Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services

API STANDARD 672
FOURTH EDITION, MARCH 2004

American
Petroleum
Institute

Helping You Get The Job Done Right.SM

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Downstream Segment

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Packaged, Integrally Geared Centrifugal Air Compressors for Petroleum, Chemical, and Gas Industry Services

0 Introduction

Users of this International Standard should be aware that further or differing requirements may be needed for individual applications. This International Standard 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 appropriate where there is innovative or developing technology. Where an alternative is offered, the vendor should identify any variations from this International Standard and provide details.

Annex A contains data sheets which purchasers are encouraged to use.

Annex B provides information on normative references.

Annex C specifies requirements for lateral analysis.

Annex D contains forms which may be used to indicate vendor drawing and data requirements.

Annex E contains schematic drawings of lubrication systems.

Annex F specifies requirements for determining residual unbalance.

Annex G contains an inspector's checklist.

Annex H contains an illustration of nomenclature for integrally geared centrifugal air compressors.

This International Standard requires the purchaser to specify certain details and features.

A bullet (●) at the beginning of a paragraph indicates that either a decision or further information is required. Further information should be shown on the data sheets (see example in Annex A) or stated in the quotation request and purchase order.

In this International Standard, where practical, US Customary units are included in brackets for information

1 Scope

1.1 This standard covers the minimum requirements for constant-speed, packaged, general purpose integrally geared centrifugal air compressors, including their accessories. This standard is not applicable to machines that develop a pressure rise of less than 0.35 bar (5.0 psi) above atmospheric pressure, which are classed as fans or blowers.

Note: Special Purpose and Process applications, including Process Air Services, are covered by API Std 617.

● **1.2** Equipment covered by this standard is considered non-critical, usually spared and may be either of two classifications, Basic or Special Duty. The purchaser shall specify which of the two classifications applies.

Basic packages are vendors' standard packages of proven design and include minimal additional requirements.

Special duty packages are typically specified for installations that require higher availability and include additional features and requirements.

1.3 Additional or overriding requirements applicable only to packages that have been specified as "Special Duty" are noted at the end of each section (see 6.12; 7.10; 8.5; and 9.4).

1.4 Conflicting Requirements

In case of conflict between this standard and the inquiry, the inquiry shall govern. At the time of the order, the order shall govern.

2 Normative References

2.1 Reference publications are listed in Annex B.

2.2 All referenced standards, to the extent specified in the text, are normative.

2.3 The editions of the Annex B standards, codes, and specifications that are in effect at the time of publication of this standard shall, to the extent specified herein, form a part of this standard.

The applicability of changes in standards, codes, and specifications that occur after publication of this document shall be mutually agreed upon by the purchaser and the vendor.

2.4 Notes following a paragraph are informative.

● **2.5** Where dual referencing of standards occurs, the system of standards to be used shall be specified.

2.6 Statutory Requirements: The purchaser and the vendor shall mutually determine the measures that must be taken to comply with any governmental codes, regulations, ordinances, or rules that are applicable to the equipment.

3 Definition of Terms

Terms used in this standard are defined in 3.1 – 3.36.

3.1 alarm point : A preset value of a parameter at which an alarm is actuated to warn of a condition that requires corrective action.

3.2 axially split: A joint that is parallel to the shaft centerline.

3.3 bearing housing: All bearing enclosures, including the gear casing.

3.4 critical speed: A shaft rotational speed at which the rotor-bearing-support system is in a state of resonance.

3.5 delivered flow: The flow rate determined at the compressor discharge or after the discharge of the aftercooler when included in the vendor scope.

Note: When the flow is measured before the compressor inlet, it must be adjusted for the effects of aftercooler pressure drop, compressor seal losses, and interstage condensate removal.

3.6 design: A term that may be used by the equipment manufacturer to describe various parameters such as design power, design pressure, design temperature, or design speed.

Note: This terminology should be used only by the equipment manufacturer and not in the purchaser's specifications.

3.7 gear wheel (bull gear): The low-speed rotor of a gear set.

3.8 informative element: Describes part of the standard which is provided for information and is intended to assist in the understanding or use of the standard. Compliance with an informative part of the standard is not mandatory.

Note: An Annex may be informative or normative as indicated.

3.9 inlet volume flow: The flow rate expressed in volume flow units at the conditions of pressure, temperature, compressibility and air moisture content, at the compressor inlet connection.

3.10 local: The location of a device mounted on or near the equipment or console.

3.11 material certificate of compliance: A document by which the vendor certifies that the material represented has been produced and tested in accordance with the requirements of the basic material specification shown on the certificate.

3.12 maximum allowable temperature: The maximum continuous temperature 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 maximum operating pressure.

3.13 maximum allowable working pressure: The 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 maximum operating temperature.

3.14 maximum discharge pressure: The maximum suction pressure plus the maximum differential the compressor is able to develop to surge at the minimum specified inlet temperature.

3.15 maximum sealing pressure: The highest pressure the seals are required to seal during any specified static or operating condition.

3.16 normally open and normally closed: Refers both to on-the-shelf state and to installed deenergized state of devices such as automatically controlled electrical switches and valves.

Note: The normal operating state of such devices is not necessarily the same as the on-the-shelf state.

3.17 normative: A requirement of the standard.

3.18 observed: An inspection or test where the purchaser is notified of the timing of the inspection or test and the inspection or test is performed as scheduled whether or not the purchaser or his representative is present.

3.19 panel: An enclosure used to mount, display, and protect gauges, switches, and other instruments.

3.20 pinion: A high-speed rotor or rotors in a gear set.

3.21 pressure casing: The composite of all stationary pressure-containing parts of the unit, including all nozzles and other attached parts.

3.22 pressure rise to surge: The difference between the discharge pressure at the rated operating point and that at the surge point when the unit is operating at rated inlet conditions and with a constant inlet guide vane position.

3.23 radially split: A joint that is perpendicular to the shaft centerline.

3.24 rated point: The maximum specified flow rate at the specified discharge pressure when operating at the specified inlet conditions and coolant temperature. This is the point at which the vendor certifies that the performance is within the tolerances stated in this standard.

3.25 rated speed (also known as 100% speed): The highest rotational speed required to meet any of the specified operating conditions.

3.26 relief valve set pressure: The pressure at which a relief valve starts to lift.

3.27 remote: The location of a device when located away from the equipment or console, typically in a control room.

3.28 shutdown set point: A preset value of a measured parameter at which automatic or manual shutdown of the system or equipment is required.

3.29 standard volume flow: The flow rate expressed in volume flow units at the following standard conditions:

ISO Standard Conditions

Flow:	Cubic meters per hour (m^3/h)
Pressure:	1.013 bar
Temperature:	15°C
Relative Humidity:	0% (Dry)

US Standard Conditions

Flow:	Standard cubic feet per minute (scfm) Million standard cubic feet per day (mmscfd)
Pressure:	14.7 PSI
Temperature:	60°F
Relative Humidity:	0% (Dry)

3.30 standby service: A normally idle, or idling, piece of equipment that is capable of immediate automatic or manual start-up and continuous operation.

3.31 total indicated reading (TIR), also known as total indicator runout: The difference between the maximum and minimum readings of a dial indicator or similar device, monitoring a face or cylindrical surface during one complete revolution of the monitored surface.

3.32 trip speed (revolutions per minute): The speed at which the independent emergency overspeed device operates to shut down a variable-speed prime mover. For the purpose of this standard, the trip speed of alternating current electric motors, except, variable frequency devices, is the speed (revolutions per minute) corresponding to the synchronous speed of the motor at maximum supply frequency.

3.33 unit responsibility: The responsibility for coordinating the delivery and technical aspects of the equipment and all auxiliary systems included in the scope of the order. The technical aspects to be considered include but are not limited to such factors as the power requirements, speed, rotation, general arrangement, couplings, dynamics, noise, lubrication, sealing system, material test reports, instrumentation, piping, conformation to specifications and testing of components.

3.34 vendor (also known as supplier): The agency that supplies the equipment.

Note: The vendor may be the manufacturer of the equipment or the manufacturer's agent and normally is responsible for service support.

3.35 verified: The purchaser's review and acceptance of vendor's certification or documentation of successful completion of the inspection or test.

3.36 witnessed: An inspection or test where the purchaser is notified of the timing of the inspection or test and a hold is placed on the inspection or test until the purchaser or his representative is in attendance.

Note: The purchaser may want to specify notification of a successful preliminary test prior to travel.

4 General

4.1 UNIT RESPONSIBILITY

The vendor who has unit responsibility shall assure that all subvendors comply with the requirements of this standard and all reference documents.

4.2 NOMENCLATURE

A guide to integrally-geared air compressor nomenclature can be found in Annex H.

5 Requirements

5.1 UNITS OF MEASUREMENT

The purchaser will specify whether data, drawings, hardware (including fasteners), and equipment supplied to this standard shall use the SI or US Customary system of measurements.

5.2 STATUTORY REQUIREMENTS

The purchaser and the vendor shall mutually determine the measures that must be taken to comply with any government codes, regulatory, ordinances, or rules that are applicable to the equipment.

5.3 ALTERNATIVE DESIGNS

The vendor may offer alternative designs for purchaser's consideration.

5.4 CONFLICTING REQUIREMENTS

In case of conflict between this standard and the inquiry, the inquiry shall govern. At the time of the order, the order shall govern.

6 Basic Design

6.1 GENERAL

6.1.1 Service Life

The equipment (including auxiliaries) covered by this standard shall be designed and constructed for a minimum service life of 20 years and at least 3 years of uninterrupted operation.

Note: It is recognized that these are design criteria.

6.1.2 The vendor shall assume unit responsibility for all equipment and auxiliary systems included in the scope of the order.

6.1.3 Sound Pressure Level

Control of the sound pressure level (SPL) of all equipment furnished shall be a joint effort of the purchaser and the vendor having unit responsibility. The equipment furnished by the vendor shall conform to the maximum allowable SPL specified. In order to determine compliance, the vendor shall provide expected maximum sound pressure level data per octave band for the equipment.

6.1.4 Packaged Equipment

Compressor package shall include:

a. Integrally geared centrifugal air compressor
b. Coupling and coupling guard
c. Baseplate (or structural framework)
d. Intercoolers and aftercooler, moisture separator and drain system
e. Lubrication oil system
f. Controls and instrumentation
g. Driver
h. Interstage air piping
i. Inlet and discharge expansion joints
j. Accessories as noted in this standard.

Note: Inlet piping from air inlet filter to compressor inlet control device, discharge piping between compressor package flange and discharge check valve, piping to blow-off valve, and mounting of accessory components is typically supplied by the purchaser. Piping should be designed with adequate supports to prevent undue loads on compressor flanges, including transient loads such as blow-off. The aftercooler is often shipped loose. The inlet throttle device, blow-off valve, and discharge check valve, are typically shipped loose for field installation by the purchaser

● 6.1.5 Environmental Conditions

The equipment, including all auxiliaries, shall be suitable for operation under the environmental conditions specified by the purchaser. These conditions shall include whether the installation is indoors (heated or unheated) or outdoors (with or without a roof), maximum and minimum temperatures, unusual humidity, and dusty or corrosive conditions.

6.1.6 Cooling Water Systems

Unless otherwise specified, cooling water systems shall be designed for the following conditions:

Water Velocity over heat exchange surfaces (Note 1)	1.2 – 2.5 m/s	4 – 8 ft/s
Maximum allowable working pressure (MAWP)	≥ 7 bar (Note 2)	≥ 100 psig
Maximum pressure drop	1 bar	15 psi
Maximum inlet temperature	30°C	90°F
Maximum outlet temperature	50°C	120°F
Maximum temperature rise	20K	30°F
Minimum temperature rise	5K	10°F
Fouling factor on water side (Note 3)	0.18 m^2 K /kW	0.001 $hrft^2$ °F/Btu
Shell corrosion allowance	1.5 mm	0.0625 in.

Note: The vendor shall notify the purchaser if the criteria for minimum temperature rise and velocity over heat exchanger surfaces result in conflict. The criterion for velocity over heat exchange surfaces is intended to minimize water-side fouling; the criterion for minimum temperature rise is intended to minimize the use of cooling water.

Note 2: Gauge pressure.

Note 3: Based on site coolant conditions and user experience, the purchaser may specify a different coolant-side fouling factor. For example, for a closed loop glycol system, 0.0005 $hrft^2$ °F/Btu may be adequate; conversely, for poorer quality coolant,0.002 $hrft^2$ °F/Btu (or higher) may be required.

6.1.7 Package Arrangement

6.1.7.1 The arrangement of the package (including piping coolers, pumps, and controls) shall provide adequate clearance areas and safe access for operation and maintenance.

6.1.7.2 All equipment shall be designed to permit rapid and economical maintenance. Major parts such as casing components and bearing housings shall be designed and manufactured to ensure accurate alignment on reassembly. This may be accomplished by the use of shoulders, cylindrical dowels or keys.

6.1.7.3 Provisions shall be made for complete venting and draining of liquid-filled systems

6.1.8 Motors and Electrical Components

Motors, electrical components, and electrical installations shall be suitable for the area classification (class, group, and division or zone) specified by the purchaser and shall meet the requirements of the applicable sections of IEC79 or NFPA 70, Articles 500, 501, 502, and 504, as well as local codes. Local codes shall be furnished by the purchaser on request of the Vendor.

6.1.9 Performance Criteria

The equipment (compressor, driver and auxiliary equipment) shall perform on the test stand and on their permanent foundation within the specified acceptance criteria. After installation, the performance of the package shall be the joint responsibility of the purchaser and the vendor who has unit responsibility.

6.1.10 Purchaser Connections

All openings or nozzles for purchaser connections shall be DN 12 ($^1/_2$ NPS) or larger and shall be in accordance with ISO 6708. Sizes DN 32, DN 65, DN 90, DN 125, DN 175 and DN 225 ($1^1/_4$, $2^1/_2$, $3^1/_2$, 5, 7, and 9 NPS) shall not be used.

6.1.11 Bolting

Bolting shall be furnished as specified in 6.1.11.1 – 6.1.11.4.

6.1.11.1 The details of threading shall conform to ISO 261, ISO 262, ISO 724, and ISO 966 or ASME B1.1.

6.1.11.2 Adequate clearance shall be provided at all bolting locations to permit the use of socket or box wrenches

6.1.11.3 Slotted-nut, or spanner-type bolting shall not be used unless specifically approved by the purchaser.

6.1.11.4 Manufacturer's marking shall be located on all fasteners 6 mm ($^1/_4$ in.) and larger (excluding washers and headless set screws). For studs, the marking shall be on the nut end of the exposed stud end.

6.1.12 Compressor Performance

6.1.12.1 The compressor total head curve shall be developed from the differential pressure measurement between the compressor inlet flange and the final-stage discharge flange.

The purchaser and vendor shall mutually agree on the pressure drop considerations for the inlet filter, aftercooler, check valves, and associated piping.

6.1.12.2 When the compressor is operating at rated operating conditions, the overall performance shall provide a minimum of 10% continuous pressure rise from rated capacity to surge.

6.1.13 Mounting Surfaces

When specified, mounting surfaces shall meet the following criteria:

1. They shall be machined to a finish of 6 µm (250 µin.) arithmetic average roughness (Ra) or better.
2. To prevent a soft foot, they shall be in the same horizontal plane within 25 µm (0.001 in.).
3. Each mounting surface shall be machined within a flatness of 80 µm per linear meters (0.001 in. per linear foot) of mounting surface.
4. Different mounting planes shall be parallel to each other within 50µm (0.002 in.).
5. The upper machined or spot faced surface shall be parallel to the mounting surface.
6. Hold-down bolt holes shall be drilled perpendicular to the mounting surface or surfaces, spot faced where necessary to accommodate fasteners and tools.

Note: Spot face is typically not necessary if surface is perpendicular to bolting within 1 degree.

6.2 PRESSURE CASINGS

6.2.1 The stress values used in the design of the casing for any material shall not exceed twenty-five percent (25%) of the ultimate stress at the maximum specified operating temperature. The vendor shall state the internationally recognized standard from which the ultimate stress value is obtained. For cast materials a factor of 0.8 for steel or 0.9 for cast and ductile iron shall be applied unless additional casting NDE is applied. The thickness of the casing shall be suitable for the maximum working and test pressure and shall include a corrosion allowance of at least 3 mm (0.125 in.).

Manufacturing data report forms, third party inspections, and stamping as specified in pressure vessel codes are not required.

6.2.2 The maximum allowable working pressure of each casing shall be at least 1.10 times the maximum discharge pressure of the stage.

6.2.3 For casing joint bolting, an allowable stress of 0.25 times the minimum ultimate tensile strength shall be used to determine the total bolting area based on hydrostatic load and gasket preload as applicable. The preload stress shall not exceed 0.75 times the bolting material minimum yield.

6.3 CASING CONNECTIONS

6.3.1 The first-stage inlet and final-stage outlet connections shall be flanged.

6.3.2 Connections welded to the casing shall meet the material requirements of the casing, including impact values, rather than the requirements of the connected piping. All welding of connections shall be completed before the casing is hydrostatically tested (see 8.3.2).

6.3.3 For connections other than main process connections, if flanged or machined and studded openings are impractical, threaded connections for pipe sizes not exceeding DN 40 ($1^1/_2$ NPS) may be used with purchasers approval as follows:

a. On non-weldable materials, such as cast iron
b. Where essential for maintenance (disassembly and assembly).

6.3.4 Threaded openings and bosses for tapered pipe threads shall conform to ISO 7—Parts l and 2 or ANSI/ASME B16.5.

6.3.5 Threaded openings not required to be connected to piping shall be plugged with steel plugs in accordance with ANSI/ASME B16.11. Thread tape shall not be used.

6.3.6 Flanges shall conform to ISO 7005-1 or 7005-2 (ASME B16.1, B16.5, B16.42, or B16.47 Series B) as applicable except as specified in 6.3.6.1 and 6.3.6.2. Class 200 and 400 flanges shall not be used.

6.3.6.1 Cast iron flanges shall be flat faced and conform to the dimensional requirements of ISO 7005-2 or ANSI/ASME B16.1 or 16.42. Class 125 flanges shall have a minimum thickness equal to Class 250 for sizes DN 200 (NPS 8) and smaller.

6.3.6.2 Flat-faced flanges with full raised-face thickness are acceptable on casings of all materials. Flanges in all materials that are thicker or have a larger outside diameter than required by ISO (ANSI) are acceptable. Non-standard (oversized) flanges shall be completely dimensioned on the arrangement drawing.

6.3.7 Machined and studded connections shall conform to the facing and drilling requirements of ISO 7005-1 or 7005-2 or ASME B16.1, B16.5, B16.42, or B16.47. Studs and nuts shall be furnished installed, the first 1.5 threads at both ends of each stud shall be removed.

6.3.8 To minimize nozzle loading and facilitate installation of piping, machine flanges shall be parallel to the plane shown on the general arrangement drawing to within 0.5 degrees. Studs or bolt holes shall straddle centerlines parallel to the main axes of the equipment.

6.3.9 All of the purchaser's connections shall be accessible for disassembly without requiring the machine, or any major part of the machine, to be moved.

6.4 EXTERNAL FORCES AND MOMENTS

6.4.1 The maximum allowable forces and moments that may be imposed on the package by the purchaser's piping shall be stated in the proposal.

6.4.2 The maximum allowable forces and moments shall be shown on the outline drawing.

6.5 ROTATING ELEMENTS

6.5.1 Shafts

6.5.1.1 Shafts shall be forged or hot-rolled alloy steel and machined throughout their entire length.

6.5.1.2 The rotor shaft sensing areas to be observed by radial vibration probes shall be concentric with the bearing journals. All shaft sensing areas shall be free from stencil and scribe marks or any other surface discontinuity, such as an oil hole or keyway, for a minimum of one probe tip diameter on each side of the probe. These areas shall not be metallized, sleeved, or plated. The final sur-

face finish shall be a maximum of 0.8 µm (32 µin.) Ra, preferably obtained by honing or burnishing. These areas shall be demagnetized as necessary to minimize electrical runout. The combined electrical and mechanical runout shall be measured and recorded.

6.5.1.3 Chrome plating of the shaft at the journal area is unacceptable.

6.5.1.4 All shaft keyways shall have fillet radii conforming to ISO 773 ANSI/ASME B17.1.

6.5.2 Impellers

6.5.2.1 The impeller material shall be stainless steel, of cast or milled construction.

6.5.2.2 The vendor's proposal shall describe in detail the type of impeller construction and the method of attachment to the shaft.

6.5.3 Gears

6.5.3.1 As a minimum, gearing shall be designed and manufactured to the tolerances specified in ISO 1328, Grade 5.

Note: For equivalent loading conditions gearing produced to higher quality levels will always result in longer service life and reduced bearing loads. The ISO tolerancing system has replaced the AGMA system of Quality Numbers. A practical comparison is to subtract the ISO number from 17 to arrive at the closest AGMA Quality Number.

6.5.3.2 The gear unit shall be rated in accordance with AGMA 6011 using minimum service factors of 1.4 for induction motor driven units and 1.6 for steam-turbine- and synchronous motor driven units. The rating shall be based on the driver nameplate rating.

6.5.3.3 Gear wheels and pinion hardness combinations shall be in accordance with the values recommended in AGMA 6011.

6.5.3.4 The tooth portion of pinions shall be integrally forged with their shaft.

6.5.3.5 Gear wheels shall be of forged construction and shall be assembled on the shaft with an interference fit.

6.6 SEALS AND SEALING SYSTEMS

6.6.1 Air and oil shaft seals shall be provided to achieve the following:

a. Contain compressed air inside the compressor casings
b. Prevent oil from entering the compressor casings and contaminating the compressed air
c. Prevent oil from leaking out of the bearing housing into the atmosphere
d. Prevent contamination of the oil system or compressed air by atmospheric dirt or moisture.

6.6.2 There shall be an atmospheric space between the air and oil seals.

6.6.3 The sealing system shall be furnished complete with piping, filters, instrumentation, and necessary start-up interlocks as applicable. This system, including air consumption, shall be fully described in the proposal.

6.6.4 Seal operation shall be suitable for all specified operating conditions, including suction throttling, startup, shutdown, standby, and momentary surge. The type of standby operation shall be agreed upon by the purchaser and the vendor.

6.7 DYNAMICS

6.7.1 Critical Speeds

6.7.1.1 For information on critical speeds, refer to Annex C.

6.7.1.2 Resonances of structural support systems that are within the vendor's scope of supply and that affect the rotor vibration amplitude shall not occur within the specified separation margins (see C.2.4, Annex C) unless the resonances are critically damped. The effective stiffness of the structural support shall be considered in the analysis of the dynamics of the rotor-bearing-support system.

Note: Resonances of structural support systems may adversely affect the rotor vibration amplitude.

6.7.1.3 The vendor shall determine that the drive-train (turbine, gear, motor, and the like) critical speeds (rotor lateral, system torsional, blading modes, and the like) will not excite any critical speed of the machinery being supplied and that the entire train is suitable for the rated speed and any starting-speed detent (hold-point) requirements of the train. A list of all undesirable speeds from zero to trip shall be submitted to the purchaser for his review and included in the instruction manual for his guidance (see Annex D, item 26d).

6.7.1.4 For the purposes of this standard, critical speeds and other resonant conditions of concern are those with an amplification factor (AF) equal to or greater than 6.5.

6.7.2 Lateral Analysis

The vendor's standard critical speed values that have been analytically derived and proven by testing of previously manufactured compressors of the same frame size are acceptable. A report is not required.

6.7.3 Torsional Analysis

6.7.3.1 The vendor's torsional critical speed values that have been analytically derived and proven by successful operation of previously manufactured compressor drive trains are acceptable. A report is not required.

6.7.3.2 The undamped torsional natural frequencies of the complete train shall be at least 10% above or 10% below any possible excitation frequency.

6.7.3.3 Torsional criticals at two or more times running speeds shall preferably be avoided or, in systems in which corresponding excitation frequencies occur, shall have no adverse effect. In addition to multiples of running speeds, torsional excitations that are not a function of running speeds or that are nonsynchronous in nature shall be considered in the torsional analysis when applicable and shall have no adverse effect.

6.7.3.4 When torsional resonances are calculated to fall within the margin specified in 6.7.3.2 a stress analysis shall demonstrate that the resonances have no adverse effect on the complete train. The assumptions made in this analysis regarding the magnitude of excitation and the degree of damping shall be clearly stated.

6.7.3.5 The vendor shall perform a transient torsional vibration analysis for synchronous-motor-driven units. The acceptance criteria for this analysis shall be mutually agreed upon by the purchaser and the vendor.

6.7.4 Vibration and Balancing

6.7.4.1 Manufacturer's standard balancing procedure shall be used

6.7.4.2 When spare rotating elements are supplied, they shall be dynamically balanced to the same tolerances as the main rotating elements.

6.7.4.3 During the shop test of the machine, assembled with the balanced rotors, operating at its rated speed, the peak-to-peak amplitude of unfiltered vibration in any plane, measured on the shaft adjacent and relative to each radial bearing, including runout, shall not exceed the following value or 40 µm (1.5 mils), whichever is less:

In SI units:

$$A = 25.4 \times (12\,000 / N)^{1/2}$$

In customary units,

$$A = (12\,000 / N)^{1/2}$$

Where:

A = amplitude of unfiltered vibration, in µms (mil) true peak to peak.

N = rated speed, in revolutions per minute.

Note: These limits are not to be confused with the limits specified in Section C.3 of Annex C for shop verification of unbalanced response.

6.8 BEARINGS AND BEARING HOUSINGS

6.8.1 Bearings—General

6.8.1.1 Unless otherwise specified, hydrodynamic radial and thrust bearings shall be provided.

6.8.1.2 Bearings shall be designed to prevent incorrect positioning.

6.8.2 Radial Bearings

6.8.2.1 Radial bearings shall be designed for ease of assembly, precision bored and of the sleeve or pad type with babbitted replaceable liners, pads, or shells. These bearings shall be equipped with antirotation pins and shall be positively secured in the axial direction.

6.8.2.2 The bearing design shall suppress hydrodynamic instabilities and provide sufficient damping over the entire range of allowable bearing clearances to limit rotor vibration to the maximum specified amplitudes (see 6.7.4.3) while the equipment is operating loaded or unloaded at the rated operating speed.

6.8.3 Thrust Bearings

6.8.3.1 Thrust loads from impellers and gears and couplings shall be absorbed by individual thrust bearings on pinions, or transmitted to the gear wheel thrust bearing by means of thrust rider rings fixed to the pinions and gear wheel. All specified operating conditions and start up conditions shall be evaluated for resulting thrust loads.

6.8.3.2 Thrust bearings shall be selected using manufacturer's standard criteria.

Note: In sizing thrust bearings, consideration should be given to the following for each specific application:

a. The shaft speed
b. The temperature of the bearing babbitt
c. The deflection of the bearing pad
d. The minimum oil-film thickness
e. The feed rate, viscosity, and supply temperature of the oil
f. The design configuration of the bearing
g. The babbitt alloy
h. The turbulence of the oil-film.

6.8.3.3 Thrust forces from flexible-element couplings shall be calculated on the basis of the maximum allowable deflection permitted by the coupling manufacturer.

6.8.3.4 If two or more rotor thrust forces are to be carried by one thrust bearing , the resultant of the forces shall be used provided the directions of the forces make them numerically additive; otherwise, the largest of the forces shall be used.

6.8.3.5 Thrust bearings shall be babbitted, and arranged for continuous pressurized lubrication. Integral thrust collars are preferred. When replaceable collars are furnished (for assembly and maintenance purposes), they shall be positively locked to the shaft to prevent fretting.

6.8.3.6 The faces of the thrust collar or rider rings shall have a surface finish of not more than 0.4 µm (16 µin.) Ra, and the axial total indicator runout of either face shall not exceed 12 µm (500 µin.).

6.8.4 Bearing Housings

6.8.4.1 Bearing Housings shall be arranged so that bearings can be replaced without disturbing equipment driver or mounting.

Note: May require removal of gear housing cover.

6.8.4.2 Bearing housings shall be arranged to minimize foaming. The drain system shall be adequate to maintain the oil and foam level below shaft end seals. The bearings shall be designed not to exceed 30°C (50°F) oil temperature rise and an outlet temperature of 80°C (180°F).

Note: This is a design criteria. Bearing exit temperature is not measured in actual machines.

6.8.4.3 Bearing housings shall be equipped with replaceable labyrinth-type end seals and deflectors where the shaft passes through the housing; lip-type seals shall not be used. The seals and deflectors shall be made of nonsparking materials. The design of the seals and deflectors shall effectively retain oil in the housing and prevent entry of foreign material into the housing.

