ MONITOR SUPPLIED BY (2-3.4.7.2) _____
○ LOCATION _____ ENCLOSURE _____
○ MFR. _____ ☐ MODEL _____
☐ SCALE RANGE _____ ALARM ☐ SET @ _____ (μm)
○ SHUTDOWN: ☐ SET @ _____ (μm) ○ TIME DELAY _____ (sec)
○ CASING VIBRATION TRANSDUCERS
○ CASING VIBRATION MONITORS

AXIAL POSITION DETECTOR:
○ SEE ATTACH. API-670 DATA SHEET
○ TYPE _____ ☐ MODEL _____
○ MFR _____ ○ NO. REQUIRED _____
○ OSCILLATOR-DEMODULATOR SUPPLIED BY _____
○ MFR _____ ☐ MODEL _____
○ MONITOR SUPPLIED BY _____
○ LOCATION _____ ENCLOSURE _____
○ MFR. _____ ☐ MODEL _____
☐ SCALE RANGE _____ ALARM ☐ SET @ _____ (μm)
○ SHUTDOWN: ☐ SET @ _____ (μm) ○ TIME DELAY _____ (sec)

REMARKS: _____

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INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
PAGE 5 OF 12 REQ'N NO. _____

CONSTRUCTION FEATURES, ROTORS (1 COLUMN PER ROTOR, USE ADDITIONAL SHEETS IF NEEDED)

☐ **DRIVER SPEEDS:**
MAX. CONT. _____
TRIP SPEED _____
PITCH LINE VELOCITY (m/s) _____
NORMAL DIAMETRAL PITCH _____
HELIX ANGLE _____ PRESSURE ANGLE _____

☐ ROTOR NUMBER	BULL GEAR	ROTOR 1	ROTOR 2	ROTOR 3	ROTOR 4
SPEED (rpm)					
SERVICE POWER (kW)					
SERVICE FACTOR					
NUMBER OF TEETH					
FACE WIDTH (mm)					
AGMA GEOMETRY FACTOR "J"					
AGMA GEOMETRY FACTOR "I"					
MINIMUM HARDNESS (Rc)					
ROTOR WEIGHT (INC WHEELS) (kg)					
BACKLASH (mm)					

GEARBOX FULL LOAD POWER LOSS _____

☐ LATERAL CRITICAL SPEEDS (DAMPED)					
FIRST CRITICAL					
SECOND CRITICAL					
THIRD CRITICAL					
FOURTH CRITICAL					

○ LATERAL ANALYSIS ADDITIONAL REQUIREMENTS (1-2.6.2.14)
○ TRAIN LATERAL ANALYSIS REQUIRED (1-2.6.2.6)
○ TRAIN TORSIONAL ANALYSIS REQUIRED (1-2.6.7.1)

☐ TORSIONAL CRITICAL SPEEDS:	
FIRST CRITICAL	
SECOND CRITICAL	
THIRD CRITICAL	
FOURTH CRITICAL	

○ LIST OF TRAIN UNDESIRABLE SPEEDS (1-2.6.14)
○ STABILITY ANALYSIS (1-2.6.5)

☐ VIBRATION:					
ALLOWABLE TEST LEVEL (PK-PK)					

☐ BALANCE PISTON:				
MATERIAL				
FIXATION METHOD				
NORMAL CLEARANCE (mm)				
AREA (mm²)				
FLOW, NORMAL CLEARANCE (kg/h)				
FLOW, 2x NORMAL CLEAR (kg/h)				
○ PRESS. CONN. BAL LINE (2-2.5.4.3)				

REMARKS: _____

	REVISION	0	1	2	3	4
	DATE					

INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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	CONSTRUCTION FEATURES, ROTOR BEARINGS (1 COLUMN PER ROTOR, USE ADDITIONAL SHEETS IF NEEDED)					
	RADIAL BEARINGS, DRIVE END	BULL GEAR	ROTOR 1	ROTOR 2	ROTOR 3	ROTOR 4
	☐ TYPE					
	☐ MANUFACTURER					
	☐ LENGTH (mm)					
	☐ SHAFT DIAMETER (mm)					
	☐ UNIT LOAD (ACT/ALLOW)					
	☐ BASE MATERIAL					
	☐ BABBIT THICKNESS (mm)					
	☐ NUMBER OF PADS					
	☐ LOAD: BETWEEN/ON PAD					
	☐ PIVOT: CENTER/OFFSET, %					
	☐ RADIAL BEARING SPAN					
	RADIAL BRG, OPPOSITE DRIVE END					
	☐ TYPE					
	☐ MANUFACTURER					
	☐ LENGTH (mm)					
	☐ SHAFT DIAMETER (mm)					
	☐ UNIT LOAD (ACT/ALLOW)					
	☐ BASE MATERIAL					
	☐ BABBIT THICKNESS (mm)					
	☐ NUMBER OF PADS					
	☐ LOAD: BETWEEN/ON PAD					
	☐ PIVOT: CENTER/OFFSET, %					
	THRUST BEARINGS, ACTIVE					
	☐ TYPE					
	☐ MANUFACTURER					
	☐ UNIT LOADING (max) (MPa)					
	☐ UNIT LOAD (ULT.) (MPa)					
	☐ AREA (mm²)					
	☐ NUMBER OF PADS					
	☐ PIVOT: CENTER / OFFSET, %					
	☐ PAD BASE MATERIAL					
	☐ COPPER BACKED?					
	☐ COLLAR MATERIAL					
	☐ INTEGRAL OR REPLACEABLE COLLAR?					
	☐ SIZING CRITERIA					
	☐ FLOODED OR DIRECTED LUBRICATION?					
	THRUST BEARINGS, INACTIVE					
	☐ TYPE					
	☐ MANUFACTURER					
	☐ UNIT LOADING (max) (MPa)					
	☐ UNIT LOAD (ULT.) (MPa)					
	☐ AREA (mm²)					
	☐ NUMBER OF PADS					
	☐ PIVOT: CENTER / OFFSET, %					
	☐ PAD BASE MATERIAL					
	☐ COPPER BACKED? (2-2.7.3.7)					
	☐ COLLAR MATERIAL					
	☐ INTEGRAL OR REPLACEABLE COLLAR?					
	☐ SIZING CRITERIA (2-2.7.3.5)					
	☐ FLOODED OR DIRECTED LUBRICATION?					

REMARKS: _____

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INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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☐ OTHER CONNECTIONS

SERVICE:	NO.	SIZE	TYPE		NO.	SIZE	TYPE
☐ LUBE-OIL INLET				☐ PRESSURE			
☐ LUBE OIL OUTLET				☐ TEMPERATURE			
☐ SEAL-OIL INLET				☐ SOLVENT INJECTION			
☐ SEAL-OIL OUTLET				☐ PURGE FOR:			
☐ SEAL GAS INLET				☐ BRG. HOUSING			
☐ SEAL GAS OUTLET				☐ BTWN BRG & SEAL			
☐ CASING DRAINS				☐ BTWN SEAL & GAS			
☐ STAGE DRAINS				_____			

○ INDIVIDUAL STAGE DRAINS REQUIRED (1-2.3.2.1.7)
○ VALVED & BLINDED
○ VALVED & BLINDED & MANIFOLD

LUBRICATION AND SEALING SYSTEMS (1-2.10) (1-3.5.1.2)

○ SEE ATTACHED API 614 DATASHEET
○ SEPARATE ○ COMBINED
○ INTEGRAL OIL RESERVOIR (1-3.3.2.11)
○ OIL TYPE (2-2.10.2)

ACCESSORIES

COUPLING AND GUARDS (3.2)

NOTE: SEE ROTATING ELEMENTS - SHAFT ENDS

○ SEE ATTACHED API-671 DATA SHEET ○ KEYLESS HYDRAULIC ○ KEYED ○ FLANGED ○ OTHER _____
COUPLING FURNISHED BY _____ MOUNTED BY _____
MANUFACTURER _____ TYPE _____ MODEL _____
COUPLING GUARD FURNISHED BY: _____
TYPE: ○ FULLY ENCLOSED ○ SEMI-OPEN ○ OTHER _____

COUPLING DETAILS

☐ MAX O.D. _____ (mm)
☐ HUB WEIGHT _____ (kg)
☐ SPACER LENGTH _____ (mm)
☐ SPACER WEIGHT _____ (kg)

○ PLUG AND RING GAUGES (1-3.2.5) ○ LAPPING TOOL
LUBRICATION REQUIREMENTS:
○ NON-LUBE ○ CONT. OIL LUBE ○ OTHER _____
☐ QUANTITY PER HUB _____ (L/min)

MOUNTING PLATES (1-3.3)

○ BASEPLATES FURNISHED BY (1-3.3.2.1) _____
○ COMPRESSOR ONLY ○ DRIVER ○ GEAR
○ OTHER _____
○ NONSKID DECKING (1-3.3.2.4) ○ SLOPED DECK (1-3.3.2.4.1)
△ LEVELING PADS OR TARGETS (1-3.3.2.6)
△ COLUMN MOUNTING (1-3.3.2.5)
○ SUB-SOLE PLATES REQUIRED (1-3.3.2.10)
☐ STAINLESS STEEL SHIM THICKNESS _____ (mm)
○ MACHINED MOUNTING PADS REQUIRED (1-3.3.2.9)

○ SOLEPLATES FURNISHED BY (1-3.3.3.1) _____
☐ THICKNESS _____ (mm)
○ SUBSOLE PLATES REQUIRED (1-3.3.3.15)
☐ STAINLESS STEEL SHIM THICKNESS _____ (mm)
○ COMPRESSOR _____
○ COUNTER BORE ANCHOR BOLT HOLES (1-3.3.3.12)

ANTI-SURGE SYSTEM (1-3.4.2.2) FURNISHED BY ○ PURCHASER ☐ SUPPLIER

○ ☐ ANTI-SURGE VALVE ○ SIZING ONLY
PRESSURE UPSTREAM: _____ (barG) DOWNSTREAM Δ P _____ (barG)
☐ Δ P VALVE _____ STROKE TIME OPEN - CLOSE _____ (sec)

○ ☐ RECIRCULATION VALVE ○ SIZING ONLY
○ ☐ BLOWOFF VALVE ○ SIZING ONLY
○ ☐ CONTROL SYSTEM
○ ☐ PIPING
○ ☐ FLOW ELEMENT
○ ☐ _____ ○ ☐ _____
○ ☐ _____ ○ ☐ _____
○ ☐ _____ ○ ☐ _____
○ ☐ _____ ○ ☐ _____
○ ☐ _____ ○ ☐ _____

REMARKS: _____

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INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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UTILITIES

○ **UTILITY CONDITIONS:**

STEAM:	DRIVERS	
INLET MIN	_____ (barG)	_____ (℃)
NORM	_____ (barG)	_____ (℃)
MAX	_____ (barG)	_____ (℃)
EXHAUST. MIN	_____ (barG)	_____ (℃)
NORM	_____ (barG)	_____ (℃)
MAX	_____ (barG)	_____ (℃)

ELECTRICITY:

	DRIVERS	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ REDUCED VOLTAGE START (1-3.16)
NUMBER OF STARTS (1-2.6.6.6.4) _____
○ **INSTRUMENT AIR:**
MAX PRESS _____ (psig) MIN PRESS _____ (barG)
☐ **ROTATION, VIEWED OPP. DRIVE END** ○ CW ○ CCW

SHOP INSPECTION AND TESTS: (1-4.1.4)

