BRITISH STANDARD

BS EN ISO
10440-2:2001
Incorporating
Corrigendum No. 1

Petroleum and natural gas industries — Rotary-type positive-displacement compressors —

Part 2: Packaged air compressors (oil-free)

The European Standard EN ISO 10440-2:2001 has the status of a British Standard

ICS 75.180.99; 23.140

BSI
British Standards

National foreword

This British Standard is the official English language version of EN ISO 10440-2:2001. It is identical with ISO 10440-2:2001.

The UK participation in its preparation was entrusted to Technical Committee MCE/8, Compressors, pneumatic tools, pneumatic machines and vacuum technology, which has the responsibility to:

— aid enquirers to understand the text;

— present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;

— monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this committee can be obtained on request to its secretary.

Cross-references

The British Standards which implement international or European publications referred to in this document may be found in the *BSI Catalogue* under the section entitled "International Standards Correspondence Index", or by using the "Search" facility of the *BSI Electronic Catalogue* or of British Standards Online.

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

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This British Standard, having been prepared under the direction of the Engineering Sector Policy and Strategy Committee, was published under the authority of the Standards Policy and Strategy Committee on 27 March 2002

Summary of pages

This document comprises a front cover, an inside front cover, the EN ISO title page, the EN ISO foreword page, the ISO title page, pages ii to v, a blank page, pages 1 to 40, the Annex ZA page and a back cover.

The BSI copyright date displayed in this document indicates when the document was last issued.

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EUROPEAN STANDARD

NORME EUROPÉENNE

EUROPÄISCHE NORM

EN ISO 10440-2

December 2001

ICS 75.180.20

English version

Petroleum and natural gas industries - Rotary-type positive-displacement compressors - Part 2: Packaged air compressors (oil-free) (ISO 10440-2:2001)

Industries du pétrole et du gaz naturel - Compresseurs volumétriques de type rotatif - Partie 2: Compresseurs à air assemblé (sans huile) (ISO 10440-2:2001)

This European Standard was approved by CEN on 12 November 2001.

CEN members are bound to comply with the CEN/CENELEC Internal Regulations which stipulate the conditions for giving this European Standard the status of a national standard without any alteration. Up-to-date lists and bibliographical references concerning such national standards may be obtained on application to the Management Centre or to any CEN member.

This European Standard exists in three official versions (English, French, German). A version in any other language made by translation under the responsibility of a CEN member into its own language and notified to the Management Centre has the same status as the official versions.

CEN members are the national standards bodies of Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and United Kingdom.

EUROPEAN COMMITTEE FOR STANDARDIZATION
COMITÉ EUROPÉEN DE NORMALISATION
EUROPÄISCHES KOMITEE FÜR NORMUNG

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Foreword

This document (EN ISO 10440-2:2001) has been prepared by Technical Committee ISO/TC 67 "Materials, equipment and offshore structures for petroleum and natural gas industries" in collaboration with Technical Committee CEN/TC 12 "Materials, equipment and offshore structures for petroleum 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 June 2002, and conflicting national standards shall be withdrawn at the latest by June 2002.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

Endorsement notice

The text of ISO 10440-2:2001 has been approved by CEN as EN ISO 10440-2:2001 without any modifications.

NOTE Normative references to International Standards are listed in Annex ZA (normative).

EN ISO 10440–2:2001

INTERNATIONAL STANDARD

ISO 10440-2

First edition
2001-12-01

Petroleum and natural gas industries — Rotary-type positive-displacement compressors —

Part 2: Packaged air compressors (oil-free)

Industries du pétrole et du gaz naturel — Compresseurs volumétriques de type rotatif —

Partie 2: Compresseurs à air assemblé (sans huile)

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 3.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this part of ISO 10440 may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

International Standard ISO 10440-2 was prepared by Technical Committee ISO/TC 118, *Compressors, pneumatic tools and pneumatic machines* and Technical Committee ISO/TC 67, *Materials, equipment and offshore structures for petroleum and natural gas industries*, Subcommittee SC 6, *Processing equipment and systems*.

ISO 10440 consists of the following parts, under the general title *Petroleum and natural gas industries — Rotary-type positive-displacement compressors*:

— *Part 1: Process compressors (oil-free)*

— *Part 2: Packaged air compressors (oil-free)*

Annex A forms a normative part of this part of ISO 10440.

Introduction

This part of ISO 10440 is based on the 2nd edition API 619 and upon the accumulated knowledge and experience of manufacturers and users of oil-free rotary compressors. The objective of this publication is to provide a purchase specification to facilitate the manufacture and procurement of oil-free rotary compressors for general petroleum and natural gas industry services but its use is not limited to these services.

The purpose of this part of ISO 10440 is to establish minimum requirements for design and construction so that the equipment will be suitable for the purpose for which it is required. This limitation in scope is one of charter rather than interest and concern. Energy conservation and protection of environment are matters of increasing concern and are important in all aspects of equipment design, application and operation. The manufacturers and users of equipment should aggressively pursue alternative innovative approaches which improve energy utilization and/or minimize environmental impact without sacrificing safety or reliability. Such approaches should be thoroughly investigated and purchase options should increasingly be based on the estimation of whole life costs and the environmental consequences rather than acquisition costs alone.

This part of ISO 10440 requires the purchaser to specify certain details and features.

For effective use of this part of ISO 10440 and ease of reference to the text, the use of the data sheets in annex A is recommended.

Users of this part of ISO 10440 should be aware that further or differing requirements may be needed for individual applications. This part of ISO 10440 is not intended to inhibit a vendor from offering, or the purchaser from accepting, alternative equipment or engineering solutions for the individual application. This may be particularly applicable where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this part of ISO 10440 and provide details.

Petroleum and natural gas industries — Rotary-type positive-displacement compressors —

Part 2:
Packaged air compressors (oil-free)

1 Scope

This part of ISO 10440 covers the minimum requirements for helical, spiral and straight-lobe, oil-free rotary compressors used for applications up to 0,20 MPa in refinery services. It is applicable to air (and other inert gas) compressors that are in continuous duty on process units.

This part of ISO 10440 is not applicable to oil injected rotary compressors.

NOTE A bullet (•) at the beginning of a clause or sub-clause indicates that either a decision is required or further information is to be provided by the purchaser. This information should be indicated on the data sheets; otherwise it should be stated in the quotation request or in the order.

2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of ISO 10440. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of ISO 10440 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of ISO and IEC maintain registers of currently valid International Standards.

ISO 7-1:1994, *Pipe threads where pressure-tight joints are made on the threads — Part 1: Dimensions, tolerances and designation*

ISO 262:1998, *ISO general-purpose metric screw threads — Selected sizes for screws, bolts and nuts*

ISO 281:1990, *Rolling bearings — Dynamic load ratings and rating life*

ISO 898-1, *Mechanical properties of fasteners made of carbon steel and alloy steel — Part 1: Bolts, screws and studs*

ISO 1217:1996, *Displacement compressors — Acceptance tests*

ISO 1328-2:1997, *Cylindrical gears — ISO system of accuracy — Part 2: Definitions and allowable values of deviations relevant to radial composit deviations and runout information*

ISO 1940-1:1986, *Mechanical vibration — Balance quality requirements of rigid rotors — Part 1: Determination of permissible residual unbalance*

ISO 3506-1:1997, *Mechanical properties of corrosion-resistant stainless-steel fasteners — Part 1: Bolts, screws and studs*

ISO 5167-1:—[1)], *Measurement of fluid flow in circular cross-section conduits running full using pressure differential devices — Part 1: General*

ISO 7005-1:1992, *Metallic flanges — Part 1: Steel flanges*

ISO 9329-2:1997, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 2: Unalloyed and alloyed steels with specified elevated temperature properties*

ISO 9329-4:1997, *Seamless steel tubes for pressure purposes — Technical delivery conditions — Part 4: Austenitic stainless steels*

ISO 10441:1999, *Petroleum and natural gas industries — Flexible couplings for mechanical power transmission — Special purpose applications*

IEC 60060-1, *High-voltage test techniques — Part 1: General definitions and test requirements*

IEC 60060-2, *High voltage test techniques — Part 2: Measuring systems*

IEC 61000-4-2, *Electromagnetic compatibility (EMC) — Part 4-2: Testing and measurement techniques — Electrostatic discharge immunity test*

IEC 61000-4-3, *Electromagnetic compatibility (EMC) — Part 4-3: Testing and measurement techniques — Radiated, radio-frequency, electromagnetic field immunity test*

IEC 61000-4-4, *Electromagnetic compatibility (EMC) — Part 4: Testing and measurement techniques — Section 4: Electrical fast transient/burst immunity test*

EN 55011, *Industrial, scientific and medical (ISM) radio-frequency equipment — Radio disturbance characteristics — Limits and methods of measurement*

EN 55022, *Information technology equipment — Radio disturbance characteristics — Limits and methods of measurement*

ASME B31.1:1998, *Power Piping*

ASME B31.3:1999, *Process Piping*

ASME BPVC Section VIII:1998, *Rules For Construction of Pressure Vessels Division 1*

API 614:1995, *Lubrication, Shaft-Sealing, and Control-Oil Systems for Special-Purpose Application*

API 661:1992, *Air-Cooled Heat Exchangers for General Refinery Service*

API 670:1993, *Vibration, Axial-Position, and Bearing-Temperature Monitoring Systems*

API 671:1990, *Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services*

NEMA SM23:1991, *Steam turbines for mechanical drive service*

1) To be published. (Revision of ISO 5167-1:1991)

3 Terms and definitions

For the purposes of this part of ISO 10440, the following terms and definitions apply.

3.1
rated conditions
specified conditions at which operation is expected and/or optimum efficiency is expected

3.2
maximum allowable differential pressure
highest differential pressure that can be permitted in the casing under the most severe operating conditions of minimum suction pressure and discharge pressure equal to the relief valve setting

3.3
maximum allowable working pressure
maximum continuous pressure for which the manufacturer has designed the equipment (or any part to which the term is referred) when handling the specified fluid at the specified temperature

3.4
rated discharge pressure
highest pressure required to meet the conditions the purchaser specifies for the intended service

3.5
maximum allowable temperature
maximum continuous temperature for which the manufacturer has designed the equipment

3.6
rated discharge temperature
predicted actual operating temperature resulting from rated conditions

3.7
rated speed
speed of the power input rotor corresponding to the requirements of the compressor rated capacity

NOTE Rated speed is expressed in revolutions per minute.

3.8
maximum allowable speed
highest speed of the power input rotor at which the manufacturer's design permits continuous operation

NOTE Maximum allowable speed is expressed in revolutions per minute.

3.9
minimum allowable speed
lowest speed of the power input rotor at which the manufacturer's design permits continuous operation for the lowest rated conditions

NOTE Minimum allowable speed is expressed in revolutions per minute.

3.10
trip speed
speed at which independent emergency overspeed devices operate to shut down a prime mover

NOTE Trip speed is expressed in revolutions per minute.

3.11
rated capacity
volume flowrate required by the rated conditions

NOTE Rated capacity is expressed in cubic metres per hour.

3.12
rotor body
profile section on or integral with the shaft

3.13
rotor
complete rotor body and the shaft and shrunk-on sleeves (when furnished)

3.14
rotor assembly
rotating elements mounted on the rotor, excluding couplings

3.15
compressor stage
one or more rotors operating in a casing, the displacement being effected by vanes, meshing elements, or by displacement of the rotor itself

3.16
packaged compressor
compressor unit, stationary or mobile (portable), as supplied by the manufacturer, fully piped and wired, including power transmission, primer mover, filters and flow rate control

NOTE A canopy may be provided with the compressor for sound insulation and/or weather protection. Packaged compressors may also include starting equipment, intercoolers, aftercoolers, silencers, moisture separators, dryers, outlet filters, minimum pressure devices, outlet valves, check valves, etc.

3.17
axially split casing
casing with joints that are parallel to the shaft centerline

3.18
radially split casing
casing with joints that are transverse to the shaft centerline

3.19
maximum sealing pressure
highest pressure expected at the seals during any specified static or operating conditions and during start-up or shut-down

3.20
pressure casing
composite of all stationary pressure-containing parts of the unit, including all nozzles and other attached parts

3.21
critical speed
finite speed where resonance exists

4 Basic design

4.1 General

4.1.1 The purchaser and the vendor shall agree upon the pressure equipment code to be applied (e.g. ASME Section VIII Division 1 for design, Section IX for welding, etc.). This shall be specified on the data sheet (see annex A).

4.1.2 Equipment shall be capable of running safely to the trip speed at 110 % relief valve setting, and specified maximum differential pressure.

NOTE To run safely involves factors other than differential pressure, such as maximum discharge temperature or limiting driver power.

4.1.3 Cooling water systems shall be designed for the following conditions unless otherwise specified.

— Velocity in exchanger tubes 1,5 m/s to 2,5 m/s

— Maximum allowable working pressure > 5 bar (> 0,5 MPa)

— Test pressure > 7,7 bar (> 0,77 MPa)

— Maximum pressure drop 1 bar (0,1 MPa)

— Maximum inlet temperature 32 °C

— Maximum outlet temperature 49 °C

— Maximum temperature rise 17 °C

— Minimum temperature rise 11 °C

— Fouling factor on water side 0,35 m2.K/kW

Provision shall be made for complete venting and draining of the system.

4.1.4 The arrangement of the equipment, including piping and auxiliaries, shall be developed jointly by the purchaser and the package vendor. The arrangement shall provide adequate clearance areas and safe access for operation and maintenance.

4.1.5 All equipment shall be designed to permit rapid and economical maintenance. Major parts such as casing components and bearing housings shall be designed (shouldered or dowelled) and manufactured to ensure accurate alignment on reassembly.

4.1.6 Unless otherwise specified by the purchaser, spare parts for these compressors and auxiliaries shall meet all the requirements of the original equipment supplied.

4.1.7 Oil reservoirs and housings that enclose moving lubricated parts (such as bearings, 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 or idleness.

4.1.8 When special tools and fixtures are required to disassemble, assemble or maintain the unit, they shall be included in the quotation and furnished as part of the initial supply of the compressor. For multi-unit installations, the requirements for quantities of special tools and fixtures shall be mutually agreed upon by the purchaser and the vendor.

4.1.9 When special tools are provided, they shall be packaged in separate, rugged boxes and marked “special tools for (tag/item number)”. Each tool shall be tagged to indicate its intended use.