6.9 LUBRICATION

6.9.1 Unless otherwise specified, bearings and bearing housings shall be arranged for oil lubrication using a mineral oil in accordance with ISO 3448.

6.9.2 A pressurized oil system shall be supplied in accordance with ISO 10438 Part 3 or API Std 614 Chapter 3 except as noted in 6.9.3 – 6.9.4. (See Annex E, Figure E-1 and Table E-1 for a schematic of the minimum system and the various options applicable.)

6.9.3 Lube oil shall be supplied at the required pressure or pressures, as applicable, to the following:

a. The bearings of the integrally geared compressor
b. The spray nozzles for the gear teeth
c. The bearings of the driver when specified or required.

6.9.4 The oil reservoir shall be fabricated carbon steel construction with an oil-compatible corrosion resistant internal coating.

6.10 MATERIALS

6.10.1 General

6.10.1.1 Materials of construction shall be the manufacturer's standard for the specified operating conditions, except as required or prohibited by this standard.

6.10.1.2 The materials of construction of all major components shall be clearly stated in the vendor's proposal. Materials shall be identified by reference to applicable international standards, including the material grade. When no such designation is available, the vendor's material specification giving physical properties, chemical composition, and test requirements shall be included in the proposal.

6.10.1.3 External parts that are subject to rotary or sliding motions (such as control linkage joints and adjusting mechanisms) shall be of corrosion-resistant materials suitable for the site environment and of sufficient hardness to resist wear.

6.10.1.4 Minor parts such as nuts, springs, washers, gaskets, and keys shall have corrosion resistance at least equal to that of specified parts in the same environment.

6.10.1.5 If austenitic stainless steel parts exposed to conditions that promote intergranular corrosion are to be fabricated, hard faced, overlaid, or repaired by welding, they shall be made of low-carbon or stabilized grades.

Note: Overlays or hard surfaces that contain more than 0.10% carbon can sensitize both low-carbon and stabilized grades of austenitic stainless steel unless a buffer layer that is not sensitive to intergranular corrosion is applied.

6.10.1.6 The vendor shall select materials to avoid conditions that may result in electrolytic corrosion. Where such conditions cannot be avoided, the purchaser and the vendor shall agree on the material selection and any other precautions necessary.

Note: When dissimilar materials with significantly different electrical potentials are placed in contact in the presence of an electrolytic solution, galvanic couples that can result in serious corrosion of the less noble material may be created. The NACE Corrosion Engineer's Reference Book is one resource for selection of suitable materials in these situations.

6.10.2 Low-carbon steels can be notch sensitive and susceptible to brittle fracture at ambient or lower temperatures. Therefore, only fully killed, normalized steels made to fine-grain practice are acceptable. The use of steel made to a coarse austenitic grain size practice (such as ASTM A515) is prohibited.

6.10.3 Castings

6.10.3.1 Pressure containing ferrous castings shall not be repaired except as specified in 6.10.2.1.1 – 6.10.2.1.3.

6.10.3.1.1 Weldable grades of steel castings, may be repaired by welding, using a qualified welding procedure based on the requirements of an internationally recognized pressure vessel welding standard. After major weld repairs, and before hydrotest, the complete repaired casting shall be given a postweld heat treatment to ensure stress relief and continuity of mechanical properties of both weld and parent metal and dimensional stability during subsequent machining operations.

6.10.3.1.2 Cast gray iron or nodular iron may be repaired by plugging within the limits specified in ASTM A 278, A 395, or A 536. The holes drilled for plugs shall be carefully examined, using liquid penetrant, to ensure that all defective material has been removed.

6.10.3.1.3 All repairs not covered by the applicable international material specification shall be subject to the purchaser's approval.

6.10.3.1.4 Fully enclosed cored voids, which become fully closed by methods such as plugging, welding, or assembly, are prohibited.

6.10.3.1.5 Nodular iron castings shall be produced in accordance with an internationally recognized standard such as ASTM A 395, or A 536.

6.10.4 Welding

6.10.4.1 Welding of piping and pressure-containing parts, as well as any dissimilar-metal welds and weld repairs, shall be performed and inspected by operators and procedures qualified in accordance with internationally recognized welding standards such as Section VIII, Division 1, and Section IX of the ASME Code or purchaser-approved standard, such as EN 287 or EN 288. No weld repairs are permitted after final machining.

6.10.4.2 The vendor shall be responsible for the review of all repairs and repair welds to ensure that they are properly heat treated and nondestructively examined for soundness and compliance with the applicable qualified procedures. Repair welds shall be nondestructively tested by the same method used to detect the original flaw.

● **6.10.4.3** When specified, documentation of major defects shall be submitted to the purchaser prior to any repairs being conducted at the manufacturer's shop and shall include the following

a. Extent of the repair
b. Location
c. Size
d. Welding procedure specification
e. Detailed photographs of the defect prior to any preparatory work and after preparation but prior to the actual repair. If the location of the defect cannot be clearly defined by photographic means, the location shall be indicated on a sketch or drawing of the affected component.

6.10.4.4 Repairs performed at the manufacturer's shop shall be considered major if any of the following conditions apply:

a. Castings leak during hydrostatic testing
b. The depth of the repair cavity prepared for welding exceeds 50% of the wall thickness or 25 mm (1 in.), whichever is smaller
c. The surface area of all repairs to the part exceeds 10% of the surface area of the part
d. The repair cavity is longer than 150 mm (6 in.) in any direction
e. Repairs are to any rotating components.

6.10.4.5 Unless otherwise specified, other welding, such as welding on baseplates, non-pressure ducting, lagging, and control panels, shall be performed by welders qualified in accordance with an appropriate internationally recognized structural welding standard such as AWS D1.1.

6.10.4.6 Connections welded to pressure casings shall be installed as specified in 6.10.3.6.1 and 6.10.3.6.2.

6.10.4.6.1 Post-weld heat treatment, when required, shall be carried out after all welds, including piping welds have been completed.

6.10.4.6.2 Unless exempted by the applicable pressure vessel code, all welds shall be heat treated in accordance with internationally recognized standards such as Section VIII, Division 1, Sections UW-10 and UW-40, of the ASME Code.

6.10.5 Low Temperature

The Vendor shall define the minimum design metal temperature (MDMT) of the equipment. If the minimum site ambient temperature is below the equipment MDMT, the Vendor and the purchaser shall agree and implement measures to assure that the equipment will not be operated with pressure casing at a metal temperature below the MDMT, to avoid brittle failures.

6.11 NAMEPLATES AND ROTATION ARROWS

6.11.1 A nameplate shall be securely attached at a readily visible location on the equipment and on any major piece of auxiliary equipment.

6.11.2 Rotation arrows shall be cast in or attached to each major item of rotating equipment at a readily visible location.

6.11.3 Nameplates and rotation arrows (if attached) shall be of austenitic stainless steel or nickel-copper alloy such as UNS N04400 alloy. Attachment pins shall be of the same material. Welding is not permitted.

6.11.4 As a minimum, the following data shall be clearly stamped or engraved on the compressor nameplate:

a. Vendor's name
b. Serial number
c. Size, model and type
d. Rated capacity

e. Rated discharge pressure
f. purchaser's item number.

Units shall be consistent with those used on the data sheets.

6.12 ADDITIONAL REQUIREMENTS FOR SPECIAL DUTY PACKAGES

6.12.1 Jackscrews, guide rods, cylindrical casing-alignment dowels, and/or other appropriate devices shall be provided to facilitate disassembly and reassembly. 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 gear casing.

When jackscrews are used as a means of parting contacting faces, one of the faces shall be relieved (counterbored or recessed) to prevent a leaking joint or improper fit caused by marring of the face.

6.12.2 Gearing shall be designed and manufactured to the tolerances specified in ISO 1328-2, Grade 4.

● **6.12.3** When specified, the vendor shall provide a damped unbalanced response analysis for each machine to assure acceptable amplitudes of vibration at any speed from zero to trip.

● **6.12.4** When specified, a damped unbalanced response analysis shall be conducted and confirmed by test stand data in accordance with Annex C.

● **6.12.5** When specified, the vendor shall perform a torsional vibration analysis of the complete coupled train and shall be responsible for directing the modifications necessary to meet the requirements of 6.7.3.2 – 6.7.3.5.

Note: Excitations of undamped torsional natural frequencies may come from many sources, which should be considered in the analysis. These sources may include but are not limited to the following:

a. Gear phenomena such as unbalance and pitch line runout
b. Startup conditions such as speed detents and other torsional oscillations
c. Torsional transients such as start-ups of synchronous electric motors and transients due to generator phase-to-phase fault or phase-to-ground fault
d. Torsional excitation resulting from drivers
e. One and two times line frequency
f. Running speeds.

6.12.6 Major parts of the rotating elements, such as the shaft and impellers, shall be dynamically balanced. When a bare shaft with a single keyway is dynamically balanced, the keyway shall be filled with a fully crowned half-key, in accordance with ISO 8821. A shaft with keyways 180 degrees apart but not in the same transverse plane shall also be filled. The initial balance correction to the bare shaft shall be recorded.

6.12.7 The rotating elements shall be multiplane dynamically balanced during assembly. This shall be accomplished after the addition of each major component. Balancing correction shall be applied only to the elements added. Balancing of impellers by welding is prohibited. Minor correction of other components may be required during the final trim balancing of the completely assembled element. In the sequential balancing process, any half-keys used in the balancing of the bare shaft (see 6.12.6) shall continue to be used until they are replaced with the final key and mating element. On rotors with single keyways, the keyway shall be filled with a fully crowned half-key. The weight of all half-keys used during final balancing of the assembled element shall be recorded on the residual unbalance work sheet (see Annex F). The maximum allowable residual unbalance per plane (journal) shall be calculated as follows:

In SI units:

$$U_{max} = 6350W/N \text{ for } N < 25{,}000 \text{ rpm} \quad (2a)$$

$$U_{max} = 6350W/25{,}000 \text{ for } N > 25{,}000 \text{ rpm} \quad (2b)$$

In customary units:

$$U_{max} = 4W/N \text{ for } N < 25{,}000 \text{ rpm}$$

$$U_{max} = 4W/25{,}000 \text{ for } N > 25{,}000 \text{ rpm}$$

Where:

U_{max} = residual unbalance, in gram-mm (ounce-in.).

W = journal static weight load, in kg (lbs.).

N = rated speed, in revolutions per minute (rpm).

Note: Balance tolerance above 25,000 rpm is based on an eccentricity of 0.25 µm (10 µin.) for each journal static weight load. Unbalance readings are measured at each journal-bearing position with no compensation to actual balance planes.

● **6.12.8** When specified, after the final balancing of each assembled rotating element has been completed, a residual unbalance check shall be performed and recorded in accordance with the residual unbalance work sheet (see Annex F).

6.12.9 Thrust bearings shall be selected such that under any operating condition the load does not exceed 50% of the bearing manufacturer's ultimate load rating. The ultimate load rating is the load that will produce the minimum acceptable oil-film thickness without inducing failure during continuous service or the load that will not exceed the creep-initiation or yield strength of the babbitt at the location of maximum temperature on the pad, whichever is less.

● **6.12.10** When specified, thrust bearings and radial bearings shall be fitted with bearing-metal temperature sensors.

● **6.12.11** When specified, installation of bearing-metal temperature sensors shall be in accordance with API Std 670.

● **6.12.12** When specified, oil cooler tubes shall have a 13 mm (0.5 in.) minimum outside diameter and be made of inhibited admiralty with an average wall thickness of 18 BWG.

● **6.12.13** When specified, an austenitic stainless steel oil reservoir shall be supplied.

7 Accessories

7.1 DRIVERS

7.1.1 General

7.1.1.1 The driver shall be of the type specified, shall be sized to meet the maximum specified operating conditions, including gear and coupling losses, and shall be in accordance with applicable specifications as stated in the inquiry and order. The driver shall be suitable for satisfactory operation under the utility and site conditions specified in the inquiry.

7.1.1.2 The driver, in combination with the controls provided, shall be sized to accept any specified process variations such as changes in the pressure, temperature, relative humidity of the air, cooling water temperature, and plant start-up conditions.

7.1.1.3 The driver shall be capable of starting under the conditions specified and the starting method shall be agreed by the purchaser and the vendor.

7.1.1.4 The driver nameplate rating (exclusive of the service factor) shall be at least 110% of the power required at the rated point.

● **7.1.1.5** When specified, the driver nameplate rating (exclusive of the service factor) shall be at least 110% of the maximum power required for all of the specified operating conditions.

7.1.1.6 For drivers that weigh more than 225 kg (500 lbs), the driver feet shall be provided with vertical jackscrews. Alternatively, a hydraulic jack may be proposed as a special tool.

7.1.2 Electric Motors

7.1.2.1 Unless otherwise specified, motor drives shall conform to internationally recognized standards such as API Std 541, 546, or IEEE 841 as applicable.

7.1.2.2 The motor's starting-torque requirements shall be met at a specified reduced voltage, and the motor shall accelerate to full speed within a period of time agreed upon by the purchaser and the vendor.

Note: Industry standards typically specify 90% voltage for starting, but for many plants the starting voltage may be 80% of the normal voltage. The time required to accelerate to full speed is generally less than 15 sec.

7.1.3 Steam Turbines

7.1.3.1 Unless otherwise specified, steam turbine drivers shall conform to ISO 10436. For purposes of this standard, API Std 611 is considered eqivalent to ISO 10436.

● **7.1.3.2** The steam turbine shall be equipped with a NEMA Class D constant speed governor as specified in NEMA SM 23. The purchaser will specify whether the governor is to be hydraulic or electronic.

7.2 COUPLINGS AND GUARDS

7.2.1 Couplings

Couplings between drivers and driven equipment shall be supplied by the manufacturer of the driven equipment and shall meet the requirements of 7.2.1.1 – 7.2.1.7.

7.2.1.1 The coupling shall be of the forged-steel, nonlubricated, flexible-element spacer type. The flexible elements shall be stainless steel or suitably coated to prevent corrosion. The purchaser and the vendor shall mutually agree upon the make, model, type, and mounting arrangement of the coupling.

7.2.1.2 The coupling spacer shall be of sufficient length to allow maintenance of the compressor, including shaft alignment, without requiring the compressor or driver to be removed.

7.2.1.3 Coupling hubs shall be keyed to the shaft. Keys and keyways and their tolerances shall conform to ISO R773, normal fit or ANSI/AGMA 9002, Commercial Class.

7.2.1.4 Flexible couplings with cylindrical bores shall be mounted with an interference fit. Cylindrical shafts shall comply with ISO R775 or ANSI/AGMA 9002 and the coupling hubs shall be bored to the following ISO 286-2 tolerances:

a. For shafts of 50 mm (2 in.) diameter and smaller — Grade N7.
b. For shafts larger than 50 mm (2 in.) diameter — Grade N8.

7.2.1.5 When the coupling hubs must be removed for maintenance, they shall be furnished with tapped puller holes of at least 10 mm (0.375 in.) diameter.

7.2.1.6 The maximum coupling operating torque load shall be limited to 80% of the manufacturer's published continuous rating. Couplings bored larger than the manufacturer's nominal rating shall be subject to the purchaser's approval.

7.2.1.7 The coupling-to-shaft juncture shall be designed and manufactured to be capable of transmitting power at least equal to the power rating of the coupling.

7.2.2 Coupling Guards

7.2.2.1 Coupling guards shall be provided and shall sufficiently enclose the coupling and the shafts to prevent any personnel from contacting parts during operation of the equipment train.

7.2.2.2 Guards shall be constructed with sufficient rigidity to withstand a 900 N (200 lb.) static point load (or force) in any direction without the guard contacting moving parts.

7.2.2.3 Guards shall preferably be fabricated from solid sheet or plate with no openings. Guards fabricated from expanded metal or perforated sheets are acceptable, provided the size of the openings does not exceed 10 mm (0.375 in.) diameter. Unless otherwise specified, guards may be constructed of either metallic or nonmetallic materials. Guards of woven wire shall not be used.

7.2.2.4 The guard shall be designed to prevent drawing oil out of adjacent bearing housings.

7.3 BASEPLATE/SUPPORT STRUCTURE

7.3.1 Unless otherwise agreed, the compressor and all other machine components shall be supported on a rigid steel frame. The frame may have full-length structural members in contact with the foundation, or it may have support feet. The term baseplate shall refer to either design.

Note: Some units are now designed with the unit's base integrally cast with the gearbox, and with the driver either flange-mounted or foot-mounted or on tubular rails. For this type equipment, the purchaser and manufacturer will need to review the applicability of 7.3.2 – 7.3.6 and 7.3.9 – 7.3.10.

7.3.2 A baseplate shall be a single fabricated steel unit, unless the purchaser and the vendor mutually agree that it may be fabricated in multiple sections. Multiple-section baseplates shall have machined and doweled mating surfaces which shall be bolted together to ensure accurate field reassembly.

7.3.3 The baseplate shall have major load-bearing members under the mounting surfaces of the major components. The structure shall be provided with lifting lugs for at least a four-point lift. Lifting the baseplate complete with all equipment mounted shall not permanently distort or otherwise damage the baseplate or the mounted equipment.

7.3.4 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.

7.3.5 Mounting surfaces shall be provided for the integrally geared compressor and all drive train components. The mounting surfaces shall be at least 25 mm (1 in.) larger than the foot of the mounted equipment to allow leveling of the baseplate without removal of the equipment. The surfaces shall:

a. be machined after the baseplate is fabricated;
b. have corresponding pads in the same horizontal plane within 25 µm (0.001 in.);
c. have each mounting surface machined within a flatness of 80 µm per linear meter (0.001 in. per linear ft) of mounting surface;
d. have different mounting planes parallel to each other within 400 µm per m (0.005 in. per ft). This requirement shall be met by supporting and clamping the baseplate at the foundation bolt holes only.

7.3.6 The baseplate shall be drilled only for drivers that are shop fitted. The baseplates shall be supplied with leveling screws. Baseplates that are to be grouted shall have 50-mm-radius (2-in.-radius) outside corners (in the plan view). Mounting surfaces that are not to be grouted shall be coated with a rust preventive immediately after machining.

Note: Ungrouted installation is common for this equipment and some baseframe designs REQUIRE that one end of the support structure is left free to expand with thermal growth.

7.3.7 Anchor bolt holes shall be drilled perpendicular to the mounting surfaces.

7.3.8 Anchor bolts will be furnished by the purchaser.

7.3.9 Driver support mounting surfaces shall be machined to allow the installation of vendor supplied austenitic stainless steel, precut, full bearing shim packs, 3 mm – 6 mm (0.125 in. – 0.250 in.) thick with no more than 5 shims in the pack between the driver and each mounting surface. Laminated shims are not acceptable. Shims shall be slotted so they can be installed and removed without removing the fasteners.

7.3.10 When the supported driver weighs more then 225 kg (500 lbs), the driver mounting plates shall be furnished with axial and lateral jackscrews the same size as or larger than the vertical jackscrews. The lugs holding these jackscrews shall be attached to the mounting plates so that the lugs do not interfere with the installation or removal of the equipment, jackscrews, or shims. If the equipment is too heavy to use jackscrews, other means shall be provided.

Note: The integral gearbox is the fixed point, and adjustments are made on the driver.

7.3.11 The underside mounting surfaces of the baseplate shall be in one plane to permit use of a single-level foundation.

7.4 CONTROLS AND INSTRUMENTATION

7.4.1 General

7.4.1.1 Unless otherwise specified, controls and instrumentation shall be in accordance with ISO 10438 Part 1 or API Std 614, Ch. 1, Section 6, except as noted below:

7.4.1.2 Unless otherwise specified, controls and instrumentation shall be designed for outdoor installation and shall meet the requirements of IP65 as detailed in IEC 79 (NEMA 4X, as detailed in NEMA Publication 250).

7.4.1.3 Unless otherwise specified, a microprocessor based control and instrumentation system shall be provided.

● **7.4.1.4** When specified, the microprocessor shall be capable of communicating with the purchaser's distributed control system (DCS).

Note: The purchaser should advise the communication protocol to be used.

7.4.1.5 All conduit, armored cable and supports shall be designed and installed so that it can be easily removed without damage and shall be located so that it does not hamper removal of bearings, seals, or equipment internals.

7.4.1.6 Neither piping without breakout points nor rigid conduit shall be routed over the cases of horizontally split rotating machinery and they shall not be routed over or in front of removable heads on vessels and exchangers, or where the piping impairs the functionality of inspection openings or panel doors.

7.4.2 Control Systems

● **7.4.2.1** The purchaser will specify which of the following compressor capacity control modes shall be furnished by the vendor:

a. Capacity modulation (inlet throttle device or variable inlet guide vanes) used when constant discharge pressure to surge is required and when the system air demand is relatively constant
b. Automatic dual control-capacity modulation plus intermittent (load-unload) mode control for smaller air demand
c. An automatic start and automatic stop control.

7.4.2.2 When more than one mode is specified, a means to change to any mode shall be supplied. If multiple compressors are to be operated in parallel, the control system proposed shall include all the necessary controls to permit the operation of all compressors on the same control mode or individual units on separate control modes.

7.4.2.3 A compressor surge recognition and protection system shall be furnished.

Note: Typically an on/off blow-off valve is provided, and is controlled by monitoring motor amps or fluctuation in discharge pressure.

7.4.2.4 An automatic driver-overload control system shall be included to permit continuous operation at minimum ambient air and water temperatures without exceeding the nameplate rating (excluding service factor, if any).

7.4.2.5 Manual override at the control panel shall be provided to allow manual operation of the inlet throttle device and discharge blowoff valve. The system shall provide bumpless transfer from manual to automatic for smooth mode transfer. The surge protection system shall remain in effect even when the manual override is active.

7.4.2.6 To reduce driver load during startup of a motor-driven compressor, automatic unloading of the compressor by closing the inlet throttle device and opening the discharge blowoff valve shall be provided by the vendor. (An auxiliary source of control air or nitrogen may be required for initial startup.)

7.4.2.6.1 The control system shall provide a “soft” shutdown (or unloaded condition) in which the inlet valve is closed and the unloading valve is opened prior to terminating the power source to the driver except for an emergency stop. This feature allows for less severe surging when stopping the unit.

7.4.2.6.2 The control system shall also provide warning to the operator that a hot-start condition exists for the motor driver because the unit was shut down and an adequate cool-down time period has not occurred for restart of the driver.

7.4.3 Instrument and Control Panels

7.4.3.1 A panel from which startup and shutdown can be accomplished shall be provided and shall include the following:

a. Components for control systems as defined in 7.4.2.1, exclusive of the inlet throttle device or variable inlet guide vanes and discharge blowoff valve
b. A control mode selector (see 7.4.2.2)
c. Manual override and adjustment of control valves (see 7.4.2.5)
d. Digital-readout pressure measurements
e. Digital-readout temperature measurements
f. A display for annunciation (see 7.4.5.2)
g. Control devices for alarms and shutdowns
h. An alarm indication and reset push button.
i. The capability for starting and stopping the package from the control panel
j. Vibration measurement and readout instruments (see 7.4.4.5)
k. Self-diagnostics to check that the microprocessor and all instruments are functioning properly
l. Logging of the compressor’s cumulative operating time
m. Logging of the total number of compressor starts
n. On/off switch for panel power
o. On/auto/standby switch for auxiliary oil pump

p. Auxiliary pump running indicator
q. Lubrication oil heater status indicator.

7.4.3.2 The panel shall be fully enclosed. The panel enclosure shall have a display visible in darkness or direct sunlight, and shall be mounted on the package baseplate. If required to meet the area classification, purging shall be provided in accordance with NFPA 496. The panel shall include the following:

a. Shielding of the devices in the panel for protection from 5 watts radio-frequency (RF) interference at 1 m (3 ft) using commercial frequency bandwidths
b. Cooling for devices within the panel if the temperature inside the panel exceeds the electronic hardware temperature rating

Note: typically of concern for ambient conditions above 38°C (100°F)

c. An interior panel heater for units when required by the ambient condition
d. Driver, instrumentation, and control power separated in the same cabinet
e. Sun screen/shade for control panel display for outdoor installations without a roof.

7.4.4 Instrumentation

7.4.4.1 Unless otherwise specified, signals may be generated from transmitters, transducers or switches.

7.4.4.2 Thermowells

7.4.4.2.1 Temperature sensing elements that are located in pressurized or flooded lines shall have DN 12 (NPS 1/2) minimum thermowells made of austenitic stainless steel.

● **7.4.4.2.2** When specified, thermowells shall be at least DN 19 (NPS 3/4).

7.4.4.3 Thermocouples and Resistance Temperature Detectors

Thermocouples and Resistance Temperature Detectors shall meet requirements of ISO 10438 Part 1 or API Std 614, Fourth Edition, Ch. 1, 6.4.4.

7.4.4.4 Pressure Indication

Unless otherwise specified, pressure indications shall be on the local panel display screen. When pressure gauges are specified, they shall be in accordance with API Std 614, Ch. 1, 6.4.5.2.

7.4.4.5 Vibration and Position Detectors

7.4.4.5.1 Each bearing adjacent to an impeller shall be provided with a vibration-monitoring system consisting of the following:

a. single, radially oriented, noncontacting shaft vibration sensing probe;
b. an oscillator-demodulator; and
c. a readout instrument.

7.4.4.5.2 The vendor shall include with his proposal a statement listing whether phase angle probe and both x and y radial probes can be mounted adjacent to each impeller shaft. Where possible, casings shall have tapped and plugged holes for mounting a second vibration probe at 90° from the original probe. Angular orientation of probe mounting holes shall be the same for both ends of each pinion. Unless otherwise specified, these devices are monitored by the compressor control system.

Note: The vibration monitoring system supplied as standard is substantially different from an API Std 670 standard system and may not interface with other user systems.

7.4.4.6 Solenoid Valves

Solenoid valves shall meet requirements of API Std 614, Ch. 1, 6.4.7.

7.4.4.7 Pressure Limiting Valves

Pressure Limiting valves shall meet requirements of API Std 614, Ch. 1, 6.4.8.

7.4.4.8 Flow indicators

Where practical, flow indicators shall be furnished in the atmospheric oil-drain return lines.

Note: Flow indicators are not feasible from individual compressor bearing drains, and sometimes not from the gear casing drain.

7.4.5 Alarms and Shutdowns

● 7.4.5.1 General

Switches, sensors, control devices, and annunciation function shall be furnished as specified by purchaser and mounted by the vendor and shall include those listed in Table 3 as a minimum. The alarm setting shall precede the shutdown setting. Program logic shall distinguish between a shutdown device and alarm device such that failure of a shutdown device will not allow operation of the compressor until the device problem is corrected; whereas, failure of an alarm device will cause an alarm condition but will allow continued operation of the compressor.

Table 3—Equipment Monitoring

Condition	Alarm	Shutdown
High vibration of compressor	X	X
High last-stage air temperature (inlet)	X	X
Low lube-oil pressure	X	X
High oil-supply temperature	X	X
High oil filter differential pressure	X	
Low sealing-system pressure[a]	X	
Operation of the standby oil pump	X	
Low-lube level in reservoir[b]	X	
High inlet-air filter differential pressure	X	
High vibration of driver[c]	X	
Panel purge[d]	X	
Surge recognition	X	
Permissive start contact[e]	X	

Notes:
[a] If applicable
[b] With oil heater cutout
[c] If specified
[d] If required
[e] Separate pilot-light indication

7.4.5.2 Annunciator

The vendor shall furnish first-out annunciation either as a separate device or as a function contained within the control system, e.g., a section of the PLC or microprocessor used for control of the compressor. If a separate annunciator is utilized, the annunciator shall contain approximately 25% spare points, and connections shall be provided for actuation of a remote signal when any function alarms or trips. The sequence of operation shall be as specified in 7.4.5.2.1 – 7.4.5.2.5.

7.4.5.2.1 The alarm condition shall be acknowledged by operating an alarm-silencing button via the keypad or a switch common to all alarm functions.

● **7.4.5.2.2** When specified, alarm indication shall consist of a flashing or rotating beacon, or equivalent, and the sounding of an audible device.

7.4.5.2.3 When the alarm is acknowledged, the flashing display or alarm shall change to steady display of alarm. The annunciator shall be capable of indicating a new alarm (with a flashing display) if another function reaches an alarm condition, even if the previous alarm condition has been acknowledged but still exists.

7.4.5.2.4 Alarm and shutdown set points shall have default values set by the vendor. These values shall be field configurable with a user-defined password or key.