○ (SEE INSPECTOR'S CHECKLIST)	REQ'D	WIT/OBV
HYDROSTATIC (1-4.3.2)	●	
IMPELLER OVERSPEED (1-4.3.3)	●	
MECHANICAL RUN (1-4.3.6)	●	
○ CONTRACT COUPLING ○ IDLING ADAPTOR(S)		
○ CONTRACT PROBES ○ SHOP PROBES		
○ PURCHASER VIB. EQUIPMENT (2-4.3.1.1.10)		
VARY LUBE & SEAL OIL PRESSURES	○	
AND TEMPERATURES (1-4.3.6.1.5)	○	
POLAR FORM VIB DATA (1-4.3.6.1.2)	○	
TAPE RECORD VIB DATA (1-4.3.6.1.3)	○	
SHAFT END SEAL INSP (1-4.3.6.2.2)	○	
GAS LEAK TEST AT DISCH PRESS (2-4.3.2.3)	○	
○ POST TEST INTERNAL INSP (1-4.3.8.5)		
○ BEFORE GAS LEAKAGE TEST		
○ AFTER GAS LEAKAGE TEST	○	
PERFORMANCE TEST (GAS) (AIR) (2-4.3.3.1.1)	○	
COMPLETE UNIT TEST (2-4.3.3.2)	○	
TANDEM TEST (2-4.3.3.3)	○	
GEAR TEST (2-4.3.3.4)	○	
HELIUM LEAK TEST (1-4.3.8.2)	○	
SOUND LEVEL TEST (1-4.3.8.3)	○	
AUX. EQUIPMENT TEST (1-4.3.8.4) _____	○	
FULL LOAD / SPEED / PRESS TEST (1-4.3.8.6)	○	
HYDRAULIC COUPLING INSP (1-4.3.8.7)	○	
SPARE PARTS TEST (1-4.3.8.8) _____	○	
INSPECTOR'S CHECKLIST COMPLIANCE (1-4.1.6)	○	
GAS SEAL TEST VENDOR SHOP (1-4.3.5)	○	

MANUALS
○ DRAFT MANUAL FOR REVIEW (1-5.3.5.12)
○ TECHNICAL DATA MANUAL (1-5.3.5)

MISCELLANEOUS:
☐ RECOMMENDED STRAIGHT RUN OF PIPE DIAMETERS BEFORE SUCTION _____
○ COMPRESSOR TO BE SUITABLE FOR FIELD RUN-IN ON AIR (1-2.1.16)
○ PROVISION FOR LIQUID INJECTION (1-2.1.10) _____
○ INJECTION MANIFOLD (2-3.5.12)
○ VENDOR'S REVIEW & COMMENTS ON PURCHASER'S
○ CONTROL SYSTEMS (1-3.4.1.1)
○ SHOP FITUP OF VENDOR PROCESS PIPING (1-4.4.3.11)
○ WELDING HARDNESS TESTING (1-4.2.1.5)
_____
○ DESIGN AUDIT (1-5.14)
○ BALANCE PISTON ΔP (1-5.3.3.1.5)
○ PROVIDE TAIL END SCHEDULES (1-5.3.3.2)
○ BOROSCOPIC INSPECTION PORTS (2-2.3.2.4)

VENDOR'S REPRESENTATIVE SHALL (1-2.1.13)
○ OBSERVE FLANGE PARTING
○ CHECK ALIGNEMENT AT TEMPERATURE
○ BE PRESENT AT INITIAL ALIGNMENT

☐ **WEIGHTS:** (kg)
COMPR. _____ GEAR _____ DRIVER _____ BASE _____
ROTORS: COMPR. _____ DRIVER _____ GEAR _____
COMPRESSOR UPPER CASE _____
MAX. FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS:** (mm)
COMPLETE UNIT: L _____ W _____ H _____

SPECIAL TOOL PACKAGING
○ METAL STORAGE CONTAINER
○ OTHER: _____

PAINTING:
○ MANUFACTURER'S STD.
○ OTHER _____

NAMEPLATE (2-2.11.2) ○ US CUSTOMARY ○ METRIC

SHIPMENT: (4.4)
○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQ'D.
○ OUTDOOR STORAGE MORE THAN 6 MONTHS (1-4.4.1) _____ MO
SPARE ROTOR ASSEMBLY PACKAGE (1-4.4.3.10)
○ HORIZONTAL STORAGE ○ VERTICAL STORAGE
○ METAL STORAGE CONTAINER
○ N2 PURGE ○ OTHER: _____

MATERIALS INSPECTION REQUIREMENTS (1-4.2.1.3)

○ RADIOGRAPHY REQUIRED FOR _____
○ ULTRASONIC REQUIRED FOR _____
○ MAGNETIC PARTICLE REQUIRED FOR _____
○ LIQUID PENETRANT REQUIRED FOR _____

○ LOW TEMPERATURE (1-2.2.1.15.2) _____
MIN.DESIGN METAL TEMPERATURE _____ (℃)
AT CONCURRANT PRESSURE _____ (barG)
○ OTHER TRAIN COMPONENTS (1-2.2.1.15.2)
○ Q.C. OF INACCESSIBLE WELDS (1-2.3.1.11.2)

REMARKS: _____

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INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO _____
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INTER COOLER(S) - BETWEEN 1st and 2nd STAGE

SERVICE OF UNIT: _____ ITEM NO _____
SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES
SURF/UNIT: (GROSS/EFF) _____ (m²) SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (℃)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg ℃)				
☐ THERMAL CONDUCTIVITY, (kJ/m h ℃)				
☐ LATENT HEAT, (kJ/kg ℃)				
☐ INLET PRESSURE, (barG)				
◎ VELOCITY, (m/s)				
◎ PRESSURE DROP--ALLOW/CALC, (bar)				
◎ FOULING RESISTANCE--MINIMUM (hr m² ℃/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (℃)
☐ TRANSFER RATE, (kJ/hr m² ℃) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, (barG)		
DESIGN TEMPERATURE, (℃)		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, (mm)		
NOZZLES: INLET		
SIZE & OUTLET		
RATING VENT-DRAIN		

SKETCH: BUNDLE NOZZLE ORIENTATIONS

TUBE NO. _____ O.D. _____ (mm THK (MIN) (AVG) _____ (mm LENGTH _____ (m) PITCH _____ (mm) ◁ 30 △ 60 ☐ 90 ◇ 45
TUBE TYPE _____ MATERIAL _____
SHELL MATL _____ I.D. _____ (mm) O.D. _____ (mm SHELL COVER MATL _____ (INTEG)(REMOV)
CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____
TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____
FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____
BAFFLES--CROSS MATL _____ TYPE _____ % CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ (mm)
BAFFLES--LONG MATL _____ SEAL TYPE _____
SUPPORTS--TUBE _____ U-BEND _____ TYPE _____
BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____
GASKETS--SHELL SIDE _____ -- TUBE SIDE _____
--FLOATING HEAD _____
ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE ○ TEMA CLASS _____
WEIGHT/SHELL _____ (kg) FILLED WITH WATER _____ (kg) BUNDLE _____ (kg)

REMARKS: _____

REVISION	0	1	2	3	4
DATE					

INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO _____
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INTER COOLER(S) - BETWEEN 2nd and 3rd STAGE

SERVICE OF UNIT: _____ ITEM NO _____
SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES
SURF/UNIT: (GROSS/EFF) _____ (m²) SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (℃)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg ℃)				
☐ THERMAL CONDUCTIVITY, (kJ/m h ℃)				
☐ LATENT HEAT, (kJ/kg ℃)				
☐ INLET PRESSURE, (barG)				
◎ VELOCITY, (m/s)				
◎ PRESSURE DROP--ALLOW/CALC, (bar)				
◎ FOULING RESISTANCE--MINIMUM (hr m² ℃/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (℃)
☐ TRANSFER RATE, (kJ/hr m² ℃) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

SKETCH: BUNDLE NOZZLE ORIENTATIONS

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, (barG)		
DESIGN TEMPERATURE, (℃)		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, (mm)		
NOZZLES: SIZE & RATING — INLET		
OUTLET		
VENT-DRAIN		

TUBE NO. _____ O.D. _____ (mm THK (MIN) (AVG) _____ (mm LENGTH _____ (m) PITCH _____ (mm) ◁ 30 △ 60 ☐ 90 ◇ 45
TUBE TYPE _____ MATERIAL _____
SHELL MATL _____ I.D. _____ (mm) O.D. _____ (mm SHELL COVER MATL _____ (INTEG)(REMOV)
CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____
TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____
FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____
BAFFLES--CROSS MATL _____ TYPE _____ % CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ (mm)
BAFFLES--LONG MATL _____ SEAL TYPE _____
SUPPORTS--TUBE _____ U-BEND _____ TYPE _____
BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____
GASKETS--SHELL SIDE _____ -- TUBE SIDE _____
--FLOATING HEAD _____
ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE ○ TEMA CLASS _____
WEIGHT/SHELL _____ (kg) FILLED WITH WATER _____ (kg) BUNDLE _____ (kg)

REMARKS: _____

REVISION	0	1	2	3	4
DATE					

INTEGRALLY GEARED COMPRESSOR
DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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INTER COOLER(S) - BETWEEN 3rd and 4th STAGE

SERVICE OF UNIT: _____ ITEM NO. _____
SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES
SURF/UNIT: (GROSS/EFF) _____ (m²) SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (℃)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg ℃)				
☐ THERMAL CONDUCTIVITY, (kJ/m h ℃)				
☐ LATENT HEAT, (kJ/kg ℃)				
☐ INLET PRESSURE, (barG)				
◎ VELOCITY, (m/s)				
◎ PRESSURE DROP--ALLOW/CALC, (bar)				
◎ FOULING RESISTANCE--MINIMUM (hr m² ℃/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (℃)
☐ TRANSFER RATE, (kJ/hr m² ℃) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, (barG)		
DESIGN TEMPERATURE, (℃)		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, (mm)		
NOZZLES: INLET		
SIZE & OUTLET		
RATING VENT-DRAIN		

SKETCH: BUNDLE NOZZLE ORIENTATIONS

TUBE NO. _____ O.D. _____ (mm) THK (MIN) (AVG) _____ (mm) LENGTH _____ (m) PITCH _____ (mm) ◁ 30 △ 60 □ 90 ◇ 45
TUBE TYPE _____ MATERIAL _____
SHELL MATL _____ I.D. _____ (mm) O.D. _____ (mm) SHELL COVER MATL _____ (INTEG)(REMOV)
CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____
TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____
FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____
BAFFLES--CROSS MATL _____ TYPE _____ % CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ (mm)
BAFFLES--LONG MATL _____ SEAL TYPE _____
SUPPORTS--TUBE _____ U-BEND _____ TYPE _____
BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____
GASKETS--SHELL SIDE _____ -- TUBE SIDE _____
--FLOATING HEAD _____
ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE ○ TEMA CLASS _____
WEIGHT/SHELL _____ (kg) FILLED WITH WATER _____ (kg) BUNDLE _____ (kg)

REMARKS: _____

REVISION	0	1	2	3	4
DATE					

INTEGRALLY GEARED COMPRESSOR DATA SHEET (API 617-8TH Chapter 3)
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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INTER COOLER(S) - BETWEEN 4th and 5th STAGE

SERVICE OF UNIT: _____ ITEM NO. _____
SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES
SURF/UNIT: (GROSS/EFF) _____ (m²) SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (℃)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg ℃)				
☐ THERMAL CONDUCTIVITY, (kJ/m h ℃)				
☐ LATENT HEAT, (kJ/kg ℃)				
☐ INLET PRESSURE, (barG)				
◎ VELOCITY, (m/s)				
◎ PRESSURE DROP--ALLOW/CALC, (bar)				
◎ FOULING RESISTANCE--MINIMUM (hr m² ℃/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (℃)
☐ TRANSFER RATE, (kJ/hr m² ℃) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, (barG)		
DESIGN TEMPERATURE, (℃)		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, (mm)		
NOZZLES: INLET		
SIZE & OUTLET		
RATING VENT-DRAIN		

SKETCH: BUNDLE NOZZLE ORIENTATIONS

TUBE NO. _____ O.D. _____ (mm) THK (MIN) (AVG) _____ (mm) LENGTH _____ (m) PITCH _____ (mm) ◁ 30 △ 60 □ 90 ◇ 45
TUBE TYPE _____ MATERIAL _____
SHELL MATL _____ I.D. _____ (mm) O.D. _____ (mm) SHELL COVER MATL _____ (INTEG)(REMOV)
CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____
TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____
FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____
BAFFLES--CROSS MATL _____ TYPE _____ %CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ (mm)
BAFFLES--LONG MATL _____ SEAL TYPE _____
SUPPORTS--TUBE _____ U-BEND _____ TYPE _____
BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____
GASKETS--SHELL SIDE _____ -- TUBE SIDE _____
--FLOATING HEAD _____
ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE ○ TEMA CLASS _____
WEIGHT/SHELL _____ (kg) FILLED WITH WATER _____ (kg) BUNDLE _____ (kg)

REMARKS: _____

Annex B
(informative)

Vendor (Supplier) data and drawing requirements (VDDR)

B.1 VDDR for integrally geared compressors

The vendor (supplier) data and drawing requirements (VDDR) for integrally geared compressors are also available in electronic format via http://standards.iso.org/iso/. The text for details of the description is given in B.2.