4.1.10 Packaged compressors shall perform on the test stand to the specified acceptance criteria. Other guarantees should be agreed upon between the purchaser and the vendor.

4.1.11 Many factors (such as pipe loadings, nozzle loadings, alignment at operating conditions, piping and foundation vibrations from other equipment installed locally, supporting structure, handling during shipment and handling and assembly at site) may adversely affect site performance.

To minimize the influence of these factors, the vendor shall propose a total compressor package. Allowable loads on the interconnecting flanges are specified by the vendor.

4.1.12 All electrical components and installations shall be suitable for the area classification and grouping specified by the purchaser on the data sheets and be in accordance with the local codes specified.

4.1.13 Control of the sound level from the packaged compressors shall be presented by the vendor. The equipment furnished shall conform to the requirements and local codes as specified by the purchaser and as detailed on the data sheets.

4.1.14 Water and/or oil separation shall be included in the package. The vendor shall prepare contamination levels. Where needed, contamination levels shall be specified by the purchaser.

4.1.15 The purchaser shall specify whether the installation is indoors (heated or unheated) or outdoors (with or without a roof) and the weather or environmental conditions in which the equipment shall operate (including maximum and minimum temperatures and unusual humidity or dust problems). The unit and its auxiliaries shall be suitable for operation in these specified conditions. For the purchaser's guidance, the vendor shall list in the proposal any special protection that the purchaser is required to supply.

4.2 Pressure casing

4.2.1 The hoop stress values used in the design of the casings shall not exceed the maximum allowable stress values in tension, as specified in the design code in 4.1.1, at the maximum and minimum operating temperature of the materials used.

4.2.2 The maximum allowable working pressure of the casing shall be at least equal to the specified relief valve setting.

4.2.3 Split pressure level casings shall be avoided. If the casing is split into two or more pressure levels, the vendor shall define the physical limits and the maximum allowable working pressure of each part of the casing. See 7.1 h) for proposal requirements.

4.2.4 Each axially split casing shall be sufficiently rigid to allow removal and replacement of its upper half without disturbing rotor-to-casing running clearances.

4.2.5 Casings and supports shall be designed to have sufficient strength and rigidity to limit a change of shaft alignment to 50 μm at the coupling flange caused by the worst combination of pressure, torque, allowable piping forces and moments. Supports and alignment bolts shall be rigid enough to permit the machine to be moved by the use of its lateral, axial and vertical jackscrews.

4.2.6 Axially split casings shall use a metal-to-metal joint (with a suitable joint compound) that is tightly maintained by suitable bolting. Gaskets (including string type) shall not be used on the axial joint. When gasketed joints are used between the end covers and the cylinder of radially split casings, they shall be securely maintained by confining the gaskets.

4.2.7 Jacket cooling systems shall be designed to positively prevent leakage of the process stream into the coolant. Coolant passages shall not open into casing joints.

4.2.8 Jackscrews, guide rods and casing alignment dowels shall be provided to facilitate disassembly and reassembly. When jackscrews are used as a means of parting contacting faces, one of the faces shall be relieved (counter-bored or recessed) to prevent a leaking joint or improper fit caused by marring. Guide rods shall be of sufficient length to prevent damage to the internals or casing studs by the casing during disassembly and

reassembly. Lifting lugs or eyebolts shall be provided for lifting only the top half of the casing. Methods of lifting the assembled machine shall be specified by the vendor.

4.2.9 For corrosion resistance, wear resistance and running in, overlay cladding or plating may be applied to the casing wall. The end wall may be similarly lined or have compatible end plates provided. The vendor shall include details of his procedures in the casing design proposal.

NOTE This procedure may require an overbore of the casing during manufacture prior to final machining.

4.2.10 Details of threading shall be in accordance with ISO 262.

4.2.11 Studs are preferred to cap screws.

4.2.12 A clearance shall be provided at bolting locations to permit the use of socket or box wrenches. The vendor shall supply any required special tools and fixtures.

4.2.13 Socket, slotted nut or spanner bolting shall not be used unless specifically approved by the purchaser.

4.2.14 Tapped holes in pressure parts shall be kept to a minimum. Sufficient metal in addition to the metal allowance for corrosion shall be left around and below the bottom of drilled and tapped holes in pressure sections of casings to prevent leakage.

4.2.15 Studded connections shall be furnished with studs installed. Blind stud holes should only be drilled deep enough to allow a preferred tap depth of 1,5 times the major diameter of the stud; the first 1,5 threads at both ends of each stud shall be removed.

4.3 Casing connections

4.3.1 Inlet and outlet connections shall be flanged or machined and studded, oriented as specified in the data sheets, and suitable for the working pressure of the casing as defined in clause 3.

4.3.2 All of the purchaser's connections shall be accessible for disassembly without the machine being moved.

4.3.3 No connections shall be welded to the casing.

4.3.4 When the following items are required or specified, flanged or studded boss connections not less than 20 mm pipe size shall be provided. Smaller connections may be used with the purchaser's approval.

a) Vents.

b) Pressure and temperature gauge connections.

c) Liquid injection.

d) Water cooling.

e) Lubricating and seal oil.

f) Flushing.

g) Buffer gas.

h) Casing drains.

i) Pressure equalizing pipes.

4.3.5 All casing openings for pipe connections shall not be less than 20 mm nominal pipe size and shall be flanged or machined and studded. Where flanged or machined and studded openings are impractical, threaded openings are allowable in sizes 20 mm and 25 mm nominal pipe size. These threaded openings shall be installed as specified in 4.3.5.1 to 4.3.5.5.

4.3.5.1 A pipe nipple, preferably not more than 150 mm long, shall be screwed into the threaded openings.

4.3.5.2 Pipe nipples shall be made from seamless tube capable of handling the pressure requirements of the data sheets and withstanding a mechanical load of 1 000 N in any direction.

4.3.5.3 The pipe nipple shall be provided with a welding neck or socket-weld flange.

4.3.5.4 The nipple and flange material shall meet the material requirements, including impact values, of the casing rather than the requirements of the connected piping.

4.3.5.5 The threaded connections shall not be seal welded.

4.3.6 Industry non standard openings shall not be used.

4.3.7 Flanges shall be in accordance with ISO 7005-1.

4.3.7.1 Cast iron flanges shall be flat faced.

4.3.7.2 Flat faced flanges with full raised-face thickness are acceptable in cases other than cast iron.

4.3.7.3 Flanges that are thicker or have a larger outside diameter than required by ISO 7005-1 are acceptable.

4.3.7.4 When connections not covered by ISO 7005-1 are used, then all mating parts shall be supplied and details shall be approved by the purchaser.

4.3.8 Machined and studded connections shall be in accordance with ISO 7005-1 for facing and drilling requirements. Studs and nuts shall be furnished and installed.

4.3.9 Tapped openings and bosses for pipe threads shall be in accordance with ISO 7-1. Pipe threads shall be taper threads in accordance with ISO 7-1.

4.3.10 Tapped openings not connected to piping shall be plugged with solid steel plugs. Plugs that may later require removal shall be of corrosion-resistant material. Threads shall be lubricated. Tape shall not be applied to threads. Plastic plugs are not permitted.

4.4 External forces and moments

Compressors shall be designed to withstand external forces and moments at least equal to 1,85 times the values calculated in accordance with NEMA SM23. Wherever possible, these allowable forces and moments should be increased after considering such factors as location and degree of compressor supports, nozzle length and degree of reinforcement, and casing configuration and thickness. The allowable forces and moments shall be shown on the outline drawing.

Care shall be exercized in the selection and location of expansion joints in order to prevent possible early fatigue due to either pulsation or expansion strain or both. Expansion joints shall not be used in inflammable or toxic service.

4.5 Rotating elements

4.5.1 Rotors

4.5.1.1 Rotor stiffness shall be sufficient to prevent contact between the rotor bodies and the casing and between gear-timed rotor bodies at the most unfavourable specified conditions, including 110 % of the relief valve set pressure. Rotor bodies not integral with the shaft shall be permanently attached to the shaft to prevent relative motion under any conditions.

4.5.1.2 Shafts shall be forged steel unless otherwise approved by the purchaser.

4.5.1.3 Vibration measurements shall be taken on the bearing housings, not on the rotor bearing journal.

4.5.1.4 The shaft ends may be treated (hardened, coated, plated, etc.) to cope with the applied sealing material.

4.5.2 Timing gears

4.5.2.1 Timing gears shall be made of forged steel or rolled steel and shall be a minimum of Quality 6 of ISO 1328-2:1995.

4.5.2.2 The meshing relationship between gear-timed rotors shall be adjustable and the adjustment shall be arranged for positive or functional locking. The adjustment and locking provisions shall be accessible with the rotors in their bearings. The gear enclosing chamber shall not be subject to contact with the gas.

4.5.2.3 If timing gears have to be removed for seal replacement it shall be possible to retime the rotors without further disassembly of the casing.

4.5.2.4 Timing gears for helical and spiral compressors shall have the same helix hand (right or left) as the rotors so that axial position has minimal effect on timing.

4.6 Seals

4.6.1 Application

4.6.1.1 Shaft seals shall be provided to prevent leakage from or into the compressor over the range of specified conditions and during periods of idleness. Seal operation shall be suitable for all conditions that may prevail during start-up, shut-down and any other special operation specified by the purchaser.

4.6.1.2 Shaft seals may be one of or a combination of the types described in 4.6.2 to 4.6.4, as specified by the purchaser. Materials of component parts shall be suitable for service.

4.6.2 Labyrinth type as airseal

Sealing between compressed air and atmosphere may be performed by means of a labyrinth seal. Vent holes in between the labyrinth for early venting may be provided.

4.6.3 Restrictive-ring type

Restrictive-ring type seals as airseals shall include segmental rings of carbon or other suitable material mounted in retainers or spacers. The sealrings shall be axially preloaded by springforce.

4.6.4 Mechanical (contact type)

Both labyrinth or restrictive ring-type seal may be used as oil seal in combination with blocking gas, provided all equipment such as piping, regulators, control valves, etc. be furnished by the vendor. In case the compressed air is used as buffer gas, provisions shall be taken for sealing during start-up and shut-down.

4.7 Dynamics

4.7.1 Critical speed

4.7.1.1 If the frequency of any harmonic component of a periodic forcing phenomenon is equal to or approximate to the frequency of any mode of rotor vibration, a condition of resonance may exist. If resonance exists at a finite speed, that speed is called a critical speed. This part of ISO 10440 is concerned with the actual critical speeds rather than various calculated values. Actual critical speeds are not calculated undamped values but are critical speeds confirmed by test stand data. Criticals above test speeds shall be calculated damped values or shall be determined by externally applied rotor excitations.

4.7.1.2 A forcing phenomenon or exciting frequency may be less than, equal to or greater than the synchronous frequency of the rotor. Such forcing frequencies may include, but are not limited to, the following:

a) unbalance in the rotor system;

b) oil film frequencies;

c) internal rub frequencies;

d) rotor-passing frequencies;

e) gear meshing and side band frequencies;

f) coupling misalignment frequencies;

g) acoustic or aerodynamic frequencies;

h) start-up condition frequencies, such as speed detents under inertial impedance or torsional deflections contributing to torsional resonances.

4.7.1.3 Support and bearing housing resonances of the driver and driven equipment shall not occur within the specified range of operating speeds or the specified separation margins.

4.7.1.4 None of the actual rotor critical speeds shall occur within the specified range of rated speeds or the specified margins.

4.7.1.5 The torsional natural frequencies of the system shall not be within 10 % of any shaft speed in the rotating system, nor within 5 % of twice any speed, nor within 5 % of the pocket-passing frequency

4.7.1.6 The margin of separation specified in 4.7.1.4 and 4.7.1.5 is intended to prevent the critical response envelope from overlapping into the operating speed range.

4.7.1.7 Slow roll, start up and shut-down shall not cause any damage as critical speeds are passed.

4.7.1.8 When specified, the compressor vendor shall make a lateral critical speed analysis and determine that the critical speeds of the driver are compatible with the critical speeds of the compressor and that the combination is suitable for the specified operating speed range.

4.7.1.9 When specified for motor driven compressor units and units including gears, and for turbine driven units, the vendor shall perform a torsional vibration analysis of the compressor driver unit.

4.7.1.10 Along with the torsional analysis required in 4.7.1.9, the vendor shall perform a transient torsional vibration analysis for synchronous driven units.

4.7.2 Vibration and balance

4.7.2.1 Major parts of the rotating element shall be dynamically balanced in accordance with ISO 1940-1.

4.7.2.2 The rotating element shall be multiplane dynamically balanced. Rotors with single keys for couplings shall be balanced with the keyway fitted with a crowned half key so that the shaft keyway is filled for its full length. The maximum allowable unbalance force at any journal at maximum continuous speed shall not exceed 10 % of the static loading of that journal.

4.7.2.3 During the shop test of the assembled machine operating at rated speed or at any other speed within the specified operating speed range, the vibration shall be measured. Acceptance limits shall be agreed between purchaser and vendor. When required by 6.3.3.5, these tests can be completed with shaft vibration measurements of double amplitude in any plane measured on the shaft adjacent and relative to each radial bearing and shall not exceed the value of 63 μm.

4.8 Bearings and bearing housings

4.8.1 Radial bearings

Generally, radial bearings shall be of the antifriction type, unless specifically agreed upon between purchaser and vendor.

4.8.2 Thrust bearings

Generally, thrust bearings shall be of the antifriction type, unless specifically agreed upon between purchaser and vendor.

4.8.3 Antifriction bearings

Antifriction type bearings shall be selected to provide a minimum lifetime of 30 000 h of continuous duty for rated compressor operating conditions. This bearing lifetime shall be calculated in accordance with ISO 281. Bearings other than the angular contact type shall have loose internal clearances and shall be single-row or double-row bearings. The shaft and housing fits and the methods of retention shall be in accordance with recommended practices.

4.9 Bearing housings

4.9.1 Bearing housings shall be furnished with corrosion-resistant, weather-protected screened vents or via adequately sized venting of the oil reservoir. The shaft end seals shall be made of non-sparking metal and shall effectively retain oil in the housing and prevent entry of foreign material into the housing.