7.4.5.2.5 Connections shall be provided for a common remote alarm and a common remote shutdown indication.

Note: typically this would be in the form of a relay dry (unpowered) contact.

7.4.5.3 Alarm and Shutdown Devices

7.4.5.3.1 Unless otherwise specified, the alarm and shutdown device shall utilize a single instrument located to facilitate inspection and maintenance. Where switches are specified, refer to API Std 614, Fourth Edition, Ch. 1, 6.3.4, for requirements. Mercury switches shall not be used.

7.4.5.3.2 Unless otherwise specified, contacts shall be configured to open (deenergize) to initiate alarms and shutdowns.

Note: Contacts that open (deenergize) are normally considered to be fail safe.

7.4.5.3.3 Where switches are provided, alarm and shutdown settings shall not be adjustable from outside the housing.

7.4.5.3.4 Unless otherwise specified, shutdown systems shall be provided with switches or another suitable means to permit testing without shutting down the unit.

● **7.4.5.3.5** When specified, alarm and shutdown instruments shall be arranged to permit testing of the control circuit, including when possible the actuating element, without interfering with normal operation of the equipment. The vendor shall provide a clearly visible light on the panel to indicate when shutdown circuits are in a test bypass mode.

7.4.5.3.6 The vendor shall furnish with the proposal a complete description of the alarm and shutdown facilities to be provided.

7.4.6 Electrical Systems

7.4.6.1 Electrical Systems shall meet requirements of ISO 10438, Part 1 or API Std 614, Ch. 1, Section 6.5, except as modified below.

7.4.6.2 Electrical starting and supervisory controls may be either AC or DC.

7.4.6.3 To guard against accidental contact, enclosures shall be provided for all terminal strips, relays, switches and other energized parts. Electrical power wiring shall be segregated from instrument and control signal wiring both externally and, as far as possible, inside enclosures. Inside enclosures which may be required to be opened with the equipment in operation, for example, for alarm testing or adjustment, shall be provided with secondary shields or covers for all terminal strips and other exposed parts carrying electrical potential in excess of 50 volts. Maintenance access space shall be provided around or adjacent to electrical equipment or in accordance with the appropriate code such as the National Electrical Code, Article 110.

Note: The 50 volt components inside a panel are meant to be in a secondary enclosure.

7.4.6.4 No terminal blocks shall be located in wire-ways. The terminals shall be straight-through compression type with shrouded screws (dead front) and center tapping for test purposes. Terminal block connections shall be single level (not tiered). The panel shall contain two bare soft copper grounding connections. One shall be used for a signal ground, the other an equipment ground bus. The instrument case shall not be grounded through the steel of the panel.

7.4.6.5 Control, instrumentation, and power wiring, that is not within a fully enclosed panel or other enclosure, shall be in the form of armored cable or shall be run in metal conduit as specified. Cables shall be supported on cable trays. Conduit shall be properly supported to avoid damage caused by vibration and isolated and shielded to prevent interference between different services. Conduits may terminate (in the case of the leads to temperature elements, shall terminate) with a length of flexible metal conduit, long enough to facilitate maintenance without removal of the conduit.

7.4.6.6 Internal vibration probe or thermocouple leads exposed to lube-oil turbulence shall be sufficiently anchored to prevent fatigue failures due to excessive movement.

7.5 PIPING

7.5.1 General

7.5.1.1 Piping shall meet requirements of ISO 10438, Part 1 or API Std 614, Ch. 1, Section 5 except as specifically modified below:

● **7.5.1.2** When specified, a manifolded cooling water piping system shall terminate with flanged single-supply and single-return connections at the edge of the package. It is not necessary to provide flanged connections for tubing systems.

7.5.1.3 The minimum requirement for piping material shall be as specified by ISO 10438, Part 1 or API Std 614 Ch. 1 Tables 1A, 1B, 1C, and 1D except as allowed below including 7.5.2.

7.5.1.4 Special pipe fittings in air, water or atmospheric oil service may be acceptable with purchaser approval.

Note: Such fittings facilitate maintenance and allow for misalignment of close-coupled systems.

7.5.1.5 Sealwelding of galvanized pipe as noted in ISO 10438, Part 1 or API Std 614 4th Edition, Ch. 1, Table 1-C, is not allowed.

7.5.1.6 Steel flanges mating with iron compressor flanges shall be flat faced.

7.5.1.7 Butterfly valves are acceptable for water balance valves DN 80 (NPS 3) and larger and for inlet air throttling valves. They shall not be used for other services unless approved by the purchaser.

7.5.1.8 Gaskets and packing for flanges, valves, and other components shall not contain asbestos.

7.5.2 Oil Piping

7.5.2.1 Oil piping, tubing, and fittings downstream of filters (excluding slip-on flanges), shall be stainless steel (see ISO 10438, Part 1 or API Std 614 Table 1-D).

7.5.2.2 Oil drains shall be sized to run no more than half full and shall be arranged or sloped to ensure good drainage using manufacturer's proven practices.

7.5.2.3 Pipe joints downstream of the oil filter (filter to supply points) shall be butt-welded. Piping joints in return lines and upstream of the filter (reservoir to filter) may be socket welded. Threaded connections shall be used for instrument connections and where tubing is used.

7.5.3 Instrument Piping

Instrument piping shall meet requirements of ISO 10438, Part 1 or API Std 614, Ch. 1, 5.3, except bleeder valves are required between instruments and their isolating valves. Combinations of isolating and bleeder valves may be used.

7.6 INTERCOOLERS AND AFTERCOOLERS

Intercoolers and aftercoolers shall meet requirements of ISO 10438, Part 1 or API Std 614 , Ch. 1, 5.5, except as specifically noted below:

7.6.1 The vendor shall provide an inter-cooler between each compression stage. Unless otherwise specified, an aftercooler shall be provided after the final compression stage.

7.6.2 Unless otherwise specified, the coolers shall have continuous-bleed notched gate valves to permit removal of liquid.

7.6.3 Unless otherwise specified, intercoolers and aftercooler shall be of the water-cooled shell and tube type with water on the tube side. A removable-bundle design is required. Tubes shall not have an outside diameter of less than 15 mm (5/8 in.), and the tube wall shall not have a thickness of less than 18 BWG, 1.25 mm (0.049 in.). Each cooler shall be sized to accommodate the total cooling load of the associated stage.

Note: Due to physical limitations, smaller units are commonly supplied with 10 mm ($^3/_8$ in.) tubes and thinner walls which may be acceptable with purchaser approval.

7.6.4 Double-pipe coolers and finned double-pipe designs may be furnished only when specifically approved by the purchaser.

7.6.5 Unless otherwise specified, cooler shells shall be of steel; tube sheet shall be carbon steel, painted on each side with a suitable coating for corrosion protection; and tubes shall be of manufacturer's standard copper alloy. U-bend tubes are not permitted.

Note 1: Typical tube materials are 90-10 copper-nickel, or hard drawn Cl 220 copper.

Note 2: Some plant locations may require consideration of alternative materials to combat atmospheric corrosion.

7.6.6 The vendor shall include in the proposal complete details of any proposed air-cooled cooler.

7.7 INLET AIR FILTER/SILENCER

The vendor shall furnish a dry-type multistage, high-efficiency air intake filter-silencer suitable for mounting outdoors. Unless otherwise specified, the filter-silencer shall be shipped loose for field installation by purchaser. This filter-silencer shall be provided with the following:

a. Differential pressure alarm instrumentation and indication
b. Filter portion designed such that the first-stage (prefilter) elements may be changed while the unit is operating
c. Weather hood or louvers

d. Clean pressure drop across the filter elements which shall not exceed 5.0 millibar (2 in.) water gauge
e. Removal of a minimum of 99.5% of particle sized 2 micron or larger over the inlet capacity range
f. Element(s) designed to withstand pressure reversal from compressor surge
g. Carbon steel components shall be galvanized to resist internal and external corrosion. The internal fasteners and hardware downstream of the final filter element shall be stainless steel.

Note 1: Many configurations and arrangements are available. Thus, the purchaser will need to specify any required specific features.

Note 2: The filter-silencer may be elevated some distance above the compressor for certain plant locations subject to unusual conditions such as sand storms. Inlet piping between filter-silencer and the compressor is typically supplied by the purchaser. The piping should be of corrosion-resistant material to avoid ingestion of rust into the compressor.

7.8 DISCHARGE BLOWOFF SILENCER

7.8.1 The vendor shall furnish a flanged discharge blowoff silencer. The silencer is typically shipped loose for field installation by the purchaser.

7.8.2 Silencer construction shall be suitable for service in an unprotected location. The silencer preferably should be located immediately downstream of the discharge blowoff valve and oriented as specified.

7.9 SPECIAL TOOLS

7.9.1 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 machine. For multiple-unit installations, the requirements for quantities of special tools and fixtures shall be mutually agreed upon by the purchaser and the vendor. These or similar special tools shall be used during shop assembly and post-test disassembly of the equipment.

7.9.2 When special tools are provided, they shall be packaged in a separate, rugged metal box or boxes and shall be marked "special tools for (tag/item number)." Each tool shall be stamped or tagged to indicate its intended use.

7.10 ADDITIONAL REQUIREMENTS FOR "SPECIAL DUTY" PACKAGES.

● **7.10.1** When specified, the product of driver nameplate rating and any applicable service factor shall be no less than the power required (including losses from shaft-driven oil pump, coupling, and gear) when the compressor is operated unthrottled (inlet throttle device wide open) at the specified low-ambient operating conditions. The purchaser will specify the inlet air temperature and the inlet cooling water temperature to be used by the vendor in calculating the maximum unthrottled power.

Note: The specified inlet temperature is not necessarily the minimum ambient temperature.

● **7.10.2** When specified, drain rim decking shall extend under the drive-train components so that any leakage from these components is contained.

● **7.10.3** When specified, the vendor shall commercially sand blast, in accordance with ISO 8501, Grade Sa2 or SSPC SP6, all grout contact surfaces of the baseplate, and coat those surfaces with a primer compatible with epoxy grouting.

7.10.4 The microprocessor shall be capable of communicating with the purchaser's distributed control system (DCS).

Note: The purchaser should advise the communication protocol to be used.

● **7.10.5** When specified, a surge avoidance system shall be provided.

Note: Typically this requires additional instrumentation for measuring flow, pressure and temperature, a modulating type anti-surge (blow-off) valve and additional control logic.

● **7.10.6** When specified, the system shall have the capability of recording data at multiple intervals just prior to an alarm or trip as an aid for troubleshooting compressor operational problems.

● **7.10.7** When specified, provisions for phase reference (phase angle probes) shall be made on all pinions in accordance with API Std 670.

● **7.10.8** When specified, a tapped and plugged hole shall be provided for mounting a probe to sense axial position of the gear wheel. Manufacturer shall advise if their thrust bearing arrangement makes it more advantageous to utilize axial position probes on the pinions instead of the bullgear.

● **7.10.9** When specified, gear casing shall have a machined surface for mounting the purchaser's accelerometer in accordance with API Std 670.

Note: This requirement is for purchaser's field diagnostics of gear condition.

● **7.10.10** When specified, vibration and axial position transducers shall be supplied, installed, and calibrated in accordance with API Std 670.

● **7.10.11** When specified, vibration and axial position monitors shall be supplied, installed, and calibrated in accordance with API Std 670.

● **7.10.12** When specified, a bearing-temperature monitor shall be supplied and calibrated in accordance with API Std 670.

7.10.13 The control system shall maintain a chronological record of the shutdowns. The panel shall have the capability of storing operational parameters related to the chronological shutdowns in a battery-backed nonvolatile memory. The Vendor and the purchaser shall mutually determine the required parameters to be stored.

● **7.10.14** When specified, each alarm device and each shutdown device shall be furnished as separate devices.

● **7.10.15** When specified, a pilot light shall be provided on the incoming side of each supply to indicate that the circuit is energized. The pilot lights shall be installed on the control panel.

7.10.16 If temperature element heads are exposed to temperatures above 60°C (140°F), a 19-mm ($^3/_4$ in.) bronze hose with four-wall-interlocking construction and joints with packed-on heatproof couplings shall be used.

7.10.17 Piping wall thickness shall conform to the minimum requirement of ISO 10438, Part 1 or API Std 614, Table 2-A. Where space does not permit the use of NPS $^1/_2$, $^3/_4$, or 1 pipe, seamless tubing may be furnished in accordance with ISO 10438, Part 1 or API Std 614 Table 2-B. Stainless steel fittings shall be furnished with stainless steel tubing. The make and model of fittings shall be subject to purchaser's approval.

● **7.10.18** When specified, piping on external return lines and upstream of filters shall be stainless steel (excluding slip-on flanges).

● **7.10.19** Heads of oil-actuated control valves shall be vented back to the reservoir. When specified, instrument sensing lines to safety switches shall have a continuous through flow of oil.

7.10.20 All piping components such as flanges, valves, control valve bodies or heads, and relief valves shall be made of steel.

● **7.10.21** When specified, intercooler and aftercooler channels and covers shall be of steel; tube sheet shall be of brass and tubes shall be of inhibited admiralty.

7.10.22 Intercoolers and aftercoolers shall be in accordance with TEMA Class C and shall be constructed with a removable channel cover.

8 Inspection, Testing and Preparation for Shipment

8.1 GENERAL

8.1.1 Unless otherwise specified, inspection, testing and preparation for shipment shall be in accordance with ISO 10438, Part 1 or API Std 614, Ch. 1, Section 7 except as noted below:

● **8.1.2** When specified, the purchaser's representative, the vendor's representative, or both shall indicate compliance in accordance with the inspector's checklist (see Annex G) by initialing, dating, and submitting the completed checklist to the purchaser prior to shipment.

8.2 INSPECTION

8.2.1 General

The vendor shall keep the following data available for at least 20 years:

a. Material certificates of compliance for shafts, pinions, gear wheels, and impellers
b. Documentation to verify that the requirements of this specification have been met, for the required level of service
c. Results of documented tests and inspections, including fully identified records of all heat treatment and nondestructive examinations.

8.2.1.1 Pressure-containing parts shall not be painted until the specified inspection and testing of the parts is complete.

Note: Purchased auxiliaries typically arrive already tested and painted. Some components may be primed at the sub-supplier.

8.2.2 Material Inspection

Material inspection including major drive train components shall meet requirements of ISO 10438, Part 1 or API Std 614, Ch. 1, 7.2.2, except as noted below:

8.2.2.1 General

8.2.2.1.1 Castings may also be inspected per MSS SP55.

8.2.2.1.2 Defects that exceed the limits imposed in ISO 10438, Part 1 or API Std 614, Ch. 1, 7.2.2, shall be removed to meet the quality standards cited, as determined by the inspection method specified.

8.2.3 Mechanial Inspection Prior to Run Test

8.2.3.1 Each component (including cast-in passages of these components) and all piping and appurtenances shall be inspected to ensure they have been cleaned and are free of foreign materials, corrosion products, and mill scale.

8.2.3.2 The gear contact pattern shall be checked in a static test with all pinions in place. Unmodified profile leads shall show a minimum contact of 60% of tooth contact along the axis, 30% radially—with no edge loading. For crowned gear teeth, 50% centered contact is acceptable.

8.3 TESTING

8.3.1 General

8.3.1.1 The equipment shall be tested in accordance with 8.3.2 – 8.3.4.

8.3.1.2 The oil parameters described in 6.9.1 shall be included in these test procedures.

8.3.2 Hydrostatic Tests

8.3.2.1 Components designed and fabricated to an internationally recognized pressure design code or standard shall be pressure tested in accordance with that code or standard. Compressor casings, interstage piping and other pressure containing components not designed to a specific code or standard shall be tested hydrostatically with liquid at a minimum of one and one-half times the maximum allowable working pressure of the component but not less than 1.5 bar (20 psi).

8.3.2.2 The chloride content of liquids used to test austenitic stainless steel materials shall not exceed 50 parts per million. To prevent deposition of chlorides on austenitic stainless steel as a result of evaporative drying, all residual liquid shall be removed from tested parts at the conclusion of the test.

8.3.2.3 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 neither leaks nor seepage through the pressure containing parts or complex systems may require a longer testing period to be agreed upon by the purchaser and the vendor. Seepage past internal closures required for testing of segmented cases and operation of a test pump to maintain pressure are acceptable.

8.3.2.4 Gaskets used during hydrotest of an assembled casing shall be of the same design as supplied with the casing.

8.3.2.5 Following hydrostatic testing, all equipment subassemblies shall be cleaned and dried to prevent corrosion.

8.3.3 IMPELLER OVERSPEED TEST

8.3.3.1 An overspeed test to 115% of rated speed shall be performed for a minimum duration of 1 minute. Impellers shall be examined for dimensional changes and cracking in high stress areas. No inspection/dimensional check is required of the impellers provided the following criteria are met:

a. The test is successful
b. The design impeller stress at max continuous speed does not exceed 50% of material yield strength at the highest stress point of the impeller
c. Vibration signatures comparison before and after the impeller overspeed test are virtually identical
d. Castings used are radiographic quality
e. Impellers are of a design of proven success employing this approach.

● **8.3.3.2** When specified, after the overspeed test, each impeller shall be examined by magnetic particle or liquid penetrant methods. Impeller dimensions identified by the manufacturer as critical (such as bore and outside diameter) shall be measured before

and after the overspeed test. Any permanent deformation of the bore or other critical dimensions outside drawing tolerances shall be resolved to the satisfaction of the vendor and the purchaser.

8.3.4 Combined Mechanical and Performance Tests

8.3.4.1 The combined mechanical and performance test of the package, in accordance with vendor's standard test procedure, shall be conducted at rated operating speed for a continuous 2-hour period. Aerodynamic performance test shall be in accordance with either ASME PTC-10 or ISO 5389 as mutually agreed between purchaser and vendor. The purchaser and the vendor shall mutually agree upon equipment and accessories to be included in the scope of the test and the test class.

8.3.4.2 All oil pressures, viscosities, and temperatures shall be within the range of operating values recommended in the vendor's operating instructions for the specific unit being tested. Performance data shall be obtained only after bearing and lube-oil temperatures have stabilized.

8.3.4.3 During the running test, peak-to-peak vibration levels shall be recorded for each stage at operating speed.

8.3.4.4 Performance shall be calculated using the test raw data, reduced to the specified site-rated conditions, including expected inlet air filter and aftercooler losses, cooling water temperatures and flows, tube side fouling factors, and all mechanical, blowdown, and condensate losses in accordance with the vendor's standard procedure.

8.3.4.5 The requirements of 8.3.4.5.1 – 8.3.4.5.5 shall be met before the combined mechanical and performance test of the package is performed.

8.3.4.5.1 All joints and connections shall be checked for tightness, and any leaks shall be corrected.

8.3.4.5.2 Test stand oil filtration shall not exceed 10 microns nominal. Oil-system components downstream of the filters shall meet the cleanliness requirements of ISO 10438 or API Std 614 before any test is started

8.3.4.5.3 If the job lube system is not used for the package test, a functional test of the job lube system shall be performed, including verification of calibration and operation of all valves and instrumentation.

8.3.4.5.4 Total indicated runout measurements (combined electrical and mechanical) of the pinion probe areas and calibration records for flow, pressure, temperature, and vibration-measuring devices utilized during the test shall be available to the purchaser's representative for review.

8.3.4.5.5 All warning, protective, and control devices used during the test shall be checked, and adjustments shall be made as required.

8.3.4.6 The requirements of 8.3.4.6.1 – 8.3.4.6.5 shall be met during the combined mechanical and performance test.

8.3.4.6.1 With the compressor operating at its rated discharge pressure, the delivered capacity at the rated operating point reduced to rated conditions specified on the data sheets shall have zero negative tolerance when compared to rated capacity (that is, –0% tolerance on the specified rated flowrate).

8.3.4.6.2 The required power referred to the gear wheel shaft, at the rated operating point, including mechanical and convection losses, shall not exceed 104% of the value quoted for the rated operating point.

8.3.4.6.3 Overall pressure rise shall meet the criteria of 6.1.12.2.

8.3.4.6.4 Compressor vibration levels shall be recorded at every performance data point and shall meet the criteria of 6.7.4.3, and 8.5.9.

8.3.4.6.5 The performance test shall verify the expected turndown flow at the specified rated discharge pressure.

8.3.4.7 If replacement or modification of bearings or seals or dismantling of the case to replace or modify other parts is required to correct mechanical or performance deficiencies, the initial test will not be acceptable, and the final shop tests shall be run after these replacements or corrections are made.

8.3.5 Final Inspection

The purchaser's representative may perform a final inspection prior to shipment, including dimensional inspection, review of scope of supply, and documentation review.

8.3.6 Test Data

Immediately upon completion of each mechanical and performance test, copies of the data logged and the as-tested performance data shall be submitted to the purchaser.

8.4 PREPARATION FOR SHIPMENT

8.4.1 Equipment shall be suitably prepared for the type of shipment specified, including blocking of the rotor when necessary. Blocked rotors shall be identified by means of corrosion-resistant tags attached with stainless-steel wire. The preparation shall make the equipment suitable for 6 months of outdoor storage from the time of shipment, with no disassembly required before operation except for inspection of bearings and seals. If storage for a longer period is contemplated, the purchaser will consult with the vendor regarding the recommended procedures to be followed.

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

8.4.3 Lifting points and lifting lugs shall be clearly identified on the equipment or the equipment package. The recommended lifting arrangement shall be identified on the boxed equipment.

8.4.4 The package shall be identified with item and serial number. 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 be shipped with duplicate packing lists, one inside and one on the outside of the shipping container.

8.4.5 When spare rotating elements are purchased, they shall be prepared and crated for unheated indoor storage for a period of at least 3 years.

8.4.6 Auxiliary piping connections furnished on the purchased equipment shall be impression stamped or permanently tagged to agree with the vendor's connection table or general arrangement drawing. Service and connection designations shall be indicated.

8.4.7 One copy of the vendor's standard installation instructions shall be packed and shipped with the equipment.

8.5 ADDITIONAL INSPECTION, TESTING & PREPARATION FOR SHIPMENT REQUIREMENTS FOR "SPECIAL DUTY" PACKAGES

● **8.5.1** When specified, the vendor shall keep final assembly maintenance and running clearances for at least 20 years.

8.5.2 Impellers that are welded or machined from other than investment castings, forgings, or bar stock, shall be 100% radiographed and inspected. The radiographs, when compared with the standard reference radiographs within ASTM E446 for steel castings up to 50 mm (2 in.) in thickness or standard reference radiographs for heavy walled 50 mm – 100 mm (2 in. – 4 in.) steel castings within ASTM E186, shall show a casting quality equal to or better than Severity Level 2 for Categories A, B, and C (Types 1 – 4). Defects per categories D, E, and F are unacceptable. The methods of radiographic examination shall be in accordance with ASTM E 94.

8.5.3 Inspection of the impeller is required following overspeed testing per 8.3.3.

8.5.4 All gear wheel and pinion teeth shall be 100% magnetic particle inspected in accordance with ASTM A 275. Cracks are not acceptable. Linear indications due to metallic inclusions larger than 1.5 mm (0.06 in.) located in the tooth flanks or roots shall be reported to the purchaser for disposition. Linear indications are defined as indications whose length is at least three times the width. Acceptance or rejection shall be decided on a case-by-case basis and shall be mutually agreed upon by the purchaser and the vendor.

8.5.5 The vendor shall verify that dimensions of all rotating components and stationary gas path components fall within the drawing tolerances. Dimensional nonconformances shall be reported to the purchaser within 5 days after approval of the non-conformance by the vendor's engineering department.

● **8.5.6** When specified, the combined test shall be for a continuous 4-hour period.

● **8.5.7** When specified, a minimum of five test points shall be recorded, including surge, rated, and maximum capacity.

● **8.5.8** When specified, an unthrottled test curve shall be produced.

● **8.5.9** When specified, while the equipment is operating at rated speed, sweeps shall be made for vibration amplitudes at frequencies other than synchronous. As a minimum, these sweeps shall cover a frequency from 0.25 times to 8 times the rated speed

of the shaft being observed. If the amplitude of any discrete, nonsynchronous vibration exceeds 20% of the allowable vibration as defined in 6.7.4.3, the purchaser and the vendor shall mutually agree on requirements for any additional testing and on the equipment's suitability for shipment.

8.5.10 During the combined test, the difference between inlet- and drain-oil temperature shall not exceed 30°C (50°F).

● **8.5.11** When specified, the requirements of 8.5.11.1 – 8.5.11.3 shall be met after the combined mechanical and performance test is completed.

8.5.11.1 The bearings, seals, and gearing shall be inspected.

● **8.5.11.2** When, due to the design of the integrally geared compressor, inspection of the bearings and seals requires disassembly of any pinion rotor, the purchaser shall specify either:

a. to inspect the bearings one time and retest in accordance with 8.3.4 or
b. to forego inspection of the bearings and seals based upon analysis of test data.

8.5.11.3 The gear contact pattern shall be checked using the hard-bluing method with all pinions in place. Unmodified profile leads shall show a minimum contact of 70% of tooth contact along the axis, 30% radially, with no edge loading.

● 8.5.12 Optional Tests

The purchaser will specify whether either of the shop tests specified in 8.5.12.1 or 8.5.12.2 shall be performed (see also 6.12.4).

● 8.5.12.1 Guide Vane Test

The package shall be tested at the number of guide vane settings specified by the purchaser. Each setting shall include surge, rated, and maximum capacity.

8.5.12.2 Spare Rotor Test

Spare rotating elements with duplicate performance to the contract rotating elements shall be given a mechanical test only in accordance with the requirements of this standard. Spare rotating elements with different performance from the contract rotating elements shall be given a combined mechanical and performance test.

9 Vendor Data

9.1 GENERAL

9.1.1 The information to be furnished by the vendor is specified in 9.2 and 9.3.

9.1.2 The data shall be identified on transmittal (cover) letters, title pages, and in title blocks or other prominent position on drawings, with the following information:

a. The purchaser's/owner's corporate name
b. The job/project number
c. The equipment item number and service name
d. The inquiry or purchase order number
e. Any other identification specified in the inquiry or purchase order
f. The vendor's identifying proposal number, shop order number, or serial number, or other reference required to completely identify return correspondence.

● **9.1.3** When specified, a coordination meeting shall be held, preferably at the vendor's plant, within 4-6 weeks after the order commitment. Unless otherwise specified, the vendor shall prepare and distribute an agenda prior to this meeting which as a minimum shall include review of the following items:

a. The purchase order, scope of supply, unit responsibility, subvendor items and lines of communication
b. The data sheets
c. Applicable specifications and previously agreed exceptions
d. Schedules for transmittal of data, production, and testing
e. The quality assurance program and procedures
f. Inspection, expediting, and testing
g. Schematics and bills of material for auxiliary systems

h. The physical orientation of the equipment, piping, and auxiliary systems including access for operation and maintenance
i. Coupling selection and rating
j. Equipment performance, alternate operating conditions, startup, shutdown, and any operating limitations
k. Instrumentation and controls.

9.2 PROPOSALS

9.2.1 General

The proposal shall include as a minimum, the data specified in 9.2.2 – 9.2.4 and a specific statement that the equipment and all its components and auxiliaries are in strict accordance with this standard. If the equipment or any of its components or auxiliaries are not in strict accordance, the vendor shall include a list that details and explains each deviation to enable the purchaser to evaluate any proposed alternative designs. All correspondence shall be clearly identified in accordance with 9.1.2.

9.2.2 Drawings

The drawings indicated on the Vendor Drawing and Data Requirements or VDDR form (see Annex D) shall be included in the proposal. As a minimum, the following data shall be included:

a. A general arrangement or outline drawing for each major skid or remote mounted component , showing overall dimensions, maintenance clearance dimensions, overall weights, erection weights, maximum maintenance weights (indicated for each piece) the direction of rotation, and the size and location of major purchaser connections
b. Cross-sectional drawings showing the details of the proposed equipment
c. Schematics of all auxiliary systems, including the air, lube-oil, seal air, control, and electrical systems, with bills of material identifying components by make, model, and materials of construction for each system.