INTEGRALLY GEARED COMPRESSOR SUPPLIER DRAWING AND DATA REQUIREMENTS	Job No. Purchase order No. Requisition No. Inquiry No. Revision …….. by For Site	Item No. Date Date Date Manufacturer Unit Service

Proposal [a] – Bidder shall furnish number of paper copies /number of electronic copies of data as indicated
Review – Supplier shall furnish number of paper copies /number of electronic copies of data as indicated
Final – Supplier shall furnish number of paper copies /number of electronic copies of data as indicated

				Description (see text)	**Distribution record**				
					Review due from supplier [b c]	Review received from supplier	Review returned to supplier	Final due from supplier [c]	Final received from supplier
	/	/	/	1. Certified dimensional outline drawing and list of connections					
	/	/	/	2. Cross-sectional drawings and part numbers					
	/	/	/	3. Rotor assembly drawings and part numbers					
	/	/	/	4. Thrust-bearing assembly drawings and part numbers					
	/	/	/	5. Journal-bearing assembly drawings and bill of materials					
	/	/	/	6. Coupling assembly drawings and bill of materials					
	/	/	/	7. Lube-oil schematic and bill of materials					
	/	/	/	8. Lube-oil arrangement drawing and list of connections					
	/	/	/	9. Lube-oil component drawings and data					
	/	/	/	10. Seal system schematic and bill of material					
	/	/	/	11. Seal system arrangement drawing and list of connections					
	/	/	/	12. Seal system component drawings and data					
	/	/	/	13. Seal assembly drawing and part numbers					
	/	/	/	14. Electrical and instrumentation schematics and bill of materials					
	/	/	/	15. Electrical and instrumentation arrangement drawing and list of connections					
	/	/	/	16. Buffer gas system schematic and bill of material					
	/	/	/	17. Buffer gas system arrangement drawing and list of connections					
	/	/	/	18. Buffer gas system component drawing and data					
	/	/	/	19. Data sheets (proposal/as-built)					

	/	/	/	20. Allowable external forces and moments for each nozzle in tabular form (with proposal)					
	/	/	/	21. Gear quality documentations					
	/	/	/	22. Gear tooth contact check results					
	/	/	/	23. Certificates for gear materials					
	/	/	/	24. Predicted noise sound level (proposal)					
	/	/	/	25. Metallurgy of major components (in proposal)					
	/	/	/	26. Lateral analysis report					
	/	/	/	27. Torsional analysis report					
	/	/	/	28. Vibration analysis report					
	/	/	/	29. Performance curves for each compressor section (proposal/as-built)					
	/	/	/	30. Impeller overspeed test report					
	/	/	/	31. Mechanical running test report					
	/	/	/	32. Coupling selection and rating					
	/	/	/	33. List of recommended spare parts					
	/	/	/	34. List of special tools					
	/	/	/	35. Preparation for storage at job site before installation					
	/	/	/	36. Weather protection and winterization required at job site					
	/	/	/	37. Tabulation of all utilities					
	/	/	/	38. List of similar machines					
	/	/	/	39. Operating restrictions to protect equipment during start-up operation and shutdown					
	/	/	/	40. List of components requiring purchaser's approval					
	/	/	/	41. Summary of materials and hardness of materials exposed to H2S					
	/	/	/	42. Seal leakage rates					
	/	/	/	43. Interstage cooler system data					
	/	/	/	44. Drawings, details and description of instrumentation and controls					
	/	/	/	45. Minimum length of straight pipe required at machine inlet or side inlets					
	/	/	/	46. Maximum and minimum allowable seal pressure for each compressor					
	/	/	/	47. Statement of manufacturer's testing capabilities					
	/	/	/	48. Performance test data and curves					
	/	/	/	49. Back-to-back impeller machine supplier to provide thrust-bearing loads versus differential pressure curve					
	/	/	/	50. Production delivery schedule					
	/	/	/	51. Testing procedures					
	/	/	/	52. Progress reports					

	/	/	/	53. Installation manual					
	/	/	/	54. Operating and maintenance manual					
	/	/	/	55. Technical data manual					
a Proposal drawings and data do not have to be certified. Typical data shall be clearly identified as such. b Purchase may indicate in the column the desired time frame for submission of data. c Bidder shall complete these two columns to reflect the actual distribution schedule and include this form with the proposal.									

NOTES:

1. Where necessary to meet the scheduled shipping date, the supplier shall proceed with manufacture upon receipt of the order and without awaiting the purchaser's approval of drawings.
2. The supplier shall send all drawings and data to the following:

_____

_____

_____

3. All drawings and data shall show project, purchase order, and item numbers as well as plant location and unit. One set of the drawings and instructions necessary for field installation, in addition to the copies specified above, shall be forwarded with shipment.
4. See the descriptions of required items that follow.
5. All of the information indicated on the distribution schedule shall be received before final payment is made.
6. If typical drawings, schematics, bills of material are used for proposals, they shall be marked-up to show the expected weight and dimensions to reflect the actual equipment and scope proposed.

Nomenclature:

S — number of weeks before shipment.

F — number of weeks after firm order.

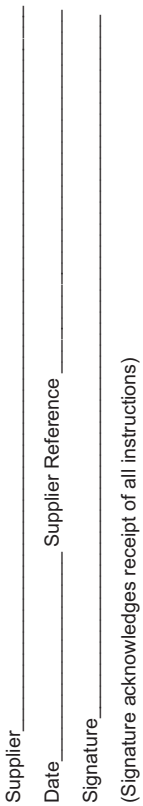
D — number of weeks after receipt of approved drawings.

Supplier_____

Date_____ Supplier Reference _____

Signature_____

(Signature acknowledges receipt of all instructions)



B.2 Descriptions

1) Certified dimensional outline drawing and list of connections, including the following:
   i) the size, rating, and location of all customer connections;
   ii) approximate overall and handling weights;
   iii) overall dimensions and maintenance and dismantling clearances;
   iv) shaft centering height
   v) dimensions of base plate (if furnished) for train- or skid-mounted package, complete with diameters, number, and locations of bolt holes and thicknesses of sections through which the bolts shall pass;
   vi) grounding details;
   vii) forces and moments allowed for suction and discharge nozzles;
   viii) centre of gravity and lifting points;
   ix) shaft-end separation and alignment data;
   x) direction of rotation;
   xi) winterization, tropicalization, and/or noise attenuation details, when required;
   xii) sketches to show lifting of assembled machine and major components and auxiliaries.
2) Cross-sectional drawings and part numbers of major equipment.
3) Rotor assembly drawings and part numbers.
4) Thrust-bearing assembly drawings and part numbers.
5) Journal-bearing assembly drawings and bill of materials.
6) Coupling assembly drawing and bill of materials.
7) Lube-oil schematic and bill of material including the following:
   i) oil flows, temperatures, and pressure at each point;
   ii) control alarm shutdown settings for pressure and temperature;
   iii) total heat loads;
   iv) utility requirements including electrical, water, air, and steam;
   v) pipe, valve, and orifice sizes;
   vi) instrumentation, safety devices, control schemes, and wiring diagrams.
8) Lube-oil arrangement drawing and list of connections.
9) Lube-oil component drawings and data, including the following:
   i) pumps and drivers;
   ii) coolers, filter, and reservoir;
   iii) instrumentation.
10) Seal system schematic and bill of material, including the following:
   i) flows oil or gas, temperatures, and pressures at each point;

ii) control, alarm, and shutdown settings for pressure and temperatures;

iii) total heat load for coolers, if required;

iv) utility requirements including electrical, water, air, and steam;

v) pipe, valve, and orifice sizes;

vi) instrumentation, safety devises, control schemes, and wiring diagrams;

vii) filtration requirements;

viii) height of overhead tank above centreline of machine.

11) Seal system arrangement drawing and list of connections.

12) Seal system components drawing and data, including the following:

i) pumps and drivers;

ii) coolers, filter, and reservoirs;

iii) instrumentation.

13) Seal assembly drawing and part numbers.

14) Electrical and instrumentation arrangement drawing and list of connections:

i) vibration warning and shutdown limits;

ii) bearing temperature warning and shutdown limits;

iii) lube-oil temperature warning and shutdown limits;

iv) lube-oil pressure warning and shutdown limits;

v) lube-oil level warning and shutdown limits;

vi) machine discharge pressure and temperature warning and shutdown limits;

vii) seal, pressure, temperature, flow warning, and shutdown limits.

15) Electrical and instrumentation arrangement drawing and list of connections.

16) Buffer gas system schematic and bill of material.

17) Buffer gas system arrangement drawing and list of connections.

18) Buffer gas system component drawings and data, including the following:

i) control devices;

ii) pressure and filtration requirements.

19) Data sheets provided with proposal as-built.

20) Supplier shall furnish the allowable forces and moments for each nozzle in tabular form with the proposal.

21) The supplier shall provide documentation showing the gear has met the quality levels of AGMA 2015-1-A01, Grade 4.

22) The supplier shall make available to the purchaser the results of the gear tooth contact check for each gear set installed in the job gear box.

23) Certificates for gearing materials:

    i) mill test reports for all gear element components;

    ii) UT of all gear element components after rough machining;

    iii) record of all heat treatment and resulting hardness versus case depth of all welds on rotating elements;

    iv) MP of gear and pinion teeth;

    v) results of quality control checks;

    vi) gear tooth surface finish;

    vii) plating of teeth;

    viii) tooth profile, helix deviation pitch error, and cumulative pitch error;

    ix) contact checks in job casing;

    x) records of all radiographs and UT;

    xi) hardness versus case depth.

24) Predicted noise level, sound pressure, and sound power level.

25) Metallurgy of major components identified with ASTM, AISI, ASME, or SAE numbers stated in proposal.

26) Lateral analysis report when specified shall also include a stability analysis.

27) Torsional analysis report.

28) Vibration analysis conducted on machines that require disassembly after balancing to allow machine assembly. The supplier shall also provide historic unbalance data for the machine size and type.

29) Performance data and curves, sufficient performance data to enable the purchaser to properly design a control system and surge prevention.

30) Dimensions taken from each impeller before and after overspeed testing shall be submitted for review.

31) Mechanical running test report to include the following:

    i) unfiltered vibration;

    ii) plots showing synchronous vibration and phone angle, filtered and unfiltered;

    iii) when specified, data shall be furnished in polar form;

    iv) when specified, tape recordings shall be made of all real-time vibration data;

    v) electrical and mechanical runout at each probe;

    vi) immediately upon completion of each witnessed mechanical or performance test, copies of the log and data recorded during the test shall be given to the witnesses.

32) Coupling selection and rating.

33) List of spare parts recommended for start-up and normal maintenance purposes.

34) List of the special tools furnished for maintenance.

35) The supplier shall provide the purchaser with instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up.

36) A description of any special weather protection required for start-up, operation, and period of idleness under the site conditions specified on the data sheets.

37) A complete list of utility requirements: quantity, filtration, and supply pressure of the following:

    i) steam;

    ii) water;

    iii) electricity;

    iv) air;

    v) gas;

    vi) lube oil and seal oil (quantity and supply pressure);

    vii) heat loads;

    viii) power ratings and operating power requirements for auxiliary drivers.

38) A list of machines similar to the proposed machines that have been installed and operating under conditions analogous to those specified in the inquiry.

39) Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment, including any unacceptable speeds due to natural frequencies.

40) A list of any components that can be construed as being of alternative design, requiring purchaser's acceptance.

41) A summary of the materials of construction for the compressor, including hardness for materials exposed to H_2S.

42) The maximum seal gas rates (injection or eduction) and rated or expected inner seal-oil leakage rates, if applicable. When self-acting dry gas seals are supplied, expected seal gas consumption, minimum seal gas supply flow, and primary vent flow should be given at maximum sealing pressure and at conditions over the operating envelope of the machine.