4.9.2 Compressors shall have bearing housing shaft seals at the drive end to prevent oil leakage.

4.9.3 Bearing housings for hydrodynamic bearings designed for pressure lubrication shall be arranged to minimize foaming. The drain system shall be adequate to maintain the oil and foam levels below the shaft end seals. When the inlet oil temperature is 45 °C, the rise in oil temperature through the bearing and housing shall not exceed 30 °C under the most adverse rated conditions. Where the oil inlet temperature exceeds 50 °C, special consideration shall be given to bearing design, oil flow and allowable temperature rise. Oil outlets from thrust bearings shall be tangential in the control ring or, if oil control rings are not used, in the thrust bearing cartridge.

4.10 Lube oil and seal oil systems

4.10.1 Pressure lubrication systems shall consist of a main positive-displacement oilpump, a supply-and-return system, coolers full-flow filter and all necessary instruments.

A complete pressure oil system, or systems, shall be furnished with each compressor unit to supply oil at a suitable pressure to the following, as applicable:

a) the bearings of the compressor and the driver (including the gear) unless otherwise specified;

b) couplings (if lubricated continuously);

c) the turbine governor and the trip and throttle valve;

d) the purchaser's control system (if hydraulic);

e) the seal oil system;

f) compressor internal cooling.

4.10.2 Bearings and bearing housings shall be arranged for hydrocarbon oil lubrication unless otherwise specified by the purchaser.

4.10.3 Unless otherwise specified, the manufacturer's standard pressurized oil system shall be supplied.

4.10.4 The vendor shall state in the operating manual the amount of and the specifications for the lubricating oil required.

4.11 Materials

4.11.1 General

4.11.1.1 Materials of construction shall be the manufacturer's standard, except that all materials for compressors in contact with process gases shall be compatible with the gases handled. The metallurgy of all major components shall be clearly stated in the vendor's proposal.

4.11.1.2 Materials shall be identified by reference to an appropriate recognized standard. Where no such appropriate designation is available, the manufacturer's code or trade name may be used. In such cases, the manufacturer shall be identified and the chemical composition and significant physical properties of the material shall be presented elsewhere in the proposal. Properties of the selected materials shall comply with the design requirements over the full operating and ambient temperature range.

4.11.1.3 The purchaser shall specify the presence of corrosive agents in the motive and process fluids and in the environment, including constituents that may cause stress cracking.

4.11.1.4 Bolted connections shall be dimensioned to ensure proper functioning and full reliability of the joint at extreme operating conditions. Carbon steel and alloy steel bolting material shall be in accordance with ISO 898-1. Corrosion resistant stainless steel fasteners shall be in accordance with ISO 3506-1.

4.11.1.5 Where mating parts such as studs and nuts of 18/8 stainless steel or materials having similar galling tendencies are used, they shall be lubricated with a suitable antiseizure compound.

4.11.1.6 Materials, casting factors and the quality of any welding shall be equal to those specified by ASME Boiler and Pressure Vessel Code, Section VIII Division 1 or another standard specified or agreed by the purchaser. The manufacturer's data report forms, as specified in the code, are not required.

4.11.1.7 The vendor of packaged compressors shall specify the tests and inspection procedures necessary to ensure that the materials are satisfactory for the service. For non-packaged compressors the purchaser may consider specifying additional tests and inspections, especially for materials in critical service.

4.11.1.8 External parts subject to rotary or sliding motions (such as control linkage joints and adjusting mechanisms) shall be corrosion resistant materials suitable for the site environment.

4.11.1.9 Minor parts not identified (such as nuts, springs, washers, gaskets and keys) shall have corrosion resistance equal to that of other parts in the same environment.

4.11.2 Castings

4.11.2.1 Unless otherwise specified, cast iron shall be used for compressor casings.

4.11.2.2 The vendor shall specify the material grade of castings on the data sheet, if required.

4.11.2.3 Castings shall be sound and free of shrink holes, blow holes, cracks, scale, blisters or other similar injurious defects. Surfaces of castings shall be cleaned by sandblasting, shot blasting, pickling or any other standard method. All mold-parting fins and remains of gates and risers shall be chipped, filed or ground flush.

4.11.2.4 Iron castings shall not be repaired.

4.11.2.5 Fully enclosed cored voids should not be used. When an exception is to be made, this shall be subjected to a written purchaser approval.

4.11.3 Forgings

Forging material shall be specified or agreed by the purchaser.

4.11.4 Welding

4.11.4.1 All welding of piping and pressure-containing parts as well as any weld repairs shall be performed by operators and procedures qualified in accordance with approved codes.

4.11.4.2 The vendor shall be responsible for the review of all repairs and repair welds to ensure that they are properly heat-treated and non-destructively examined for soundness and compliance with applicable qualified procedures (see 4.11.1.6).

4.11.4.3 Major repair welds in ferritic steel shall be given a stress relief heat treatment unless otherwise agreed upon by the purchaser. A magnetic particle inspection shall be performed on all repair welds in accordance with 4.11.5.1

4.11.5 Material inspection

4.11.5.1 When radiographic, ultrasonic, magnetic particle, or dye-penetrant inspection of welds or materials is required by the applied code, or specified by the purchaser, the degree of inspection shall be agreed between purchaser and vendor.

4.12 Nameplates

4.12.1 Depending on environmental influences or other factors, the following materials can be used:

— anodized aluminium sheet;

— stainless steel sheet;

— chrome-plated brass sheet.

The plate shall be located in full view and fixed on to the product in a satisfactory way.

4.12.2 Unless required by local codes the following data, as a minimum, shall be clearly stamped on the nameplate:

a) vendor's name;

b) serial number;

c) size and type;

d) rated capacity;

e) maximum speed;

f) maximum working pressure.

5 Accessories

5.1 Drivers

5.1.1 The driver is normally part of the package. Where preferred, the type of driver shall be specified by the purchaser. The driver shall be sized to meet the maximum rated conditions, including external gear and/or coupling

losses, and shall be in accordance with applicable specifications as stated in the inquiry and the order. All driver units shall be suitable for satisfactory operation under the specified utility and site conditions.

5.1.2 Anticipated process variations that may affect the sizing of the driver (such as changes in pressure, temperature or properties of the fluid handled, and special plant start-up conditions) shall be specified by the purchaser.

5.1.3 The starting conditions for the compressor shall be specified by the purchaser and the starting method shall be mutually agreed upon by the purchaser and the vendor. The driver's starting torque capabilities shall exceed the speed torque requirements of the compressor. Consideration should be given to starting the compressor at normal site conditions.

5.1.4 Steam turbine drivers shall be as specified by the purchaser. Steam turbine drivers shall be sized to continuously deliver 110 % of the maximum power.

5.1.5 For motor driven units, the motor nameplate rating (exclusive of the service factor) shall be a minimum of 110 % of the maximum power (including gear and coupling losses) required for any of the rated conditions.

5.1.6 The purchaser shall specify the type of motor driver, electrical characteristics, starting conditions (including expected voltage drop on starting), type of enclosure, sound pressure level, area classification as detailed in data sheets, type of insulation, service factor required, ambient temperature and elevation above sea level, transmission losses, and so forth. The purchaser shall also specify temperature detectors, vibration sensors and heaters, if these are required, as well as auxiliaries (such as motor generator sets, ventilation blower and instrumentation).

5.1.7 Gas turbine drivers shall be as specified by the purchaser and shall be sized by mutual agreement between the vendor and purchaser.

5.1.8 Speed increasers and reducers may be as specified by the purchaser.

5.2 Couplings and guards

5.2.1 Flexible couplings and guards between the driver and the compressor shall be supplied by the manufacturer of the compressor unless otherwise specified on the data sheets.

5.2.2 Couplings and guards shall be in accordance with API 671 or ISO 10441 or another standard specified or agreed by the purchaser. The coupling make, type and mounting arrangement shall be agreed upon by the purchaser and the vendor of the driver and the compressor. A spacer coupling shall be used unless otherwise specified.

5.2.3 Information on the shaft, keyway dimensions (if any), and shaft end movements due to end play and thermal effects shall be furnished to the vendor supplying the coupling.

5.2.4 The power and torque rating of the coupling-to-shaft juncture shall be at least equal to the power and torque rating of the coupling.

5.2.5 For package compressors the contract coupling (see 6.3.3.2) shall be used in final package test.

5.3 Mounting plates

5.3.1 General

5.3.1.1 The vendor shall provide the compressor package suitable ready for erection on site without the need for special foundations, other than a departure from flatness of no more than 6 mm. Where the equipment is not supported the requirements given in 5.3.1.2 apply.

5.3.1.2 In the following, the term mounting plate refers to both baseplates and soleplates.

The equipment feet and the mounting plates shall have machined surfaces and shall be furnished with horizontal jackscrews and vertical jackscrews.

Compressor supports shall be provided with stainless steel shims of not less than 3 mm and not more than 12,7 mm thickness, with jackscrews for easy removal or addition of shims.

Where centreline supports are provided, they shall be designed and manufactured to permit the machine to be moved using the horizontal jackscrews.

- When epoxy grout is specified on the data sheet, the vendor shall precoat all the grouting surfaces of the mounting plates with a catalysed epoxy primer applied to degreased white metal. The epoxy primer shall be compatible with the epoxy grout. Instructions for field preparation of the epoxy primer shall be submitted to the purchaser by the vendor (see 7.2.5).

Anchor bolts shall not be used to fasten machinery to the mounting plates.

Mounting plates shall not be drilled for equipment to be mounted by others. Mounting plates for installation on concrete shall be supplied with levelling screws.

Anchor bolts shall be furnished by the purchaser.

Fasteners for attaching the components to the mounting plates and jackscrews for levelling the pedestal soleplates shall be supplied by the vendor.

The feet or equipment shall be drilled with pilot holes for use in final dowelling.

5.3.2 Baseplates

NOTE A package includes the baseplate.

- **5.3.2.1** When a baseplate is specified, the data sheet shall show its dimensions. A baseplate, where possible, shall be a single fabricated steel unit. When a baseplate is in more than one section, the mating surfaces shall be machined and dowelled for accurate reassembly. When specified, baseplates shall be provided with levelling pads or targets protected by removable covers. The pads or targets shall be accessible for field levelling after installation and with the equipment mounted and the baseplate on the foundation.

- **5.3.2.2** If specified, the baseplate shall be extended as necessary to support the driver, other compressors, gear units and control panel.

- **5.3.2.3** If specified by the purchaser, the baseplate shall be suitable for column mounting (i.e. of sufficient rigidity to be supported as specified points) without continuous grouting under structural members.

5.3.2.4 Unless agreed with the purchaser, the baseplate shall be provided with lifting lugs for a four-point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or the machinery mounted thereon.

- **5.3.2.5** The bottom of the baseplate, between structural members, shall be open. When the baseplate is installed on a concrete foundation, accessibility shall be provided for grouting under all load-carrying structural members. The mounting pads on the bottom of the baseplate shall be in one plane to permit use of a single level foundation. When specified, sub-sole plates shall be provided by the vendor.

5.3.2.6 Oil reservoirs shall be separate from the baseplate unless otherwise approved by the purchaser.

- **5.3.2.7** When specified, non-skid decking covering all walk and work areas shall be provided on the top of the baseplate.

5.4 Controls and instrumentation

5.4.1 General

5.4.1.1 The vendor shall finish and install instrumentation, controls and solenoids, and shall demonstrate conformity to recognized standards.

The vendor shall inform the purchaser of any deviation to the enquiry or order concerning instrumentation, control and solenoids, and installation.

5.4.1.2 If the purchaser intends to supply any part of the control system, this shall be specified in the enquiry. When requested by the purchaser, the vendor shall review the purchaser's overall compressor control system for compatibility with the vendor furnished control equipment.

5.4.1.3 Unless otherwise specified, all controls and instrumentation shall be suitable for outdoor installation.

5.4.2 Control systems

5.4.2.1 The purchaser shall indicate the parameter to be controlled (inlet pressure, discharge pressure, flow). The vendor shall design a control system suitable for the application and shall specify the control elements dimensioned by the compressor characteristics, even if these elements are not part of his supply.

5.4.2.2 For variable speed drive, the control signal shall act to reset the driver's speed governing system. Unless otherwise specified, the control range limits shall be from maximum allowable speed to 95 % of the minimum speed required for any specified operating case or 70 % of the maximum allowable speed, whichever is lower.

5.4.2.3 When constant-speed drive is specified, the control signal shall actuate the slide valve control device or the control valve in the compressor piping or in the compressor package.

5.4.2.4 The full range of the purchaser's specified control signal shall correspond to the required operating range of the compressor. Unless otherwise specified, the maximum control signal shall correspond to the rated speed or to the rated capacity.

5.4.3 Instrumentation and control panels.

5.4.3.1 When an instrument panel is specified, the purchaser shall define the type and location of instruments required.

5.4.3.2 Instrumentation built into the package shall include as a minimum the end pressure temperature indicators. The vendor shall list instrumentation submitted to the purchaser.

5.4.3.3 The purchaser shall specify any additional instrumentation to be furnished by the vendor.

5.4.3.4 The vendor shall furnish relief valves that are to be installed on equipment or in piping that the vendor is supplying. Other relief valves shall be furnished by the purchaser. Relief valves for all operating equipment are required to meet the limiting relief valve requirements defined in the applied standards. The vendor shall determine the size and the set pressure of all relief valves related to the equipment. The vendor's quotation shall list all relief valves and shall clearly indicate those furnished by the vendor. Relief valve settings, including accumulation, shall take into consideration all possible types of equipment failure and the protection of piping systems.

5.4.3.5 Solenoids shall have continuous duty rating and shall have Class F insulation or better.

5.4.4 Alarms and shut-downs

5.4.4.1 All compressors shall be furnished with high discharge temperature alarm and shutdown devices.

5.4.4.2 Any alarm and shut-down switches shall be furnished in separate housings. When used, switches shall be “single pole, double throw”. Mercury switches shall not be used.

5.4.4.3 Electric switches that open (de-energize) or close (energize) to alarm and/or trip shall be part of the package unless otherwise specified by the purchaser.

5.4.4.4 The vendor shall furnish a first-out type of annunciator when an annunciator system is specified.

5.4.4.5 Connections shall be provided to actuate a remote alarm when any of the locally displayed compressor alarms or shut-downs operate.