9.2.3 Technical Data

9.2.3.1 The following data shall be included in the proposal:

a. The purchaser's data sheets with complete vendor's information entered thereon and literature to fully describe details of the offering
b. The predicted noise data
c. The Vendor Drawing and Data Requirements form (see Annex D), indicating the schedule according to which the vendor agrees to transmit all the data specified
d. A schedule for shipment of the equipment, in weeks after receipt of an order
e. A list of major wearing components, showing any interchangeability with the owner's existing units
f. A list of priced spare parts recommended for start-up and 3 years of normal operation
g. A list of the special tools furnished for maintenance
h. A description of any special weather protection and winterization required for start-up, operation, and periods of idleness under the site conditions specified and clearly indicating the protection to be furnished by the purchaser, as well as that included in the vendor's scope of supply
i. A complete tabulation of utility requirements (clearly indicating approximate data where applicable), such as those for steam, water electricity, air, and lube oil (including the quantity and supply pressure of the lube oil required, and the heat load to be removed by the oil), and the nameplate power rating and operating power requirements of auxiliary driver
j. A description of any special requirements specified in the purchaser's inquiry and as outlined in 6.5.2.2, 6.10.1.2, and 7.6.6
k. Allowable forces and moments on customer inlet and discharge air connections, as required by 6.4.1
l. A description of the sealing system including air consumption as required by 6.6.3
m. A description of the alarm and shutdown functions as required by 7.4.5.3.6
n. A statement of the number of radial vibration probes that can be mounted adjacent to each impeller as required by 7.4.4.5.2
o. The vendor's recommended ISO grade and the minimum allowable oil temperature as requested in API Std 614, Ch. 1
p. A description of standard tests including mechanical run and performance, control functionality, and oil system cleanliness
q. Descriptive literature
r. Vendor Quality Assurance Plan.

9.2.4 Curves

9.2.4.1 The vendor shall provide complete performance curves to encompass the map of operations, with any limitations indicated thereon.

9.2.4.2 Overall performance curves shall be submitted for rated, minimum, and maximum specified ambient temperatures.

9.2.4.3 Curves shall include a plot of discharge pressure, and brake horsepower against delivered standard flow. Curves shall indicate surge, rated capacity, and any other specified operating points. Curves that show throttling effects at off-design inlet conditions shall also be provided.

9.2.4.4 Preliminary speed-torque curves shall be provided.

9.3 CONTRACT DATA

9.3.1 General

9.3.1.1 Contract data shall be furnished by the vendor in accordance with the agreed VDDR form.

9.3.1.2 Each drawing shall have a title block in the lower right-hand corner with the date of certification, identification data specified in 9.1.2, the revision number and date, and the title. Similar information shall be provided on all other documents including subvendor items.

9.3.1.3 The purchaser will promptly review the vendor's data upon receipt; however, this review shall not constitute permission to deviate from any requirements in the order unless specifically agreed upon in writing. After the data have been reviewed and accepted, the vendor shall furnish certified copies in the quantities specified.

9.3.1.4 A complete list of vendor data shall be included with the first issue of the major drawings. This list shall contain titles, drawing numbers, and a schedule for transmittal of each item listed. This list shall cross-reference data with respect to the VDDR form in Annex D.

9.3.2 Drawings and Technical Data

The drawings furnished shall contain sufficient information so that together with the manuals specified in 9.3.5, the purchaser can properly install, operate, and maintain the equipment covered by the purchase order. All contract drawings and data shall be clearly legible (8-point minimum font size even if reduced from a larger size drawing), shall cover the scope of the agreed VDDR form, and shall satisfy the applicable detailed descriptions in Annex D.

9.3.3 Progress Reports

The vendor shall submit progress reports to the purchaser at the intervals specified.

9.3.4 Parts Lists and Recommended Squares

9.3.4.1 The vendor shall submit complete parts lists for all equipment and accessories supplied. The lists shall include part names, manufacturer's unique part numbers, materials of construction (identified by applicable international standards), and delivery times. Each part shall be completely identified and shown on appropriate cross-sectional, assembly-type cutaway or exploded-view isometric drawings. Interchangeable parts shall be identified as such. Parts that have been modified from standard dimensions or finish to satisfy specific performance requirements shall be uniquely identified by part number. Standard purchased items shall be identified by the original manufacturer's name and part numbers.

9.3.4.2 The vendor shall indicate on these complete parts lists all those parts that are recommended spares for start-up or maintenance spares and the recommended stocking quantities of each. This should include spare parts recommendations of subsuppliers that were not available for inclusion in the vendor's original proposal (see 9.2.3.1, item F).

9.3.5 Installation, Operation, Maintenance, and Technical Data Manuals

9.3.5.1 General

The vendor shall provide sufficient written instructions and all necessary drawings to enable the purchaser to install, operate, and maintain all of the equipment covered by the purchase order. This information shall be compiled in a manual or manuals with a cover sheet showing the information listed in 9.1.2, an index sheet, and a complete list of the enclosed drawings by title and drawing number.

9.3.5.2 Installation Manual

Any special information required for proper installation design that is not on the drawings shall be compiled in a manual that is separate from the operating and maintenance instructions. This manual shall be forwarded at a time that is mutually agreed upon in the order but not later than the issue of final certified drawings. the final issue of prints.

The manual shall contain information for receiving the units and for preservation of the units prior to service. It will include information such as special alignment and grouting procedures, utility specifications (including quantities), and all other installation design data, including the drawings and data specified in 9.2.2 and 9.2.3. The manual shall also include sketches that show the location of the center of gravity and rigging provisions to permit the removal of the top half of the casings, rotors, and any subassemblies that weigh more than 136 kg (300 lbs.).

9.3.5.3 Operating and Maintenance Manual

A manual containing all required operating and maintenance instructions shall be supplied. In addition to covering operation at specified rated conditions, this manual shall also contain separate sections that provide special instructions for operation at specified extreme environmental conditions.

9.3.5.4 Technical Data Manual

The vendor shall provide the purchaser with a technical data manual within 30 days of completion of shop testing. (see Annex D for minimum requirements of this manual.)

9.4 ADDITIONAL VENDOR DATA REQUIREMENTS FOR "SPECIAL DUTY" PACKAGES

9.4.1 When Special Duty has been specified, the following additional data shall be included in the proposal:

a. A list of similar machines installed and operating under conditions analogous to those specified in the proposal
b. Any start-up, shutdown, or operating restrictions required to protect the integrity of the equipment
c. The calculated values of gear-rated power, based on AGMA 6011.

9.4.2 The coordination meeting agenda shall include discussion of the following:

a. Thrust-bearing sizing, estimated loading and specific configurations
b. The rotor dynamics analysis (lateral, torsional and transient torsional, as required).

● **9.4.3** When specified, the Installation, Operating and Maintenance Instructions (IOMI) manual(s) shall be prepared for the equipment covered by the purchase order and "Typical" manuals are not acceptable.

ANNEX A—DATA SHEETS

REVISION	0	1	2	3	4
DATE					
BY					
REV/APPR					

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (bar)

JOB NO. _____ ITEM NO. _____

PAGE 1 OF 11 REQ'N NO. _____

APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR _____ UNIT _____

SITE _____ NO. REQUIRED _____

SERVICE _____ DRIVER ITEM NO. _____

○ CONTINUOUS ○ INTERMITTENT ○ STANDBY (3.30) SPARED BY: _____

NOTE: INFORMATION TO BE COMPLETED: ○ BY PURCHASER ☐ BY MANUFACTURER ◎ BY PURCHASER OR MFR

GENERAL

COMPRESSOR MFR _____ MODEL (SIZE AND TYPE) _____ SERIAL NO. _____

DRIVER MFR _____ DRIVER TYPE _____ RATED (BkW) _____ RPM _____

DRIVE SYSTEM: ○ DIRECT COUPLED ○ OTHER _____ DUTY (1.2) ○ BASIC ○ SPECIAL

OPERATING CONDITIONS (6.1.9)

(ALL DATA ON PER UNIT BASIS)	RATED (3.24)	LOW AMB * (7.10.1)	MIN AMB	OTHER
○ DELIVERED FLOW, NM_/H (1.013 barA & 0°C DRY)				
○ WEIGHT FLOW, (kg/h) (WET) (DRY)				
○ INLET COOLING WATER TEMP, (°C)				
INLET CONDITIONS:				
○ PRESSURE (barA)				
○ TEMPERATURE (°C)				
○ RELATIVE HUMIDITY %				
○ MOLECULAR WEIGHT (M)				
☐ INLET VOLUME, (m_/h) (WET / DRY)				
DISCHARGE CONDITIONS:				
○ PRESSURE (barA)				
☐ TEMPERATURE (°C)				
PERFORMANCE:				
☐ MAX (BkW) REQUIRED (ALL LOSSES INCL)				
☐ (BkW/ 100 m_/h) AIR DELIVERED				
☐ INPUT SPEED (rpm)				
☐ ESTIMATED SURGE, (m_/h) (@ ABOVE SPEED)				
○ MAX DP ACROSS INLET FILTER, (bar)				
DP INCLUDED IN CALCULATION ☐ YES ☐ NO				
◎ AFTERCOOLER OUTLET TEMP, (°C)				
☐ PERFORMANCE CURVE NO.				
☐ % RISE TO SURGE (6.1.12.2)				
☐ _____				
☐ _____				

* UNTHROTTLED PERFORMANCE FOR DRIVER SIZING

CONTROL SYSTEM (7.4.2)

CONTROL METHOD: (7.4.2.1)

○ CAPACITY MODULATION (CONST DISCH PRESS) (7.4.2.1 a.)
- ○ INLET THROTTLE DEVICE ○ DAMPER
- ○ GLOBE VALVE ○ BUTTERFLY VALVE
- ○ VARIABLE INLET GUIDE VANES

○ AUTOMATIC DUAL CONTROL (7.4.2.1 b.)
- ○ _____ (barG TO _____ (barG) DISCH PRESS

○ AUTO START AND STOP (7.4.2.1 c.)
- ○ START _____ (barG) STOP _____ (barG)

○ OTHER (DESCRIBE): _____

CONTROL SYSTEM REQUIREMENTS:

○ UNIT OPERATES IN PARALLEL (7.4.2.2)
- ○ W/CENTRIFUGAL
- ○ W/ROTARY ○ W/RECIPROCATING

○ MICROPROCESSOR CAPABLE OF COMMUNICATION WITH PURCHASER'S DCS (7.4.1.4)
- ○ COMM PROTOCOL _____

CONTROL SYSTEM ALTERNATES: (7.4.1.3)

○ OTHER THAN MICROPROCESSOR BASED: _____

○ SUITABLE FOR INDOOR ONLY

○ FURNISHED BY PURCHASER

INTER- AND AFTER-COOLERS (7.6)

REMARKS: _____

AFTERCOOLER:

○ FURNISHED BY PURCHASER (7.6.1)

○ NOT NEEDED (7.6.1)

○ AIR-COOLED TYPE BY VENDOR

○ AIR-COOLED INTERCOOLERS REQD (7.6.3, 7.6.6)
- ○ FURNISHED BY PURCHASER

◎ AIR-COOLED EXCHANGER AUTOMATIC TEMPERATURE CONTROL MEANS: (7.6.6)
- ○ LOUVERS ○ VARIABLE SPEED FANS
- ○ VARIABLE PITCH FANS ○ BYPASS VALVE

◎ AIR-COOLER CONTROL MANUAL ONLY (7.6.6) BY:
- ○ LOUVERS ○ BYPASS VALVE
- ○ VARIABLE PITCH FANS

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET
SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
PAGE **2** OF **11** REQ'N NO. _____

○ LOCATION, SITE DATA (6.1.5)

LOCATION:

○ INDOOR ○ HEATED ○ UNDER ROOF
○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES
○ GRADE ○ MEZZANINE ○ _____
○ WINTERIZATION REQD ○ TROPICALIZATION REQD

SITE DATA:

○ ELEVATION _____ (m) ○ BAROMETER _____ (barA)
○ RANGE OF AMBIENT TEMPERATURE, (°C)

	DRY BULB	WET BULB
NORMAL		
MAXIMUM		
MINIMUM		

UNUSUAL CONDITIONS:

○ DUST ○ FUMES ○ CORROSIVE CONDITIONS
○ CORROSIVES PRESENT: _____
○ CONDITIONS CAUSE STRESS CORROSION CRACKING
○ OTHER _____

AREA ELECTRICAL CLASSIFICATION: (6.1.8) T-CODE ____

○ CLASS _____ GROUP _____ DIVISION _____
○ LOCAL ELECTRICAL CODES: _____

○ UTILITY CONDITIONS:

○ **STEAM HEATING:**

INLET MIN	_____ (barG)	_____ (°C)
NORM	_____ (barG)	_____ (°C)
MAX	_____ (barG)	_____ (°C)
OUTLET MIN	_____ (barG)	_____ (°C)
NORM	_____ (barG)	_____ (°C)
MAX	_____ (barG)	_____ (°C)

○ **ELECTRICITY:**

	HEATING	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ **COOLING WATER: (6.1.6)**

TEMP INLET _____ (°C) MAX RETURN _____ (°C)
PRESS NORM _____ (barG) DESIGN _____ (barG)
MIN RETURN _____ (barG) MAX ALLOW DP _____ (bar)
WATER SOURCE _____

○ **AIR/NITROGEN:**

MAX PRESS _____ (barG) MIN PRESS _____ (barG)
GAS COMPOSITION _____

REMARKS: _____

○ SPECIFICATIONS

NOISE SPECIFICATIONS: (6.1.3)

○ MAX ALLOWABLE SPL _____ (@ 1 m)
○ APPLICABLE SPEC _____
ACOUSTIC HOUSING: ○ YES ○ NO
APPLICABLE SPECIFICATIONS:
API 672 AND ○ _____

○ NON-ASME WELDING IF NOT AWS D1.1: (6.10.3.5) _____
○ UNITS OF MEASURE (5.1) ○ US CUSTOMARY ○ SI ○ OTHER _____

PAINTING:

○ MANUFACTURER'S STD
○ OTHER _____

BASEPLATE GROUT: (7.10.3) ○ EPOXY ○ CEMENT ○ NONE

PREPARATION FOR GROUT SURFACES: (7.10.3)

○ MFR STD ○ SSPC 6 BLAST ○ BARE FOR FIELD BLAST
○ INORGANIC ZINC SILICATE COATING
○ OTHER _____

SHIPMENT: (8.4.1)

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD
○ OUTDOOR STORAGE OVER 6 MONTHS

□ UTILITY CONSUMPTION (9.2.3 i.)

STEAM:

OIL HEATER: _____ (kg/h) OTHER _____ (kg/h)

ELECTRIC:

	(kW)	LOCKED ROTOR AMPS	FULL LOAD AMPS
MAIN LO PUMP			
AUX LO PUMP			

OIL HEATER _____ (kW) SPACE HEATER _____ (kW)
CONTROL SYSTEM LOAD: _____ (kW)

COOLING WATER:

	L.O. COOLER	INTER-COOLER	AFTER-COOLER	OTHER
QUANTITY, (L/min)				
OUTLET TEMP, (°C)				
PRESS DROP, (bar)				
TOTAL CW, (L/min)				

AIR/NITROGEN:

	INLET PRESS (barG)	QUANTITY (m_/h)
SEAL SYSTEM:		
CONTROL PANEL:		
LO RESERVOIR:		
INSTR HOUSINGS:		
CONTROL SYSTEM:		
OTHER: _____		

TOTAL PURGE, (m_/h) _____

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JOB NO. _____ ITEM NO. _____

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CONSTRUCTION FEATURES

☐ **COMPRESSOR SPEEDS:**

RATED INPUT: _____ (rpm) TRIP _____ (rpm)

BULLGEAR CRITICALS: 1st _____ (rpm)

PINION CRITICALS:

1st STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
2nd STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
3rd STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
4th STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)

OTHER UNDESIRABLE SPEEDS: (6.7.1.3) _____

	STAGE SPEED	IMPELLER DIAMETER	TIP SPEED
1st STAGE	_____ (rpm)	_____ (mm)	_____ (m/hr)
2nd STAGE	_____ (rpm)	_____ (mm)	_____ (m/hr)
3rd STAGE	_____ (rpm)	_____ (mm)	_____ (m/hr)
4th STAGE	_____ (rpm)	_____ (mm)	_____ (m/hr)

☐ **IMPELLERS: (6.5.2)**

NO. OF IMPELLERS: _____ MATERIAL _____

TYPE (OPEN, RADIAL, BACKWARD LEANING, ETC.) _____

TYPE CONSTRUCTION: (6.5.2.2) _____

METHOD OF ATTACH: (6.5.2.2) _____

ROTATION, VIEWED FROM INPUT SHAFT END: ☐ CW ☐ CCW

☐ **COMPRESSOR CASING:**

MODEL _____ CASING SPLIT _____

	STG 1	STG 2	STG 3	STG 4
MATERIAL				
MAWP, (barG)				
HYDRO TEST, (barG)				
MAX OPT TEMP, (°C)				

○ MIN DESIGN METAL TEMP (6.10.5) _____ (°C)

☐ CASING HEAT TREATMENT REQUIRED (6.10.3.1.1)

☐ ULTIMATE STRESS FOR MATL (6.2.1) _____ (MPa)

☐ CASTING FACTOR (6.2.1) _____

WELDED CONNECTIONS--NDT PROVIDED

☒ 100% RADIOGRAPH ☒ MAG PARTICLE ☒ LIQ PENETRANT

○ _____

☐ **COMPRESSOR BEARINGS & BEARING HOUSINGS:**

BEARING HSG MATERIAL: _____

PINION RADIAL BEARINGS: (6.8.2)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (bar)				
ACTUAL LOAD, (bar)				
BRG SPAN, (mm)				

PINION THRUST BEARINGS: (6.8.3)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (bar)				
ACTUAL LOAD, (bar)				
THRUST COLLAR				

☐ **INTEGRAL GEAR HOUSING:**

MATERIAL _____ SPLIT _____

☐ **BULL GEAR: (6.5.3), (6.12.2)**

RATED POWER BASED ON TOOTH SURFACE DURABILITY: _____ (kW)

RATED POWER BASED ON TOOTH BENDING: _____ (kW)

○ MIN AGMA SERVICE FACTOR: _____ ☐ ACTUAL S.F. _____

GEAR RIM MATERIAL: _____ HARDNESS: _____

GEAR FACE WIDTH: _____ (mm) GEAR CENTER MATL: _____

MECHANICAL EFFICIENCY: _____ % ISO 1328 GRADE: _____

PITCH DIA _____ (mm) PITCH LINE VELOCITY _____ (m/s)

☐ **PINIONS: (6.5.3), (6.12.2)**

	1st	2nd	3rd	4th
SERVICE FACTOR:				
MATERIAL:				
HARDNESS: (BHN) (R_c)				

☐ **BULL GEAR SHAFT:**

☐ REPLACEABLE ☐ INTEGRAL W/GEAR

MATL: _____ HARDNESS: _____ (BHN) (R_c)

BRG SPAN _____ (mm) WEIGHT (W/GEAR) _____ (kg)

DIA @ GEAR _____ (mm) DIA @ COUPLING _____ (mm)

SHAFT SLEEVES AT SEALS: MATL _____

SHAFT LABYS: TYPE _____ MATL _____

BULL GEAR RADIAL BRG TYPE: _____ LENGTH _____ (mm)

ALLOW LOAD _____ (bar) ACTUAL LOAD _____ (bar)

☐ **BULL GEAR THRUST BEARINGS: (6.8.3)**

LOCATION _____ TYPE _____

MFR _____ AREA _____ (mm_)

THRUST COLLAR (6.8.3.6) ☐ INTEGRAL ☐ REPLACEABLE

ALLOW LOAD _____ (bar) ACTUAL LOAD _____ (bar)

GAS LOAD _____ (kg) COUPLING LOAD _____ (kg)

BEARINGS FITTED W/TEMP SENSORS (6.12.10, 6.12.11)

○ PINION RADIAL BRG ○ BULL GEAR RADIAL BRG

○ THRUST BRG _____

☒ **MAIN CONNECTIONS: (6.3)**

	SIZE	ASME RATING	FACING	POSITION
COMPR INLET				
COMPR DISCH				
PKG OUTLET				
ATM BLOWOFF				
FILTER OUTLET				

☐ **OTHER CONNECTIONS:**

	NO.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
COOLING WATER INLET			
PRESSURE GAUGE			
TEMPERATURE GAUGE			
CONDENSATE DRAINS			

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SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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VIBRATION DETECTORS: (7.4.4.5), (7.10.10)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
○ NO. AT EACH PINION BEARING _____ TOTAL NO. _____
○ NO. AT EACH DRIVER BEARING _____ TOTAL NO. _____
☐ X&Y RADIAL PROBES CAN BE MOUNTED ADJACENT TO IMPELLERS FOR:
☐ 1st STG ☐ 2nd STG ☐ 3rd STG ☐ 4th STG

OSCILLATOR-DEMODULATORS:
○ MFR _____ ☒ MODEL _____
○ MONITOR SUPPLIED BY _____
○ MFR _____ ☒ MODEL _____
○ LOCATION ENCLOSURE
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (μm)
○ SHUTDOWN: ☐ SET @ ____ (μm) ○ TIME DELAY ____ SEC
○ PER API 670 (7.10.10), (7.10.11)

BEARING-TEMPERATURE MONITOR: (7.10.12)
○ REQD ○ SUPPLIED BY: _____ ○ PER API 670
○ MFR _____ ☒ MODEL _____

AXIAL POSITION MOVEMENT DETECTOR: (7.10.10, 7.10.11)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (μm)
○ SHUTDOWN: ☐ SET @ ____ (μm) ○ TIME DELAY ____ (sec)

DYNAMICS: (6.7), (6.12)
○ CRITICAL LATERAL SPEEDS ARE PROVEN BY PRIOR UNITS (6.7.2)
○ DAMPED UNBALANCED RESPONSE ANALYSIS REQD (6.12.3)
○ TORSIONAL VIBRATION ANALYSIS OF TRAIN REQD (6.12.5)
○ RESIDUAL UNBALANCE WORKSHEET REQD (6.12.8)
☒ REMARKS _____

COUPLINGS: (7.2.1)
TYPE: ☒ DISK PAK ☒ DIAPHRAGM ○ OTHER _____
DISK MATL: ☒ STAINLESS STEEL ☒ COATED W/ _____
☒ MAKE _____ ☒ MODEL _____
○ NON-LUBE ○ LUB'D ☒ LUBRICATION _____
☐ SPACER LENGTH _____ (mm) ☒ LIMITED END-FLOAT REQD
☐ CPLG RATING _____ (kW/100 r @ 1.0 S.F. ACTUAL S.F. _____
☐ SHAFT JCT RATING: @ DRIVER ____ (kW) @ INPUT SHAFT ____ (kW)
☒ MOUNTING ARRANGEMENT @ INPUT SHAFT: _____ DRIVER ____
☐ MFR MAX BORE _____ (mm) PROPOSED BORE ____ (mm) (7.2.1.6)
DRIVER HALF-CPLG MTD BY: ☒ DRIVER MFR ☒ COMPR VENDOR
☒ IDLING ADAPTER FOR DRIVER HALF-COUPLING REQD

PIPING REQUIREMENTS:
☐ RECOMMENDED STRAIGHT RUN OF PIPE DIA BEFORE SUCTION: _____
○ VENDOR TO OBSERVE FLANGE PARTING
○ THROUGH STUDS REQUIRED FOR PIPING FLANGES

MISCELLANEOUS:
○ VENDOR PRESENT DURING INITIAL ALIGN CHECK
○ VENDOR CHECK ALIGN AT OPERATING TEMP
○ BASE DESIGNED FOR COLUMN MOUNTING
○ THERMAL RELIEF VALVES PROVIDED BY VENDOR
○ FOR WATER-COOLED EXCHANGERS
○ FOR _____
○ PURCHASER WILL PREPARE COORDINATION MEETING AGENDA (9.1.3)

SHOP INSPECTIONS & TESTS: (8.1.1)
○ ADVANCE NOTIFICATION REQD _____ DAYS

	OBSERVED	WITNESSED
○ SHOP INSPECTION		
○ HYDROSTATIC (8.3.2)	○	○
○ COMBINED TEST (8.3.4), (8.5.6)	○	○
○ ASME PTC 10 TEST (8.3.4.1)	○	○
INCLUDES ○ AIR FILTER		
○ AFTERCOOLER		
○ _____		
○ GUIDE VANE TEST (8.5.12.1)	○	○
○ AT NON-100% POSITIONS		
○ SOUND-LEVEL TEST	○	○
○ SPARE ROTOR TEST (8.5.12.2)	○	○
○ SPARE ROTOR MECH ONLY	○	○
○ IMPELLER OVERSPEED TEST (8.3.3)	○	○
○ POST OVERSPEED TEST NDE OF IMPELLERS (8.3.3.2)	○	○
○ RESIDUAL UNBALANCE CHECK (6.12.8)	○	○
○ OIL SYSTEM CLEANLINESS	○	○
○ CONTROL SYSTEM CHECK (8.3.4.5.5)	○	○
○ BRG, SEAL, GEAR CHECK (8.5.11.1, 6.5.11.2)	○	○
○ GEAR CONTACT CHECK (8.2.3.2)	○	○
○ CLEANLINESS CHECK--VESSELS (8.2.3.3)	○	○
○ CLEANLINESS CHECK--PIPING (8.2.3.3)	○	○
○ HARDNESS CHECK OF PINIONS (8.2.3.4)	○	○
○ OF BULL-GEAR	○	○
○ OF WELD REPAIRS	○	○
○ NDE OF MAJOR REPAIRS (8.2)	○	○
○ GEAR TOOTH MAG-PART (8.5.4)	○	○
○ FINAL INSPECTION PRIOR TO PAINT	○	○
○ INSPECTION OF PREP FOR SHIPMENT (8.4)	○	○
○ _____	○	○
○ _____	○	○

○ PRIOR DOCUMENTATION ON MAJOR REPAIRS NOT REQD (6.10.4.3)
○ RETAIN FINAL ASSEMBLY CLEARANCES (8.5.1)
○ SUBMITTAL OF INSPECTOR'S CHECKLIST (8.1.2)
SIGNED BY REP FOR: ○ PURCHASER ○ VENDOR
IF DESIGN REQUIRES DISASSEMBLY OF PINION FOR BRG INSPECTION,
○ FORGO BEARING INSPECTION BASED ON TEST DATA; OR
○ INSPECT BEARING AND RETEST (8.5.11.2)

☐ **WEIGHT:** (kg)
INTEG GEAR/COMPR _____ DRIVER _____
GEAR UPPER CASE _____ BULL-GEAR _____
1st STAGE PINION _____ 2nd STAGE PINION _____
INTERCOOLER _____ BUNDLE _____
AFTERCOOLER _____ BUNDLE _____
BASE _____ CONTROL PANEL _____
MAX FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS,** (mm)

	L	W	H
COMPLETE UNIT:			
CONTROL PANEL: (IF SEP)			
INLET FILTER-SILENCER:			
AFTERCOOLER: (IF FURN)			
OTHER: _____			

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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LUBE OIL SYSTEM (6.9)

BASIC SYSTEM REQ'MNTS--NORMAL OIL FLOW

LUBE OIL TO:	(L/min)	(barG)	(SSU @ 37.7°C)
☐ COMPR/GEAR			
☐ DRIVER			
☐ EXT GEAR			

☐ OIL SYSTEM PRESSURES:
SUPPLY _____ (barG) PUMP RV SETTING _____ (barG)
SYS DESIGN _____ (barG) HYDROTEST _____ (barG)

OIL COOLER:

	SHELL SIDE	TUBE SIDE
☐ OPERATING PRESS, (barG)		
☐ MAX ALLOW WORK PRESS, (barG)		
☐ MAX ALLOW TEMP, (°C)		
☒ FOULING FACTOR		

☐ SURFACE AREA _____ (m_) DUTY _____ (kJ/hr)
☒ REMOVABLE BUNDLE TO BE FURNISHED
☐ ASME CODE STAMPED ○ DESIGNED TO TEMA _____
☒ TUBES: NO. _____ O.D. _____ (mm) LENGTH _____ (mm)
WALL THICKNESS _____ (mm) ☐ AVG ☐ MIN
☒ MATERIALS
CHANNELS/HEADS _____ SHELL _____
TUBES _____ TUBE SHEETS _____
CHANNEL COVERS _____ TUBE SUPPORTS _____

OIL FILTERS:
☒ MICRON RATING _____ ○ NOMINAL ○ ABSOLUTE
☒ DP: (bar) CLEAN _____ DIRTY _____ COLLAPSE _____
☒ ELEMENT: MAKE _____ MODEL _____
☐ NO. ELEMENTS _____ ☒ MEDIA _____
☒ CORE MATL _____ ☒ HSG MATL _____
☐ HSG MAWP _____ (barG) ☐ MAX ALLOW TEMP _____ (°C)