43) When interstage coolers are furnished, the supplier shall provide the following:

    i) drawing showing cooling system details;

    ii) data for purchasers heat and material balances;

    iii) details of provisions for separating and withdrawing condensate;

    iv) supplier's recommendations regarding provision for support and piping expansion.

44) Drawings, details, and descriptions of the operations of instrumentation and controls, as well as the makes, materials, and type of auxiliary equipment. The supplier shall also include a complete description of the alarm and shutdown facilities to be provided.

45) The minimum length of straight pipe required for proper flow characteristics at the inlet and at any side inlet connection.

46) Maximum and minimum allowable seal pressure for each compressor.

47) A statement of the manufacturer's capability regarding testing (including performance testing) of the compressor and any other specified items on the train. Details of each optional test specified shall be included.

48) Performance curves shall be submitted for each section (between purchasers process nozzles) of each casing, as well as an overall curve for the train. All curves submitted prior to complete performance testing shall be marked “predicted”.

    i) Any set of curves resulting from a test shall be marked “tested”;

    ii) If a performance test is specified, the supplier shall provide test data and curves when the test has been completed; the surge points shall be shown on the performance curves.

49) For compressors that have a back-to-back impeller arrangement, the supplier shall furnish a curve showing the expected loading on the active or inactive side of the thrust bearing versus any combination of differential pressures across the low pressure and high pressure sections of the casing.

50) The supplier shall provide production and delivery schedules.

51) The supplier shall submit detailed procedures, including acceptance criteria for the mechanical running test and all optional tests, at least 6 weeks before the first running test.

52) The supplier shall submit progress reports.

53) All information required for the proper installation of the equipment shall be compiled in a manual that shall be issued no later than the time of final certified drawings.

54) A manual containing all required operating and maintenance instructions shall be supplied not later than 2 weeks after all specified tests shall have been successfully completed.

55) The supplier shall provide a “technical data manual within 30 days of completion” of shop testing including the following:

    i) necessary certification of materials;

    ii) purchase specification for all items on the bill of materials;

    iii) test data to verify requirements of specifications have been met;

    iv) heat treat records;

    v) results of quality test and inspections;

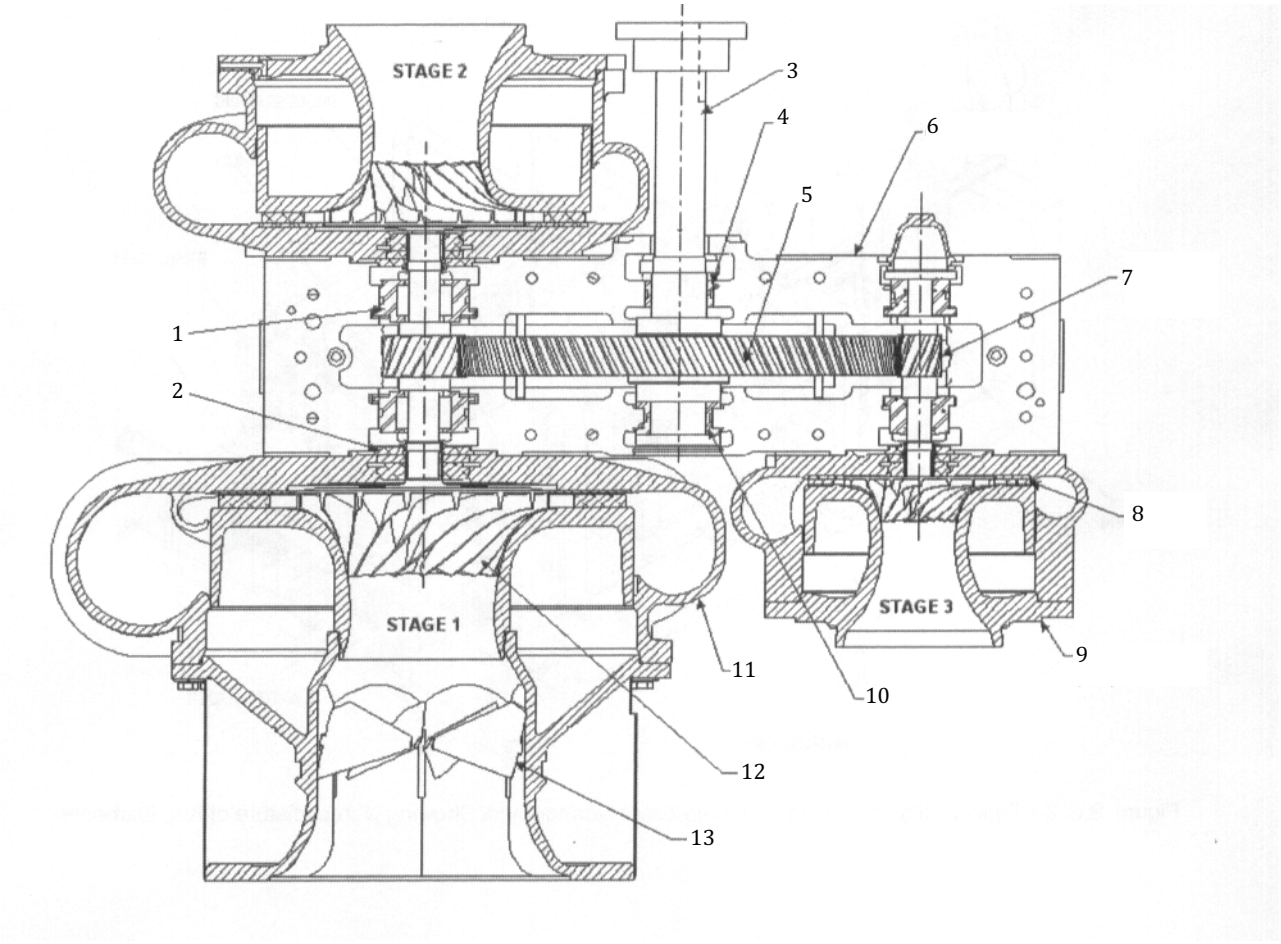
    vi) mechanical running test data log;

    vii) final assembly maintenance and running clearances;

    viii) the supplier is also required to keep this data available for examination by the purchaser upon request, for at least 5 years.

Annex C
(informative)

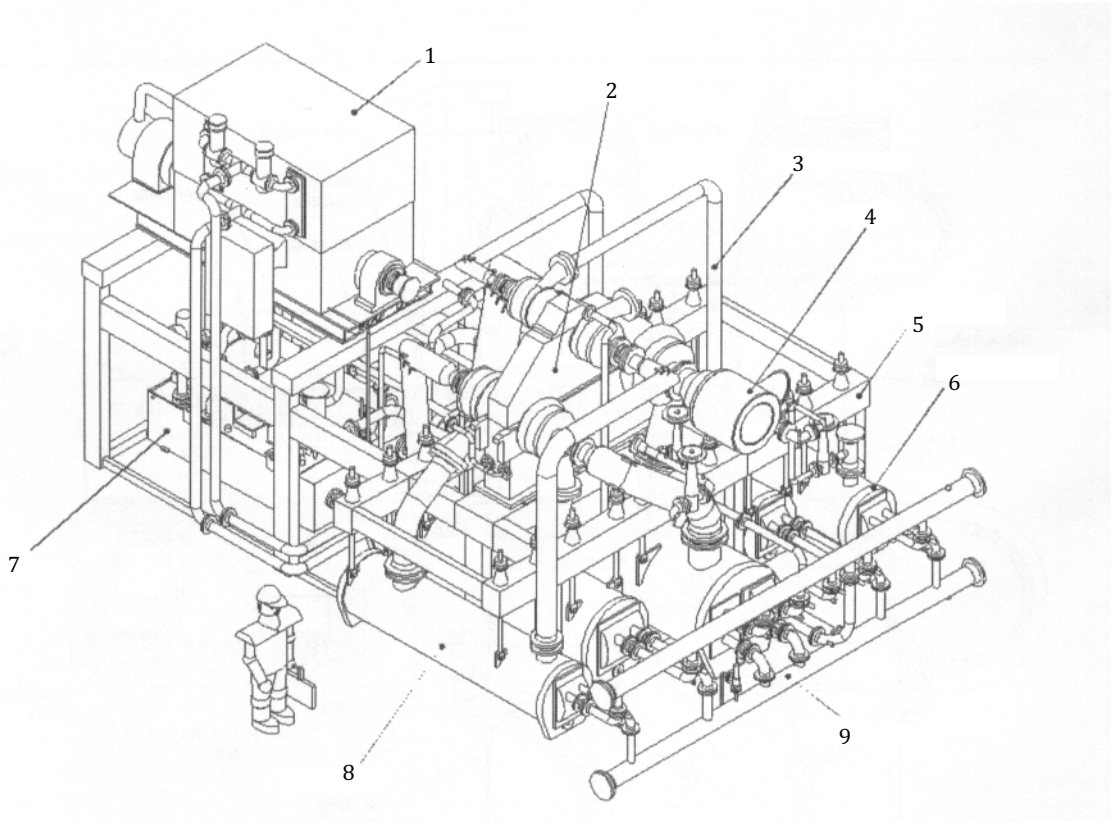
Nomenclature



Key

1 radial/thrust bearing (typ.)
2 seal (typ.)
3 input shaft
4 radial bearing
5 bull gear
6 gear case
7 pinion (typ.)
8 diffuser (typ.)
9 suction cover (typ.)
10 radial thrust bearing (typ.)
11 pressure casing (typ.)
12 impeller (typ.)
13 inlet guide vane

Figure C.1 — Cross-sectional view 3-stage, 2-pinion compressor



Key

1	driver	6	aftercooler
2	compressor	7	oil system
3	process piping	8	intercooler
4	inlet	9	water header
5	steel frame		

Figure C.2 — Typical integrally geared compressor package

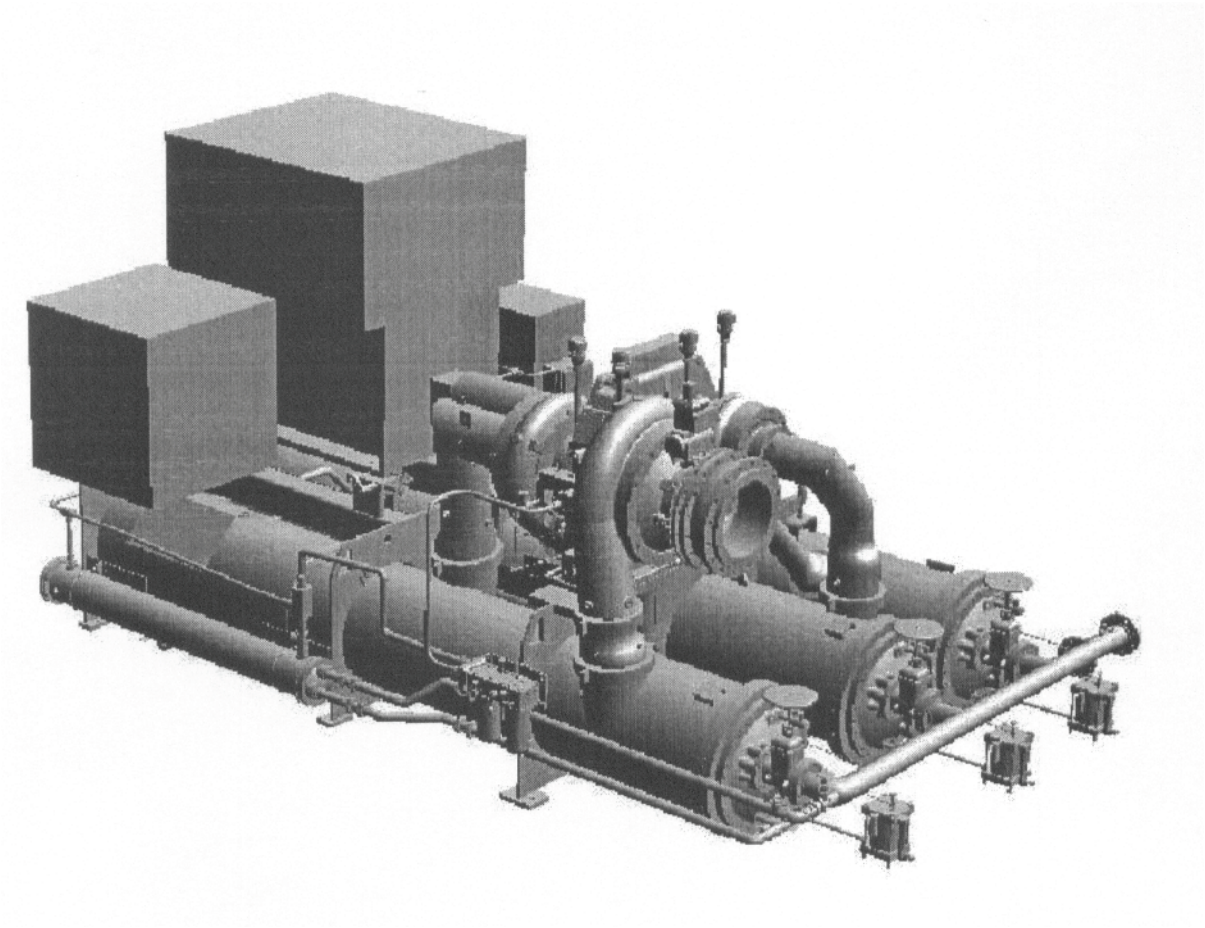


Figure C.3 — Typical integrally geared compressor arrangement

Annex D
(informative)

Typical materials for integrally geared compressors

The materials listed in this annex are considered equivalent as far as suitability for service. This does not imply that they are exactly equivalent. There can be significant differences in testing and other material requirements. The list of typical materials is also available in electronic format via http://standards.iso.org/iso/.