5.4.4.6 Alarm and trip device settings shall not be adjustable from outside the housing. Pressure elements shall be of 18/8 stainless steel. Alarm and shut-down devices shall be arranged to permit testing of the control circuit, including the actuating element, where possible, without interfering with normal operation of the equipment. The vendor shall furnish with the proposal complete descriptions of alarm and shut-down testing facilities to be provided. Specifically, low-pressure devices shall be equipped with valved bleed or vent connections for controlled depressurising so that the operator can note the alarm set pressure on the associated pressure gauge. Similarly, high-pressure devices shall be equipped with valved test connections so that a portable test pump can be used to raise the pressure.

5.4.4.7 All instruments and controls other than shut-down sensing devices shall be installed with sufficient valving or thermowells to permit the removal of instruments and controls while the system is in operation.

5.4.5 Electronic devices

5.4.5.1 Electronic control equipment shall receive power from the electrical supply of the machine. The device shall operate continuously and without disturbance in a supply range of + 40 % to − 30 % of the nominal voltage.

5.4.5.2 The device shall fulfil the test conditions for immunity and emission according to the following IEC and EN rules:

a) surge voltage immunity: tests in accordance with IEC 60060-1 and IEC 60060 -2;

b) fast transient voltage burst: tests in accordance with IEC 61000-4-4;

c) electrostatic discharge: tests in accordiance with IEC 61000-4-2;

d) electromagnetic field immunity: tests in accordance with IEC 61000-4-3;

e) radiated magnetic fields emission: tests in accordance with EN 55011 and EN 55022.

5.4.5.3 The electronic device shall receive analogue signals from temperature sensors and pressure transducers. Alarms and shut-downs shall be internally set in the electronic control equipment and the alarm and tripping levels shall be determined by the integrity requirements of the machine.

— Alarms and pre-alarms shall be indicated on the electronic device without switching-off the machine. The indication shall disappear automatically when the alarm signals go back under the alarm level.

— Shut-downs or trippings shall be indicated on the electronic device and shall switch off the machine.

As long as the shutdown signal remains the device cannot be reset and the machine shall not restart. It shall be possible to verify the appropriate operation of the electronic controller by means of software, without interfering with normal operation of the equipment. The vendor shall furnish with the proposal complete descriptions of alarm and shut-down testing facilities to be provided.

5.4.6 Vibration and position detectors

5.4.6.1 When specified by the purchaser, the vendor shall propose the most appropriate vibration-measuring equipment to suit his bearing configuration.

5.4.6.2 When specified, non-contacting vibration and axial position transducers shall be supplied, installed and calibrated in accordance with API 670 or another standard specified or agreed by the purchaser.

5.4.6.3 When specified, seismic vibration transducers shall be supplied, installed and calibrated in accordance with API 670 or another standard specified or agreed by the purchaser.

5.4.6.4 When specified, vibration and axial position monitors shall be supplied and calibrated in accordance with API 670 as applicable or another standard specified or agreed by the purchaser.

5.5 Piping and appurtenances

5.5.1 General

5.5.1.1 Piping design, joint fabrication, examination and inspection shall be in accordance with ANSI B31.3 or another standard specified or agreed by the purchaser.

5.5.1.2 Piping systems are defined as those auxiliary systems that supply lubricating oil, control oil, sealing fluid, cooling water, buffer gas or injection fluid.

NOTE Requirements for casing connections are specified in 4.3.

5.5.1.3 Piping systems include piping, check valves, isolating valves, switch valves, control valves, relief valves, pressure reducers, restriction orifices, thermometers and thermowells, pressure gauges, sight flow indicators and all related vents and drains.

5.5.1.4 The vendor shall furnish all piping systems, including mounted appurtenances, located within the confines of the main unit base area, any console base area or any auxiliary base area. The piping shall terminate with flanged connections at the edge of the base. The purchaser shall furnish only interconnecting piping between equipment groupings and off-base facilities.

5.5.1.5 Design of piping systems shall achieve the following:

a) proper support and protection to prevent damage from vibration or from shipment, operation or maintenance;

b) proper flexibility and normal accessibility for operation, maintenance and thorough cleaning;

c) installation in a neat and orderly arrangement adapted to the contour of the machine and not obstructing access openings;

d) elimination of air pockets;

e) complete drainage through low points without piping disassembly.

5.5.1.6 Piping shall be fabricated preferably by bending and welding to minimize the use of flanges and fittings. Welded fittings and flanges shall be of the butt-welded or socket-welded type, except that socket-welded fittings shall not be used downstream of the filters in lubricating oil piping (see 5.5.2.2). Pipe bushings and lap joint flanges shall not be used.

5.5.1.7 Pipe threads shall be taper threads in accordance with ISO 7-1 or similar recognized standards; flanges shall be in accordance with ISO 7005-1 or a similar recognized standard.

5.5.1.8 Non-standard size pipe connections, pipe, valves and fittings shall not be used.

5.5.1.9 Where specified by the purchaser, piping systems containing air at pressures above 0,5 MPa shall be of seamless carbon steel, manufactured in accordance with ISO 9329-2 or or another standard specified or agreed by the purchaser. Stainless steel shall be in accordance with ISO 9329-4 or another standard specified or agreed by the purchaser.

5.5.1.10 Where space does not permit the use of 12 mm, 20 mm or 25 mm pipe, seamless steel tubing conforming to ISO 9329-2 or another standard specified or agreed by the purchaser may be furnished with steel fittings; stainless steel tubing conforming to ISO 9329-4 or another standard specified or agreed by the purchaser may be furnished with steel fittings. Minimum wall thickness shall be 1,5 mm for 12 mm nominal diameter, 2,5 mm for 20 mm nominal diameter and 2,7 mm for 25 mm nominal diameter. Make and model of fittings shall be subject to approval by the purchaser.

5.5.1.11 The minimum diameter of any connection shall be 20 mm nominal pipe diameter, unless otherwise approved by the purchaser.

5.5.1.12 Piping systems furnished by the vendor shall be fabricated, installed in the shop and properly supported.

5.5.2 Oil piping

5.5.2.1 For external-lubrication oil systems, oil drains shall be sized to run no more than half full and shall be arranged to ensure good drainage (recognizing the possibility of foaming conditions). Horizontal runs shall slope continuously, at least 40 mm m^{-1}, toward the reservoir. Laterals (not more than one in any transverse plane) should, if possible, enter drain headers at 45° angles in the direction of the flow.

5.5.2.2 Non-consumable backup rings and sleeve-type joints shall not be used. Pressure piping downstream of oil filters shall be free of internal obstructions that could accumulate dirt. Socket-welded fittings shall not be used in pressure piping downstream of oil filters.

5.5.2.3 Unless otherwise specified, all oil piping including fittings downstream of the oil filter shall be stainless steel. Other oil piping may be carbon steel.

5.5.3 Instrument piping

Each instrument pressure line shall be provided with a block and bleed valve at the sensing point.

5.5.4 Intercoolers and aftercoolers

5.5.4.1 When specified, the vendor shall furnish a water-cooled shell and tube intercooler between each compression stage or any other type of cooler.

5.5.4.2 The purchaser shall specify which aftercoolers the vendor is to furnish.

5.5.4.3 Water-cooled shell and tube intercoolers and aftercoolers shall be designed and constructed to an approved code as specified on the data sheets.

Caution should be exercised regarding the susceptibility of heat exchangers and their supporting structures to pulsation-induced vibration.

5.5.4.4 Unless otherwise approved by the purchaser, the intercoolers and aftercoolers shall be constructed and located in such a way as to allow removal of the tube bundles.

5.5.4.5 Fixed tube sheet exchangers shall have inspection openings into the gas passages. Rupture disks on the shell shall not be used unless specifically approved by the purchaser.

5.5.4.6 When air coolers are specified they shall conform to API 661 or another standard specified or agreed by the purchaser.

5.5.4.7 Where coolers are not an integral part of the package, and unless otherwise specified, air cooled heat exchangers used for intercoolers shall have automatic temperature control. This control may be accomplished by means of louvers, variable speed fans, variable pitch fans or bypass valves. Proposed control systems shall be approved by the purchaser.

5.5.4.8 Double pipe intercoolers and aftercoolers may be furnished unless otherwise specified by the purchaser. A finned double pipe design may be furnished only with the purchaser's approval.

5.5.4.9 Intercoolers shall be machine-mounted or separate, as specified by the purchaser.

5.5.4.10 Materials shall be as specified on the data sheets.

5.5.4.11 When condensate separation and collection facilities are furnished by the vendor, they shall include an automatic drain trap with manual by-pass.

When specified by the customer, following options can be included:

a) an armoured gauge glass on the collection pot;

b) separate connections and level switches for high-level alarm and trip on the collection pot;

c) collection pots sized to provide an agreed-upon holding capacity and a 5 min time span between high level alarms and trip.

5.5.5 Intake filters

5.5.5.1 Unless otherwise specified, the vendor shall furnish dry type, multistage, high efficiency air intake filters for air compressors taking suction from the atmosphere. High efficiency filters shall be capable of removing 97 % of particles 1 μm or larger over the inlet capability range. The maximum clean pressure drop shall not exceed 300 Pa.

5.5.5.2 Air intake filters shall be an integral part of the package. Alternatively they may be suitable for mounting outdoors and shall be provided with a weather hood or louvres. For plant locations subject to unusual conditions, e.g. sandstorms, a prefilter may be used where the inlet to the prefilter may be elevated above the compressor.

5.5.5.3 Each filter shall be provided with a differential pressure switch.

5.5.5.4 Filters shall be designed such that elements may be changed while the unit is operating in the offload (blocked) condition.

It should be recognized that many configurations and arrangements are available. Where specific filter features are desired, these shall be in the purchaser's inquiry specifications or data sheets.

5.5.5.5 The filter, frame and inlet pipe shall be adequately protected to suit the application.

5.5.6 Silencers

5.5.6.1 Silencers shall be designed to meet the maximum sound level specified by the vendor for the package.

Where specified, inlet and discharge silencers shall be supplied for each compressor. The primary function of silencers shall be to provide the maximum practical reduction of pulsations in the frequency range of audible sound without exceeding the pressure drop limit specified in 5.5.6.2.

5.5.6.2 Unless otherwise agreed upon, the pressure drop through each silencer shall not exceed 1 % of the absolute pressure at the silencer inlet.

5.5.6.3 The peak-to-peak pulsation level of the compressor in the piping shall not exceed 2 % of the mean line absolute pressure or the value calculated from the following formula, whichever is smaller.

$$P_{1\%} = 15 \times \sqrt[3]{P}$$

where

$P_{1\%}$ is the the maximum allowable peak-to-peak pulsation, expressed as a percentage of the mean line-side absolute pressure;

P is the mean line-side pressure, expressed in kilopascals.

5.5.6.4 Maximum silencer efficiency results from mounting the silencers directly on the compressor flanges.

5.5.6.5 Discharge silencers shall be designed and fabricated in accordance with ANSI B31.3 or another standard specified or agreed by the purchaser and shall be suitable for not less than the specified relief valve setting.

5.5.6.6 All welds shall be continuous full penetration.

5.5.6.7 A pressure test connection shall be provided at each silencer inlet and outlet nozzle. An external drain connection shall be provided for each compartment where liquids could collect while the compressor is in service. Where individual compartment drains are impracticable and bulkheads extend to the vessel wall, circular notched openings in the bulkheads may be used with the purchaser's approval. The arrangement of internals shall ensure that liquids flow to drain connections under all operating conditions. The effect of drain openings on silencer performance shall be taken into consideration.

5.5.6.8 Connections shall be of proven design to avoid breakage due to pulsation-induced vibration.

5.5.6.9 All main connections to silencers shall be flanged unless otherwise specified by the purchaser.

5.5.6.10 Side-entering main nozzle connections shall be reinforced by saddles. All other flanged connections shall be reinforced with pad-type metal providing a metal area equal to the cutaway area (excluding the thickness of any metal present in the connection wall).

5.5.6.11 For lagged silencers, construction shall be suitable for service in an unprotected outdoor location. When specified, insulation clips shall be provided. All connections and nameplates shall be arranged to clear the insulation.

6 Inspection, testing, and preparation for shipment

6.1 General

6.1.1 The vendor shall provide the purchaser with advance notification of shop inspections and testing as outlined in the purchase order or other agreement. The purchaser's representative shall have entry, after prior notification by the purchaser to the vendor, to all vendor and subvendor plants, where work upon or testing of the equipment is in progress.

6.1.2 It shall be the responsibility of the vendor to notify subvendors of the purchaser's inspection requirements.

6.2 Inspection

6.2.1 The vendor shall keep the following data available for at least 5 years for examination by the purchaser or his representative upon request:

a) all necessary certification of material, such as mill test reports;

b) purchase specifications for all items on bills of material;

c) running test data to verify that the requirements of the specification are being met;

d) results of quality assurance tests;

e) when specified, final assembly records and running clearances.

6.2.2 All painting of surfaces of pressure-containing parts shall be deferred until the specified inspection of that part is completed.

6.2.3 During assembly of the system and prior to testing, each component (including cast-in passages), and all piping and appurtenances shall be cleaned by pickling or by another appropriate method to remove foreign materials, corrosion products and mill scale.

6.2.4 The oil system supplied shall meet the cleanliness requirements of. API 614 or another standard specified or agreed upon by the purchaser.

6.2.5 When specified, the purchaser may make an inspection, for cleanliness, of the equipment and all piping and appurtenances furnished by or through the vendor prior to the welding of heads to vessels, the closure of openings in vessels or exchangers or the final assembly of piping.

6.2.6 When specified, hardness of parts, welds and heat affected zones shall be verified as being within the allowable values by testing of the parts. The method, extent, documentation and witnessing of the test shall be mutually agreed upon by the purchaser and the vendor.

6.2.7 When specified, the purchaser's representative shall have access to the vendor's quality plan for review.

6.3 Testing

6.3.1 General

6.3.1.1 All equipment shall be tested in accordance with 6.3.2 and 6.3.3. Other tests that may be specified by the purchaser are described in 6.3.4.

6.3.1.2 The vendor shall notify the purchaser of testing not less than 5 d prior to the date the equipment shall be ready for testing.

6.3.1.3 The purchaser's acceptance of shop test results shall not remove the vendor's obligation to provide equipment that meets the specified operating conditions.

6.3.1.4 When specified, the purchaser reserves the right to witness or observe the testing, dismantling, inspection and reassembly of equipment.