OIL HEATER: ####
☒ STEAM HEATER REQD ☐ ELECTRIC HEATER REQD NO ELEC
☐ RATING _____ (kJ/hr)
☐ WATT DENSITY _____ (W/in_)

OIL RESERVOIR:
☒ RETENTION TIME _____ MIN ☐ CAPACITY _____ (l)
☐ FREE SURFACE AREA _____ (cm_) ☐ INTERNAL BAFFLES

LUBRICANT: ☒ SYNTHETIC ☒ HYDROCARBON
☒ DESCRIPTION _____
☐ MIN ALLOW OIL TEMP _____ (°C) _____ (SSU)

☒ SYSTEM COMPONENT SUPPLIERS:

	MFR	MODEL
MAIN PUMP		
STANDBY PUMP		
ELECTRIC MOTOR(S)		
STEAM TURBINE(S)		
OIL COOLER(S)		
OIL FILTERS		
ACCUMULATOR(S)		
SUCTION STRAINERS		
CHECK VALVES		
TRANSFER VALVE(S)		
PUMP COUPLING		
PUMP RELIEF VALVES		
ELECTRIC HEATER		

PUMPS:	MAIN	STANDBY
☒ HORIZONTAL		
☒ VERTICAL		
☒ SUBMERGED		
☒ MOTOR DRIVEN		
☒ TURBINE DRIVEN		
☒ SHAFT DRIVEN		
☒ CENTRIFUGAL		
☒ ROTARY		
☒ FLANGE CONNECTED		
☐ RATED CAPACITY (m_/h)		
☐ DISCHARGE PRESS (barG)		
☐ (BkW) @ MAX SSU		
☐ DRIVER RATING (kW)		
☒ CASING MATERIAL		
☐ SPEED		
☒ COUPLING		
☒ OSHA GUARD		
☒ MECHANICAL SEAL		

STANDBY PUMP CONTROL RESET:
○ MANUAL ○ AUTOMATIC ○ HOA SELECTOR SWITCH

SILENCERS

INLET AIR FILTER/SILENCER: (7.7)
☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ PIPING CONNECTION _____
☐ CLEAN DP, AS QUOTED _____ (bar)
☒ CORROSION PROTECTION _____
○ FILTER WILL BE REMOTE MOUNTED BY PURCHASER AT A DISTANCE _____ (m) FROM COMPRESSOR
○ FILTER WILL BE ELEVATED _____ (m) ABOVE GRADE

DISCHARGE BLOWOFF SILENCER: (7.8)
☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ FLANGE CONNECTION _____
MOUNTING ☒ HORIZONTAL ☒ VERTICAL
SUPPORTED BY ☒ PIPING ☒ OTHER _____
☐ SPL (dBA) (@ 1 m) FROM DISCHARGE OF SILENCER _____

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CONTROLS AND INSTRUMENTATION (7.4)

LOCAL CONTROL PANEL: (7.4.3)

○ ELECTRICAL AREA CLASSIFICATION:
CL _____ GR _____ DIV _____ ()

PANEL ENCLOSURE REQUIREMENT: (7.4.3.2)

☒ NEMA TYPE 4X ENCLOSURE MATERIAL: _____
☒ NEMA TYPE 7 (INDOOR EXPLOSION-PROOF FOR HAZARDOUS GAS AREAS) REQUIRED

PANEL FEATURES: (7.4.3.2)

○ VIBRATION ISOLATORS ○ STRIP HEATER ○ INTERNAL COOLING
○ WEATHERHOOD ☒ PURGE CONNECTIONS ○ OTHER _____

PURGE REQUIREMENT: (7.4.3.2)

☒ NONE ○ INSTRUMENT AIR ○ NITROGEN
☒ TYPE X--REDUCES THE CLASSIFICATION FROM DIV 1 TO NONHAZARDOUS
☒ TYPE Y--REDUCES THE CLASSIFICATION FROM DIV 1 TO DIV 2
☒ TYPE Z--REDUCES THE CLASSIFICATION FROM DIV 2 TO NONHAZARDOUS
○ TROPICALIZATION REQUIRED

☒ **INSTRUMENT SUPPLIERS:**

	MFR	SIZE & TYPE
PRESSURE GAUGES:		
TEMPERATURE GAUGES:		
LEVEL GAUGES:		
DIFF PRESSURE GAUGES:		
PRESSURE SWITCHES:		
TEMPERATURE SWITCHES:		
LEVEL SWITCHES:		
PRESSURE TRANSMITTERS:		
TEMPERATURE TRANSMITTERS:		
LEVEL TRANSMITTERS:		
CONTROL VALVES:		
PRESSURE RELIEF VALVES:		
THERMAL RELIEF VALVES:		
TEMPERATURE CONTROL VALVES:		
SIGHT FLOW INDICATORS:		
PURGE FLOW INDICATORS:		
SOLENOID VALVES:		
ANNUNCIATOR:		
TUBE FITTINGS		
_____		
_____		
_____		
_____		

SWITCH CLOSURES: (7.4.5.3.2)

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)

○ SHUTDOWN SYSTEMS ARE NOT TO BE PROVIDED WITH A MEANS TO PERMIT TESTING WITHOUT SHUTTING DOWN THE UNIT (7.4.5.3.4)
○ NON-SHUTDOWN DEVICES ARE NOT REQUIRED TO HAVE VALVING TO PERMIT REPLACEMENT DURING OPERATION
○ ISOLATION VALVES ARE REQUIRED FOR SHUTDOWN SENSING DEVICES

MISCELLANEOUS INSTRUMENTATION:

○ THROUGH FLOWING INSTRUMENT SENSING LINE REQUIRED
○ LIQUID-FILLED GAUGES ARE REQUIRED FOR AREAS SUBJECT TO VIBRATION
○ RELIEF VALVES MAY HAVE BODIES IN MATERIALS OTHER THAN STEEL ☒ RV BODY MATERIAL: _____
○ THERMAL RELIEF VALVES REQUIRED FOR COMPONENTS THAT CAN BE ISOLATED
○ FLOW INDICATOR TYPE/MATERIAL IF OTHER THAN BULLS EYE TYPE WITH STEEL BODY _____
○ PURGE REQUIRED FOR ANNUNCIATOR (7.4.3.2) NFPA 496 PURGE TYPE: ○ X ○ Y ○ Z ○ CONNECTION ONLY
○ COMBINATION BLOCK AND BLEED VALVES MAY BE SUBSTITUTED
○ _____
○ _____

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INSTRUMENTATION SCOPE OF SUPPLY

	ELEMENT											INDICATOR						
	PROV BY		TYPE			LOCATION			INSTALL BY		PROV BY	LOCATION						
	VENDOR	PURCHASER	DIRECT READOUT	SWITCH	TRANSMITTER (1)	VENDOR PKG	LOCAL PANEL	PURCH PIPING	VENDOR	PURCHASER	VENDOR	PURCHASER	VENDOR PKG	PURCH PIPING	LOCAL PANEL	ALARM	SHUTDOWN	REPEAT SIGNAL (2)
PRESSURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
LUBE OIL DISCHARGE																		
LUBE OIL FILTER DP																		
LUBE OIL SUPPLY																		
AIR FILTER/SILENCER DP																		
TEMPERATURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
OIL COOLER INLET & OUTLET																		
COMPRESSOR PINION JOURNAL BRG																		
BULL GEAR JOURNAL BRG																		
BULL GEAR THRUST BRG																		
DRIVER JOURNAL BRG																		
DRIVER THRUST BRG																		
RESERVOIR																		
LEVEL:																		
LUBE OIL RESERVOIR																		
SEPARATOR																		
VIBRATION:																		
RADIAL VIBRATION EACH STAGE																		
RADIAL VIBRATION BULL GEAR SHAFT																		
AXIAL POSITION BULL GEAR SHAFT																		
AXIAL POSITION _____ STAGE PINION																		
RADIAL VIBRATION ON DRIVER																		
AXIAL POSITION ON DRIVER SHAFT																		
ACCELEROMETER ON GEAR BOX																		
FLOW:																		
OIL RETURN																		
SEAL GAS																		
MISCELLANEOUS:																		
STANDBY L.O. PUMP RUNNING																		
PANEL PURGE FAILURE																		
ANNUNCIATOR PURGE FAILURE																		
SURGE RECOGNITION																		
OIL HEATER ON																		
COMMON REMOTE ALARM INDICATION																		
COMMON REMOTE SHUTDOWN INDICATION																		

NOTES: 1) TRANSMITTERS SUPPLIED BY VENDOR SHALL INCLUDE SENSING ELEMENT

2) SUPPLY "REPEAT SIGNAL" FOR CONTROL ROOM ALSO

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (bar)

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(INTER-) (AFTER-) COOLER(S) (7.6)

SERVICE OF UNIT: _____ ITEM NO. _____

SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES

SURF/UNIT: (GROSS/EFF) _____ (m_) SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____ (m_)

PERFORMANCE OF ONE UNIT

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

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (°C)

☐ TRANSFER RATE, (kJ/hr m_ °C) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

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

SKETCH: BUNDLE NOZZLE ORIENTATIONS

TUBE NO. _____ O.D. _____ (mm) THK (MIN) (AVG) _____ (mm) LENGTH _____ (m) PITCH _____ (mm) ◁ 30 △ 60 ☐ 90 ◇ 45

TUBE TYPE _____ MATERIAL _____

SHELL MATL _____ I.D. _____ (mm) O.D. _____ (mm) SHELL COVER MATL _____ (INTEG)(REMOV)

CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____

TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____

FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____

BAFFLES--CROSS MATL _____ TYPE _____ % CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ (mm)

BAFFLES--LONG MATL _____ SEAL TYPE _____

SUPPORTS--TUBE _____ U-BEND _____ TYPE _____

BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____

GASKETS--SHELL SIDE _____ --TUBE SIDE _____

--FLOATING HEAD _____

ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE TEMA CLASS _____

WEIGHT/SHELL _____ (kg) FILLED WITH WATER _____ (kg) BUNDLE _____ (kg)

REMARKS: _____

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NEMA FRAME INDUCTION MOTORS TO IEEE 841

MFR _____ MODEL _____ SERIAL NO. _____ NEMA FRAME _____
DRIVEN EQUIPMENT TYPE _____ DRIVEN EQUIPMENT ITEM NO. _____ MOTOR ITEM NO. _____

OPERATING CONDITIONS

SITE DATA:
ELECTRICAL SUPPLY: VOLT _____ PHASE _____ HERTZ _____
ELECTRICAL AREA CLASSIFICATION: ○ NON-HAZARDOUS
○ CLASS _____ GROUP _____ DIVISION _____
ATMOSPHERIC MIXTURE: _____
IGNITION TEMPERATURE: _____ (°C) TEMP CODE: _____
ALTITUDE: ○ LESS THAN (1000 m) ○ _____ (m)
AMBIENT TEMPERATURE MINIMUM: _____ (°C) MAXIMUM: _____ (°C)
UNUSUAL CONDITIONS: _____

DRIVE SYSTEM:
○ DIRECT CONNECTED ○ EXTERNAL GEAR
○ OTHER _____

STARTING: (7.1.2.2)
○ FULL VOLTAGE ○ REDUCED VOLTAGE _____ %
○ LOADED ○ UNLOADED
○ VOLTAGE DIP _____ %

PERFORMANCE

NO LOAD CURRENT, AMPS _____
FULL LOAD TORQUE, (N-m) _____
STARTS PER HOUR: _____ HOT _____ COLD
ACCELERATION TIME: _____ SEC

LOAD	CURRENT, AMP	EFFICIENCY	POWER FACTOR
FULL			
75%			
50%			
LOCKED ROTOR			

CONSTRUCTION FEATURES

☐ NAMEPLATE (kW) _____ (rpm) _____ S.F. _____
NEMA TORQUE DESIGN: ○ A ○ B ○ C ○ D
☐ NEMA LOCKED ROTOR kVA CODE LETTER: _____

EFFICIENCY: ○ STANDARD ○ HIGH ○ PREMIUM

NOISE DESIGN: ○ STANDARD ○ LOW NOISE
○ MAX SOUND PRESSURE LEVEL (dBA) (@ 1 m) _____
☐ EXPECTED SPL (dBA) (@ 1 m) _____

ENCLOSURE: ○ TEFC ○ TENV ○ EXPLOSION PROOF
TEFC
MOUNTING: ◎ HORIZONTAL ◎ VERTICAL
◎ FOOT MOUNTED ◎ FLANGE MOUNTED
☐ SHAFT UP ☐ SHAFT DOWN

MAIN TERMINAL BOX MOUNTING LOCATION: ◎ F-1 ◎ F-2

FAN: ☐ REVERSIBLE ☐ UNI-DIRECTIONAL
○ NON-SPARKING

BEARING TYPE: ☐ BALL ☐ ROLLER ☐ SLEEVE
BRG LUBRICATION: ◎ GREASE ☐ RING OIL ○ OIL MIST
GREASE FITTING: ◎ PLUGGED ○ ALEMITE ○ OTHER
BRG SHIELDING: ☐ SINGLE ◎ DOUBLE ⬭ SEALED FOR LIFE

MOTOR ROTATION: (FACING END OPPOSITE SHAFT EXTENSION)
◎ CW ◎ CCW ◎ BI-DIRECTIONAL

INSULATION CLASS: ○ B ○ F ○ OTHER: _____
○ NON-HYGROSCOPIC ○ TROPICALIZED

◎ TEMPERATURE RISE: (DEFAULT IS 80°C ABOVE 40°C BY RES @ 1.0)
_____ °C ABOVE _____ °C BY _____ @ _____ S.F.

◎ MOTOR TO BE "THERMALLY PROTECTED"
◎ MOTOR TO BE "OVER TEMP PROTECTED"
☐ TYPE #1--"WINDING--RUNNING AND LOCKED-ROTOR PROTECTED"
☐ TYPE #2--"WINDING--RUNNING PROTECTED"
☐ TYPE #3--"WINDING--PROTECTED, NON-SPECIFIC"

○ SPACE HEATER REQD ☐ RATED AT: _____ WATTS
◎ VOLTS ____ PHASE ____ HERTZ ____
◎ MAX SHEATH TEMPERATURE: _____ °C
○ SEPARATE JUNCTION BOX FOR SPACE HEATER LEADS

MOTOR THRUST LOAD: ○ _____ (kg) ○ NONE
DIRECTION OF THRUST: ○ TOWARD COUPLING
○ AWAY FROM COUPLING
☐ MOTOR THRUST RATING: _____ (kg)

TESTING

IEEE TESTING: ○ OBSVD ○ WIT ○ SUBMIT CERT'D RESULTS
○ SPECIAL TESTING: _____

MISCELLANEOUS

PAINTING: ○ IEEE 841 STD ○ OTHER _____
○ _____

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SI UNITS (bar)

JOB NO. _____ ITEM NO. _____
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ALLOWABLE PIPING FORCES AND MOMENTS (6.4)

	COMPRESSOR INLET		COMPRESSOR DISCHARGE		PACKAGE OUTLET	
	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)
AXIAL						
VERT						
TRANS						

ADDITIONAL DATA:

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CENTRIFUGAL AIR COMPRESSOR PERFORMANCE CURVES

When this requisition is issued for purchase, the supplier's proposed curves for the selected compressor will be inserted here as a substitute for this sheet.

The compressor performance and characteristics as given on this performance curve will be a part of the supplier's contractual obligation within the tolerances agreed upon.

REVISION	0	1	2	3	4
DATE					
BY					
REV/APPR					

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET
Hybrid

JOB NO. _____ ITEM NO. _____
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APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT
FOR _____ UNIT _____
SITE _____ NO. REQUIRED _____
SERVICE _____ DRIVER ITEM NO. _____
○ CONTINUOUS ○ INTERMITTENT ○ STANDBY (3.30) SPARED BY: _____
NOTE: INFORMATION TO BE COMPLETED: ○ BY PURCHASER ☐ BY MANUFACTURER ◯ BY PURCHASER OR MFR

GENERAL

COMPRESSOR MFR _____ MODEL (SIZE AND TYPE) _____ SERIAL NO. _____
DRIVER MFR _____ DRIVER TYPE _____ RATED 0 _____ RPM _____
DRIVE SYSTEM: ○ DIRECT COUPLED ○ OTHER _____ DUTY (1.2) ○ BASIC ○ SPECIAL

OPERATING CONDITIONS (6.1.9)

(ALL DATA ON PER UNIT BASIS)	RATED (3.24)	LOW AMB * (7.10.1)	MIN AMB	OTHER
○ DELIVERED FLOW,				
○ WEIGHT FLOW, 0 (WET) (DRY)				
○ INLET COOLING WATER TEMP, 0				
INLET CONDITIONS:				
○ PRESSURE 0				
○ TEMPERATURE 0				
○ RELATIVE HUMIDITY %				
○ MOLECULAR WEIGHT (M)				
☐ INLET VOLUME, 0 (WET / DRY)				
DISCHARGE CONDITIONS:				
○ PRESSURE 0				
☐ TEMPERATURE 0				
PERFORMANCE:				
☐ MAX 0 REQUIRED (ALL LOSSES INCL)				
☐ 0 AIR DELIVERED				
☐ INPUT SPEED 0				
☐ ESTIMATED SURGE, 0 (@ ABOVE SPEED)				
○ MAX DP ACROSS INLET FILTER, 0				
DP INCLUDED IN CALCULATION ☐ YES ☐ NO				
◯ AFTERCOOLER OUTLET TEMP, 0				
☐ PERFORMANCE CURVE NO.				
☐ % RISE TO SURGE (6.1.12.2)				
☐ _____				
☐ _____				

* UNTHROTTLED PERFORMANCE FOR DRIVER SIZING

CONTROL SYSTEM (7.4.2)

CONTROL METHOD: (7.4.2.1)
○ CAPACITY MODULATION (CONST DISCH PRESS) (7.4.2.1 a.)
○ INLET THROTTLE DEVICE ○ DAMPER
○ GLOBE VALVE ○ BUTTERFLY VALVE
○ VARIABLE INLET GUIDE VANES
○ AUTOMATIC DUAL CONTROL (7.4.2.1 b.)
○ _____ 0 TO _____ 0 DISCH PRESS
○ AUTO START AND STOP (7.4.2.1 c.)
○ START _____ 0 STOP _____ 0
○ OTHER (DESCRIBE): _____

CONTROL SYSTEM REQUIREMENTS:
○ UNIT OPERATES IN PARALLEL (7.4.2.2)
○ W/CENTRIFUGAL
○ W/ROTARY ○ W/RECIPROCATING
○ MICROPROCESSOR CAPABLE OF COMMUNICATION WITH PURCHASER'S DCS (7.4.1.4)
○ COMM PROTOCOL _____

CONTROL SYSTEM ALTERNATES: (7.4.1.3)
○ OTHER THAN MICROPROCESSOR BASED: _____
○ SUITABLE FOR INDOOR ONLY
○ FURNISHED BY PURCHASER

INTER- AND AFTER-COOLERS (7.6)

REMARKS: _____

AFTERCOOLER:
○ FURNISHED BY PURCHASER (7.6.1)
○ NOT NEEDED (7.6.1)
○ AIR-COOLED TYPE BY VENDOR
○ AIR-COOLED INTERCOOLERS REQD (7.6.3, 7.6.6)
○ FURNISHED BY PURCHASER
◯ AIR-COOLED EXCHANGER AUTOMATIC TEMPERATURE CONTROL MEANS: (7.6.6)
○ LOUVERS ○ VARIABLE SPEED FANS
○ VARIABLE PITCH FANS ○ BYPASS VALVE
◯ AIR-COOLER CONTROL MANUAL ONLY (7.6.6) BY:
○ LOUVERS ○ BYPASS VALVE
○ VARIABLE PITCH FANS

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET

Hybrid

JOB NO. _____ ITEM NO. _____

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○ LOCATION, SITE DATA (6.1.5)

LOCATION:

○ INDOOR ○ HEATED ○ UNDER ROOF

○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES

○ GRADE ○ MEZZANINE ○ _____

○ WINTERIZATION REQD ○ TROPICALIZATION REQD

SITE DATA:

○ ELEVATION _____ 0 ○ BAROMETER _____ 0

○ RANGE OF AMBIENT TEMPERATURE, 0

	DRY BULB	WET BULB
NORMAL		
MAXIMUM		
MINIMUM		

UNUSUAL CONDITIONS:

○ DUST ○ FUMES ○ CORROSIVE CONDITIONS

○ CORROSIVES PRESENT: _____

○ CONDITIONS CAUSE STRESS CORROSION CRACKING

○ OTHER _____

AREA ELECTRICAL CLASSIFICATION: (6.1.8) T-CODE ____

○ CLASS _____ GROUP _____ DIVISION _____

○ LOCAL ELECTRICAL CODES: _____

○ UTILITY CONDITIONS:

○ **STEAM HEATING:**

INLET MIN	0	0
NORM	0	0
MAX	0	0
OUTLET MIN	0	0
NORM	0	0
MAX	0	0

○ **ELECTRICITY:**

	HEATING	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ **COOLING WATER: (6.1.6)**

TEMP INLET _____ 0 MAX RETURN _____ 0

PRESS NORM _____ 0 DESIGN _____ 0

MIN RETURN _____ 0 MAX ALLOW DP _____ 0

WATER SOURCE _____

○ **AIR/NITROGEN:**

MAX PRESS _____ 0 MIN PRESS _____ 0

GAS COMPOSITION _____

REMARKS: _____

○ SPECIFICATIONS

NOISE SPECIFICATIONS: (6.1.3)

○ MAX ALLOWABLE SPL _____ 0

○ APPLICABLE SPEC _____

ACOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:

API 672 AND ○ _____

○ NON-ASME WELDING IF NOT AWS D1.1: (6.10.3.5) _____

○ UNITS OF MEASURE (5.1) ○ US CUSTOMARY ○ SI ○ OTHER _____

PAINTING:

○ MANUFACTURER'S STD

○ OTHER _____

BASEPLATE GROUT: (7.10.3) ○ EPOXY ○ CEMENT ○ NONE

PREPARATION FOR GROUT SURFACES: (7.10.3)

○ MFR STD ○ SSPC 6 BLAST ○ BARE FOR FIELD BLAST

○ INORGANIC ZINC SILICATE COATING

○ OTHER _____

SHIPMENT: (8.4.1)

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD

○ OUTDOOR STORAGE OVER 6 MONTHS

☐ UTILITY CONSUMPTION (9.2.3 i.)

STEAM:

OIL HEATER: _____ 0 OTHER _____ 0

ELECTRIC:

		LOCKED ROTOR AMPS 0	FULL LOAD AMPS
MAIN LO PUMP			
AUX LO PUMP			

OIL HEATER _____ 0 SPACE HEATER _____ 0

CONTROL SYSTEM LOAD: _____ 0

COOLING WATER:

	L.O. COOLER	INTER-COOLER	AFTER-COOLER	OTHER
QUANTITY, 0				
OUTLET TEMP, 0				
PRESS DROP, 0				
TOTAL CW, 0				

AIR/NITROGEN:	INLET PRESS 0	QUANTITY 0
SEAL SYSTEM:		
CONTROL PANEL:		
LO RESERVOIR:		
INSTR HOUSINGS:		
CONTROL SYSTEM:		
OTHER: _____		

TOTAL PURGE, 0 _____

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CONSTRUCTION FEATURES

☐ **COMPRESSOR SPEEDS:**
RATED INPUT: _____ 0 TRIP _____ 0
BULLGEAR CRITICALS: 1st _____ 0
PINION CRITICALS:
1st STG PINION 1st _____ 0 2nd _____ 0
2nd STG PINION 1st _____ 0 2nd _____ 0
3rd STG PINION 1st _____ 0 2nd _____ 0
4th STG PINION 1st _____ 0 2nd _____ 0
OTHER UNDESIRABLE SPEEDS: (6.7.1.3) _____

	STAGE SPEED	IMPELLER DIAMETER	TIP SPEED
1st STAGE	_____ 0	_____ 0	_____ 0
2nd STAGE	_____ 0	_____ 0	_____ 0
3rd STAGE	_____ 0	_____ 0	_____ 0
4th STAGE	_____ 0	_____ 0	_____ 0

☐ **IMPELLERS: (6.5.2)**
NO. OF IMPELLERS: _____ MATERIAL _____
TYPE (OPEN, RADIAL, BACKWARD LEANING, ETC.) _____
TYPE CONSTRUCTION: (6.5.2.2) _____
METHOD OF ATTACH: (6.5.2.2) _____
ROTATION, VIEWED FROM INPUT SHAFT END: ☐ CW ☐ CCW

☐ **COMPRESSOR CASING:**
MODEL _____ CASING SPLIT _____

	STG 1	STG 2	STG 3	STG 4
MATERIAL				
MAWP, 0				
HYDRO TEST, 0				
MAX OPT TEMP, 0				

○ MIN DESIGN METAL TEMP (6.10.5) _____ 0
☐ CASING HEAT TREATMENT REQUIRED (6.10.3.1.1)
☐ ULTIMATE STRESS FOR MATL (6.2.1) _____ 0
☐ CASTING FACTOR (6.2.1) _____
WELDED CONNECTIONS--NDT PROVIDED
○ 100% RADIOGRAPH ○ MAG PARTICLE ○ LIQ PENETRANT
○ _____

☐ **COMPRESSOR BEARINGS & BEARING HOUSINGS:**
BEARING HSG MATERIAL: _____
PINION RADIAL BEARINGS: (6.8.2)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, 0				
ACTUAL LOAD, 0				
BRG SPAN, 0				

PINION THRUST BEARINGS: (6.8.3)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, 0				
ACTUAL LOAD, 0				
THRUST COLLAR				

☐ **INTEGRAL GEAR HOUSING:**
MATERIAL _____ SPLIT _____

☐ **BULL GEAR: (6.5.3), (6.12.2)**
RATED POWER BASED ON TOOTH SURFACE DURABILITY: _____ 0
RATED POWER BASED ON TOOTH BENDING: _____ 0
○ MIN AGMA SERVICE FACTOR: _____ ☐ ACTUAL S.F. _____
GEAR RIM MATERIAL: _____ HARDNESS: _____
GEAR FACE WIDTH: _____ 0 GEAR CENTER MATL: _____
MECHANICAL EFFICIENCY: _____ % ISO 1328 GRADE: _____
PITCH DIA _____ 0 PITCH LINE VELOCITY _____ 0

☐ **PINIONS: (6.5.3), (6.12.2)**

	1st	2nd	3rd	4th
SERVICE FACTOR:				
MATERIAL:				
HARDNESS: (BHN) (R_c)				

☐ **BULL GEAR SHAFT:**
☐ REPLACEABLE ☐ INTEGRAL W/GEAR
MATL: _____ HARDNESS: _____ (BHN) (R_c)
BRG SPAN _____ 0 WEIGHT (W/GEAR) _____ 0
DIA @ GEAR _____ 0 DIA @ COUPLING _____ 0
SHAFT SLEEVES AT SEALS: MATL _____
SHAFT LABYS: TYPE _____ MATL _____
BULL GEAR RADIAL BRG TYPE: _____ LENGTH _____ 0
ALLOW LOAD _____ 0 ACTUAL LOAD _____ 0

☐ **BULL GEAR THRUST BEARINGS: (6.8.3)**
LOCATION _____ TYPE _____
MFR _____ AREA _____ 0
THRUST COLLAR (6.8.3.6) ☐ INTEGRAL ☐ REPLACEABLE
ALLOW LOAD _____ 0 ACTUAL LOAD _____ 0
GAS LOAD _____ 0 COUPLING LOAD _____ 0
BEARINGS FITTED W/TEMP SENSORS (6.12.10, 6.12.11)
○ PINION RADIAL BRG ○ BULL GEAR RADIAL BRG
○ THRUST BRG _____

○ **MAIN CONNECTIONS: (6.3)**

	SIZE	ASME RATING	FACING	POSITION
COMPR INLET				
COMPR DISCH				
PKG OUTLET				
ATM BLOWOFF				
FILTER OUTLET				

☐ **OTHER CONNECTIONS:**

	NO.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
COOLING WATER INLET			
PRESSURE GAUGE			
TEMPERATURE GAUGE			
CONDENSATE DRAINS			

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VIBRATION DETECTORS: (7.4.4.5), (7.10.10)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
○ NO. AT EACH PINION BEARING _____ TOTAL NO. _____
○ NO. AT EACH DRIVER BEARING _____ TOTAL NO. _____
☐ X&Y RADIAL PROBES CAN BE MOUNTED ADJACENT TO IMPELLERS FOR:
☐ 1st STG ☐ 2nd STG ☐ 3rd STG ☐ 4th STG