Table D.1

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
Casing, Inlet Casing, Discharge Casing	Cast iron	ASTM A 278, Class 30	JIS G5501 FC200	EN 1561 EN-GJL-250	EN-JL1040	Cast	−45 (−50)	230 (450)
		ASTM A 278, Class 40	JIS G5501 FC300	EN 1561 EN-GJL-300	EN-JL1050	Cast	−28 (−20)	260 (500)
	Austenitic cast iron	ASTM A 436, Type 2	JIS G5510 FCA-NiCr202			Cast	−45 (−50)	260 (500)
		ASTM A 571, Type D-2M Class 1 and 2	JIS G5510 FCDA-Ni22			Cast	−195 (−320)	260 (500)
	Ductile iron	ASTM A 395	JIS G5502	EN 1563 EN-GJS-400–18U-RT	EN-JS1059	Cast	−28 (−20)	260 (500)
	Cast steel	ASTM A 216, Grade WCB[b]	JIS G5102 SCW450	EN 10213 GP240GH ISO 4991-G240 similar reference DIN 1681 GS-38	1.0619 1.0420	Cast	−28 (−20)	400 (750)
		ASTM A 352, Grade LCB	JIS G5152 SCPL1	GC24E	1.1156	Cast	−45 (−50)	345 (650)
		ASTM A 352, Grade LC2	JIS G5152 SCPL21	EN 10213 G9Ni10	1.5636	Cast	−75 (−100)	345 (650)
		ASTM A 352, Grade LC3	JIS G5152 SCPL31	EN 10213 G9Ni14	1.5638	Cast	−100 (−150)	345 (650)
		ASTM A 352, Grade LC4	similar reference JIS G5152 SCPL31	similar reference EN 10213 G9Ni14	1.5638	Cast	−115 (−175)	345 (650)
		ASTM A 352, Grade LC9	JIS G 5101 SC450 JIS G 5101 SC480			Cast	−195 (−320)	205 (400)
		ASTM A 352, Grade LCC	similar reference JIS G5152 SCPL1	EN 10213 G17Mn5 EN 10213 G20Mn5 similar reference SEW 685 G26CrMo4	1.1131 1.6220 1.7221	Cast	−45 (−50)	345 (650)

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

a The temperature limits shown in this table are those commonly observed by compressor manufacturers and are not necessarily the same as any temperature limits specified in the applicable material specifications.

b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 217	JIS G5151	EN 10213		Cast	−28 (−20)	345 (650)
	Cast stainless steel	ASTM A 743/744 or A 351, Grade CF3, CF3M	CF3: JIS G5121 SCS19A CF3M: JIS G5121 SCS16A CF8: JIS G5121 SCS13A	CF3: EN 10213 GX2CrNi19–11 CF3M: EN 10213 GX2CrNiMo19–11–2	1.4309 1.4409	Cast	−195 (−320)	345 (650)
		ASTM A 743/744 or A 351CF8 or CF8M	CF8M: JIS G5121 SCS14A	CF8: EN 10213 GX5CrNi19–10 or SEW 685 GX6CrNi18–10 CF8M: EN 10213 GX5CrNiMo19–11–2	1.4308 1.6902 1.4408	Cast	−195 (−320)	345 (650)
		ASTM A 351, Grade CF3MA or CF8MA	JIS G5121 SCS19A	CF3MA: EN 10213 GX2CrNiMo19–11–2 CF8MA: EN 10213 GX5CrNiMo19–11–2	1.4409 1.4408	Cast	−195 (−320)	345 (650)
		ASTM A 487 Grade CA6NM Class A and B	JIS G 5121 SCS6	EN 10213 GX4CrNi13–4	1.4317	Cast	−45 (−50)	345 (650)
		ASTM A 757 Grade E3N	JIS G 5152 SCPL1	EN 10213 GX3CrNi13–4	1.6982	Cast	−75 (−100)	345 (650)
		ASTM A 757 Grade D1Q1	JIS G 5152 SCPL11 similar reference	SEW 685 G15CrMo9–10	1.7377	Cast	−28 (−20)	345 (650)
		ASTM A 747 Grade CB7Cu-1	JIS G5121 SCS 24			Cast		
	Cast aluminium	ASTM A 356 or A 357	JIS G5151	NA		Cast	−195 (−320)	150 (300)
	Cast Hastelloy	ASTM A 494 Grade CW2M	JIS H5701 NMCrC similar reference			Cast		

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

a The temperature limits shown in this table are those commonly observed by compressor manufacturers and are not necessarily the same as any temperature limits specified in the applicable material specifications.

b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 494 Grade N-7M	JIS H4551 NW0665			Cast		
	Cast titanium	ASTM B 367, Grade C3 or C4	C3: JIS H4600 Class 2 C4: NA	NA		Cast	−45 (−50)	150 (300)
		ASTM B 367, Grade C5	JIS H4600 Class 3			Cast		
Casing, Inlet Casing, Discharge Casing								
Fabricated	Steel	ASTM A 285, Grade C	JIS G3118 SGV450			Plate	−45 (−50)	345 (650)
		ASTM A 516, Grade 55, 60, 65, 70	55: JIS G3118 60 SGV410: JIS G3118 65 SGV410: JIS G3118 70 SGV450: JIS G3118 SGV480	55: EN 10028–2 P235GH 60: EN 10028–2 P265GH 65: EN 10028–2 P355GH EN 10025 S355J2+N 70: EN 10028–2 P355GH	1.0345 1.0425 1.0473 1.0577 1.0473	Plate	−45 (−50)	345 (650)
		ASTM A 203, Grade A or B	A: JIS G3127N255 SL2 B: NA	12Ni9	1.5635	Plate	−60 (−75)	345 (650)
		ASTM A 203, Grade D or E	D: JIS G3127N255 SL3 E: JIS G3127N275 SL3	EN 10028–4 12Ni14	1.5637	Plate	−105 (−160)	345 (650)
		ASTM A 537, Class 1 or 2	1: JIS G3115 2 SPV355: JIS G3115 SPV450	EN 10028–6 P355QH EN 10028–6 P460QH	1.8867 1.8871	Plate	−60 (−75)	345 (650)
		ASTM A 353	JIS G3127N520 SL9	EN 10028–3 X8Ni9	1.5662	Plate	−195 (−320)	345 (650)

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

a The temperature limits shown in this table are those commonly observed by compressor manufacturers and are not necessarily the same as any temperature limits specified in the applicable material specifications.

b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 553, Type I	JIS G3127N590 SL9	EN 10028–3 X8Ni9	1.5662	Plate	–195 (–320)	345 (650)
		ASTM A 553, Type II	JIS G3127N590 SL9	EN 10028–3 X8Ni9	1.5662	Plate	–170 (–275)	345 (650)
		ASTM A 266, Class 1 or 4	JIS G3202 SFVC1	EN 10222–4 P355NH	1.0565	Forged	–28 (–20)	345 (650)
		ASTM A 336, Class F1	JIS G3202 SFVA F1	EN 10222–2 16Mo3	1.5415	Forged	–28 (–20)	345 (650)
		ASTM A 414	JIS G3116	EN 10120		Sheet	–28 (–20)	345 (650)
		ASTM A 508, Class 5a [now: Grade 5 Class 2]	JIS G3204 SFVQ3	20NiCrMo14–6	1.6742	Forged	–28 (–20)	345 (650)
		ASTM A 350, Grade LF2	JIS G3205 SFL2	EN 10222–3 12Ni14	1.5637	Forged	–45 (–50)	345 (650)
		ASTM A 350, Grade LF3	JIS G3205 SFL3	EN 10222–3 12Ni14	1.5637	Forged	–100 (–150)	345 (650)
		ASTM A266 CL.1	JIS G3202 SFVC1			Forged	–28 (–20)	345 (650)
		ASTM A662 Grade B	JIS G3205 SFL1	EN 10028–4 P355N EN 10028–4 P355NL2	1.0562 1.1106	Plate	–45 (–50)	345 (650)
		ASTM A 765 Grade IV	JIS G3201 SF490A	EN 10222–4 P355QH1	1.0571	Forged	–30 (–20)	345 (650)
		ASTM A 350 Grade LF6 Class 1	JIS G3201 SF340A	DIN 17103 TStE 355	1.0566	Forged	–50 (–60)	345 (650)

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

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b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
	Stainless steel	ASTM A 240, Type 304, 304L, 316, 316L	304: JIS G4304 SUS304, JIS G4305 SUS304 304L: JIS G4304 SUS304L, JIS G4305 SUS304L 316: JIS G4304 SUS316, JIS G4305 SUS316 316L: JIS G4304 SUS316L, JIS G4305 SUS316L 321:JIS G4304 SUS321, JIS G4305 SUS321	304: EN 10028–7 X5CrNi18–10 304L: EN 10028–7 X2CrNi18–9 316: EN 10028–7 X5CrNiMo17–12–2 316L: EN 10028–7 X2CrNiMo17–12–2 or EN 10028–7 X5CrNiMoTi17–12–2 321: EN 10028–7 X5CrNiTi18–10	1.4301 1.4307 1.4401 1.4404 1.4571 1.4541			
		ASTM A 240, Type 321						
		ASTM A 182, Grade F304, F304L, F316	F304: JIS G3214 SUS F304 F304L: JIS G3214 SUS F304L F316: JIS G3214 SUS F316 F321: JIS G3214 SUS F321	F304: EN 10222–5 X5CrNi18–10 F304L: EN 10222–5 X2CrNi18–9 F316: EN 10222–5 X5CrNiMo17–12–2 or EN 10222–5 X5CrNiMoTi17–12–2 F321: EN 10222–5 X5CrNiTi18–10	1.4301 1.4307 1.4401 1.4571 1.4541	Forged	–195 (–320)	345 (650)
		ASTM A 182, Grade F321				Forged	–195 (–320)	345 (650)
		ASTM A 182, Grade F 6NM	JIS G3214 SUS F6 NM	EN 10222–5 X3CrNiMo13–4	1.4313	Forged	–45 (–50)	345 (650)
		AISI Type 304L	JIS G3214 SUS 304L			Plate	–195 (–320)	345 (650)
	Aluminium	ASTM B 209, Alloy 6061 or 7075	6061: JIS H4000 6061 7075: JIS H4000 7075			Plate	–195 (–320)	150 (300)