6.3.2 Pressure tests

6.3.2.1 Pressure-containing parts (including auxiliaries) subjected to code requirements shall be tested hydrostatically at a minimum of 1,5 times the rated discharge pressure but not less than 0,14 MPa. The test liquid should be at a higher temperature than the nil-ductility transition temperature of the material being tested.

6.3.2.2 Tests shall be made according to code requirements. Tests shall be maintained for a sufficient period of time to permit complete examination of parts under pressure. The hydrostatic test shall be considered satisfactory when no leakage through the casing or casing joints is observed for a minimum of 30 min. Large, heavy castings may require a longer testing period to be agreed upon by the purchaser and the vendor. Leakage past internal closures required for segmented case testing, and operation of the test pump to maintain pressure, are acceptable.

6.3.2.3 If the part tested is to operate at a temperature at which the strength of the material is below the strength of that material at room temperature, the hydrostatic test pressure shall be multiplied by a factor obtained by dividing the permitted working stress for the material at room temperature by that at operating temperature. The stress values used shall conform to those given in ANSI B31.3 for piping or e.g. in Section VIII, Division 1 of the ASME Boiler and Pressure Vessel Code or another standard specified or agreed by the purchaser. The pressure thus obtained shall then be the minimum pressure at which the hydrostatic test shall be performed. The data sheets shall list actual hydrostatic test pressures.

6.3.2.4 All tests shall be in accordance with an acceptable recognized standard. In the event of a discrepancy existing between the test pressure in such a standard and the specified code test pressure, the higher pressure shall prevail.

6.3.3 Mechanical running test

6.3.3.1 The mechanical running test of the compressor shall include the procedures described below (not necessarily in this order).

For electrically-driven compressors the compressor shall be operated at the rated speed for the contract. In the case of turbine-driven compressors, the compressor shall be operated at the rated speed plus 5 % or at a speed agreed with the purchaser. After the casings and lubricating oil temperature have stabilized, the mechanical performance shall be checked including oil temperature, cooling water temperature, vibration amplitude and seal operation. Operation shall be continued for 2 h after the temperature has stabilized.

A “heat run” shall be performed at the mechanical running test speed, with the discharge temperature stabilized at the rated discharge temperature plus 12 °C for a minimum of 30 min.

After the heat run, a check shall be performed with the compressor operating on air at the highest test pressure practical at rated speed. The capacity, the power required and the temperature of the bearings where instrumentation is included shall be noted.

For compressors using oil-buffered seal units, when any test run with air involves a discharge temperature above 120 °C, the test shall be conducted using a modified procedure to eliminate the oil-air high-temperature hazard. The modified test procedure shall be agreed upon by the purchaser and the vendor.

Variable speed compressors shall be operated at speeds increasing by five approximately equal increments up to the rated speed for the contract in order to check all temperatures and lateral and torsional vibration amplitudes. Caution should be exercised when operating at or near critical speeds.

6.3.3.2 The requirements below shall be met for the running test.

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

All oil pressures, viscosities and temperatures shall be at the operating values recommended in the manufacturer's operating instructions for the specific unit under test. Oil flows shall be verified (accepted methods other than by flowmeter may be used). Test-stand oil filtration shall be 10 μm or better.

Joints and connections in the casing and oil system shall be checked for tightness and any leaks shall be stopped.

Facilities to ensure against the entrance of oil into the compressor shall be in operation throughout the test.

During the shop test the contract coupling shall be used.

6.3.3.3 When spare rotor sets are ordered to permit concurrent manufacture, each spare rotor set shall be mechanically fitted into the casing prior to the mechanical run test of the contract rotor set.

6.3.3.4 During the running test, the operation of the test instrumentation shall be satisfactory. During this test the vibration measurements shall be in accordance with 4.7.2.3 and shall be recorded throughout the operating speed range.

6.3.3.5 When specifically requested by the purchaser and in addition to the test specified in 4.7.2.3, shaft vibration measurements can be performed under the conditons specified below and may be completed during the mechanical test.

All purchased vibration sensors and signal conditioners shall be in use during the mechanical running test. When provisions for vibration sensors are made and they are not furnished by the compressor vendor, or the purchased sensors are not compatible with shop readout facilities, then shop sensors and readout that meet the accuracy requirements of API 670 or another standard specified or agreed by the purchaser shall be taken into consideration.

Shop test facilities shall include instrumentation with the capability of continuously monitoring and plotting revolutions per minute, peak-to-peak displacement and phase angle (X-Y-Y'). Presentation of vibration displacement and phase markers shall also be by oscilloscope.

The vibration characteristics determined by the use of the instrumentation specified here shall serve as the basis for acceptance or rejection of the machine based on redefined criteria.

6.3.3.6 Where access permits, the bearings and seals at the opposite end from the timing gears shall be inspected after the running tests.

6.3.3.7 If replacement or modifications of bearings or seals, adjustment of timing gears or dismantling of the case to replace or modify other parts is required for correction of mechanical or performance deficiencies, the initial test shall not be acceptable and the final shop tests shall be run after such replacements or corrections are made.

6.3.3.8 The vibration data from the mechanical running test 6.3.3.4 shall be recorded. When an additional test is specified as in 6.3.3.5**,** vibration limits, vibration data and vibration records shall be agreed upon between the purchaser and the vendor. The vibration characteristics determined by the used of the instrumentation specified shall serve as the basis for acceptance or rejection of the machine.

6.3.4 Optional tests

6.3.4.1 General

The purchaser shall specify in the inquiry or in the order whether any of the shop tests specified in 6.3.4.2 to 6.3.4.10 shall be performed. The use of special equipment to analyse vibration characteristics during testing shall be mutually agreed upon in advance by the vendor and the purchaser.

6.3.4.2 Performance test

The machine shall be performance tested on air in accordance with the applicable sections of ISO 1217 and ISO 5167.

6.3.4.3 Complete unit test

Such components as compressors, gears, drivers and auxiliaries that make up a complete unit shall be tested together during the complete unit test. A separate auxiliaries test may be performed with the purchaser's approval.

All warning, protective and control devices shall be checked and adjustments shall be made as required.

6.3.4.4 Gear test

The gear shall be tested with the machine unit during the mechanical running test.

6.3.4.5 Helium test

The pressure-containing parts of the compressor shall be tested for gas leakage with helium. The rated discharge pressure shall be maintained while the unit is submerged for a minimum of 30 min. The acceptable leakage rate shall be specified and agreed upon by the purchaser and the vendor.

6.3.4.6 Sound level test

- The sound level test shall be performed in accordance with an agreed standard between the purchaser and the vendor and with respect to any local code requirements.

6.3.4.7 Auxiliary equipment tests

- Auxiliary equipment such as oil systems and control systems shall be tested in the vendor's shop. Details of the auxiliary equipment tests shall be developed jointly by the purchaser and the vendor.

6.3.4.8 Post-test inspection

Serial-produced packages are normally not dismantled. Where required by the purchaser the compressor, the gear and the driver shall be dismantled, inspected and reassembled after satisfactory completion of the mechanical running test. After assembly a functional test shall be carried out.

6.3.4.9 Full pressure/full load/full speed test

Details shall be developed jointly by the purchaser and the vendor. Such tests may be submitted for the mechanical running test.

6.3.4.10 Spare element test

When spare elements are ordered to permit concurrent manufacture, each shall be given a mechanical running test as described in 6.3.3.

6.4 Preparation for shipment

- **6.4.1** Equipment shall be suitably prepared for the type of shipment specified, including blocking of the rotors when necessary. The preparation shall include protection such that the equipment may be stored outdoors for 6 months from the time of shipment without requiring disassembly, except for inspection of bearings and seals, before operation. If storage for longer periods is contemplated, the purchaser shall consult with the vendor regarding recommended procedures to be followed.

6.4.2 The vendor shall provide the purchaser with the necessary instructions to preserve the integrity of the storage preparation after the equipment arrives at the job site.

6.4.3 Preparation for shipment shall be made after all testing and inspection of the equipment has been accomplished and the equipment has been approved by the purchaser. The preparation shall include at least that specified in 6.4.3.1 to 6.4.3.9.

6.4.3.1 All exterior surfaces except machined surfaces shall be given a coat of the manufacturer's standard paint.

6.4.3.2 All exterior machined surfaces shall be coated with a suitable rust preventive.

6.4.3.3 The interior of the equipment shall be clean and free of scale, welding spatter and foreign objects, and shall be sprayed or flushed with a suitable rust preventive that is removable by solvent. The rust preventive shall be applied through all openings while the machine is slow-rolled.

6.4.3.4 All internal steel areas of bearing housings and of carbon steel oil systems' auxiliary equipment such as reservoirs, vessels and piping shall be coated with a suitable oil-soluble rust preventive.

6.4.3.5 All flanged openings shall be provided with metal closures at least 5 mm thick, with rubber gaskets and at least four full-diameter bolts. For studded openings, all nuts needed for the intended service shall be used for securing closures.

6.4.3.6 All threaded openings shall be provided with steel caps or solid shank steel plugs whose metallurgical properties are equal to or better than that of the pressure casing. In no case shall nonmetallic plugs (such as plastic) be used.

6.4.3.7 Lifting points and lifting lugs shall be clearly identified.

6.4.3.8 The equipment shall be identified with item and serial numbers. All material shipped separately shall be identified with securely affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. In addition, crated equipment shall have two duplicate packing lists, one inside and one on the outside of the shipping container.

6.4.3.9 If a spare element is purchased, the element shall be suitably prepared for unheated indoor storage for a period of at least 3 years. The element shall be treated with a rust preventive and shall be housed in a vapour-barrier envelope with slow-release vapour-phase inhibitor. The element shall be suitably crated for domestic or export shipment, as specified. Suitable sheeting 3 mm thick shall be used between the element and the cradle at the support areas. The element shall not be supported at journals.

6.4.4 All components (individual pieces, as well as packaged sets) shipped with mounted preassembled piping, tubing or wiring shall comply with the requirements of the local safety and health administration and shall carry outside securely affixed, large, red, all-weather tags stating the following in bold letters:

THIS SYSTEM HAS BEEN PRE-ASSEMBLED AND TESTED FOR OPERABILITY AND SAFETY, AND SHALL NOT BE DISTURBED BY UNAUTHORIZED PERSONNEL.

6.4.5 Auxiliary piping connections furnished with the purchased equipment shall be impression-stamped or permanently tagged to agree with the vendor's connection table or general arrangements drawing.

6.4.6 Exposed shafts and shaft couplings shall be wrapped in waterproof mouldable waxed cloth or vapour-phase inhibitor paper. The seams shall be sealed with adhesive tape.

6.4.7 One copy of the manufacturer's standard installation instruction shall be packed and shipped with the equipment.

6.4.8 Bearing assemblies and the exposed ends of shafts shall be fully protected from contamination by moisture and dirt. If vapour phase inhibitor crystals in bags are installed in large cavities, they shall be attached in an accessible area for ease of removal. Bags shall be installed in wire cages attached to flanged covers, where applicable, and all locations shall be indicated by corrosion-resistant tags attached by stainless steel wire.

7 Vendor’s data

7.1 Proposals

The vendor's proposal shall include the information listed in a) to q) below.

a) A copy of the Vendor Drawing and Data Requirements form indicating the schedule by which the vendor agrees to furnish the data requested by the purchaser (see 7.2).

b) Copies of the purchaser's data sheets with complete vendor's information entered thereon.

c) Complete performance curves to fully define the envelope of operations.

d) Utility requirements such as steam, water, electricity, air, gas and lubricating oil, including the quantity of lubricating oil required at supply pressure, the heat load to be removed by the oil and the ratings and net loads of auxiliary drivers. (Approximate data shall be clearly identified as such.) This information shall be entered on the data sheets.

e) Net and maximum operating weights, maximum shipping and erection weights with identification of the item, and maximum normal maintenance weight with identification of the item. This data shall be stated individually

where separate shipments, packages or assemblies are involved. This data shall be entered on the data sheets where applicable.

f) Preliminary outline and arrangement drawings and schematic diagrams.

g) Typical cross-sectional drawings and literature to fully describe details of the offers.

h) A specific statement that the system and all components are in strict accordance with the purchaser's specifications. If the equipment is not in strict accordance with the specifications, the vendor shall include a specific list detailing and explaining every deviation. Deviations may include alternative designs or systems equivalent to and guaranteed for the specified duties.

i) A statement of the fixed number of weeks to effect shipment after receipt of the order. Separate times shall be stated for multiple shipment as in the case of separate packages, assemblies or multiple units.

j) A list of spare parts recommended for normal maintenance purposes. (The purchaser shall specify any special requirements for long-term storage.)

k) An itemized list of the special tools included in the offer.

l) The tests and inspection procedures for materials as required by 4.11.1.7.

m) A statement of the requirements for furnishing a competent erection supervisor, and an estimate of the length of time his services might be required under normal conditions.

n) When applicable, descriptions of special requirements as outlined in 4.2.9, 4.11.1.2 and 5.4.4.6.

o) An outline of all necessary special weather and winterizing protection required by the compressor, the auxiliaries and the driver (if furnished by the compressor vendor) for start-up, operation and idleness. The vendor shall list separately the protective items he proposes to furnish.

p) Any start-up, shut-down, or operating restrictions required to protect the integrity of the equipment.

q) A list of recognized standards used to complement this part of ISO 10440.

7.2 Contract information

7.2.1 General

7.2.1.1 The following paragraphs specify the information to be furnished by the vendor. The vendor shall complete and forward the Vendor Drawing and Data Requirements form to the address or addresses noted on the 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.

7.2.1.2 The data shall be identified on transmittal (cover) letters and in the title blocks or pages, with purchaser/user corporate name, job/project number, equipment name and item number, purchase order number, any other identification specified in the purchase order, and the vendor's identifying shop order number, serial number or other reference required to completely identify return correspondence.

7.2.2 Drawings

7.2.2.1 The purchaser shall state in the inquiry and in the order the number of prints and/or reproducibles required and the times within which they are to be submitted by the vendor [see 7.1 a)].

7.2.2.2 Where agreed upon between purchaser and vendor, the purchaser shall promptly review the vendor's drawings when he receives them; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed upon in writing. After the drawings have been approved by the

purchaser, the vendor shall furnish copies of the certified drawings in the quantity specified. All drawings shall be clearly legible and in accordance with ISO Standards.