OSCILLATOR-DEMODULATORS:
○ MFR _____ ☒ MODEL _____
○ MONITOR SUPPLIED BY _____
○ MFR _____ ☒ MODEL _____
○ LOCATION _____ ENCLOSURE _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____0
○ SHUTDOWN: ☐ SET @ ____0 ○ TIME DELAY ____SEC
○ PER API 670 (7.10.10), (7.10.11)

BEARING-TEMPERATURE MONITOR: (7.10.12)
○ REQD ○ SUPPLIED BY: _____ ○ PER API 670
○ MFR _____ ☒ MODEL _____

AXIAL POSITION MOVEMENT DETECTOR: (7.10.10, 7.10.11)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____0
○ SHUTDOWN: ☐ SET @ ____0 ○ TIME DELAY ____0

DYNAMICS: (6.7), (6.12)
○ CRITICAL LATERAL SPEEDS ARE PROVEN BY PRIOR UNITS (6.7.2)
○ DAMPED UNBALANCED RESPONSE ANALYSIS REQD (6.12.3)
○ TORSIONAL VIBRATION ANALYSIS OF TRAIN REQD (6.12.5)
○ RESIDUAL UNBALANCE WORKSHEET REQD (6.12.8)
☒ REMARKS _____

COUPLINGS: (7.2.1)
TYPE: ☒ DISK PAK ☒ DIAPHRAGM ○ OTHER _____
DISK MATL: ☒ STAINLESS STEEL ☒ COATED W/ _____
☒ MAKE _____ ☒ MODEL _____
○ NON-LUBE ○ LUB'D ☒ LUBRICATION _____
☐ SPACER LENGTH _____0 ☒ LIMITED END-FLOAT REQD
☐ CPLG RATING _____ 0 @ 1.0 S.F. ACTUAL S.F. _____
☐ SHAFT JCT RATING: @ DRIVER ____0 @ INPUT SHAFT ____0
☒ MOUNTING ARRANGEMENT @ INPUT SHAFT: _____ DRIVER ____
☐ MFR MAX BORE _____0 PROPOSED BORE ____0 (7.2.1.6)
DRIVER HALF-CPLG MTD BY: ☒ DRIVER MFR ☒ COMPR VENDOR
☒ IDLING ADAPTER FOR DRIVER HALF-COUPLING REQD

PIPING REQUIREMENTS:
☐ RECOMMENDED STRAIGHT RUN OF PIPE DIA BEFORE SUCTION: _____
○ VENDOR TO OBSERVE FLANGE PARTING
○ THROUGH STUDS REQUIRED FOR PIPING FLANGES

MISCELLANEOUS:
○ VENDOR PRESENT DURING INITIAL ALIGN CHECK
○ VENDOR CHECK ALIGN AT OPERATING TEMP
○ BASE DESIGNED FOR COLUMN MOUNTING
○ THERMAL RELIEF VALVES PROVIDED BY VENDOR
○ FOR WATER-COOLED EXCHANGERS
○ FOR _____
○ PURCHASER WILL PREPARE COORDINATION MEETING AGENDA (9.1.3)

SHOP INSPECTIONS & TESTS: (8.1.1)
○ ADVANCE NOTIFICATION REQD _____ DAYS

	OBSERVED	WITNESSED
○ SHOP INSPECTION		
○ HYDROSTATIC (8.3.2)	○	○
○ COMBINED TEST (8.3.4), (8.5.6)	○	○
○ ASME PTC 10 TEST (8.3.4.1)	○	○
INCLUDES ○ AIR FILTER		
○ AFTERCOOLER		
○ _____		
○ GUIDE VANE TEST (8.5.12.1)	○	○
○ AT ____ NON-100% POSITIONS		
○ SOUND-LEVEL TEST	○	○
○ SPARE ROTOR TEST (8.5.12.2)	○	○
○ SPARE ROTOR MECH ONLY	○	○
○ IMPELLER OVERSPEED TEST (8.3.3)	○	○
○ POST OVERSPEED TEST NDE OF IMPELLERS (8.3.3.2)	○	○
○ RESIDUAL UNBALANCE CHECK (6.12.8)	○	○
○ OIL SYSTEM CLEANLINESS	○	○
○ CONTROL SYSTEM CHECK (8.3.4.5.5)	○	○
○ BRG, SEAL, GEAR CHECK (8.5.11.1, 6.5.11.2)	○	○
○ GEAR CONTACT CHECK (8.2.3.2)	○	○
○ CLEANLINESS CHECK--VESSELS (8.2.3.3)	○	○
○ CLEANLINESS CHECK--PIPING (8.2.3.3)	○	○
○ HARDNESS CHECK OF PINIONS (8.2.3.4)	○	○
○ OF BULL-GEAR	○	○
○ OF WELD REPAIRS	○	○
○ NDE OF MAJOR REPAIRS (8.2)	○	○
○ GEAR TOOTH MAG-PART (8.5.4)	○	○
○ FINAL INSPECTION PRIOR TO PAINT	○	○
○ INSPECTION OF PREP FOR SHIPMENT (8.4)	○	○
○ _____	○	○
○ _____	○	○

○ PRIOR DOCUMENTATION ON MAJOR REPAIRS NOT REQD (6.10.4.3)
○ RETAIN FINAL ASSEMBLY CLEARANCES (8.5.1)
○ SUBMITTAL OF INSPECTOR'S CHECKLIST (8.1.2)
SIGNED BY REP FOR: ○ PURCHASER ○ VENDOR
IF DESIGN REQUIRES DISASSEMBLY OF PINION FOR BRG INSPECTION,
○ FORGO BEARING INSPECTION BASED ON TEST DATA; OR
○ INSPECT BEARING AND RETEST (8.5.11.2)

☐ **WEIGHT:** 0
INTEG GEAR/COMPR _____ DRIVER _____
GEAR UPPER CASE _____ BULL-GEAR _____
1st STAGE PINION _____ 2nd STAGE PINION _____
INTERCOOLER _____ BUNDLE _____
AFTERCOOLER _____ BUNDLE _____
BASE _____ CONTROL PANEL _____
MAX FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS,** 0

	L	W	H
COMPLETE UNIT:			
CONTROL PANEL: (IF SEP)			
INLET FILTER-SILENCER:			
AFTERCOOLER: (IF FURN)			
OTHER:			

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LUBE OIL SYSTEM (6.9)

BASIC SYSTEM REQ'MNTS--NORMAL OIL FLOW

LUBE OIL TO: 0 0 0

- ☐ COMPR/GEAR
- ☐ DRIVER
- ☐ EXT GEAR
- ☐ OIL SYSTEM PRESSURES:
  - SUPPLY 0 PUMP RV SETTING 0
  - SYS DESIGN 0 HYDROTEST 0

OIL COOLER:

	SHELL SIDE	TUBE SIDE
☐ OPERATING PRESS, 0		
☐ MAX ALLOW WORK PRESS, 0		
☐ MAX ALLOW TEMP, 0		
☒ FOULING FACTOR		

- ☐ SURFACE AREA 0 DUTY 0
- ☒ REMOVABLE BUNDLE TO BE FURNISHED
- ☐ ASME CODE STAMPED ○ DESIGNED TO TEMA
- ☒ TUBES: NO. O.D. 0 LENGTH 0
  - WALL THICKNESS 0 ☐ AVG ☐ MIN
- ☒ MATERIALS
  - CHANNELS/HEADS SHELL
  - TUBES TUBE SHEETS
  - CHANNEL COVERS TUBE SUPPORTS

OIL FILTERS:

- ☒ MICRON RATING ○ NOMINAL ○ ABSOLUTE
- ☒ DP: 0 CLEAN DIRTY COLLAPSE
- ☒ ELEMENT: MAKE MODEL
- ☐ NO. ELEMENTS ☒ MEDIA
- ☒ CORE MATL ☒ HSG MATL
- ☐ HSG MAWP 0 ☐ MAX ALLOW TEMP 0

OIL HEATER: ####

- ☒ STEAM HEATER REQD ☐ ELECTRIC HEATER REQD NO ELEC
- ☐ RATING 0
- ☐ WATT DENSITY 0

OIL RESERVOIR:

- ☒ RETENTION TIME MIN ☐ CAPACITY 0
- ☐ FREE SURFACE AREA 0 ☐ INTERNAL BAFFLES

LUBRICANT: ☒ SYNTHETIC ☒ HYDROCARBON

- ☒ DESCRIPTION
- ☐ MIN ALLOW OIL TEMP 0 0

☒ SYSTEM COMPONENT SUPPLIERS:

	MFR	MODEL
MAIN PUMP		
STANDBY PUMP		
ELECTRIC MOTOR(S)		
STEAM TURBINE(S)		
OIL COOLER(S)		
OIL FILTERS		
ACCUMULATOR(S)		
SUCTION STRAINERS		
CHECK VALVES		
TRANSFER VALVE(S)		
PUMP COUPLING		
PUMP RELIEF VALVES		
ELECTRIC HEATER		

PUMPS:	MAIN	STANDBY
☒ HORIZONTAL		
☒ VERTICAL		
☒ SUBMERGED		
☒ MOTOR DRIVEN		
☒ TURBINE DRIVEN		
☒ SHAFT DRIVEN		
☒ CENTRIFUGAL		
☒ ROTARY		
☒ FLANGE CONNECTED		
☐ RATED CAPACITY 0		
☐ DISCHARGE PRESS 0		
☐ 0 @ MAX SSU		
☐ DRIVER RATING 0		
☒ CASING MATERIAL		
☐ SPEED		
☒ COUPLING		
☒ OSHA GUARD		
☒ MECHANICAL SEAL		

STANDBY PUMP CONTROL RESET:
○ MANUAL ○ AUTOMATIC ○ HOA SELECTOR SWITCH

SILENCERS

INLET AIR FILTER/SILENCER: (7.7)

- ☐ MFR MODEL
- ☐ DESCRIPTION
- ☐ PIPING CONNECTION
- ☐ CLEAN DP, AS QUOTED 0
- ☒ CORROSION PROTECTION
- ○ FILTER WILL BE REMOTE MOUNTED BY PURCHASER AT A DISTANCE 0 FROM COMPRESSOR
- ○ FILTER WILL BE ELEVATED 0 ABOVE GRADE

DISCHARGE BLOWOFF SILENCER: (7.8)

- ☐ MFR MODEL
- ☐ DESCRIPTION
- ☐ FLANGE CONNECTION
- MOUNTING ☒ HORIZONTAL ☒ VERTICAL
- SUPPORTED BY ☒ PIPING ☒ OTHER
- ☐ SPL (dBA) 0 FROM DISCHARGE OF SILENCER

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CONTROLS AND INSTRUMENTATION (7.4)

LOCAL CONTROL PANEL: (7.4.3)

○ ELECTRICAL AREA CLASSIFICATION:
CL _____ GR _____ DIV _____ ()

PANEL ENCLOSURE REQUIREMENT: (7.4.3.2)

☒ NEMA TYPE 4X ENCLOSURE MATERIAL: _____
☒ NEMA TYPE 7 (INDOOR EXPLOSION-PROOF FOR HAZARDOUS GAS AREAS) REQUIRED

PANEL FEATURES: (7.4.3.2)

○ VIBRATION ISOLATORS ○ STRIP HEATER ○ INTERNAL COOLING
○ WEATHERHOOD ☒ PURGE CONNECTIONS ○ OTHER _____

PURGE REQUIREMENT: (7.4.3.2)

☒ NONE ○ INSTRUMENT AIR ○ NITROGEN
☒ TYPE X--REDUCES THE CLASSIFICATION FROM DIV 1 TO NONHAZARDOUS
☒ TYPE Y--REDUCES THE CLASSIFICATION FROM DIV 1 TO DIV 2
☒ TYPE Z--REDUCES THE CLASSIFICATION FROM DIV 2 TO NONHAZARDOUS
○ TROPICALIZATION REQUIRED

☒ **INSTRUMENT SUPPLIERS:**

	MFR	SIZE & TYPE
PRESSURE GAUGES:		
TEMPERATURE GAUGES:		
LEVEL GAUGES:		
DIFF PRESSURE GAUGES:		
PRESSURE SWITCHES:		
TEMPERATURE SWITCHES:		
LEVEL SWITCHES:		
PRESSURE TRANSMITTERS:		
TEMPERATURE TRANSMITTERS:		
LEVEL TRANSMITTERS:		
CONTROL VALVES:		
PRESSURE RELIEF VALVES:		
THERMAL RELIEF VALVES:		
TEMPERATURE CONTROL VALVES:		
SIGHT FLOW INDICATORS:		
PURGE FLOW INDICATORS:		
SOLENOID VALVES:		
ANNUNCIATOR:		
TUBE FITTINGS		
_____		
_____		
_____		
_____		

SWITCH CLOSURES: (7.4.5.3.2)

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)

○ SHUTDOWN SYSTEMS ARE NOT TO BE PROVIDED WITH A MEANS TO PERMIT TESTING WITHOUT SHUTTING DOWN THE UNIT (7.4.5.3.4)
○ NON-SHUTDOWN DEVICES ARE NOT REQUIRED TO HAVE VALVING TO PERMIT REPLACEMENT DURING OPERATION
○ ISOLATION VALVES ARE REQUIRED FOR SHUTDOWN SENSING DEVICES

MISCELLANEOUS INSTRUMENTATION:

○ THROUGH FLOWING INSTRUMENT SENSING LINE REQUIRED
○ LIQUID-FILLED GAUGES ARE REQUIRED FOR AREAS SUBJECT TO VIBRATION
○ RELIEF VALVES MAY HAVE BODIES IN MATERIALS OTHER THAN STEEL ☒ RV BODY MATERIAL: _____
○ THERMAL RELIEF VALVES REQUIRED FOR COMPONENTS THAT CAN BE ISOLATED
○ FLOW INDICATOR TYPE/MATERIAL IF OTHER THAN BULLS EYE TYPE WITH STEEL BODY
○ PURGE REQUIRED FOR ANNUNCIATOR (7.4.3.2) NFPA 496 PURGE TYPE: ○ X ○ Y ○ Z ○ CONNECTION ONLY
○ COMBINATION BLOCK AND BLEED VALVES MAY BE SUBSTITUTED
○ _____
○ _____

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INSTRUMENTATION SCOPE OF SUPPLY

	ELEMENT											INDICATOR						
	PROV BY		TYPE			LOCATION			INSTALL BY		PROV BY	LOCATION						
	VENDOR	PURCHASER	DIRECT READOUT	SWITCH	TRANSMITTER (1)	VENDOR PKG	LOCAL PANEL	PURCH PIPING	VENDOR	PURCHASER	VENDOR	PURCHASER	VENDOR PKG	PURCH PIPING	LOCAL PANEL	ALARM	SHUTDOWN	REPEAT SIGNAL (2)
PRESSURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
LUBE OIL DISCHARGE																		
LUBE OIL FILTER DP																		
LUBE OIL SUPPLY																		
AIR FILTER/SILENCER DP																		
TEMPERATURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
OIL COOLER INLET & OUTLET																		
COMPRESSOR PINION JOURNAL BRG																		
BULL GEAR JOURNAL BRG																		
BULL GEAR THRUST BRG																		
DRIVER JOURNAL BRG																		
DRIVER THRUST BRG																		
RESERVOIR																		
LEVEL:																		
LUBE OIL RESERVOIR																		
SEPARATOR																		
VIBRATION:																		
RADIAL VIBRATION EACH STAGE																		
RADIAL VIBRATION BULL GEAR SHAFT																		
AXIAL POSITION BULL GEAR SHAFT																		
AXIAL POSITION _____ STAGE PINION																		
RADIAL VIBRATION ON DRIVER																		
AXIAL POSITION ON DRIVER SHAFT																		
ACCELEROMETER ON GEAR BOX																		
FLOW:																		
OIL RETURN																		
SEAL GAS																		
MISCELLANEOUS:																		
STANDBY L.O. PUMP RUNNING																		
PANEL PURGE FAILURE																		
ANNUNCIATOR PURGE FAILURE																		
SURGE RECOGNITION																		
OIL HEATER ON																		
COMMON REMOTE ALARM INDICATION																		
COMMON REMOTE SHUTDOWN INDICATION																		

NOTES: 1) TRANSMITTERS SUPPLIED BY VENDOR SHALL INCLUDE SENSING ELEMENT
2) SUPPLY "REPEAT SIGNAL" FOR CONTROL ROOM ALSO

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(INTER-) (AFTER-) COOLER(S) (7.6)

SERVICE OF UNIT: _____ ITEM NO. _____
SIZE: _____ TYPE: _____ ☐ HORIZ ☐ VERT CONNECTED IN ☐ PARALLEL ☐ SERIES
SURF/UNIT: (GROSS/EFF) _____ 0 SHELLS/UNIT: _____ SURF/SHELL: (GROSS/EFF) _____ 0

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL 0				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT 0				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID 0				
☐ SPECIFIC HEAT, 0				
☐ THERMAL CONDUCTIVITY, 0				
☐ LATENT HEAT, 0				
☐ INLET PRESSURE, 0				
☐ VELOCITY, 0				
☐ PRESSURE DROP--ALLOW/CALC, 0				
☐ FOULING RESISTANCE--MINIMUM 0				

☐ HEAT EXCHANGED _____ 0 MTD CORRECTED _____ 0
☐ TRANSFER RATE, 0 SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, 0		
DESIGN TEMPERATURE, 0		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, 0		
NOZZLES: INLET		
SIZE & OUTLET		
RATING VENT-DRAIN		

SKETCH: BUNDLE NOZZLE ORIENTATIONS

TUBE NO. _____ O.D. _____ 0 THK (MIN) (AVG) _____ 0 LENGTH _____ 0 PITCH _____ 0 ◁ 30 △ 60 ☐ 90 ◇ 45
TUBE TYPE _____ MATERIAL _____
SHELL MATL _____ I.D. _____ 0 O.D. _____ 0 SHELL COVER MATL _____ (INTEG)(REMOV)
CHANNEL OR BONNET MATL _____ CHANNEL COVER MATL _____
TUBESHEET--STATIONARY MATL _____ TUBESHEET--FLOATING MATL _____
FLOATING HEAD COVER MATL _____ IMPINGEMENT PROTECTION _____
BAFFLES--CROSS MATL _____ TYPE _____ % CUT (DIA) (AREA) _____ SPACING: C/C _____ INLET _____ 0
BAFFLES--LONG MATL _____ SEAL TYPE _____
SUPPORTS--TUBE _____ U-BEND _____ TYPE _____
BYPASS SEAL ARRANGEMENT _____ TUBE--TUBESHEET JOINT _____
GASKETS--SHELL SIDE _____ --TUBE SIDE _____
--FLOATING HEAD _____
ASME SECTION VIII CODE REQUIREMENTS: ☐ DESIGN & TEST ☐ STAMP ☐ NOT APPLICABLE TEMA CLASS _____
WEIGHT/SHELL _____ 0 FILLED WITH WATER _____ 0 BUNDLE _____ 0

REMARKS: _____

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NEMA FRAME INDUCTION MOTORS TO IEEE 841

MFR _____ MODEL _____ SERIAL NO. _____ NEMA FRAME _____
DRIVEN EQUIPMENT TYPE _____ DRIVEN EQUIPMENT ITEM NO. _____ MOTOR ITEM NO. _____

OPERATING CONDITIONS

SITE DATA:
ELECTRICAL SUPPLY: VOLT _____ PHASE _____ HERTZ _____
ELECTRICAL AREA CLASSIFICATION: ○ NON-HAZARDOUS
○ CLASS _____ GROUP _____ DIVISION _____
ATMOSPHERIC MIXTURE: _____
IGNITION TEMPERATURE: _____ 0 TEMP CODE: _____
ALTITUDE: ○ LESS THAN 0 ○ _____ 0
AMBIENT TEMPERATURE MINIMUM: _____ 0 MAXIMUM: _____ 0
UNUSUAL CONDITIONS: _____

DRIVE SYSTEM:
○ DIRECT CONNECTED ○ EXTERNAL GEAR
○ OTHER _____

STARTING: (7.1.2.2)
○ FULL VOLTAGE ○ REDUCED VOLTAGE _____ %
○ LOADED ○ UNLOADED
○ VOLTAGE DIP _____ %

PERFORMANCE

NO LOAD CURRENT, AMPS _____
FULL LOAD TORQUE, 0 _____
STARTS PER HOUR: _____ HOT _____ COLD
ACCELERATION TIME: _____ SEC

LOAD	CURRENT, AMP	EFFICIENCY	POWER FACTOR
FULL			
75%			
50%			
LOCKED ROTOR			

CONSTRUCTION FEATURES

☐ NAMEPLATE 0 _____ 0 _____ S.F. _____
NEMA TORQUE DESIGN: ○ A ○ B ○ C ○ D
☐ NEMA LOCKED ROTOR kVA CODE LETTER: _____

EFFICIENCY: ○ STANDARD ○ HIGH ○ PREMIUM

NOISE DESIGN: ○ STANDARD ○ LOW NOISE
○ MAX SOUND PRESSURE LEVEL (dBA) 0 _____
☐ EXPECTED SPL (dBA) 0 _____

ENCLOSURE: ○ TEFC ○ TENV ○ EXPLOSION PROOF
TEFC
MOUNTING: ◎ HORIZONTAL ◎ VERTICAL
◎ FOOT MOUNTED ◎ FLANGE MOUNTED
☐ SHAFT UP ☐ SHAFT DOWN

MAIN TERMINAL BOX MOUNTING LOCATION: ◎ F-1 ◎ F-2

FAN: ☐ REVERSIBLE ☐ UNI-DIRECTIONAL
○ NON-SPARKING

BEARING TYPE: ☐ BALL ☐ ROLLER ☐ SLEEVE
BRG LUBRICATION: ◎ GREASE ☐ RING OIL ○ OIL MIST
GREASE FITTING: ◎ PLUGGED ○ ALEMITE ○ OTHER _____
BRG SHIELDING: ☐ SINGLE ◎ DOUBLE ⬭ SEALED FOR LIFE

MOTOR ROTATION: (FACING END OPPOSITE SHAFT EXTENSION)
◎ CW ◎ CCW ◎ BI-DIRECTIONAL

INSULATION CLASS: ○ B ○ F ○ OTHER: _____
○ NON-HYGROSCOPIC ○ TROPICALIZED

◎ TEMPERATURE RISE: (DEFAULT IS 80°C ABOVE 40°C BY RES @ 1.0)
_____ °C ABOVE _____ °C BY _____ @ _____ S.F.

◎ MOTOR TO BE "THERMALLY PROTECTED"
◎ MOTOR TO BE "OVER TEMP PROTECTED"
☐ TYPE #1--"WINDING--RUNNING AND LOCKED-ROTOR PROTECTED"
☐ TYPE #2--"WINDING--RUNNING PROTECTED"
☐ TYPE #3--"WINDING--PROTECTED, NON-SPECIFIC"

○ SPACE HEATER REQD ☐ RATED AT: _____ WATTS
◎ VOLTS _____ PHASE _____ HERTZ _____
◎ MAX SHEATH TEMPERATURE: _____ °C
○ SEPARATE JUNCTION BOX FOR SPACE HEATER LEADS

MOTOR THRUST LOAD: ○ _____ 0 ○ NONE
DIRECTION OF THRUST: ○ TOWARD COUPLING
○ AWAY FROM COUPLING
☐ MOTOR THRUST RATING: _____ 0

TESTING

IEEE TESTING: ○ OBSVD ○ WIT ○ SUBMIT CERT'D RESULTS
○ SPECIAL TESTING: _____

MISCELLANEOUS

PAINTING: ○ IEEE 841 STD ○ OTHER _____
○ _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET
Hybrid

JOB NO. _____ ITEM NO. _____
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ALLOWABLE PIPING FORCES AND MOMENTS (6.4)

	COMPRESSOR INLET		COMPRESSOR DISCHARGE		PACKAGE OUTLET	
	FORCE, 0	MOMENT, 0	FORCE, 0	MOMENT, 0	FORCE, 0	MOMENT, 0
AXIAL						
VERT						
TRANS						

ADDITIONAL DATA: _____

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PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET Hybrid	JOB NO. _____ ITEM NO. _____ PAGE **11** OF **11** REQ'N NO.

CENTRIFUGAL AIR COMPRESSOR PERFORMANCE CURVES

When this requisition is issued for purchase, the supplier's proposed curves for the selected compressor will be inserted here as a substitute for this sheet.

The compressor performance and characteristics as given on this performance curve will be a part of the supplier's contractual obligation within the tolerances agreed upon.

REVISION	0	1	2	3	4
DATE					
BY					
REV/APPR					

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____

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APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR _____ UNIT _____

SITE _____ NO. REQUIRED _____

SERVICE _____ DRIVER ITEM NO. _____

○ CONTINUOUS ○ INTERMITTENT ○ STANDBY (3.30) SPARED BY: _____

NOTE: INFORMATION TO BE COMPLETED: ○ BY PURCHASER ☐ BY MANUFACTURER ◎ BY PURCHASER OR MFR

GENERAL

COMPRESSOR MFR _____ MODEL (SIZE AND TYPE) _____ SERIAL NO. _____

DRIVER MFR _____ DRIVER TYPE _____ RATED (BkW) _____ RPM _____

DRIVE SYSTEM: ○ DIRECT COUPLED ○ OTHER _____ DUTY (1.2) ○ BASIC ○ SPECIAL

OPERATING CONDITIONS (6.1.9)

(ALL DATA ON PER UNIT BASIS)	RATED (3.24)	LOW AMB * (7.10.1)	MIN AMB	OTHER
○ DELIVERED FLOW, NM_/H (101.3 kPaA & 0°C DRY)				
○ WEIGHT FLOW, (kg/h) (WET) (DRY)				
○ INLET COOLING WATER TEMP, (°C)				
INLET CONDITIONS:				
○ PRESSURE (kPaA)				
○ TEMPERATURE (°C)				
○ RELATIVE HUMIDITY %				
○ MOLECULAR WEIGHT (M)				
☐ INLET VOLUME, (m_/h) (WET / DRY)				
DISCHARGE CONDITIONS:				
○ PRESSURE (kPaA)				
☐ TEMPERATURE (°C)				
PERFORMANCE:				
☐ MAX (BkW) REQUIRED (ALL LOSSES INCL)				
☐ (BkW/ 100 m_/h) AIR DELIVERED				
☐ INPUT SPEED (rpm)				
☐ ESTIMATED SURGE, (m_/h) (@ ABOVE SPEED)				
○ MAX DP ACROSS INLET FILTER, (kPa)				
DP INCLUDED IN CALCULATION ☐ YES ☐ NO				
◎ AFTERCOOLER OUTLET TEMP, (°C)				
☐ PERFORMANCE CURVE NO.				
☐ % RISE TO SURGE (6.1.12.2)				
☐ _____				
☐ _____				

* UNTHROTTLED PERFORMANCE FOR DRIVER SIZING

CONTROL SYSTEM (7.4.2)

CONTROL METHOD: (7.4.2.1)

○ CAPACITY MODULATION (CONST DISCH PRESS) (7.4.2.1 a.)
- ○ INLET THROTTLE DEVICE ○ DAMPER
- ○ GLOBE VALVE ○ BUTTERFLY VALVE
- ○ VARIABLE INLET GUIDE VANES

○ AUTOMATIC DUAL CONTROL (7.4.2.1 b.)
- ○ _____ (kPaG TO _____ (kPaG) DISCH PRESS

○ AUTO START AND STOP (7.4.2.1 c.)
- ○ START _____ (kPaG) STOP _____ (kPaG)

○ OTHER (DESCRIBE): _____

CONTROL SYSTEM REQUIREMENTS:

○ UNIT OPERATES IN PARALLEL (7.4.2.2)
- ○ W/CENTRIFUGAL
- ○ W/ROTARY ○ W/RECIPROCATING

○ MICROPROCESSOR CAPABLE OF COMMUNICATION WITH PURCHASER'S DCS (7.4.1.4)
- ○ COMM PROTOCOL _____

CONTROL SYSTEM ALTERNATES: (7.4.1.3)

○ OTHER THAN MICROPROCESSOR BASED: _____

○ SUITABLE FOR INDOOR ONLY

○ FURNISHED BY PURCHASER

INTER- AND AFTER-COOLERS (7.6)

AFTERCOOLER:

○ FURNISHED BY PURCHASER (7.6.1)

○ NOT NEEDED (7.6.1)

○ AIR-COOLED TYPE BY VENDOR

○ AIR-COOLED INTERCOOLERS REQD (7.6.3, 7.6.6)
- ○ FURNISHED BY PURCHASER

◎ AIR-COOLED EXCHANGER AUTOMATIC TEMPERATURE CONTROL MEANS: (7.6.6)
- ○ LOUVERS ○ VARIABLE SPEED FANS
- ○ VARIABLE PITCH FANS ○ BYPASS VALVE

◎ AIR-COOLER CONTROL MANUAL ONLY (7.6.6) BY:
- ○ LOUVERS ○ BYPASS VALVE
- ○ VARIABLE PITCH FANS

REMARKS: _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET
SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____
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○ **LOCATION, SITE DATA (6.1.5)**

LOCATION:
○ INDOOR ○ HEATED ○ UNDER ROOF
○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES
○ GRADE ○ MEZZANINE ○ _____
○ WINTERIZATION REQD ○ TROPICALIZATION REQD

SITE DATA:
○ ELEVATION _____ (m) ○ BAROMETER _____ (kPaA)
○ RANGE OF AMBIENT TEMPERATURE, (°C)

	DRY BULB	WET BULB
NORMAL		
MAXIMUM		
MINIMUM		

UNUSUAL CONDITIONS:
○ DUST ○ FUMES ○ CORROSIVE CONDITIONS
○ CORROSIVES PRESENT: _____
○ CONDITIONS CAUSE STRESS CORROSION CRACKING
○ OTHER _____

AREA ELECTRICAL CLASSIFICATION: (6.1.8) T-CODE ____
○ CLASS _____ GROUP _____ DIVISION _____
○ LOCAL ELECTRICAL CODES: _____

○ **UTILITY CONDITIONS:**

○ **STEAM HEATING:**

INLET MIN	(kPaG)	(°C)
NORM	(kPaG)	(°C)
MAX	(kPaG)	(°C)
OUTLET MIN	(kPaG)	(°C)
NORM	(kPaG)	(°C)
MAX	(kPaG)	(°C)

○ **ELECTRICITY:**

	HEATING	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ **COOLING WATER: (6.1.6)**
TEMP INLET _____ (°C) MAX RETURN _____ (°C)
PRESS NORM _____ (kPaG) DESIGN _____ (kPaG)
MIN RETURN _____ (kPaG) MAX ALLOW DP _____ (kPa)
WATER SOURCE _____

○ **AIR/NITROGEN:**
MAX PRESS _____ (kPaG) MIN PRESS _____ (kPaG)
GAS COMPOSITION

REMARKS: _____

○ **SPECIFICATIONS**

NOISE SPECIFICATIONS: (6.1.3)
○ MAX ALLOWABLE SPL _____ (@ 1 m)
○ APPLICABLE SPEC _____
ACOUSTIC HOUSING: ○ YES ○ NO
APPLICABLE SPECIFICATIONS:
API 672 AND ○ _____
_____
○ NON-ASME WELDING IF NOT AWS D1.1: (6.10.3.5) _____
○ UNITS OF MEASURE (5.1) ○ US CUSTOMARY ○ SI ○ OTHER _____

PAINTING:
○ MANUFACTURER'S STD
○ OTHER _____
_____
BASEPLATE GROUT: (7.10.3) ○ EPOXY ○ CEMENT ○ NONE

PREPARATION FOR GROUT SURFACES: (7.10.3)
○ MFR STD ○ SSPC 6 BLAST ○ BARE FOR FIELD BLAST
○ INORGANIC ZINC SILICATE COATING
○ OTHER _____
_____

SHIPMENT: (8.4.1)
○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD
○ OUTDOOR STORAGE OVER 6 MONTHS
_____

☐ **UTILITY CONSUMPTION** (9.2.3 i.)