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b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM B 211, Alloy 6061 or 7075	6061: JIS H4040 6061 7075: JIS H4040 7075			Bar	−195 (−320)	150 (300)
		ASTM B 247, Alloy 6061 or 7075	6061: JIS H4140 6061 7075: JIS H4140 7050			Forged	−195 (−320)	150 (300)
		AMS 4108, Alloy 7050	JIS H4140 7050			Forged	−195 (−320)	150 (300)
Diffuser, shroud, guide vanes								
	Cast iron	ASTM A 48 or A 278, Class 30	JIS G5501 FC250	EN 1561 EN-GJL-250	EN-JL1040	Cast	−195 (−320)	345 (650)
	Ductile iron	ASTM A 536	JIS G5502	EN 1563 EN-GJS-400–15U	EN-JS1072	Cast	−195 (−320)	345 (650)
	Cast steel	ASTM A 216, Grade WCB	JIS G5102 SCW450	EN 10213 GP240GH ISO 4991-G240 similar reference DIN 1681 GS-38	1.0619 1.0420	Cast	−195 (−320)	345 (650)
		ASTM A 352, Grade LCB	JIS G5152 SCPL1	GC24E	1.1156	Cast	−45 (−50)	345 (650)
	Steel	ASTM A 283, A 284, A 285, A 516 or	JIS G3101 SS400	EN 10025 S235JR EN 10025 S355J2+N	1.0038 1.0577	Plate	−195 (−320)	345 (650)
		A 543				Plate	−195 (−320)	345 (650)
		ASTM A 36	JIS G3101 SS400	EN 10025 S235JR	1.0038	Plate	−195 (−320)	345 (650)

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b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
	Stainless steel	ASTM A 743/744 or A 351, Grade CA15,	JIS G5121 SCS13A, JIS G5121 SCS19A	CF8: EN 10213 GX5CrNi19–10 or SEW 685 GX6CrNi18–10 CF8M: EN 10213 GX5CrNiMo19–11–2	1.4308 1.6902 1.4408	Cast	–195 (–320)	345 (650)
		CF3, CF3M, CF8 or CF8M				Cast	–195 (–320)	345 (650)
		ASTM A 240, Type 410	JIS G4304 SUS410, JIS G4305 SUS410	EN 10088–2 X12Cr13	1.4006	Plate	–195 (–320)	345 (650)
		ASTM A 276, Type 410	JIS G4303 SUS410	EN 10088–3 X12Cr13	1.4006	Bar	–195 (–320)	345 (650)
		AISI Type 304	JIS G4304 SUS304			Plate	–195 (–320)	345 (650)
		AISI Type 304L	JIS G3214 SUSF304L	similar reference EN 10250 X6Cr-NiTi18–10	1.4541	Plate	–195 (–320)	345 (650)
		ASTM A 182, Grade F321, F316Ti	F321: JIS G 3214 SUS F 321 F316Ti:	F316 Ti: EN 10250 X6CrNiMoTi17–12–2 F321: EN 10250 X6CrNiTi18–10	1.4571 1.4541	Forged	–195 (–320)	345 (650)
		ASTM A662 Grade B	JIS G3205 SFL1	EN 10028–4 P355N EN 10028–4 P355NL2	1.0562 1.1106	Plate	–195 (–320)	345 (650)
		ASTM A 350 Grade LF6 Class 1	JIS G3201 SF340A	DIN 17103 TStE 355	1.0566	Forged	–195 (–320)	345 (650)
		ASTM A 182, Grade F 6NM	JIS G3214 SUS F6 NM	EN 10250 X3CrN-iMo13–4	1.4313	Forged	–195 (–320)	345 (650)

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b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 487 Grade CA6NM Class A and B	JIS G5151 SCPH 32 similar reference	EN 10213 GX4CrNi13–4	1.4317	Cast	–195 (–320)	345 (650)
		ASTM A 757 Grade E3N	JIS G5152 1991 SCPL1	EN 10213 GX3CrNi13–4	1.6982	Cast	–195 (–320)	345 (650)
	Titanium	ASTM B 367, Grade C5	JIS H4600 Class 3			Cast		
	Aluminium	ASTM B 26, Alloy 355 or C355	JIS H5202 AC4D	.		Cast	–195 (–320)	345 (650)
Fixed, Pre-whirl, De-whirl, and Variable Stator Vanes								
	Stainless Steel	ASTM A478 Type 347	JIS G4309 SUS347			Bar	–195 (–320)	345 (650)
		ASTM A240 Type 304 or 304L	304: JIS G4304 SUS304, JIS G4305 304 SUS304L: JIS G4304 SUS304L, JIS G4305 SUS304L			Plate	–195 (–320)	345 (650)
		ASTM A276 Type 316/316L	316: JIS G4303 316 SUS316L: JIS G4303 SUS316L			Bar	–195 (–320)	345 (650)
Shaft								
	Steel	ASTM A 470, Class 1	similar reference JIS G3201 SF540A			Forged	–28 (–20)	345 (650)

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b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 470, Class 7	similar reference JIS G3204 SFVQ3(WH□ 10325UA-UE)	SEW 555 26NiCr-MoV11–5 SEW 555 26NiCr-MoV14–5	1.6948 1.6957	Forged	–115 (–175)	400 (750)
		AISI Type 4340	JIS G4053 SNCM439	EN 10083–3 30CrN-iMo8	1.6580	Forged	–115 (–175)	345 (650)
		AISI Type 4140	JIS G4053 SCM440	EN 10083–3 42CrMo4	1.7225	Forged	–28 (–20)	400 (750)
		AISI Types 1040–1050[a]	JIS G4051 S40C	EN 10083–2 C45E	1.1191	Bar or Forged	–28 (–20)	345 (650)
		AISI Types 4140–4150[a]	JIS G4053 SCM440	EN 10083–3 42CrMo4	1.7225	Bar or Forged	–28 (–20)	400 (750)
		AISI Type 2320[a]	NA			Bar or Forged	–110 (–170)	345 (650)
		AISI Type 2330	NA			Bar or Forged	–110 (–170)	345 (650)
		AISI Type 9310	JIS G4053 SNCM 625			Bar or Forged		
		ASTM A 522, Type 1	JIS G3127N520 SL9	EN 10222–3 X8Ni9	1.5662	Forged	–195 (–320)	345 (650)
		ASTM 4340–4345	ASTM maybe replaced to AISI. JIS G4053 SNCM439	EN 10083–3 30CrN-iMo8 ISO 4957-55NiCr-MoV7	1.6580 1.2714	Forged	–115 (–175)	345 (650)
	Stainless steel	ASTM A 336, Grade F6	G3214 SUS F410-C	EN 10088–3 X12Cr13	1.4006	Forged	–60 (–75)	345 (650)

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Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 473, Type 410	JIS G3214 SUS F410	EN 10088–3 X12Cr13	1.4006	Forged	–60 (–75)	345 (650)
		ASTM A1021, Grade D, Class 2 (422)	NA			Forged	–60 (–75)	345 (650)
		ASTM A 182, Grade F 6NM	JIS G3214 SUS F6 NM	EN 10250 X3CrN-iMo13–4	1.4313	Forged	–60 (–75)	345 (650)
	Precipitation hardening stainless steel	ASTM A 705, Types 630 or XM-12	JIS G3214 SUS F630	EN 10250 X5CrNi-CuNb16–4	1.4542	Forged	–75 (–100)	345 (650)
	Nickel Alloys	ASTM A 564, Type 630 or XM-12	JIS G4303 SUS630	EN 10250 X5CrNi-CuNb16–4	1.4542	Bar	–270 (–454)	345 (650)
		AMS 4676	JIS H4553			Bar		
Impellers								
Cast and Forged	Aluminium	ASTM B 26, Alloy C355	JIS H5202 AC4C			Cast	–195 (–320)	150 (300)
	Precipitation hardening stainless steel	ASTM A 747, Type CB7CU-1 or CB7CU-2	JIS G5121 SCS 24			Cast	–75 (–100)	345 (650)
	Steel	ASTM A 148	JIS G5111			Cast	–28 (–20)	345 (650)
		ASTM A 487 Gs 4Q	JIS G5111 SCMnCrM2			Cast	–45 (–50)	345 (650)
	Stainless steel	ASTM A 743/744 or A 351, Grade CA15	JIS G5121 SCS1			Cast	–45 (–50)	345 (650)
		or CA6NM				Cast	–45 (–50)	345 (650)

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Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 743/744 or A 351, Grade CF3, CF3M,	CF3: JIS G5121 SCS19A CF3M: JIS G5121 SCS16A CF8: JIS G5121 SCS13A CF8M: JIS G5121 SCS14A			Cast	−195 (−320)	345 (650)
		CF8 or CF8M				Cast	−195 (−320)	345 (650)
	Aluminium	ASTM A 356 or A 357	JIS G5151			Cast	−195 (−320)	150 (300)
	Titanium	ASTM B 367, Grade C3 or C4	C3: JIS H4600 Class 2 C4: NA			Cast	−45 (−50)	345 (650)
		ASTM B 367, Grade C5	JIS H4600 Class 3			Cast	−195 (−320)	345 (650)
		ASTM B 348, Grade 5	JIS H4650 Class 60			Cast		
		ASTM B 348, Grade 19	NA			Cast		
		ASTM B 381, Grade F-19	NA			Forged		
	Inconel	ASTM B 637 Alloy N07718	JIS G4902 NCF718			Bar or Forged		
Fabricated (covers,hubs, blades)	Aluminium	ASTM B 209, Alloy 6061 or 7075	6061: JIS H4000 6061 7075: JIS H4000 7075			Plate	−195 (−320)	150 (300)
		ASTM B 211, Alloy 6061 or 7075	6061: JIS H4040 6061 7075: JIS H4040 7075			Bar	−195 (−320)	150 (300)
		ASTM B 221, Alloy 6061 or 7075	6061: JIS H4040 6061 7075: JIS H4040 7075			Extruded	−195 (−320)	150 (300)
		ASTM B 247, Alloy 2618,	2618: JIS H4140 2618 6061: JIS H4140 6061 7075: JIS H4140 7050			Forged	−195 (−320)	150 (300)

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Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		6061 or 7075				Forged	–195 (–320)	150 (300)
		AMS 4108, Alloy 7050	JIS H4140 7050			Forged	–195 (–320)	150 (300)
Impellers, Fabricated	Steel	AISI Types 4130–4140[a]	JIS G4053 SCM430	EN 10083–3 42CrMo4	1.7225	Plate or Forged	–28 (–20)	400 (750)
		AISI Types 4320–4345[a]	JIS G4053 SNCM431	EN 10083–3 30CrN-iMo8	1.6580	Plate or Forged	–115 (–175)	400 (750)
		ASTM A 470, Class 8	JIS G3221 SFCM 740S similar reference	14CrMoV6–9	1.7735	Forged	–45 (–50)	400 (750)
		AISI Type 3140[a]	similar reference JIS G4102 SNC236			Forged	–45 (–50)	400 (750)
		ASTM A 543	JIS G3101 SS400			Plate	–115 (–175)	400 (750)
		ASTM A 522, Type I	JIS G3127N520 SL9	EN 10222–3 X8Ni9	1.5662	Forged	–145 (–230)	345 (650)
		ASTM A 522, Type II	JIS G3127N520 SL9	EN 10222–3 X8Ni9	1.5662	Forged	–170 (–275)	345 (650)
		ASTM A 353	JIS G3127N520 SL9	EN 10222–3 X8Ni9	1.5662	Plate	–195 (–320)	345 (650)
		AISI Type 403[a]	JIS G3214 SUS F403	EN 10088–3 X6Cr13	1.4000	Forged	–60 (–75)	345 (650)
		ASTM A 473, Type 410	JIS G3214 SUS F410	EN 10088–3 X12Cr13	1.4006	Forged	–60 (–75)	345 (650)