7.2.2.3 The following information shall be provided on the drawings (typical drawings are not acceptable but standardized drawings are acceptable for package compressors):

a) the purchaser's order number (on every drawing);

b) the purchaser's equipment item number (on every drawing);

c) the mass of each assembly;

d) all principal dimensions, including those required for the purchaser's foundation, piping design, maintenance clearances and dismantling clearances, and the maximum loading limit on the flanges (both forces and moments);

e) the direction and magnitude of all unbalanced forces and couples and the location of the centre of gravity;

f) the direction of rotation;

g) the size, type, location and identification of all the purchaser's connections, including vents, drains, lubricating oil, conduits and instruments (the vendor's plugged connections shall be identified);

h) when couplings are furnished, the make, size and type of couplings and the location and style of the coupling guards;

i) complete bills of material covering the vendor's entire scope of supply;

j) a complete list of reference drawings, including those for the driver, the lubricating oil system, the sealing system, the controls and the control panel;

k) a list of any special weather protection and climatization features;

l) cold setting data for equipment furnished by the vendor. Expected thermal growth data, including transient effects, shall be included.

7.2.2.4 The vendor shall supply schematic diagrams of each system in the vendor's scope of supply, as well as outline and cross-section drawings and specifications for the components.

7.2.2.5 The vendor shall supply cross-sectional or assembly type drawings for all equipment furnished, showing all parts, running fits, clearances and balancing data required for erection and maintenance. (Typical drawings are unacceptable.)

7.2.3 Performance data

After the inspection and tests have been made, the vendor shall provide complete performance data to encompass the operations, with any limitations indicated thereon.

The compressor serial number shall be shown on all data sheets.

7.2.4 Data

7.2.4.1 The vendor shall provide full information to enable completion of the data sheets first “as-purchased” and then “as-built”. This should be done by correcting and filling in the data sheets and submitting copies.

7.2.4.2 The vendor shall make available to the purchaser the following information:

a) a record of shop test data, which the vendor shall maintain for at least 18 months after date of shipment. When specified, certified copies of test data shall be submitted to the purchaser prior to shipment;

b) when specified, lateral and torsional analysis summary reports shall be submitted;

c) when specified, the calculated rotor response curves;

d) optional test data and reports.

7.2.4.3 The vendor shall provide as-built thrust bearing and radial bearing clearances, where appropriate.

7.2.4.4 A parts list shall be furnished for all equipment supplied. The list shall completely identify each part so that the purchaser may determine the interchangeability of parts with other equipment furnished by the same manufacturer. Standard purchased items shall be identified by the original manufacturer's name and part number. Materials shall be identified as specified in 4.11.1.2.

7.2.4.5 For series-produced package compressors, the vendor shall supply all information necessary for supply and installation of spare parts. Alternatively the vendor shall submit a supplementary list of spare parts other than those included in his original proposal. This supplementary list shall include recommended spare parts, cross-sectional or assembly type drawings, part numbers and materials. Part numbers shall identify each part for interchangeability purposes. Standard purchased items shall be identified by the original manufacturer's numbers. The supplementary list shall be forwarded to the purchaser in time to permit order and delivery of parts prior to field start-up.

7.2.5 Instruction manual

No later than 28 d after the shipping date, the vendor shall furnish the required number of instruction manuals for the equipment and any auxiliaries and instruments the vendor provides. The manuals shall include legible drawings for the specific equipment included (typical drawings are not acceptable), a parts list and completed data sheets. They shall also include instructions covering installation, final tests and checks, start-up, shut-down, operating limits, and operating and maintenance procedures.

The recommended clearances and maximum and minimum design clearances shall be clearly stated.

7.2.6 Vendor information

When specified, progress reports shall be submitted to the purchaser at the specified frequency. The reports shall contain engineering and manufacturing information on all major components including:

a) the vendor's physical and chemical data from mill reports (or certification) of steel pressure parts and forgings;

b) completed as-built data sheets;

c) certified shop logs of the mechanical run test outlined in 6.3.3.

Annex A
(normative)

Data sheets

ROTARY-TYPE POSITIVE DISPLACEMENT COMPRESSOR DATA SHEET SI UNITS

JOB No. _____ ITEM No. _____
PURCH. ORDER No. _____ DATE _____
REQUISITION No. _____
INQUIRY No. _____
PAGE _____ OF _____ BY _____

APPLICABLE TO: O PROPOSAL O PURCHASE O AS-BUILT DATE _____ REVISION _____
FOR _____ UNIT _____
SITE _____ SERIAL No. _____
SERVICE _____ No. REQUIRED _____
MANUFACTURER _____ MODEL _____ DRIVER _____
NOTE: O INDICATES INFORMATION TO BE COMPLETED BY PURCHASER, ☐ BY MANUFACTURER

OPERATING CONDITIONS

(ALL DATA ON PER UNIT BASIS)	NORMAL	RATED	OTHER CONDITIONS A	B	C	D
O GAS HANDLED (ALSO SEE PAGE _____)						
O m^3/h (760 mm Hg & 0 °C) DRY						
O MASS FLOW (kg/h) (WET) (DRY)						
INLET CONDITIONS:						
O PRESSURE (BAR) (kPa-abs)						
O TEMPERATURE (°C)						
O RELATIVE HUMIDITY (%)						
O MOLAR MASS (M)						
☐ Cp/Cv (K_1) OR (K_{avg})						
☐ COMPRESSIBILITY (Z_1) OR (Z_{AVG})						
☐ INLET VOLUME, (m^3/h-WET)						
DISCHARGE CONDITIONS						
O PRESSURE (BAR) (kPa-abs)						
☐ TEMPERATURE (0 °C)						
☐ Cp/Cv (K_2) OR (K_{avg})						
☐ COMPRESSIBILITY (Z_2) OR (Z_{avg})						
☐ kW REQUIRED (ALL LOSSES INCL)						
☐ SPEED (r/min)						
☐ PRESSURE RATIO (R)						
☐ VOLUMETRIC EFFICIENCY (%)						
☐ SILENCER ΔP						
O _____						
☐ PERFORMANCE CURVE No.						

PROCESS CONTROL:
METHOD: O BYPASS FROM _____ TO _____
O BYPASS: O MANUAL O AUTO
O SPEED VARIATION FROM _____ TO _____
O OTHER _____
SIGNAL: O SOURCE _____
O TYPE _____
O RANGE: FOR PNEUMATIC CONTROL _____ r/min @ _____ (BARG) & _____ r/min @ _____ (BARG) _____
(kPa) (kPa)
OTHER _____
SERVICE: O CONTINUOUS O INTERMITTENT O STANDBY

REMARKS: _____

ROTARY-TYPE POSITIVE DISPLACEMENT COMPRESSOR DATA SHEET
SI UNITS

JOB No. _____ ITEM No. _____
PAGE _____ OF _____ BY _____
DATE _____ REVISION _____

GAS ANALYSIS ○ MOL % ○ _____		NOR-MAL	RATED	OTHER CONDITIONS				REMARKS
				A	B	C	D	
AIR	M.W.							
	28,966							
OXYGEN	32,000							
NITROGEN	28,016							
WATER VAPOUR	18,016							
CARBON MONOXIDE	28,010							
CARBON DIOXIDE	44,010							
HYDROGEN SULFIDE	34,076							
HYDROGEN	2,016							
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								
TOTAL								
AVG. MOL. WT.								

LOCATION	NOISE SPECIFICATIONS
○ INDOOR ○ HEATED ○ UNDER ROOF	○ APPLICABLE TO MACHINE
○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES	SEE SPECIFICATION _____
○ GRADE ○ MEZZANINE ○ _____	○ APPLICABLE TO NEIGHBOURHOOD
○ ELECTRICAL AREA CLASS ___ GR. ___ DIV. ___	SEE SPECIFICATION _____
○ WINTERIZATION REQ'D. ○ TROPICALIZATION REQ'D.	ACOUSTIC HOUSING: ○ YES ○ NO
SITE DATA:	SOUND LEVEL _____ dB @ _____ PM _____
○ ELEVATION _____PM BAROMETER _____ (BAR) (kPa-abs)	dB RE: 0,0002 MICROBAR
○ RANGE OF AMBIENT TEMPS.:	APPLICABLE SPECIFICATIONS:
DRY BULB WET BULB	API 619 POSITIVE DISPLACEMENT ROTARY COMPRESSORS
SITE RATED °C _____	_____
NORMAL °C _____	_____
MAXIMUM °C _____	_____
MINIMUM °C _____	_____
UNUSUAL CONDITIONS: ○ DUST ○ FUMES	PAINTING:
○ OTHER _____	○ MANUFACTURER'S STD.
_____	○ OTHERS _____
_____	_____
_____	SHIPMENT:
_____	○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQ'D.
	○ LONG-TERM STORAGE FOR _____ MONTHS
REMARKS: _____	

ROTARY-TYPE POSITIVE DISPLACEMENT COMPRESSOR DATA SHEET SI UNITS

JOB No. _____ ITEM No. _____
PAGE _____ OF ____ BY _____
DATE _____ REVISION _____

☐ SPEEDS:
MAX. CONT. _____ r/min TRIP _____r/min
MAX. TIP SPEEDS _____ m/s @ RATED SPEED
_____ m/s @ MAX. CONT. SPEED

☐ LATERAL CRITICAL SPEEDS:
FIRST CRITICAL _____ r/min
DAMPED _____ UNDAMPED _____
MODE SHAPE _____
LATERAL CRITICAL SPEED – BASIS:
☐ DAMPED UNBALANCE RESPONSE ANALYSIS
☐ SHOP TEST
☐ OTHER TYPE ANALYSIS: _____
(Specify)

☐ TORSIONAL CRITICAL SPEEDS:
FIRST CRITICAL_____ r/min
SECOND CRITICAL _____ r/min
THIRD CRITICAL _____ r/min

☐ VIBRATION:
ALLOWABLE LEVEL _____ TEST
(PEAK TO PEAK) _____ SITE

☐ ROTATION, VIEWED FROM DRIVEN END:

☐ CASING:
MODEL _____
CASING SPLIT _____
MATERIAL _____
OPERATION: ☐ DRY ☐ FLOODED, WITH _____LIQUID
THICKNESS (mm) _____ CORR.ALLOW.(mm) _____
MAX. WORK. PRESS. _____ (BARG)(kPa)
RELIEF VALVE SETTING _____ (BARG)(kPa)
MARGIN FOR ACCUMULATION _____ (BARG)(kPa)
TEST PRESS. (BARG)(kPa) HELIUM _____HYDRO_____
MAX. ALLOW. TEMP._____°C MIN. OPER. TEMP._____°C
MAX. CASING CAPACITY (INLET m^3/h) _____
RADIOGRAPH QUALITY O YES _____ O NO _____

☐ ROTORS:
DIAMETER (mm): _____
No. LOBES: MALE _____ FEMALE _____
TYPE: _____
TYPE FABRICATION _____
MATERIAL _____
MAX. YIELD STRENGTH (N/mm^2) _____
BRINELL HARDNESS: MAX._____ MIN. _____
ROTOR LENGTH TO DIAMETER RATIO (L/D) _____
ROTOR CLEARANCE (mm) _____
MAX. DEFLECTION (mm) _____
MAX. MACHINE MACH NO. @ LOBES _____
INTERNALLY COOLED _____ UNCOOLED _____

☐ SHAFT:
MATERIAL _____
DIA @ ROTORS (mm) __ DIA @ COUPLING (mm) _____
SHAFT END: ☐ TAPERED ☐ CYLINDRICAL

SHAFT SLEEVES:
O AT SHAFT SEALS _____ ☐ MATL. _____
_____
_____

☐ TIMING GEARS:
SIZE (in) _____ TYPE _____
MATERIAL _____
SHAFT SEALS:
☐ TYPE
O SEAL SYSTEM TYPE _____
☐ INNER OIL LEAKAGE GUAR. (l/DAY/SEAL) _____
☐ TYPE BUFFER GAS _____
☐ BUFFER GAS FLOW (PER SEAL) _____
NORMAL: _____ kg/min @ _____ (BARG) (kPa)
MAX.: _____ kg/min @ _____ (BARG) (kPa)

☐ BEARING HOUSING CONSTRUCTION:
TYPE (SEPARATE, INTEGRAL) _____ SPLIT _____
MATERIAL _____

☐ RADIAL BEARINGS:
TYPE _____ SPAN (mm) _____
AREA (mm^2) ____ LOADING N/mm^2: ACT.____ ALLOW. ____
CENTRE PIVOT _____ OFFSET PIVOT _____
% OFFSET FROM LEADING EDGE _____
No. PADS ____ ROTOR ON ____ OR BETWEEN____PADS
PAD MATERIAL _____
TYPE BABBITT _____ THICKNESS _____ (mm)
_____

☐ THRUST BEARING:
LOCATION _____ TYPE _____
MFR. _____ AREA (mm^2) _____
LOADING (N/mm^2) _____ ACT. _____ ALLOW. _____
GAS LOADING (N) _____ CPLG. SLIP LOAD (N) _____
CPLG. COEFF. FRICT:___CPLG. GEAR PITCH DIA.(mm) ___
BAL. PISTON COMPENSATING LOAD _____ (N)
CENTRE PIVOT _____ OFFSET PIVOT _____
% OFFSET FROM LEADING EDGE _____
NUMBER OF PADS _____
PAD MATERIAL _____
TYPE BABBITT _____ THICKNESS _____ (mm)
_____
_____
_____

REMARKS _____
_____
_____
_____
_____

ROTARY-TYPE POSITIVE DISPLACEMENT COMPRESSOR DATA SHEET
SI UNITS

JOB No. _____ ITEM No. _____
PAGE _____ OF ____ BY _____
DATE _____ REVISION _____

☐ MAIN CONNECTIONS:

	SIZE	ANSI RATING	FACING	POSI-TION
INLET				
DISCHARGE				
_____				
_____				
_____				

☐ ALLOWABLE PIPING FORCES AND MOMENTS:

	INLET		DISCHARGE			
	FORCE N	MOMT N·m	FORCE N	MOMT N·m	FORCE N	MOMT N·m
AXIAL						
VERTICAL						
HORIZ. 90°						
	FORCE N	MOMT N·m	FORCE N	MOMT N·m	FORCE N	MOMT N·m
AXIAL						
VERTICAL						
HORIZ. 90°						