STEAM:
OIL HEATER: _____ (kg/h) OTHER _____ (kg/h)

ELECTRIC:

	(kW)	LOCKED ROTOR AMPS	FULL LOAD AMPS
MAIN LO PUMP			
AUX LO PUMP			

OIL HEATER _____ (kW) SPACE HEATER _____ (kW)
CONTROL SYSTEM LOAD: _____ (kW)

COOLING WATER:

	L.O. COOLER	INTER-COOLER	AFTER-COOLER	OTHER
QUANTITY, (L/min)				
OUTLET TEMP, (°C)				
PRESS DROP, (kPa)				
TOTAL CW, (L/min)				

AIR/NITROGEN:

	INLET PRESS (kPaG)	QUANTITY (m_/h)
SEAL SYSTEM:		
CONTROL PANEL:		
LO RESERVOIR:		
INSTR HOUSINGS:		
CONTROL SYSTEM:		
OTHER: _____		

TOTAL PURGE, (m_/h) _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____

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CONSTRUCTION FEATURES

☐ **COMPRESSOR SPEEDS:**

RATED INPUT: _____ (rpm) TRIP _____ (rpm)

BULLGEAR CRITICALS: 1st _____ (rpm)

PINION CRITICALS:

1st STG PINION	1st	(rpm)	2nd	(rpm)
2nd STG PINION	1st	(rpm)	2nd	(rpm)
3rd STG PINION	1st	(rpm)	2nd	(rpm)
4th STG PINION	1st	(rpm)	2nd	(rpm)

OTHER UNDESIRABLE SPEEDS: (6.7.1.3) _____

	STAGE SPEED		IMPELLER DIAMETER		TIP SPEED	
1st STAGE		(rpm)		(mm)		(m/hr)
2nd STAGE		(rpm)		(mm)		(m/hr)
3rd STAGE		(rpm)		(mm)		(m/hr)
4th STAGE		(rpm)		(mm)		(m/hr)

☐ **IMPELLERS: (6.5.2)**

NO. OF IMPELLERS: _____ MATERIAL _____

TYPE (OPEN, RADIAL, BACKWARD LEANING, ETC.) _____

TYPE CONSTRUCTION: (6.5.2.2) _____

METHOD OF ATTACH: (6.5.2.2) _____

ROTATION, VIEWED FROM INPUT SHAFT END: ☐ CW ☐ CCW

☐ **COMPRESSOR CASING:**

MODEL _____ CASING SPLIT _____

	STG 1	STG 2	STG 3	STG 4
MATERIAL				
MAWP, (kPaG)				
HYDRO TEST, (kPaG)				
MAX OPT TEMP, (°C)				

○ MIN DESIGN METAL TEMP (6.10.5) _____ (°C)

☐ CASING HEAT TREATMENT REQUIRED (6.10.3.1.1)

☐ ULTIMATE STRESS FOR MATL (6.2.1) _____ (MPa)

☐ CASTING FACTOR (6.2.1) _____

WELDED CONNECTIONS--NDT PROVIDED

☐ 100% RADIOGRAPH ☐ MAG PARTICLE ☐ LIQ PENETRANT

○ _____

☐ **COMPRESSOR BEARINGS & BEARING HOUSINGS:**

BEARING HSG MATERIAL: _____

PINION RADIAL BEARINGS: (6.8.2)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (kPa)				
ACTUAL LOAD, (kPa)				
BRG SPAN, (mm)				

PINION THRUST BEARINGS: (6.8.3)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (kPa)				
ACTUAL LOAD, (kPa)				
THRUST COLLAR				

☐ **INTEGRAL GEAR HOUSING:**

MATERIAL _____ SPLIT _____

☐ **BULL GEAR: (6.5.3), (6.12.2)**

RATED POWER BASED ON TOOTH SURFACE DURABILITY: _____ (kW)

RATED POWER BASED ON TOOTH BENDING: _____ (kW)

○ MIN AGMA SERVICE FACTOR: _____ ☐ ACTUAL S.F. _____

GEAR RIM MATERIAL: _____ HARDNESS: _____

GEAR FACE WIDTH: _____ (mm) GEAR CENTER MATL: _____

MECHANICAL EFFICIENCY: _____ % ISO 1328 GRADE: _____

PITCH DIA _____ (mm) PITCH LINE VELOCITY _____ (m/s)

☐ **PINIONS: (6.5.3), (6.12.2)**

	1st	2nd	3rd	4th
SERVICE FACTOR:				
MATERIAL:				
HARDNESS: (BHN) (R_c)				

☐ **BULL GEAR SHAFT:**

☐ REPLACEABLE ☐ INTEGRAL W/GEAR

MATL: _____ HARDNESS: _____ (BHN) (R_c)

BRG SPAN _____ (mm) WEIGHT (W/GEAR) _____ (kg)

DIA @ GEAR _____ (mm) DIA @ COUPLING _____ (mm)

SHAFT SLEEVES AT SEALS: MATL _____

SHAFT LABYS: TYPE _____ MATL _____

BULL GEAR RADIAL BRG TYPE: _____ LENGTH _____ (mm)

ALLOW LOAD _____ (kPa) ACTUAL LOAD _____ (kPa)

☐ **BULL GEAR THRUST BEARINGS: (6.8.3)**

LOCATION _____ TYPE _____

MFR _____ AREA _____ (mm_)

THRUST COLLAR (6.8.3.6) ☐ INTEGRAL ☐ REPLACEABLE

ALLOW LOAD _____ (kPa) ACTUAL LOAD _____ (kPa)

GAS LOAD _____ (kg) COUPLING LOAD _____ (kg)

BEARINGS FITTED W/TEMP SENSORS (6.12.10, 6.12.11)

○ PINION RADIAL BRG ○ BULL GEAR RADIAL BRG

○ THRUST BRG _____

☐ **MAIN CONNECTIONS: (6.3)**

	SIZE	ASME RATING	FACING	POSITION
COMPR INLET				
COMPR DISCH				
PKG OUTLET				
ATM BLOWOFF				
FILTER OUTLET				

☐ **OTHER CONNECTIONS:**

	NO.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
COOLING WATER INLET			
PRESSURE GAUGE			
TEMPERATURE GAUGE			
CONDENSATE DRAINS			

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____
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VIBRATION DETECTORS: (7.4.4.5), (7.10.10)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
○ NO. AT EACH PINION BEARING _____ TOTAL NO. _____
○ NO. AT EACH DRIVER BEARING _____ TOTAL NO. _____
☐ X&Y RADIAL PROBES CAN BE MOUNTED ADJACENT TO IMPELLERS FOR:
☐ 1st STG ☐ 2nd STG ☐ 3rd STG ☐ 4th STG

OSCILLATOR-DEMODULATORS:
○ MFR _____ ☒ MODEL _____
○ MONITOR SUPPLIED BY _____
○ MFR _____ ☒ MODEL _____
○ LOCATION _____ ENCLOSURE _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ _____ (μm)
○ SHUTDOWN: ☐ SET @ _____ (μm) ○ TIME DELAY _____ SEC
○ PER API 670 (7.10.10), (7.10.11)

BEARING-TEMPERATURE MONITOR: (7.10.12)
○ REQD ○ SUPPLIED BY: _____ ○ PER API 670
○ MFR _____ ☒ MODEL _____

AXIAL POSITION MOVEMENT DETECTOR: (7.10.10, 7.10.11)
☒ TYPE _____ ☒ MODEL _____
○ MFR _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ _____ (μm)
○ SHUTDOWN: ☐ SET @ _____ (μm) ○ TIME DELAY _____ (sec)

DYNAMICS: (6.7), (6.12)
○ CRITICAL LATERAL SPEEDS ARE PROVEN BY PRIOR UNITS (6.7.2)
○ DAMPED UNBALANCED RESPONSE ANALYSIS REQD (6.12.3)
○ TORSIONAL VIBRATION ANALYSIS OF TRAIN REQD (6.12.5)
○ RESIDUAL UNBALANCE WORKSHEET REQD (6.12.8)
☒ REMARKS _____

COUPLINGS: (7.2.1)
TYPE: ☒ DISK PAK ☒ DIAPHRAGM ○ OTHER _____
DISK MATL: ☒ STAINLESS STEEL ☒ COATED W/ _____
☒ MAKE _____ ☒ MODEL _____
○ NON-LUBE ○ LUB'D ☒ LUBRICATION _____
☐ SPACER LENGTH _____ (mm) ☒ LIMITED END-FLOAT REQD
☐ CPLG RATING _____ (kW/100 r @ 1.0 S.F. ACTUAL S.F. _____
☐ SHAFT JCT RATING: @ DRIVER _____ (kW) @ INPUT SHAFT _____ (kW)
☒ MOUNTING ARRANGEMENT @ INPUT SHAFT: _____ DRIVER _____
☐ MFR MAX BORE _____ (mm) PROPOSED BORE _____ (mm) (7.2.1.6)
DRIVER HALF-CPLG MTD BY: ☒ DRIVER MFR ☒ COMPR VENDOR
☒ IDLING ADAPTER FOR DRIVER HALF-COUPLING REQD

PIPING REQUIREMENTS:
☐ RECOMMENDED STRAIGHT RUN OF PIPE DIA BEFORE SUCTION: _____
○ VENDOR TO OBSERVE FLANGE PARTING
○ THROUGH STUDS REQUIRED FOR PIPING FLANGES

MISCELLANEOUS:
○ VENDOR PRESENT DURING INITIAL ALIGN CHECK
○ VENDOR CHECK ALIGN AT OPERATING TEMP
○ BASE DESIGNED FOR COLUMN MOUNTING
○ THERMAL RELIEF VALVES PROVIDED BY VENDOR
○ FOR WATER-COOLED EXCHANGERS
○ FOR _____
○ PURCHASER WILL PREPARE COORDINATION MEETING AGENDA (9.1.3)

SHOP INSPECTIONS & TESTS: (8.1.1)
○ ADVANCE NOTIFICATION REQD _____ DAYS

	OBSERVED	WITNESSED
○ SHOP INSPECTION		
○ HYDROSTATIC (8.3.2)	○	○
○ COMBINED TEST (8.3.4), (8.5.6)	○	○
○ ASME PTC 10 TEST (8.3.4.1)	○	○
INCLUDES ○ AIR FILTER		
○ AFTERCOOLER		
○ _____		
○ GUIDE VANE TEST (8.5.12.1)	○	○
○ AT _____ NON-100% POSITIONS		
○ SOUND-LEVEL TEST	○	○
○ SPARE ROTOR TEST (8.5.12.2)	○	○
○ SPARE ROTOR MECH ONLY	○	○
○ IMPELLER OVERSPEED TEST (8.3.3)	○	○
○ POST OVERSPEED TEST NDE OF IMPELLERS (8.3.3.2)	○	○
○ RESIDUAL UNBALANCE CHECK (6.12.8)	○	○
○ OIL SYSTEM CLEANLINESS	○	○
○ CONTROL SYSTEM CHECK (8.3.4.5.5)	○	○
○ BRG, SEAL, GEAR CHECK (8.5.11.1, 6.5.11.2)	○	○
○ GEAR CONTACT CHECK (8.2.3.2)	○	○
○ CLEANLINESS CHECK--VESSELS (8.2.3.3)	○	○
○ CLEANLINESS CHECK--PIPING (8.2.3.3)	○	○
○ HARDNESS CHECK OF PINIONS (8.2.3.4)	○	○
○ OF BULL-GEAR	○	○
○ OF WELD REPAIRS	○	○
○ NDE OF MAJOR REPAIRS (8.2)	○	○
○ GEAR TOOTH MAG-PART (8.5.4)	○	○
○ FINAL INSPECTION PRIOR TO PAINT	○	○
○ INSPECTION OF PREP FOR SHIPMENT (8.4)	○	○
○ _____	○	○
○ _____	○	○

○ PRIOR DOCUMENTATION ON MAJOR REPAIRS NOT REQD (6.10.4.3)
○ RETAIN FINAL ASSEMBLY CLEARANCES (8.5.1)
○ SUBMITTAL OF INSPECTOR'S CHECKLIST (8.1.2)
SIGNED BY REP FOR: ○ PURCHASER ○ VENDOR
IF DESIGN REQUIRES DISASSEMBLY OF PINION FOR BRG INSPECTION,
○ FORGO BEARING INSPECTION BASED ON TEST DATA; OR
○ INSPECT BEARING AND RETEST (8.5.11.2)

☐ **WEIGHT:** (kg)
INTEG GEAR/COMPR _____ DRIVER _____
GEAR UPPER CASE _____ BULL-GEAR _____
1st STAGE PINION _____ 2nd STAGE PINION _____
INTERCOOLER _____ BUNDLE _____
AFTERCOOLER _____ BUNDLE _____
BASE _____ CONTROL PANEL _____
MAX FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS,** (mm)

	L	W	H
COMPLETE UNIT:			
CONTROL PANEL: (IF SEP)			
INLET FILTER-SILENCER:			
AFTERCOOLER: (IF FURN)			
OTHER: _____			

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____
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LUBE OIL SYSTEM (6.9)

BASIC SYSTEM REQ'MNTS--NORMAL OIL FLOW

LUBE OIL TO:	(L/min)	(kPaG)	(SSU @ 37.7°C)
☐ COMPR/GEAR			
☐ DRIVER			
☐ EXT GEAR			

☐ OIL SYSTEM PRESSURES:
SUPPLY _____ (kPaG) PUMP RV SETTING _____ (kPaG)
SYS DESIGN _____ (kPaG) HYDROTEST _____ (kPaG)

OIL COOLER:

	SHELL SIDE	TUBE SIDE
☐ OPERATING PRESS, (kPaG)		
☐ MAX ALLOW WORK PRESS, (kPaG)		
☐ MAX ALLOW TEMP, (°C)		
☒ FOULING FACTOR		

☐ SURFACE AREA _____ (m_) DUTY _____ (kJ/hr)
☒ REMOVABLE BUNDLE TO BE FURNISHED
☐ ASME CODE STAMPED ○ DESIGNED TO TEMA _____
☒ TUBES: NO. _____ O.D. _____ (mm) LENGTH _____ (mm)
WALL THICKNESS _____ (mm) ☐ AVG ☐ MIN
☒ MATERIALS
CHANNELS/HEADS _____ SHELL _____
TUBES _____ TUBE SHEETS _____
CHANNEL COVERS _____ TUBE SUPPORTS _____

OIL FILTERS:

☒ MICRON RATING _____ ○ NOMINAL ○ ABSOLUTE
☒ DP: (kPa) CLEAN _____ DIRTY _____ COLLAPSE _____
☒ ELEMENT: MAKE _____ MODEL _____
☐ NO. ELEMENTS _____ ☒ MEDIA _____
☒ CORE MATL _____ ☒ HSG MATL _____
☐ HSG MAWP _____ (kPaG) ☐ MAX ALLOW TEMP _____ (°C)

OIL HEATER: ####
☒ STEAM HEATER REQD ☐ ELECTRIC HEATER REQD NO ELEC
☐ RATING _____ (kJ/hr)
☐ WATT DENSITY _____ (W/in_)

OIL RESERVOIR:

☒ RETENTION TIME _____ MIN ☐ CAPACITY _____ (l)
☐ FREE SURFACE AREA _____ (cm_) ☐ INTERNAL BAFFLES

LUBRICANT: ☒ SYNTHETIC ☒ HYDROCARBON
☒ DESCRIPTION _____
☐ MIN ALLOW OIL TEMP _____ (°C) _____ (SSU)

☒ SYSTEM COMPONENT SUPPLIERS:

	MFR	MODEL
MAIN PUMP		
STANDBY PUMP		
ELECTRIC MOTOR(S)		
STEAM TURBINE(S)		
OIL COOLER(S)		
OIL FILTERS		
ACCUMULATOR(S)		
SUCTION STRAINERS		
CHECK VALVES		
TRANSFER VALVE(S)		
PUMP COUPLING		
PUMP RELIEF VALVES		
ELECTRIC HEATER		

PUMPS:	MAIN	STANDBY
☒ HORIZONTAL		
☒ VERTICAL		
☒ SUBMERGED		
☒ MOTOR DRIVEN		
☒ TURBINE DRIVEN		
☒ SHAFT DRIVEN		
☒ CENTRIFUGAL		
☒ ROTARY		
☒ FLANGE CONNECTED		
☐ RATED CAPACITY (m_/h)		
☐ DISCHARGE PRESS (kPaG)		
☐ (BkW) @ MAX SSU		
☐ DRIVER RATING (kW)		
☒ CASING MATERIAL		
☐ SPEED		
☒ COUPLING		
☒ OSHA GUARD		
☒ MECHANICAL SEAL		

STANDBY PUMP CONTROL RESET:
○ MANUAL ○ AUTOMATIC ○ HOA SELECTOR SWITCH

SILENCERS

INLET AIR FILTER/SILENCER: (7.7)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ PIPING CONNECTION _____
☐ CLEAN DP, AS QUOTED _____ (kPa)
☒ CORROSION PROTECTION
○ FILTER WILL BE REMOTE MOUNTED BY PURCHASER AT A DISTANCE _____ (m) FROM COMPRESSOR
○ FILTER WILL BE ELEVATED _____ (m) ABOVE GRADE

DISCHARGE BLOWOFF SILENCER: (7.8)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ FLANGE CONNECTION _____
MOUNTING ☒ HORIZONTAL ☒ VERTICAL
SUPPORTED BY ☒ PIPING ☒ OTHER _____
☐ SPL (dBA) (@ 1 m) FROM DISCHARGE OF SILENCER _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET SI UNITS (kPa)

JOB NO. _____ ITEM NO. _____
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CONTROLS AND INSTRUMENTATION (7.4)

LOCAL CONTROL PANEL: (7.4.3)

○ ELECTRICAL AREA CLASSIFICATION:
CL _____ GR _____ DIV _____ ()

PANEL ENCLOSURE REQUIREMENT: (7.4.3.2)

◎ NEMA TYPE 4X ENCLOSURE MATERIAL: _____
◎ NEMA TYPE 7 (INDOOR EXPLOSION-PROOF FOR HAZARDOUS GAS AREAS) REQUIRED

PANEL FEATURES: (7.4.3.2)

○ VIBRATION ISOLATORS ○ STRIP HEATER ○ INTERNAL COOLING
○ WEATHERHOOD ◎ PURGE CONNECTIONS ○ OTHER _____

PURGE REQUIREMENT: (7.4.3.2)

◎ NONE ○ INSTRUMENT AIR ○ NITROGEN
◎ TYPE X--REDUCES THE CLASSIFICATION FROM DIV 1 TO NONHAZARDOUS
◎ TYPE Y--REDUCES THE CLASSIFICATION FROM DIV 1 TO DIV 2
◎ TYPE Z--REDUCES THE CLASSIFICATION FROM DIV 2 TO NONHAZARDOUS
○ TROPICALIZATION REQUIRED

◎ **INSTRUMENT SUPPLIERS:**

	MFR	SIZE & TYPE
PRESSURE GAUGES:		
TEMPERATURE GAUGES:		
LEVEL GAUGES:		
DIFF PRESSURE GAUGES:		
PRESSURE SWITCHES:		
TEMPERATURE SWITCHES:		
LEVEL SWITCHES:		
PRESSURE TRANSMITTERS:		
TEMPERATURE TRANSMITTERS:		
LEVEL TRANSMITTERS:		
CONTROL VALVES:		
PRESSURE RELIEF VALVES:		
THERMAL RELIEF VALVES:		
TEMPERATURE CONTROL VALVES:		
SIGHT FLOW INDICATORS:		
PURGE FLOW INDICATORS:		
SOLENOID VALVES:		
ANNUNCIATOR:		
TUBE FITTINGS		
_____		
_____		
_____		
_____		

SWITCH CLOSURES: (7.4.5.3.2)

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)

○ SHUTDOWN SYSTEMS ARE NOT TO BE PROVIDED WITH A MEANS TO PERMIT TESTING WITHOUT SHUTTING DOWN THE UNIT (7.4.5.3.4)
○ NON-SHUTDOWN DEVICES ARE NOT REQUIRED TO HAVE VALVING TO PERMIT REPLACEMENT DURING OPERATION
○ ISOLATION VALVES ARE REQUIRED FOR SHUTDOWN SENSING DEVICES

MISCELLANEOUS INSTRUMENTATION:

○ THROUGH FLOWING INSTRUMENT SENSING LINE REQUIRED
○ LIQUID-FILLED GAUGES ARE REQUIRED FOR AREAS SUBJECT TO VIBRATION
○ RELIEF VALVES MAY HAVE BODIES IN MATERIALS OTHER THAN STEEL ◎ RV BODY MATERIAL: _____
○ THERMAL RELIEF VALVES REQUIRED FOR COMPONENTS THAT CAN BE ISOLATED
○ FLOW INDICATOR TYPE/MATERIAL IF OTHER THAN BULLS EYE TYPE WITH STEEL BODY _____
○ PURGE REQUIRED FOR ANNUNCIATOR (7.4.3.2) NFPA 496 PURGE TYPE: ○ X ○ Y ○ Z ○ CONNECTION ONLY
○ COMBINATION BLOCK AND BLEED VALVES MAY BE SUBSTITUTED
○ _____
○ _____

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INSTRUMENTATION SCOPE OF SUPPLY

	ELEMENT											INDICATOR						
	PROV BY		TYPE			LOCATION			INSTALL BY		PROV BY	LOCATION						
	VENDOR	PURCHASER	DIRECT READOUT	SWITCH	TRANSMITTER (1)	VENDOR PKG	LOCAL PANEL	PURCH PIPING	VENDOR	PURCHASER	VENDOR	PURCHASER	VENDOR PKG	PURCH PIPING	LOCAL PANEL	ALARM	SHUTDOWN	REPEAT SIGNAL (2)
PRESSURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
LUBE OIL DISCHARGE																		
LUBE OIL FILTER DP																		
LUBE OIL SUPPLY																		
AIR FILTER/SILENCER DP																		
TEMPERATURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
OIL COOLER INLET & OUTLET																		
COMPRESSOR PINION JOURNAL BRG																		
BULL GEAR JOURNAL BRG																		
BULL GEAR THRUST BRG																		
DRIVER JOURNAL BRG																		
DRIVER THRUST BRG																		
RESERVOIR																		
LEVEL:																		
LUBE OIL RESERVOIR																		
SEPARATOR																		
VIBRATION:																		
RADIAL VIBRATION EACH STAGE																		
RADIAL VIBRATION BULL GEAR SHAFT																		
AXIAL POSITION BULL GEAR SHAFT																		
AXIAL POSITION _____ STAGE PINION																		
RADIAL VIBRATION ON DRIVER																		
AXIAL POSITION ON DRIVER SHAFT																		
ACCELEROMETER ON GEAR BOX																		
FLOW:																		
OIL RETURN																		
SEAL GAS																		
MISCELLANEOUS:																		
STANDBY L.O. PUMP RUNNING																		
PANEL PURGE FAILURE																		
ANNUNCIATOR PURGE FAILURE																		
SURGE RECOGNITION																		
OIL HEATER ON																		
COMMON REMOTE ALARM INDICATION																		
COMMON REMOTE SHUTDOWN INDICATION																		

NOTES: 1) TRANSMITTERS SUPPLIED BY VENDOR SHALL INCLUDE SENSING ELEMENT

2) SUPPLY "REPEAT SIGNAL" FOR CONTROL ROOM ALSO

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

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(INTER-) (AFTER-) COOLER(S) (7.6)

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

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (°C)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg °C)				
☐ THERMAL CONDUCTIVITY, (kJ/m h °C)				
☐ LATENT HEAT, (kJ/kg °C)				
☐ INLET PRESSURE, (kPaG)				
☒ VELOCITY, (m/s)				
☒ PRESSURE DROP--ALLOW/CALC, (kPa)				
☒ FOULING RESISTANCE--MINIMUM (hr m_ °C/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (°C)
☐ TRANSFER RATE, (kJ/hr m_ °C) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

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

SKETCH: BUNDLE NOZZLE ORIENTATIONS

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

REMARKS: _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)

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NEMA FRAME INDUCTION MOTORS TO IEEE 841

MFR MODEL SERIAL NO. NEMA FRAME
DRIVEN EQUIPMENT TYPE _____ DRIVEN EQUIPMENT ITEM NO. _____ MOTOR ITEM NO. _____

O OPERATING CONDITIONS

SITE DATA:
ELECTRICAL SUPPLY: VOLT _____ PHASE _____ HERTZ _____
ELECTRICAL AREA CLASSIFICATION: O NON-HAZARDOUS
O CLASS _____ GROUP _____ DIVISION _____
ATMOSPHERIC MIXTURE: _____
IGNITION TEMPERATURE: _____ (°C) TEMP CODE: _____
ALTITUDE: O LESS THAN (1000 m) O _____ (m)
AMBIENT TEMPERATURE MINIMUM: _____ (°C) MAXIMUM: _____ (°C)
UNUSUAL CONDITIONS: _____

DRIVE SYSTEM:
O DIRECT CONNECTED O EXTERNAL GEAR
O OTHER _____

STARTING: (7.1.2.2)
O FULL VOLTAGE O REDUCED VOLTAGE _____ %
O LOADED O UNLOADED
O VOLTAGE DIP _____ %

☐ PERFORMANCE

NO LOAD CURRENT, AMPS _____
FULL LOAD TORQUE, (N-m) _____
STARTS PER HOUR: _____ HOT _____ COLD
ACCELERATION TIME: _____ SEC

LOAD	CURRENT, AMP	EFFICIENCY	POWER FACTOR
FULL			
75%			
50%			
LOCKED ROTOR			

◯ CONSTRUCTION FEATURES

☐ NAMEPLATE (kW) _____ (rpm) _____ S.F. _____
NEMA TORQUE DESIGN: O A O B O C O D
☐ NEMA LOCKED ROTOR kVA CODE LETTER: _____

EFFICIENCY: O STANDARD O HIGH O PREMIUM

NOISE DESIGN: O STANDARD O LOW NOISE
O MAX SOUND PRESSURE LEVEL (dBA) (@ 1 m) _____
☐ EXPECTED SPL (dBA) (@ 1 m) _____

ENCLOSURE: O TEFC O TENV O EXPLOSION PROOF
TEFC
MOUNTING: ◯ HORIZONTAL ◯ VERTICAL
◯ FOOT MOUNTED ◯ FLANGE MOUNTED
☐ SHAFT UP ☐ SHAFT DOWN

MAIN TERMINAL BOX MOUNTING LOCATION: ◯ F-1 ◯ F-2

FAN: ☐ REVERSIBLE ☐ UNI-DIRECTIONAL
O NON-SPARKING

BEARING TYPE: ☐ BALL ☐ ROLLER ☐ SLEEVE
BRG LUBRICATION: ◯ GREASE ☐ RING OIL O OIL MIST
GREASE FITTING: ◯ PLUGGED O ALEMITE O OTHER _____
BRG SHIELDING: ☐ SINGLE ◯ DOUBLE ◯ SEALED FOR LIFE

MOTOR ROTATION: (FACING END OPPOSITE SHAFT EXTENSION)
◯ CW ◯ CCW ◯ BI-DIRECTIONAL

INSULATION CLASS: O B O F O OTHER: _____
O NON-HYGROSCOPIC O TROPICALIZED

◯ TEMPERATURE RISE: (DEFAULT IS 80°C ABOVE 40°C BY RES @ 1.0)
_____ °C ABOVE _____ °C BY _____ @ _____ S.F.