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Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		ASTM A 240, Type 304, 304L, 316	304: JIS G4304 SUS304, JIS G4305 304 SUS304L: JIS G4304 SUS304L, JIS G4305 SUS304L 316: JIS G4304 SUS316, JIS G4305 316 SUS316L: JIS G4304 SUS316L, JIS G4305 SUS316L	304: EN 10028–7 X5CrNi18–10 304L: EN 10028–7 X2CrNi18–9 316: EN 10028–7 X5CrNiMo17–12–2 316L: EN 10028–7 X2CrNiMo17–12–2	1.4301 1.4307 1.4401 1.4404	Plate	–195 (–320)	345 (650)
		ASTM A 473, Type 304, 304L, 316, or 316L	304: JIS G3214 SUS F304 304L: JIS G3214 SUS F304L 316: JIS G3214 SUS F316 316L: JIS G3214 SUS F316L	F304: EN 10222–5 X5CrNi18–10 F304L: EN 10222–5 X2CrNi18–9 F316: EN 10222–5 X5CrNiMo17–12–2 F316L: EN 10222–5 X2CrNiMo17–12–2	1.4301 1.4307 1.4401 1.4404	Forged	–195 (–320)	345 (650)
		UNS S42400	NA	EN 10250 X3CrNiMo13–4	1.4313	Forged	–101 (–150)	345 (650)
		AISI Type 410	JIS G4303 SUS410	NA		Forged	–60 (–75)	345 (650)
		ASTM A 638 Grade 660 Type 2 (A286)	JIS G4311 SUH660	EN 10302 X6NiCrTiMoVB25–15–2	1.4980			345 (650)
		AISI Types 4130–4140[a]	JIS G4053 SCM430	EN 10083–3 42CrMo4	1.7225	Plate or Forged	–28 (–20)	400 (750)

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Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
	Precipitation hardening stainless steel	ASTM A 705, Type 630 or XM-12	JIS G3214 SUS F630	EN 10250 X5CrNiCuNb16–4	1.4542	Forged	–75 (–100)	345 (650)
		AISI S17400	JIS G4303 SUS630				–75 (–100)	345 (650)
		ASTM A 693, Type 630 or XM-12	JIS G4304 SUS630, JIS G4305 SUS630	EN 10088–2 X5CrNiCuNb16–4	1.4542	Plate	–75 (–100)	345 (650)
	Ni-based	AMS 5662 Alloy 718	JIS G 4902 NCF718			Forged	–110 (–170)	345 (650)
	Ni-Cu	SAE AMS 4646	NA	?		Forged	–115 (–175)	345 (650)
		ASTM B 127	JIS H4551			Plate	–115 (–175)	345 (650)
		QQ-N-286	JIS H4551 NW5500			Plate	–115 (–175)	345 (650)
		ASTM B 865 UNS N05500	JIS H4551 NW5500	DIN 17743 NiCu30Al ISO 9725 NiCu-30Al3Ti	2.4375 NW5500	Forging	–115 (–175)	345 (650)
	Titanium	ASTM B 381 Grade F5	JIS H4657 TAF6400	DIN 17864 TiAl6V4	3.7165	Forging	–195 (–320)	345 (650)
Rotor Blades								
	Stainless Steel	UNS S45000	NA			Forged or Bar	–60 (–75)	345 (650)
		UNS S42200	JIS G4311 SUH616			Forged or Bar	–60 (–75)	345 (650)
	Titanium	AMS 4928 Ti-6Al-4V	JIS H4650 Class 60			Forged or Bar	–60 (–75)	345 (650)
Shaft sleeves	Steel	AISI Types, 4130–4150[a]	JIS G4053 SCM440	EN 10083–3 42CrMo4	1.7225	Forged	–45 (–50)	345 (650)

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

a The temperature limits shown in this table are those commonly observed by compressor manufacturers and are not necessarily the same as any temperature limits specified in the applicable material specifications.

b Normalized or normalized and tempered.

Table D.1 *(continued)*

INTEGRALLY GEARED COMPRESSORS – TYPICAL MATERIALS FOR MAJOR COMPONENTS								
							Temperature Limits	
Component	**Materials**	**Material Code**	**Equivalent JIS Material**	**Equivalent EN Material**		**Form**	**Minimum temperature** °C (°F)	**Maximum temperature** °C (°F)
		AISI Types, 4320, 4345[a]	JIS G4053 SNCM431	EN 10083–3 30CrNiMo8	1.6580	Forged	–115 (–175)	400 (750)
		AISI Type 4330[a]	JIS G4053 SNCM431			Forged	–115 (–175)	400 (750)
		ASTM A 470, Class 7	similar reference JIS G3201 SF540A	SEW 555 26NiCrMoV11–5 SEW 555 26NiCrMoV14–5	1.6948 1.6957	Forged	–115 (–175)	400 (750)
		ASTM A 522, Type I	JIS G3127N520 SL9	EN 10222–3 X8Ni9	1.5662	Forged	–195 (–320)	345 (650)
		ASTM A 106	JIS G3456	EN 10216		Pipe	–28 (–20)	345 (650)
		ASTM A 350	JIS G3205	EN 10250		Forged	–45 (–50)	345 (650)
		ASTM A 350, Grade LF-3	JIS G3205 SFL3	EN 10250 12Ni14	1.5637	Forged	–100 (–150)	345 (650)
	Stainless steel	AISI Types 403 or 410[a]	403: JIS G3214 SUS F403 410: JIS G3214 SUS F410	EN 10088–3 X6Cr13 EN 10088–3 X12Cr13	1.4000 1.4006	Forged	–75 (–100)	400 (750)
	Ni-Cu alloy	ASTM B 164 or SAE AMS 4676	JIS H4553			Forged	–115 (–175)	345 (650)
	Ni-Mo-Cr alloy	ASTM B574, Alloy N10276	JIS H4551 NW0276	DIN 17744 NiMo16Cr15W ISO 9725 NiMo16Cr15Fe6W4	2.4819 NW0276	Wrought	–115 (–175)	345 (600)
		ASTM A 494, Grade CW-12M-1	similar reference JIS H5701 NMCrC			Cast	–115 (–175)	345 (650)
	Precipitation hardening stainless steel	A 705 Type 630 or XM-12	JIS G3214 SUS F630	EN 10250 X5CrNiCuNb16–4	1.4542	Forged	–75 (–100)	345 (650)

NOTE 1 The materials shown in this table are those commonly used by compressor manufacturers, but the list is not all inclusive. Other suitable materials can exist and can be used as indicated by specific design considerations.

NOTE 2 Descriptions of AISI Types (cross-referenced to UNS) can be found in SAE HS1086. Descriptions of UNS Types can also be found in ASTM DS 56J.

NOTE 3 AISI and UNS designations are only a description of chemical analyses of types of steels; they are not procurement specifications. All materials should be purchased to a specification that adequately defines the required properties and controls.

a The temperature limits shown in this table are those commonly observed by compressor manufacturers and are not necessarily the same as any temperature limits specified in the applicable material specifications.

b Normalized or normalized and tempered.

Annex E
(informative)

Inspector's checklist

The inspector's checklist provides a cross-reference of the applicable item to be inspected according to the relevant part and clause or subclause of ISO 10439. It provides for a tabular format to document the items inspected, the date they were inspected, the person(s) inspecting, and the current status. The inspector's checklist is also available in electronic format via http://standards.iso.org/iso/.

Item	ISO 10439		Date Inspected	Inspected By	Status
	Paragraph	Part			
4.5 MATERIALS					
Coating applied prior to acceptance balance	4.5.1.15	1			
PMI	4.5.1.16.1	1			
Impact testing	4.5.1.17.5	1			
Castings - material specification compliance	4.5.2.1	1			
Castings - purchaser approval of repairs	4.5.2.3.3	1			
Castings - ductile (Nodular) iron	4.5.2.5	1			
Forgings - repairs	4.5.3.2	1			
Welding - non-pressure components	4.5.4.1	1			
Welding - pressure containing and rotating parts	4.5.4.2	1			
4.6 CASINGS					
Jackscrews, dowels and special tools	4.6.1.4	1			
Depth of threaded holes	4.6.1.5	1			
Studs instead of cap screws	4.6.1.7.2	1			
Socket-head or spanner-type bolting	4.6.1.2	3			
Adequate clearance at bolts	4.6.1.7.3	1			
Bolting materials	4.6.1.7.6	1			
Welding	4.6.1.8	1			
Casing repair - minimum level of inspection and purchaser review	4.6.2.1	1			
Casing repair - major repairs	4.6.2.2	1			
Casing repair - material standards	4.6.2.3	1			
Pressure casings - plate edges	4.6.2.4.1	1			
Pressure casings - MPT or LPT	4.6.2.4.2	1			
Pressure casings - weld QC	4.6.2.4.3	1			
Pressure casings - full penetration welds	4.6.2.4.4	1			
Casings - heat treatment	4.6.2.4.5	1			
Pressure containing weld inspection	4.6.2.4.6	1			
Materials inspection standards	4.6.3.2	1			
Cast steel casings - acceptability of defects	4.6.3.3	1			
Pressure casing connection size	4.6.4.1.3	1			
Casing connections - welding before hydrotest	4.6.4.1.5	1			
Main process connection orientation	4.6.4.2.1	1			
Flanges	4.6.4.2.2	1			
Cast iron flanges	4.6.4.2.6	1			
Concentricity of bolt circle and bore	4.6.4.2.12	1			
Steel flange facing finish	4.6.4.2.13	1			
Machined and studded connections	4.6.4.2.14	1			
Flanges parallel within 0,5 degrees	4.6.4.2.15	1			

Auxiliary connections - minimum size	4.6.4.2.2	3			
Auxiliary connections - threaded	4.6.4.2.3	3			
Auxiliary connections - flanges	4.6.4.3.2	1			
Auxiliary connections - allowable types	4.6.4.3.3	1			
Auxiliary connections - pipe nipples	4.6.4.3.4	1			
Auxiliary connections - socket weld gap	4.6.4.3.6	1			
Auxiliary connections - lube or seal service	4.6.4.3.7	1			
Threaded openings for tapered pipe threads	4.6.4.3.8.1	1			
Tapered pipe threads	4.6.4.3.8.2	1			
Seal welding tapered pipe threads	4.6.4.3.8.3	1			
Pipe nipples for threaded openings	4.6.4.3.8.4	1			
Plugs for threaded openings	4.6.4.3.8.5	1			
Machine mounting surfaces	4.6.5.1	1			
4.7 ROTATING ELEMENTS					
Shaft ends for couplings	4.7.1	1			
Impeller and shaft marking	4.7.1	3			
Shaft sensing areas for probes	4.7.2	1			
Shaft sensing areas - final surface finish	4.7.3	1			
Thrust collar surface finish and TIR	4.7.6	1			
Fabricated impeller inspection	4.7.10.3	1			
Cast impeller inspection	4.7.10.4	1			
Cast impeller repair	4.7.10.5	1			
Welding not permitted for impeller balancing	4.7.10.6	1			
MPT or LPT of impellers after overspeed	4.7.10.7	1			
4.8 DYNAMICS					
Confirmation of critical speeds	4.8.2.2	1			
Unbalanced rotor response verification test	4.8.3	1			
Additional testing	4.8.4.1	1			
Rotating element - component balance	4.8.8.1	1			
Rotating element - sequential multiplane balance	4.8.8.2	1			
Rotating element - if disassembled after balance	4.8.8.2.1	1			
Rotating element - reassembly check balance	4.8.8.2.2	1			
Operating speed balance	4.8.8.3	1			
Operating speed balance procedure	4.8.8.4	1			
4.11 INTEGRAL GEARING (Part 3)					
Doweled or keyed gearbox	4.11.1	3			
Inspection cover	4.11.1.4	3			
Documentation for gearing quality level	4.11.3.5	3			
Tooth surface finish	4.11.3.13	3			
4.12 NAMEPLATES AND ROTATION ARROWS					
Nameplate at readily visible location	4.12.1	1			
Nameplate material	4.12.2	1			
Nameplate contents	4.12.2	3			
Rotation arrows	4.12.3	3			
Lateral critical speeds on nameplate	4.12.5	1			