☐ OTHER CONNECTIONS:

SERVICE:	No.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
SEAL OIL INLET			
SEAL OIL OUTLET			
CASING DRAINS			
VENTS			
COOLING WATER			
PRESSURE			
TEMPERATURE			
PURGE FOR:			
BRG. HOUSING			
BETWEEN BRG & SEAL			
BETWEEN SEAL & GAS			

VIBRATION DETECTORS:

○ IN ACCORDANCE WITH: API 670_____ API 678 _____
OTHER (SPECIFY) _____
○ TYPE_____ ☐ MODEL _____
○ MFR. _____
○ No. AT EACH SHAFT BEARING _____ TOTAL No._____
○ OSCILLATOR DETECTORS SUPPLIED BY_____
○ MFR. _____ ☐ MODEL _____
○ MONITOR SUPPLIED BY _____
○ LOCATION _____ ENCLOSURE _____
○ MFR._____ ☐ MODEL _____
☐ SCALE RANGE _____○ ALARM. ☐ SET @ _____μm
○ SHUTDOWN: ☐ SET@____μm ○ TIME DELAY__sec
○ PHASE REFERENCE TRANSDUCER

AXIAL POSITION DETECTOR:

○ IN ACCORDANCE WITH: API 670 _____
OTHER (SPECIFY) _____
○ TYPE _____ ☐ MODEL _____
○ MFR. _____ ☐ NO. REQ.D. _____
○ OSCILLATOR.DETECTORS SUPPLIED BY _____
○ MFR. _____ ☐ MODEL _____
○ MONITOR SUPPLIED BY _____
○ LOCATION_____ ☐ ENCLOSURE _____
MFR. _____ ☐ MODEL
☐ SCALE RANGE ____ O ALARM: ☐ SET @ _____ μm
○ SHUTDOWN: ☐ SET @ ____μm ○ TIME DELAY __sec

COUPLINGS:

○ IN ACCORDANCE WITH: API 671 _____
OTHER (SPECIFY) _____

	DRIVER-COMP OR DRIVER	GEAR-COMP
○ MAKE		
☐ MODEL		
○ LUBRICATION		
○ MOUNT CPLG.HALVES		
○ SPACER REQUIRED		
○ LIMITED END FLOAT REQ'D		
○ IDLING ADAPTOR REQ'D		
☐ CPLG. RATING kW/100 r/min		
☐ KEYED(1)OR (2)OR HYDR:FIT		

BASEPLATE & SOLEPLATES:

SOLE PLATES FOR: ○ COMPRESSOR ○ GEAR ○ DRIVER
BASEPLATE:
○ COMMON (UNDER COMP:GEAR & DRIVER)
○ UNDER COMP.ONLY O OTHER _____
○ DECKED WITH NON-SKID DECK PLATE O OPEN CONST:
○ DRIP RIM O WITH OPEN DRAIN
○ HORIZONTAL ADJUSTING SCREWS FOR EQUIPMENT
○ SUITABLE FOR POINT SUPPORT
○ SUITABLE FOR PERIMETER SUPPORT

REMARKS: _____

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UTILITY CONDITIONS:

STEAM		DRIVERS	HEATING
INLET	MIN.	_____(BARG)(kPa)__°C	___(BARG)(kPa)___°C
	NORM	____(BARG)(kPa)__°C	___(BARG)(kPa)___°C
	MAX.	_____(BARG)(kPa)__°C	___(BARG)(kPa)___°C
EXHAUST	MIN.	_____(BARG)(kPa)__°C	___(BARG)(kPa)___°C
	NORM	____(BARG)(kPa)__°C	___(BARG)(kPa)___°C
	MAX.	_____(BARG)(kPa)__°C	___(BARG)(kPa)___°C

ELECTRICITY:

	DRIVERS	HEATING	CONTROL	SHUT-DOWN
VOLTAGE	_____	_____	_____	_____
HERTZ	_____	_____	_____	_____
PHASE	_____	_____	_____	_____

COOLING WATER
TEMP. INLET _____°C MAX.RETURN _____°C
PRESS. NORM_____(BARG)(kPa) DESIGN_____ (BARG)(kPA)
MIN.RETURN_____(BARG)(kPa) MAX. ALLOW ΔP_____(BAR)
WATER SOURCE _____(kPa-abs)
INSTRUMENT AIR:
MAX. PRESS _____(BARG)(kPa) MIN._____(BARG)(kPa)
☐ TOTAL UTILITY CONSUMPTION:
COOLING WATER _____m³/h
STEAM NORMAL _____kg/h
STEAM MAX. _____kg/h
INSTRUMENT AIR _____m³/h
kW (DRIVER) _____kW
kW (AUXILIARIES) _____kW

SHOP INSPECTION AND TESTS:	REQ'D.	WITNESS
SHOP INSPECTION	O	O
HYDROSTATIC	O	O
HELIUM LEAK	O	O
MECHANICAL RUN	O	O
MECHAN. RUN SPARE ROTORS	O	O
FIT IN SPARE ROTORS	O	O
PERFORMANCE TEST (GAS)(AIR)	O	O
COMP. WITH DRIVER	O	O
COMP. LESS DRIVER	O	O
USE SHOP LUBE & SEAL SYSTEM	O	O
USE JOB LUBE & SEAL SYSTEM	O	O
USE SHOP VIBRATION PROBES, ETC		
USE JOB VIB. & AXIAL DISP.PROBES, OSCILLATOR-DETECTORS & MONITOR	O	O
PRESSURE COMP. TO FULL OPER. PRESS.	O	O
DISASSEMBLE_REASSEMBLE COMP. AFTER TEST	O	O
CHECK BRGS. & SEALS AFTER TEST	O	O
NOISE LEVEL TEST	O	O

☐ MASS (KILOGRAMS):
COMPR._____ GEAR _____ DRIVER _____ BASE _____
ROTORS: COMPR._____ DRIVER_____ GEAR _____
COMPR.UPPER CASE _____
L.O.CONSOLE _____ S.O. CONSOLE _____
MAX. FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING MASS _____

☐ SPACE REQUIREMENTS (mm):
COMPLETE UNIT: L _____ W _____ H _____
L.O. L _____ W _____ H _____
S.O. CONSOLE: L _____ W _____ H _____

MISCELLANEOUS:
☐ RECOMMEND STRAIGHT RUN OF PIPE DIA. BEFORE SUCTION _____
O VENDOR'S REVIEW & COMMENTS ON PURCHASER'S PIPING & FOUNDATION
O OPTICAL ALIGNMENT FLATS REQUIRED ON COMPRESSOR, GEAR & DRIVER
O PROVISION FOR WATER WASHING BEFORE OPENING CASING BY _____
O TORSIONAL ANALYSIS REPORT REQUIRED
O PROVISIONS FOR TORSIONAL PICKUP ON CASE
CONDENSATE REMOVAL EQUIPMENT REQUIRED
O YES _____ O NO ___::_____
SILENCERS FURNISHED BY _____

REMARKS: _____

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MANUFACTURER _____

REFERENCE SPECIFICATIONS:
API 614 O YES O NO
_____
_____
_____
_____
_____

AREA CLASSIFICATION:
CLASS_____ GROUP_____ DIVISION_____
MOTOR CONTROL & INSTRUMENT VOLTAGE:
VOLTS_____ PHASE_____ CYCLES
ALARM & SHUTDOWN VOLTAGE:
VOLTS_____ PHASE_____ CYCLES OR_____DC
_____

LOCAL CONTROL PANEL:
FURNISHED BY: ☐ VENDOR ☐ PURCHASER ☐ OTHERS _____
☐ FREE STANDING ☐ WEATHERPROOF ☐ TOTALLY ENCLOSED ☐ EXTRA CUTOUTS
☐ VIBRATION ISOLATORS ☐ STRIP HEATERS ☐ PURGE CONNECTIONS
☐ ANNUNCIATOR: FURNISHED BY: ☐ VENDOR ☐ PURCHASER ☐ OTHERS _____
ANNUNCIATOR LOCATED ON ☐ LOCAL PANEL ☐ MAIN CONTROL BOARD
☐ CUSTOMER CONNECTIONS BROUGHT OUT TO TERMINAL BOXES BY VENDOR

INSTRUMENT SUPPLIERS:

PRESSURE GAUGES:	MFR. _____	SIZE & TYPE _____
TEMPERATURE GAUGES	MFR. _____	SIZE & TYPE _____
LEVEL GAUGES:	MFR. _____	SIZE & TYPE _____
DIFF. PRESSURE GAUGES:	MFR. _____	SIZE & TYPE _____
PRESSURE SWITCHES:	MFR. _____	SIZE & TYPE _____
DIFF.PRESSURE SWITCHES:	MFR. _____	SIZE & TYPE _____
TEMPERATURE SWITCHES:	MFR. _____	SIZE & TYPE _____
LEVEL SWITCHES:	MFR. _____	SIZE & TYPE _____
CONTROL VALVES:	MFR. _____	SIZE & TYPE _____
PRESSURE RELIEF VALVES:	MFR. _____	SIZE & TYPE _____
THERMAL RELIEF VALVES:	MFR. _____	SIZE & TYPE _____
SIGHT FLOW INDICATORS:	MFR. _____	SIZE & TYPE _____
GAS FLOW INDICATOR:	MFR. _____	SIZE & TYPE _____
VIBRATION EQUIPMENT:	MFR. _____	SIZE & TYPE _____
TACHOMETER:	MFR. _____	SIZE & TYPE _____
SOLENOID VALVES	MFR. _____	SIZE & TYPE _____
ANNUNCIATOR:	MFR. _____	MODEL & No.POINTS _____
_____	MFR. _____	SIZE & TYPE _____
_____	MFR. _____	SIZE & TYPE _____

NOTE: ☐ SUPPLIED BY VENDOR O SUPPLIED BY PURCHASER

PRESSURE CAGE REQUIREMENTS FUNCTION	LOCALLY MOUNTED	LOCAL PANEL	FUNCTION	LOCALLY MOUNTED	LOCAL PANEL
LUBE OIL PUMP DISCHARGE __	☐ O	☐ O	GOV.CONTROL OIL _____	☐ O	☐ O
LUBE OIL FILTER ΔP _____	☐ O	☐ O	GOV. CONTROL OIL ΔP _____	☐ O	☐ O
LUBE OIL SUPPLY _____	☐ O	☐ O	COUPLING OIL ΔP _____	☐ O	☐ O
SEAL OIL PUMP DISCHARGE __	☐ O	☐ O	MAIN STEAM IN _____	☐ O	☐ O
SEAL OIL FILTER ΔP _____	☐ O	☐ O	1ST STAGE STEAM _____	☐ O	☐ O
SEAL OIL FILTER _____	☐ O	☐ O	STEAM CHEST _____	☐ O	☐ O
SEAL OIL DIFFERENTIAL _____	☐ O	☐ O	EXHAUST STEAM _____	☐ O	☐ O
REFERENCE GAS _____	☐ O	☐ O	EXTRACTION STEAM _____	☐ O	☐ O
BALANCE LINE _____	☐ O	☐ O	STEAM EJECTOR _____	☐ O	☐ O
SEAL EDUCTOR _____	☐ O	☐ O	COMPRESSOR SUCTION ____	☐ O	☐ O
BUFFER SEAL _____	☐ O	☐ O	COMPRESSOR DISCHARGE __	☐ O	☐ O
_____	☐ O	☐ O	_____	☐ O	☐ O

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TEMPERATURE GAUGE REQUIREMENTS: FUNCTION	LOCALLY MOUNTED	LOCAL PANEL	FUNCTION	LOCALLY MOUNTED	LOCAL PANEL
LUBE OIL DISCHARGE FROM EA.___	☐ ○	☐ ○	COOLER OIL INLET & OUTLET___	☐ ○	☐ ○
COMPR. JOURNAL BEARING _____	☐ ○	☐ ○	SEAL OIL OUTLET_____	☐ ○	☐ ○
DRIVER JOURNAL BEARING	☐ ○	☐ ○	COMPRESSOR SUCTION _____	☐ ○	☐ ○
GEAR JOURNAL BEARING _____	☐ ○	☐ ○	COMPRESSOR DISCHARGE ____	☐ ○	☐ ○
COMPRESSOR THRUST BEARING___	☐ ○	☐ ○	LUBE OIL RESERVOIR _____	☐ ○	☐ ○
DRIVER THRUST BEARING _____	☐ ○	☐ ○	_____	☐ ○	☐ ○
GEAR THRUST BEARING _____	☐ ○	☐ ○	_____	☐ ○	☐ ○

MISCELLANEOUS INSTRUMENTATION:

☐ ○ SIGHT FLOW INDICATORS; EACH JOURNAL & THRUST BEARING & EACH COUPLING OIL RETURN LINE
☐ ○ SIGHT FLOW INDICATORS, EACH SEAL OIL RETURN LINE
☐ ○ LEVEL GAUGES, LUBE AND/OR SEAL OIL RESERVOIR, S.O. DRAIN TRAPS & S.O. OVERHEAD TANK
☐ ○ VIBRATION AND SHAFT POSITION PROBES & PROXIMITORS
☐ ○ VIBRATION AND SHAFT POSITION READOUT EQUIPMENT
☐ ○ VIBRATION READOUT LOCATED ON: ☐ LOCAL PANEL ☐ SEPARATE PANEL ☐ MAIN BOARD
☐ ○ TURBINE SPEED PICKUP DEVICES
☐ ○ TURBINE SPEED INDICATORS
☐ ○ TURBINE SPEED INDICATORS LOCATED ON: ☐ LOCAL PANEL ☐ MAIN BOARD
☐ ○ REMOTE HAND SPEED CHANGES - MOUNTED ON LOCAL PANEL
☐ ○ ALARM HORN & ACKNOWLEDGEMENT SWITCH