5.4 MOUNTING PLATES					
Jackscrews	5.4.1.2.1	1			
Alignment shims	5.4.1.2.2	1			
Machinery mounting surfaces	5.4.1.2.3	1			
Anchor bolt clearance	5.4.1.2.8	1			
Vertical leveling screws	5.4.1.2.9	1			
Radiused corners for grout	5.4.1.2.10	1			
Hold down bolt clearance	5.4.1.2.12	1			
Wrench clearance	5.4.1.2.13	1			
Grout contacting surface preparation	5.4.1.2.15	1			
Mounting surface preservation	5.4.1.2.17	1			
Seal welded joints	5.4.2.3	1			
Leveling pads or targets	5.4.2.6.1	1			
Additional pads or targets	5.4.2.6.2	1			
Lifting lugs	5.4.2.7	1			
Grout fill and vent holes	5.4.2.8	1			
Soleplates supplied	5.4.3	3			
Soleplate thickness	5.4.3.1.1	1			
Soleplate size	5.4.3.1.2	1			
Soleplates fully machined	5.4.3.1.4	1			
Sub-soleplates	5.4.3.1.5	1			
5.5 CONTROLS AND INSTRUMENTATION					
Controls ingress protection level	5.5.1.6	1			
Terminal box ingress protection level	5.5.1.7	1			
Conduit and cable location and installation	5.5.1.8	1			
Transducers per API 670	5.5.7.2	3			
Monitors per API 670	5.5.7.3	3			
Bearing temperature sensors per API 670	5.5.7.4	3			
Bearing temperature monitor per API 670	5.5.7.6	3			
Accelerometer per API 670	5.5.7.7	3			
Accelerometer monitor per API 670	5.5.7.8	3			
5.6 PIPING AND APPURTENANCES					
Breakout spools	5.6.1.4	1			
Provisions to bypass bearings	5.6.1.5	1			
Provisions to bypass dry gas seals	5.6.1.6	1			
Instrument piping	5.6.2	1			
Process piping	5.6.3	1			
5.7 SPECIAL TOOLS					
Use of tools	5.7.1	1			
Tool packing and marking	5.7.2	1			
6.1 INSPECTION, TESTING AND PREPARATION FOR SHIPMENT - GENERAL					
Access to vendor's quality control program	6.1.7	1			
6.2 INSPECTION					
Painting before hydrotest	6.2.1.1	1			
Cleanliness	6.2.1.3	1			
Hardness of parts, welds and heat affected zones	6.2.1.5	1			
Radiographic inspection	6.2.2.2	1			
Ultrasonic inspection	6.2.2.3	1			
Magnetic particle inspection	6.2.2.4	1			
Liquid penetrant inspection	6.2.2.5	1			
Gear contact checks	6.2.1.1	3			

6.3 TESTING					
Contract shaft seals and bearings used	6.3.1.1.1	3			
Oil system cleanliness before testing	6.3.1.1.4	3			
Joint and connection tightness	6.3.2.5 6.3.1.1.5	1 3			
Warning, protective and control devices	6.3.2.6 6.3.1.1.6	1 3			
Hydrostatic test - pressure	6.3.3.1	1			
Hydrostatic test - duration	6.3.3.2	1			
Hydrostatic test - chloride content	6.3.3.3	1			
Impeller Overspeed test	6.3.4.1	1			
Residual magnetism	6.3.5	1			
Dry gas seals	6.3.6	1			
Mechanical running test - operation of equipment and test instrumentation	6.3.7.1.1 6.3.1.3.1	1 3			
Mechanical running test - unfiltered vibration	6.3.7 .1.2	1			
Mechanical running test - casing vibration	6.3.1.3.2	3			
Mechanical running test - vibration plots	6.3.7.1.3	1			
Mechanical running test - real time vibration data recorded	6.3.7.1.4 6.3.1.3.6	1 3			
Mechanical running test - seal flow data	6.3.7.1.5 6.3.1.2.4	1 3			
Mechanical running test - lube oil and seal oil variations	6.3.7.1.6	1			
Mechanical running test - hydrodynamic bearing inspection	6.3.7.2.1	1			
Mechanical running test - shaft end seal inspection	6.3.7.3	1			
Mechanical running test - tooth mesh inspection	6.3.1.4.1	3			
Mechanical running test - spare rotor	6.3.1.4.2	3			
Gas test after hydro	6.3.9.3	1			
Assembled compressor gas leak test - seal pressure	6.3.2.2	3			
Assembled compressor gas leak test - max discharge pressure	6.3.2.3	3			
Sound-level test	6.3.9.4	1			
Auxiliary equipment test	6.3.9.5	1			
Post-test inspection of internals	6.3.9.6	1			
Full-pressure/full-load/full-speed test	6.3.9.7	1			
Post-test inspection of coupling fit	6.3.9.8	1			
Spare parts test	6.3.9.9	1			

6.4 PREPARATION FOR SHIPMENT					
Preparation for shipment	6.4.1	1			
Testing completed and equipment released	6.4.3	1			
Coating on exterior surfaces	6.4.3.1	1			
Exterior machined surfaces coating	6.4.3.2	1			
Interior of equipment	6.4.3.3	1			
Internal surfaces of bearing housings	6.4.3.4	1			
Flange covers	6.4.3.5	1			
Threaded openings	6.4.3.6	1			
Beveled welding openings	6.4.3.7	1			
Lifting point identification	6.4.3.8	1			
Equipment tagging and packing lists	6.4.3.9	1			
Spare rotor storage preparation	6.4.3.10	1			
Spare rotor container	6.4.3.10.1	1			
Cradle support liner	6.4.3.11	1			
Rotor preparation for vertical storage	6.4.3.12	1			
Fit-up and assembly of piping and intercoolers	6.4.3.13	1			
Shaft and coupling protection	6.4.3.14	1			
Auxiliary connection marking	6.4.4	1			
Auxiliary piping match marks	6.4.5	1			
IOM shipped with equipment	6.4.6	1			
Wood used in export shipping	6.4.7	1			

Annex F
(informative)

External forces and moments

For integrally geared compressors, it is not possible to give a formula to calculate the maximum allowable piping forces and moments on each casing flange. The limiting criteria are the gear contact pattern and the impeller/stator gap. The maximum value of the external forces and moments, which leads to acceptable deformations and therefore acceptable changes of the gear contact pattern and the impeller/stator gap, depends on various parameters. These parameters include the following:

a) volute geometry;

b) volute wall thickness;

c) length of overhang;

d) gear case geometry;

e) gear case wall thickness.

The possible combinations are nearly endless and unique for each manufacturer's design. Each manufacturer has limits based on his experience for each volute size and gear case combination for a given specific machine. The values are available from the manufacturer with the quotation. Allowable nozzle loads on integrally geared compressors are much less than that of the beam or those of the overhung compressors covered in ISO 10439-2. It is a common practice on integrally geared compressors to require expansion joints in order to minimize the piping loads on the machine flanges and to ensure that piping loads are within the allowable limits for the particular unit. If expansion joints are not to be allowed or if they are very preferably to be avoided if at all possible, it is necessary to obtain values for allowable nozzle loading very early; preferably in the quotation stage. This facilitates the Piping Discipline to allow for a carefully designed piping system which will meet the manufacturer's allowable nozzle loading criteria.

NOTE 1 See 4.6.6.1 and Annex B. Allowable nozzle loading on main process nozzles which are customer connections need to be supplied with the quotation. In the event these values are not furnished, they need to be a minimum of the values in NEMA SM-23. When not supplied, NEMA SM-23 values can therefore be used to develop the piping design.

NOTE 2 When a supplier has furnished nozzle loadings, they can be less than the allowed values by NEMA SM-23.

Annex G
(normative)

Rating formulae for integral gearing

G.1 Rating formulas for integrally geared compressor

The rating formulas given in this annex are based on the methods from AGMA 2101. The constant of 0,8 at the beginning of these formulae is to provide increased reliability.

G.2 Pitting resistance power rating

The pitting resistance allowable transmitted power, P_{az} (kW), for a gear set is

$$P_{az} = 0{,}8\left(\frac{\omega_1 b}{1{,}91\times10^7}\right)\left(\frac{Z_1}{K_v K_H C_{SF}}\right)\left(\frac{d_{w1}\sigma_{HP}Z_N}{Z_E}\right)^2 \quad \text{(G.1)}$$

where

ω_1 is the pinion speed, expressed in r/min;

b is the face width, expressed in mm;

d_{w1} is the operating pitch diameter of the pinion, expressed in mm, equal to 2a/(u+1);

a is the centre distance, expressed in mm;

u is the gear tooth ratio (never less than 1,0);

Z_E is the elastic coefficient, equal to 190 for steel pinion and gear;

Z_1 is the geometry factor (reference AGMA 908).

Other symbols are explained in G.4 to G.9.

G.3 Bending strength power rating

The bending strength allowable transmitted power, P_{ay} (kW), for a gear pair is

$$P_{ay} = 0{,}8\left(\frac{\varpi_1 d_{w1}}{1{,}91\times10^7}\right)\left(\frac{b m_t Y_J \sigma_{FP} Y_N}{K_v K_H K_{SF}}\right) \quad \text{(G.2)}$$

where

m_t is the transverse module (equal to normal module divided by the cosine of the helix angle at the standard pitch diameter);

Y_J is the geometry factor (reference AGMA 908).

Other symbols are explained in G.4 to G.9.

G.4 Load distribution factor (K_H)

If the value of the load distribution factor, K_H, calculated in Formula (G.3) is less than 1,1, then 1,1 shall be used as the value of K_H. Gear designs shall not result in a calculated value of K_H over 1,50 without approval from the purchaser.

$$K_H = 1{,}0 + 0{,}8\left(K_{\mathrm{Hpf}} + 0{,}054 + 0{,}4032\times10^{-3}b - 1{,}152\times10^{-7}b^2\right) \quad \text{(G.3)}$$

where

b is the face width of narrower member of gear set, expressed in mm;

K_{Hpf} bod – 0,025 when b < 25 mm;

bod – 0.037 5 + 0,000 492 b when 25 mm < b < 432 mm;

bod – 0,110 9 + 0,000 815 b – 3,53 × 10–7 b2 when 432 mm < b < 1 020 mm;

bod is the greater of 0,05 or b/(10 dw1).

NOTE The distance from the centre of the gear mesh to the centre of the bearing span divided by the bearing span needs to be less than 0,175. The tooth contact needs to be checked at assembly, with contact adjustments as required. If these conditions are not met, or for wide face gears, an analytical approach can be used to determine a more conservative load distribution factor, with prior approval by the purchaser.

G.5 Dynamic factor (K_v)

ISO 1328 Grade 5: K_v = 1,135

ISO 1328 Grade 4: K_v = 1,120

ISO 1328 Grade 3: K_v = 1,105

ISO 1328 Grade 2: K_v = 1,090

The dynamic factor, K_v, does not account for dynamic tooth loads that can occur due to torsional or lateral natural frequencies. System designs should avoid having such natural frequencies close to an excitation frequency associated with an operating speed since the resulting gear tooth dynamic loads can be very high.

G.6 Stress cycle factors (Z_N and Y_N)

The pitting stress cycle (life) factor $Z_N = 2{,}466\ N^{-0{,}056}$.

The bending stress cycle (life) factor $Y_N = 1{,}683\ 1\ N^{-0{,}032\ 3}$.

N is the number of stress cycles:

— for the pinion, N = pinion r/min × 1,052 × 10^7,

— for the bull gear, N = bull gear r/min × 1,052 × 10^7 × number of pinions in mesh.

NOTE These factors are based on the lower line in Figures 17 and 18 of AGMA 2101-D04 with 175,316 h (20 years × 365,242 days/year × 24 h/day) of continuous service at rated operating speed.

G.7 Allowable stress numbers (σ_{HP} and σ_{FP})

The values of σ_{HP} and σ_{FP} shall be for Grade 2 materials per AGMA 2101-D04, Clause 16.

G.8 Reverse loading

For idler gears and other gears where the teeth are completely reverse loaded on every cycle, use 70 % of the allowable bending stress number, σ_{FP}, in AGMA 2101-D04.

G.9 Service factor (C_{SF} and K_{SF})

The service factor used for integrally geared centrifugal compressors shall be 1,4 when driven by an induction motor, 1,6 when driven by a gas or steam turbine, and 1,7 when driven by a synchronous motor or internal combustion engine.

Bibliography

[1] API 672, *Packaged, integrally geared centrifugal air compressors for petroleum, chemical, and gas industry services*

[2] API RP 686, *Machinery installation and installation design*

[3] ISO 10439-2, *Petroleum, petrochemical and natural gas industries — Axial and centrifugal compressors and expander-compressors — Part 2: Non-integrally geared centrifugal and axial compressors*

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