ALARM & SHUTDOWN SWITCHES: FUNCTION	PRE-ALARM	TRIP	FUNCTION	PRE-ALARM	TRIP
☐ ○ LOW LUBE OIL PRESSURE	_____	_____	☐ ○ COMPRESSOR VIBRATION	_____	_____
☐ ○ HI LUBE OIL FILTER ∆P	_____	_____	☐ ○ COMPRESS. AXIAL POSITION	_____	_____
☐ ○ HI SEAL OIL FILTER ∆P	_____	_____	☐ ○ TURBINE VIBRATION	_____	_____
☐ ○ LOW LUBE OIL RESERVOIR LEV.	_____	_____	☐ ○ TURBINE AXIAL POSITION	_____	_____
☐ ○ LOW SEAL OIL RESERVOIR LEV.	_____	_____	☐ ○ GEAR VIBRATION	_____	_____
☐ ○ HI SEAL OIL LEVEL	_____	_____	☐ ○ GEAR AXIAL POSITION	_____	_____
☐ ○ LOW SEAL OIL LEVEL	_____	_____	☐ ○ COMPRESSOR MOTOR SHUTDOWN	_____	_____
☐ ○ HI SEAL OIL PRESSURE	_____	_____	☐ ○ TRIP&THROTTLE VALVE SHUT	_____	_____
☐ ○ LOW SEAL OIL PRESSURE	_____	_____	☐ ○ HI TURB.STEAM SEAL LEAKAGE	_____	_____
☐ ○ AUX. SEAL OIL PUMP START	_____	_____	☐ ○ HI COMPR.THRUST BRG:TEMP.	_____	_____
☐ ○ AUX. LUBE OIL PUMP START	_____	_____	☐ ○ HI DRIVER THRUST BRG.TEMP.	_____	_____
☐ ○ HI SEAL OIL OUTLET TEMP. (COOLER)	_____	_____	☐ ○ COMPR.BALANCE DRUM ∆P	_____	_____
☐ ○ HI LIQUID LEV.SUCT.SEPARATOR	_____	_____	☐ ○ _____	_____	_____
☐ ○ COMPRESSOR HI DISCH.TEMP.	_____	_____	☐ ○ _____	_____	_____
☐ ○ HI LUBE OIL OUTLET TEMP. (COOLER)	_____	_____	☐ ○ _____	_____	_____

SWITCH CLOSURES:

ALARM CONTACTS SHALL: ☐ OPEN ☐ CLOSE TO SOUND ALARM AND BE NORMALLY ☐ ENERGIZED ☐ DE-ENERGIZED
SHUTDOWN CONTACTS SHALL: ☐ OPEN ☐ CLOSE TO TRIP AND BE NORMALLY ☐ ENERGIZED ☐ DE-ENERGIZED
NOTE: NORMAL CONDITION IS WHEN COMPRESSOR IS IN OPERATION

MISCELLANEOUS:

○ INSTRUMENT TAGGING REQUIRED
PRE-ALARM AND SHUTDOWN SWITCHES SHALL BE SEPARATE
PURCHASER'S ELECTRICAL AND INSTRUMENT CONNECTIONS WITHIN THE CONFINES OF THE BASEPLATE AND CONSOLE SHALL BE: ☐ BROUGHT OUT TO TERMINAL BOXES ☐ MADE DIRECTLY BY THE PURCHASER
COMMENTS REGARDING INSTRUMENTATION: _____
_____
_____

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APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS-BUILT
FOR _____ UNIT _____
SITE _____ DRIVEN EQUIP. _____
SERVICE _____ NO. REQUIREC _____
MANUFACTURER _____ MODEL _____ SERIAL No. _____
NOTE: ○ INDICATES INFORMATION TO BE COMPLETED BY PURCHASER ☐ BY MANUFACTURER

MOTOR DESIGN DATA

APPLICABLE SPECIFICATIONS:
○ NEMA _____
○ _____
○ _____
SITE DATA:
AREA: ○ C.L. ____GR. ____ DIV. ____ ○ NON-HAZARDOUS
○ ALT. _____ m ○ AMB.TEMPS: MAX.____°C. MIN._____°C
UNUSUAL CONDITIONS: ○ DUST ○ FUMES
○ OTHER _____
DRIVE SYSTEM: ○ DIRECT CONNECTED
○ GEAR
○ OTHER _____
TYPE MOTOR:
○ SQUIRREL CAGE INDUCTION ○ NEMA DESIGN_____
○ SYNCHRONOUS _____
○ POWER FACTOR REQD. _____
EXCITATION: ○ BRUSHLESS ○ SLIP RING
○ FIELD DISCHARGE RESISTOR BY MOTOR MFR.
○ WOUND ROTOR INDUCTION
○ _____
ENCLOSURE:
○ CLASS _____, GROUP _____, EXP. PROOF
○ TEFC
○ TEWAC ○ TEIGF. USING _____ GAS
○ DOUBLE WALL CARBON STEEL TUBES
○ WATER SUPPLY: PRESS.____(BARG)(kPa) TEMP._____°C
○ WATER ALLOW. ΔP____ (BARG)(kPa) & TEMP.RISE_____°C
○ WATER SIDE MIN. CORR. ALLOW. _____ mm
AND FOUL FACTOR _____
○ (AIR) (GAS) SUPPLY PRESS. _____(BARG)(kPa)
○ _____
○ WEATHER PROTECTED, TYPE _____
○ FORCED VENTILATED
○ OPEN DRIP-PROOF
○ OPEN
○ _____
○ _____
BASIC DATA:
○ _____ VOLTS _____ PHASE _____ HERTZ
☐ NAMEPLATE HP _____ SERVICE FACTOR _____
○ SYNCHRONOUS r/min
○ INSULATION: CLASS _____ TYPE _____
○ TEMP. RISE: _____°C ABOVE _____°C BY _____
_____

MOTOR DESIGN DATA (CONT'D.)

STARTING:
○ FULL VOLTAGE ○ REDUCED VOLTAGE _____ %
○ LOADED ○ UNLOADED
○ VOLTAGE DIP _____ %
VIBRATION:
○ NEMA STANDARD ○ _____
NOISE:
○ NEMA STANDARD ○ _____

ACCESSORY EQUIPMENT

○ BASEPLATE ○ SOLEPLATE ○ STATOR SHIFT
○ MFR. STD. FANS ○ NON-SPARKING FANS
○ D.C. EXCITATION:
☐ kW REQD _____ VOLTS _____
BY: ○ PURCHASER ○ MANUFACTURER
DESCRIPTION _____
○ ENCLOSED COLLECTOR RINGS:
○ PURGED: MEDIUM _____ PRESS. _____ (BARG)(kPa)
○ EXPLOSION-RESISTANT NON-PURGED
○ FORCED VENTILATION
☐ m^3/h _____ PRESS. DROP _____ mm H_2O
○ BEARING TEMP. DEVICES:
☐ LOCATION _____
☐ DESCRIPTION _____
☐ SET @ _____°C FOR ALARM _____°C FOR SHUTDOWN
○ SPACE HEATERS:
☐ _____ kW ○ ____ VOLTS _____ PHASE ____ HERTZ
○ MAX. SHEATH TEMP. _____°C
WINDING TEMPERATURE DETECTORS:
○ THERMISTORS: No./PHASE _____
TYPE: ○ POS.TEMP. COEFF. ○ NEG. TEMP. COEFF.
TEMPERATURE SWITCH: ○ YES ○ NO
○ RESISTANCE TEMP: DETECTORS:No./PHASE _____
☐ RESISTANCE MATL._____ ☐ _____ OHMS
SELECTOR SWITCH & INDIC. BY: ○ PURCHR. ○ MFR.
☐ MAX. STATOR WINDING TEMPS:
_____°C FOR ALARM _____ °C FOR SHUTDOWN
WINDING TEMP. DETECTOR & SPACE HEATER LEADS:
○ IN SAME CONDUIT BOX
○ IN SEPARATE CONDUIT BOXES
○ MOTOR ARRANGED FOR DIFFERENT PROTECTION:
○ SELF-BALANCE PRIMARY-CURRENT METHOD
○ C.T. DESCRIPTION _____
○ EXTENDED LEADS ☐ LENGTH _____ m
○ SURGE CAPACITORS _____

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ACCESSORY EQUIPMENT (CONT'D.)

○ LIGHTING ARRESTERS
○ C.T. FOR AMMETER
○ DESCRIPTION _____
MAIN CONDUIT BOX SIZED FOR:
○ MAIN MOTOR LEADS ○ TYPE: _____
○ INSULATED ○ NON-INSULATED
○ C.T.'S FOR DIFF. PROTECTION (MOUNTED BY _____)
○ SURGE CAPACITORS (MOUNTED BY _____)
○ LIGHTING ARRESTERS (MOUNTED BY _____)
○ C.T. FOR AMMETER (MOUNTED BY _____)
○ SPACE FOR STRESS CONES
○ AIR FILTERS:
☐ MFR _____ ☐ TYPE _____

☐ MANUFACTURER'S DATA

MANUFACTURER _____
FRAME NO. _____ FULL LOAD r/min (IND.) _____
EFFICIENCY: F.L._____ ¾ L _____ ½ L_____
PWR. FACTOR (IND.): F.L._____ ¾ L _____ ½ L _____
CURRENT (RATED VOLT.): FULL LOAD____ LOCKED ROT.____
LOCKED ROTOR POWER FACTOR _____
LOCKED ROTOR WITHSTAND TIME (COLD START) _____
TORQUES (N·m): FULL LOAD _____
LOCKED ROTOR _____ STARTING (SYN.) _____
PULL-UP(IND.) _____ PULL-IN (SYN.) _____
BREAKDOWN (IND.) ____ PULL-OUT (SYN.) _____
_____
OPEN CIRCUIT TIME CONSTANT _____s.
SYMMETRICAL CONTRIBUTION TO 30 TERMINAL FAULT:
AT 1/2 CYCLES _____ AT 5 CYCLES _____
REACTANCES: SUB-TRANSIENT (X"d) _____
TRANSIENT (X'd) _____ SYNCHRONOUS (Xd) _____
A.C.STATOR RESISTANCE _____OHMS @ _____°C
RATED KVA _____
KVA INRUSH @ FULL VOLT. & LOCKED ROTOR (SYN.)_____%
KVA @ FULL VOLTAGE & 95% SPEED _____%
MAX. LINE CURR. IN STATOR ON 1ST SLIP CYC.@PULL- OUT (SYN.) _____
ACCELERATION TIME (MTR ONLY @ RATED VOLT)_____s.
ACCEL. TIME (MTR & LOAD @ 85% RATED VOLT.)_____s.
ROTOR/FIELD W·K³ @ MTR SHAFT (N·m²) _____
ROTATION FACING COUPLING END _____
No. OF STARTS PER HOUR _____
_____
FIELD DISCHARGE RESISTOR _____ OHMS
RATED EXCITATION FIELD VOLTAGE _____ D.C.
RESISTANCE OF EXCITATION FIELD @ 25°C _____ OHMS
EXCITATION FIELD AMPS @ FULL LOAD & RATED P.F._____
EXCITATION FIELD AMPS: MAX._____ MIN. _____
EXCITATION FIELD ☐ RHEOSTAT ☐ FIXED RES'TR REQD.
SUPPLIED BY _____
_____

☐ MANUFACTURER'S DATA (CONT'D.)

BEARING : TYPE _____ LUBR. _____
LUBE OIL REQUIRED: _____ m³/h @ _____(BARG)(kPa)
TOTAL SHAFT END FLOAT _____
LIMIT END FLOAT TO _____
MOTOR ROTOR: ☐ SOLID ☐ SPLIT
MOTOR HUB: ☐ SOLID ☐ SPLIT
FOR TEWAC & TEIGF MOTORS:
COOLING WATED REQD. _____ m³/h
C.W. TEMP. RISE ___°C PRESS.DROP ___(BAR)(kPa-abs)
(AIR)(GAS) REQD._____m³/h PRESS. MAINT._____mmH_20
CURVES REQD:BASED ON MTR SATURATION @ RATED VOLTAGE:
○ SPEED VS TORQUE (ALSO @ ____% RATED VOLTAGE)
○ SPEED VS POWER FACTOR
○ SPEED VS CURRENT
MASSES (kg):
NET MASS _____ SHIPPING MASS _____
ROTOR MASS _____ MAX. ERECTION MASS. _____
MAX. MAINT. MASS. (IDENTIFY) _____
DIMENSIONS (mm):
L _____ W _____ H _____

SHOP INSPECTION AND TESTS

	REQUIRED	WITNESS
SHOP INSPECTION	○	○
TESTING PER NEMA	○	○
MFR. STD. SHOP TESTS	○	○
IMMERSION TEST	○	○
SPECIAL TESTS (LIST BELOW)	○	○
_____	○	○
_____	○	○
_____	○	○
_____	○	○

COUPLING:
○ SUPPLIED BY _____
○ MFR. _____ ☐ MODEL _____
○ MTR MFR. ○ COMPR. MFR. ○ PURCH. TO MT MTR. HALF
_____

PAINTING:
○ MANUFACTURER'S STANDARD
○ _____

SHIPMENT
○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQ'D
○ OUTDOOR STORAGE OVER 3 MONTHS
○ _____

REMARKS: _____
_____
_____
_____
_____
_____
_____

Bibliography

[1] ASTM A 106:1999, *Standard Specification for Seamless Carbon Steel Pipe for High-Temperature Service*

[2] ASTM A 192:1996, *Standard Specification for Seamless Carbon Steel Boiler Tubes for High-Pressure Service*

[3] ASTM A 269:2000, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

[4] API 619:1992, *Rotary-Type Positive Displacement Compressors for Petroleum, Chemical and Gas Industry Services*

Annex ZA
(normative)

Normative references to international publications with their relevant European publications

This European Standard incorporates by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references the latest edition of the publication referred to applies (including amendments).

NOTE Where an International Publication has been modified by common modifications, indicated by (mod.), the relevant EN/HD applies.

Publication	Year	Title	EN	Year
ISO 898-1	1999	Mechanical properties of fasteners made of carbon steel and alloy steel - Part 1: Bolts, screws and studs	EN ISO 898-1	1999
ISO 3506-1	1997	Mechanical properties of corrosion-resistant stainless-steel fasteners - Part 1: Bolts, screws and studs	EN ISO 3506-1	1997
ISO 5167-1	1991	Measurement of fluid flow by means of pressure differential devices - Part 1: Orifice plates, nozzles and Venturi tubes inserted in circular cross-section conduits running full	EN ISO 5167-1	1995
ISO 10441	1999	Petroleum and natural gas industries - Flexible couplings for mechanical power transmission - Special purpose applications	EN ISO 10441	1999

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