◯ MOTOR TO BE "THERMALLY PROTECTED"
◯ MOTOR TO BE "OVER TEMP PROTECTED"
☐ TYPE #1--"WINDING--RUNNING AND LOCKED-ROTOR PROTECTED"
☐ TYPE #2--"WINDING--RUNNING PROTECTED"
☐ TYPE #3--"WINDING--PROTECTED, NON-SPECIFIC"

O SPACE HEATER REQD ☐ RATED AT: _____ WATTS
◯ VOLTS _____ PHASE _____ HERTZ _____
◯ MAX SHEATH TEMPERATURE: _____ °C
O SEPARATE JUNCTION BOX FOR SPACE HEATER LEADS

MOTOR THRUST LOAD: O _____ (kg) O NONE
DIRECTION OF THRUST: O TOWARD COUPLING
O AWAY FROM COUPLING
☐ MOTOR THRUST RATING: _____ (kg)

TESTING

IEEE TESTING: O OBSVD O WIT O SUBMIT CERT'D RESULTS
O SPECIAL TESTING: _____

MISCELLANEOUS

PAINTING: O IEEE 841 STD O OTHER _____
O _____

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ALLOWABLE PIPING FORCES AND MOMENTS (6.4)

	COMPRESSOR INLET		COMPRESSOR DISCHARGE		PACKAGE OUTLET	
	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)
AXIAL						
VERT						
TRANS						

ADDITIONAL DATA:

02/03 10 OF 10 API672.XLS

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET SI UNITS (kPa)	JOB NO. _____ ITEM NO. _____ PAGE **11** OF **11** REQ'N NO.

CENTRIFUGAL AIR COMPRESSOR PERFORMANCE CURVES

When this requisition is issued for purchase, the supplier's proposed curves for the selected compressor will be inserted here as a substitute for this sheet.

The compressor performance and characteristics as given on this performance curve will be a part of the supplier's contractual obligation within the tolerances agreed upon.

REVISION	0	1	2	3	4
DATE					
BY					
REV/APPR					

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR _____ UNIT _____

SITE _____ NO. REQUIRED _____

SERVICE _____ DRIVER ITEM NO. _____

○ CONTINUOUS ○ INTERMITTENT ○ STANDBY (3.30) SPARED BY: _____

NOTE: INFORMATION TO BE COMPLETED: ○ BY PURCHASER ☐ BY MANUFACTURER ◎ BY PURCHASER OR MFR

GENERAL

COMPRESSOR MFR _____ MODEL (SIZE AND TYPE) _____ SERIAL NO. _____

DRIVER MFR _____ DRIVER TYPE _____ RATED (BkW) _____ RPM _____

DRIVE SYSTEM: ○ DIRECT COUPLED ○ OTHER _____ DUTY (1.2) ○ BASIC ○ SPECIAL

OPERATING CONDITIONS (6.1.9)

(ALL DATA ON PER UNIT BASIS)	RATED (3.24)	LOW AMB * (7.10.1)	MIN AMB	OTHER
○ DELIVERED FLOW, NM_/H (1.033 kg/cm_A & 0°C DRY)				
○ WEIGHT FLOW, (kg/h) (WET) (DRY)				
○ INLET COOLING WATER TEMP, (°C)				
INLET CONDITIONS:				
○ PRESSURE (kg/cm_A)				
○ TEMPERATURE (°C)				
○ RELATIVE HUMIDITY %				
○ MOLECULAR WEIGHT (M)				
☐ INLET VOLUME, (m_/h) (WET / DRY)				
DISCHARGE CONDITIONS:				
○ PRESSURE (kg/cm_A)				
☐ TEMPERATURE (°C)				
PERFORMANCE:				
☐ MAX (BkW) REQUIRED (ALL LOSSES INCL)				
☐ (BkW/ 100 m_/h) AIR DELIVERED				
☐ INPUT SPEED (rpm)				
☐ ESTIMATED SURGE, (m_/h) (@ ABOVE SPEED)				
○ MAX DP ACROSS INLET FILTER, (kg/cm_)				
DP INCLUDED IN CALCULATION ☐ YES ☐ NO				
◎ AFTERCOOLER OUTLET TEMP, (°C)				
☐ PERFORMANCE CURVE NO.				
☐ % RISE TO SURGE (6.1.12.2)				
☐ _____				
☐ _____				

* UNTHROTTLED PERFORMANCE FOR DRIVER SIZING

CONTROL SYSTEM (7.4.2)

CONTROL METHOD: (7.4.2.1)

○ CAPACITY MODULATION (CONST DISCH PRESS) (7.4.2.1 a.)
- ○ INLET THROTTLE DEVICE ○ DAMPER
- ○ GLOBE VALVE ○ BUTTERFLY VALVE
- ○ VARIABLE INLET GUIDE VANES

○ AUTOMATIC DUAL CONTROL (7.4.2.1 b.)
- ○ _____ (kg/cn TO _____ (kg/cm_G) DISCH PRESS

○ AUTO START AND STOP (7.4.2.1 c.)
- ○ START _____ (kg/cm_G) STOP _____ (kg/cm_G)

○ OTHER (DESCRIBE): _____

CONTROL SYSTEM REQUIREMENTS:

○ UNIT OPERATES IN PARALLEL (7.4.2.2)
- ○ W/CENTRIFUGAL
- ○ W/ROTARY ○ W/RECIPROCATING

○ MICROPROCESSOR CAPABLE OF COMMUNICATION WITH PURCHASER'S DCS (7.4.1.4)
- ○ COMM PROTOCOL _____

CONTROL SYSTEM ALTERNATES: (7.4.1.3)
- ○ OTHER THAN MICROPROCESSOR BASED: _____
- ○ SUITABLE FOR INDOOR ONLY
- ○ FURNISHED BY PURCHASER

INTER- AND AFTER-COOLERS (7.6)

REMARKS: _____

AFTERCOOLER:
- ○ FURNISHED BY PURCHASER (7.6.1)
- ○ NOT NEEDED (7.6.1)
- ○ AIR-COOLED TYPE BY VENDOR

○ AIR-COOLED INTERCOOLERS REQD (7.6.3, 7.6.6)
- ○ FURNISHED BY PURCHASER

◎ AIR-COOLED EXCHANGER AUTOMATIC TEMPERATURE CONTROL MEANS: (7.6.6)
- ○ LOUVERS ○ VARIABLE SPEED FANS
- ○ VARIABLE PITCH FANS ○ BYPASS VALVE

◎ AIR-COOLER CONTROL MANUAL ONLY (7.6.6) BY:
- ○ LOUVERS ○ BYPASS VALVE
- ○ VARIABLE PITCH FANS

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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LOCATION, SITE DATA (6.1.5)

LOCATION:

○ INDOOR ○ HEATED ○ UNDER ROOF

○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES

○ GRADE ○ MEZZANINE ○ _____

○ WINTERIZATION REQD ○ TROPICALIZATION REQD

SITE DATA:

○ ELEVATION _____ (m) ○ BAROMETER _____ (kg/cm_A)

○ RANGE OF AMBIENT TEMPERATURE, (°C)

	DRY BULB	WET BULB
NORMAL		
MAXIMUM		
MINIMUM		

UNUSUAL CONDITIONS:

○ DUST ○ FUMES ○ CORROSIVE CONDITIONS

○ CORROSIVES PRESENT: _____

○ CONDITIONS CAUSE STRESS CORROSION CRACKING

○ OTHER _____

AREA ELECTRICAL CLASSIFICATION: (6.1.8) T-CODE ____

○ CLASS _____ GROUP _____ DIVISION _____

○ LOCAL ELECTRICAL CODES: _____

UTILITY CONDITIONS:

○ **STEAM HEATING:**

INLET MIN	_____	(kg/cm_G)	_____	(°C)
NORM	_____	(kg/cm_G)	_____	(°C)
MAX	_____	(kg/cm_G)	_____	(°C)
OUTLET MIN	_____	(kg/cm_G)	_____	(°C)
NORM	_____	(kg/cm_G)	_____	(°C)
MAX	_____	(kg/cm_G)	_____	(°C)

○ **ELECTRICITY:**

	HEATING	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ **COOLING WATER: (6.1.6)**

TEMP INLET _____ (°C) MAX RETURN _____ (°C)

PRESS NORM _____ (kg/cm_G) DESIGN _____ (kg/cm_

MIN RETURN _____ (kg/cm_G) MAX ALLOW DP _____ (kg/cm_

WATER SOURCE _____

○ **AIR/NITROGEN:**

MAX PRESS _____ (kg/cm_G) MIN PRESS _____ (kg/cm_

GAS COMPOSITION _____

REMARKS: _____

SPECIFICATIONS

NOISE SPECIFICATIONS: (6.1.3)

○ MAX ALLOWABLE SPL _____ (@ 1 m)

○ APPLICABLE SPEC _____

ACOUSTIC HOUSING: ○ YES ○ NO

APPLICABLE SPECIFICATIONS:

API 672 AND ○ _____

○ NON-ASME WELDING IF NOT AWS D1.1: (6.10.3.5) _____

○ UNITS OF MEASURE (5.1) ○ US CUSTOMARY ○ SI ○ OTHER _____

PAINTING:

○ MANUFACTURER'S STD

○ OTHER _____

BASEPLATE GROUT: (7.10.3) ○ EPOXY ○ CEMENT ○ NONE

PREPARATION FOR GROUT SURFACES: (7.10.3)

○ MFR STD ○ SSPC 6 BLAST ○ BARE FOR FIELD BLAST

○ INORGANIC ZINC SILICATE COATING

○ OTHER _____

SHIPMENT: (8.4.1)

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD

○ OUTDOOR STORAGE OVER 6 MONTHS

☐ UTILITY CONSUMPTION (9.2.3 i.)

STEAM:

OIL HEATER: _____ (kg/h) OTHER _____ (kg/h)

ELECTRIC:

	(kW)	LOCKED ROTOR AMPS	FULL LOAD AMPS
MAIN LO PUMP			
AUX LO PUMP			

OIL HEATER _____ (kW) SPACE HEATER _____ (kW)

CONTROL SYSTEM LOAD: _____ (kW)

COOLING WATER:

	L.O. COOLER	INTER-COOLER	AFTER-COOLER	OTHER
QUANTITY, (L/min)				
OUTLET TEMP, (°C)				
PRESS DROP, (kg/cm_)				
TOTAL CW, (L/min)				

AIR/NITROGEN:	INLET PRESS (kg/cm_G)	QUANTITY (m_/h)
SEAL SYSTEM:		
CONTROL PANEL:		
LO RESERVOIR:		
INSTR HOUSINGS:		
CONTROL SYSTEM:		
OTHER: _____		

TOTAL PURGE, (m_/h) _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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CONSTRUCTION FEATURES

☐ **COMPRESSOR SPEEDS:**

RATED INPUT: _____ (rpm) TRIP _____ (rpm)

BULLGEAR CRITICALS: 1st (rpm)

PINION CRITICALS:

1st STG PINION	1st	(rpm)	2nd	(rpm)
2nd STG PINION	1st	(rpm)	2nd	(rpm)
3rd STG PINION	1st	(rpm)	2nd	(rpm)
4th STG PINION	1st	(rpm)	2nd	(rpm)

OTHER UNDESIRABLE SPEEDS: (6.7.1.3) _____

	STAGE SPEED		IMPELLER DIAMETER		TIP SPEED	
1st STAGE		(rpm)		(mm)		(m/hr)
2nd STAGE		(rpm)		(mm)		(m/hr)
3rd STAGE		(rpm)		(mm)		(m/hr)
4th STAGE		(rpm)		(mm)		(m/hr)

☐ **IMPELLERS: (6.5.2)**

NO. OF IMPELLERS: _____ MATERIAL _____

TYPE (OPEN, RADIAL, BACKWARD LEANING, ETC.) _____

TYPE CONSTRUCTION: (6.5.2.2) _____

METHOD OF ATTACH: (6.5.2.2) _____

ROTATION, VIEWED FROM INPUT SHAFT END: ☐ CW ☐ CCW

☐ **COMPRESSOR CASING:**

MODEL _____ CASING SPLIT _____

	STG 1	STG 2	STG 3	STG 4
MATERIAL				
MAWP, (kg/cm_G)				
HYDRO TEST, (kg/cm_G)				
MAX OPT TEMP, (°C)				

○ MIN DESIGN METAL TEMP (6.10.5) _____ (°C)

☐ CASING HEAT TREATMENT REQUIRED (6.10.3.1.1)

☐ ULTIMATE STRESS FOR MATL (6.2.1) _____ (MPa)

☐ CASTING FACTOR (6.2.1) _____

WELDED CONNECTIONS--NDT PROVIDED

☐ 100% RADIOGRAPH ☐ MAG PARTICLE ☐ LIQ PENETRANT

○ _____

☐ **COMPRESSOR BEARINGS & BEARING HOUSINGS:**

BEARING HSG MATERIAL: _____

PINION RADIAL BEARINGS: (6.8.2)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (kg/cm_)				
ACTUAL LOAD, (kg/cm_)				
BRG SPAN, (mm)				

PINION THRUST BEARINGS: (6.8.3)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (kg/cm_)				
ACTUAL LOAD, (kg/cm_)				
THRUST COLLAR				

☐ **INTEGRAL GEAR HOUSING:**

MATERIAL _____ SPLIT _____

☐ **BULL GEAR: (6.5.3), (6.12.2)**

RATED POWER BASED ON TOOTH SURFACE DURABILITY: _____ (kW)

RATED POWER BASED ON TOOTH BENDING: _____ (kW)

○ MIN AGMA SERVICE FACTOR: _____ ☐ ACTUAL S.F. _____

GEAR RIM MATERIAL: _____ HARDNESS: _____

GEAR FACE WIDTH: _____ (mm) GEAR CENTER MATL: _____

MECHANICAL EFFICIENCY: _____ % ISO 1328 GRADE: _____

PITCH DIA _____ (mm) PITCH LINE VELOCITY _____ (m/s)

☐ **PINIONS: (6.5.3), (6.12.2)**

	1st	2nd	3rd	4th
SERVICE FACTOR:				
MATERIAL:				
HARDNESS: (BHN) (R_c)				

☐ **BULL GEAR SHAFT:**

☐ REPLACEABLE ☐ INTEGRAL W/GEAR

MATL: _____ HARDNESS: _____ (BHN) (R_c)

BRG SPAN _____ (mm) WEIGHT (W/GEAR) _____ (kg)

DIA @ GEAR _____ (mm) DIA @ COUPLING _____ (mm)

SHAFT SLEEVES AT SEALS: MATL

SHAFT LABYS: TYPE _____ MATL _____

BULL GEAR RADIAL BRG TYPE: _____ LENGTH _____ (mm)

ALLOW LOAD _____ (kg/cm_) ACTUAL LOAD _____ (kg/cm_)

☐ **BULL GEAR THRUST BEARINGS: (6.8.3)**

LOCATION _____ TYPE _____

MFR _____ AREA _____ (mm_)

THRUST COLLAR (6.8.3.6) ☐ INTEGRAL ☐ REPLACEABLE

ALLOW LOAD _____ (kg/cm_) ACTUAL LOAD _____ (kg/cm_)

GAS LOAD _____ (kg) COUPLING LOAD _____ (kg)

BEARINGS FITTED W/TEMP SENSORS (6.12.10, 6.12.11)

○ PINION RADIAL BRG ○ BULL GEAR RADIAL BRG

○ THRUST BRG _____

☐ **MAIN CONNECTIONS: (6.3)**

	SIZE	ASME RATING	FACING	POSITION
COMPR INLET				
COMPR DISCH				
PKG OUTLET				
ATM BLOWOFF				
FILTER OUTLET				

☐ **OTHER CONNECTIONS:**

	NO.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
COOLING WATER INLET			
PRESSURE GAUGE			
TEMPERATURE GAUGE			
CONDENSATE DRAINS			

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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VIBRATION DETECTORS: (7.4.4.5), (7.10.10)

☒ TYPE _____ ☒ MODEL _____

○ MFR _____

○ NO. AT EACH PINION BEARING _____ TOTAL NO. _____

○ NO. AT EACH DRIVER BEARING _____ TOTAL NO. _____

☐ X&Y RADIAL PROBES CAN BE MOUNTED ADJACENT TO IMPELLERS FOR:

☐ 1st STG ☐ 2nd STG ☐ 3rd STG ☐ 4th STG

OSCILLATOR-DEMODULATORS:

○ MFR _____ ☒ MODEL _____

○ MONITOR SUPPLIED BY _____

○ MFR _____ ☒ MODEL _____

○ LOCATION _____ ENCLOSURE _____

☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (μm)

○ SHUTDOWN: ☐ SET @ ____ (μm) ○ TIME DELAY ____ SEC

○ PER API 670 (7.10.10), (7.10.11)

BEARING-TEMPERATURE MONITOR: (7.10.12)

○ REQD ○ SUPPLIED BY: _____ ○ PER API 670

○ MFR _____ ☒ MODEL _____

AXIAL POSITION MOVEMENT DETECTOR: (7.10.10, 7.10.11)

☒ TYPE _____ ☒ MODEL _____

○ MFR _____

☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (μm)

○ SHUTDOWN: ☐ SET @ ____ (μm) ○ TIME DELAY ____ (sec)

DYNAMICS: (6.7), (6.12)

○ CRITICAL LATERAL SPEEDS ARE PROVEN BY PRIOR UNITS (6.7.2)

○ DAMPED UNBALANCED RESPONSE ANALYSIS REQD (6.12.3)

○ TORSIONAL VIBRATION ANALYSIS OF TRAIN REQD (6.12.5)

○ RESIDUAL UNBALANCE WORKSHEET REQD (6.12.8)

☒ REMARKS _____

COUPLINGS: (7.2.1)

TYPE: ☒ DISK PAK ☒ DIAPHRAGM ○ OTHER _____

DISK MATL: ☒ STAINLESS STEEL ☒ COATED W/ _____

☒ MAKE _____ ☒ MODEL _____

○ NON-LUBE ○ LUB'D ☒ LUBRICATION _____

☐ SPACER LENGTH _____ (mm) ☒ LIMITED END-FLOAT REQD

☐ CPLG RATING _____ (kW/100 r @ 1.0 S.F. ACTUAL S.F. _____

☐ SHAFT JCT RATING: @ DRIVER ____ (kW) @ INPUT SHAFT ____ (kW)

☒ MOUNTING ARRANGEMENT @ INPUT SHAFT: _____ DRIVER ____

☐ MFR MAX BORE _____ (mm) PROPOSED BORE ____ (mm) (7.2.1.6)

DRIVER HALF-CPLG MTD BY: ☒ DRIVER MFR ☒ COMPR VENDOR

☒ IDLING ADAPTER FOR DRIVER HALF-COUPLING REQD

PIPING REQUIREMENTS:

☐ RECOMMENDED STRAIGHT RUN OF PIPE DIA BEFORE SUCTION: _____

○ VENDOR TO OBSERVE FLANGE PARTING

○ THROUGH STUDS REQUIRED FOR PIPING FLANGES

MISCELLANEOUS:

○ VENDOR PRESENT DURING INITIAL ALIGN CHECK

○ VENDOR CHECK ALIGN AT OPERATING TEMP

○ BASE DESIGNED FOR COLUMN MOUNTING

○ THERMAL RELIEF VALVES PROVIDED BY VENDOR

○ FOR WATER-COOLED EXCHANGERS

○ FOR _____

○ PURCHASER WILL PREPARE COORDINATION MEETING AGENDA (9.1.3)

SHOP INSPECTIONS & TESTS: (8.1.1)

○ ADVANCE NOTIFICATION REQD _____ DAYS

	OBSERVED	WITNESSED
○ SHOP INSPECTION		
○ HYDROSTATIC (8.3.2)	○	○
○ COMBINED TEST (8.3.4), (8.5.6)	○	○
○ ASME PTC 10 TEST (8.3.4.1)	○	○
INCLUDES ○ AIR FILTER		
○ AFTERCOOLER		
○ _____		
○ GUIDE VANE TEST (8.5.12.1)	○	○
○ AT ____ NON-100% POSITIONS		
○ SOUND-LEVEL TEST	○	○
○ SPARE ROTOR TEST (8.5.12.2)	○	○
○ SPARE ROTOR MECH ONLY	○	○
○ IMPELLER OVERSPEED TEST (8.3.3)	○	○
○ POST OVERSPEED TEST NDE OF IMPELLERS (8.3.3.2)	○	○
○ RESIDUAL UNBALANCE CHECK (6.12.8)	○	○
○ OIL SYSTEM CLEANLINESS	○	○
○ CONTROL SYSTEM CHECK (8.3.4.5.5)	○	○
○ BRG, SEAL, GEAR CHECK (8.5.11.1, 6.5.11.2)	○	○
○ GEAR CONTACT CHECK (8.2.3.2)	○	○
○ CLEANLINESS CHECK--VESSELS (8.2.3.3)	○	○
○ CLEANLINESS CHECK--PIPING (8.2.3.3)	○	○
○ HARDNESS CHECK OF PINIONS (8.2.3.4)	○	○
○ OF BULL-GEAR	○	○
○ OF WELD REPAIRS	○	○
○ NDE OF MAJOR REPAIRS (8.2)	○	○
○ GEAR TOOTH MAG-PART (8.5.4)	○	○
○ FINAL INSPECTION PRIOR TO PAINT	○	○
○ INSPECTION OF PREP FOR SHIPMENT (8.4)	○	○
○ _____	○	○
○ _____	○	○

○ PRIOR DOCUMENTATION ON MAJOR REPAIRS NOT REQD (6.10.4.3)

○ RETAIN FINAL ASSEMBLY CLEARANCES (8.5.1)

○ SUBMITTAL OF INSPECTOR'S CHECKLIST (8.1.2)

SIGNED BY REP FOR: ○ PURCHASER ○ VENDOR

IF DESIGN REQUIRES DISASSEMBLY OF PINION FOR BRG INSPECTION,

○ FORGO BEARING INSPECTION BASED ON TEST DATA; OR

○ INSPECT BEARING AND RETEST (8.5.11.2)

☐ **WEIGHT:** (kg)

INTEG GEAR/COMPR _____ DRIVER _____

GEAR UPPER CASE _____ BULL-GEAR _____

1st STAGE PINION _____ 2nd STAGE PINION _____

INTERCOOLER _____ BUNDLE _____

AFTERCOOLER _____ BUNDLE _____

BASE _____ CONTROL PANEL _____

MAX FOR MAINTENANCE (IDENTIFY) _____

TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS,** (mm)

COMPLETE UNIT: L _____ W _____ H _____

CONTROL PANEL: (IF SEP) L _____ W _____ H _____

INLET FILTER-SILENCER: L _____ W _____ H _____

AFTERCOOLER: (IF FURN) L _____ W _____ H _____

OTHER: L W H

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____
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LUBE OIL SYSTEM (6.9)

BASIC SYSTEM REQ'MNTS--NORMAL OIL FLOW

LUBE OIL TO:	(L/min)	(kg/cm_G)	(SSU @ 37.7°C)
☐ COMPR/GEAR			
☐ DRIVER			
☐ EXT GEAR			

☐ OIL SYSTEM PRESSURES:
SUPPLY _____ (kg/cm_G) PUMP RV SETTING _____ (kg/cm_G)
SYS DESIGN _____ (kg/cm_G) HYDROTEST _____ (kg/cm_G)

OIL COOLER:

	SHELL SIDE	TUBE SIDE
☐ OPERATING PRESS, (kg/cm_G)		
☐ MAX ALLOW WORK PRESS, (kg/cm_G)		
☐ MAX ALLOW TEMP, (°C)		
☒ FOULING FACTOR		

☐ SURFACE AREA _____ (m_) DUTY _____ (kJ/hr)
☒ REMOVABLE BUNDLE TO BE FURNISHED
☐ ASME CODE STAMPED ○ DESIGNED TO TEMA _____
☒ TUBES: NO. _____ O.D. _____ (mm) LENGTH _____ (mm)
WALL THICKNESS _____ (mm) ☐ AVG ☐ MIN
☒ MATERIALS
CHANNELS/HEADS _____ SHELL _____
TUBES _____ TUBE SHEETS _____
CHANNEL COVERS _____ TUBE SUPPORTS _____

OIL FILTERS:

☒ MICRON RATING _____ ○ NOMINAL ○ ABSOLUTE
☒ DP: (kg/cm_) CLEAN _____ DIRTY _____ COLLAPSE _____
☒ ELEMENT: MAKE _____ MODEL _____
☐ NO. ELEMENTS _____ ☒ MEDIA _____
☒ CORE MATL _____ ☒ HSG MATL _____
☐ HSG MAWP _____ (kg/cm_G) ☐ MAX ALLOW TEMP _____ (°C)

OIL HEATER: ####
☒ STEAM HEATER REQD ☐ ELECTRIC HEATER REQD NO ELEC
☐ RATING _____ (kJ/hr)
☐ WATT DENSITY _____ (W/in_)

OIL RESERVOIR:

☒ RETENTION TIME _____ MIN ☐ CAPACITY _____ (l)
☐ FREE SURFACE AREA _____ (cm_) ☐ INTERNAL BAFFLES

LUBRICANT: ☒ SYNTHETIC ☒ HYDROCARBON
☒ DESCRIPTION _____
☐ MIN ALLOW OIL TEMP _____ (°C) _____ (SSU)

☒ SYSTEM COMPONENT SUPPLIERS:

	MFR	MODEL
MAIN PUMP		
STANDBY PUMP		
ELECTRIC MOTOR(S)		
STEAM TURBINE(S)		
OIL COOLER(S)		
OIL FILTERS		
ACCUMULATOR(S)		
SUCTION STRAINERS		
CHECK VALVES		
TRANSFER VALVE(S)		
PUMP COUPLING		
PUMP RELIEF VALVES		
ELECTRIC HEATER		

PUMPS:	MAIN	STANDBY
☒ HORIZONTAL		
☒ VERTICAL		
☒ SUBMERGED		
☒ MOTOR DRIVEN		
☒ TURBINE DRIVEN		
☒ SHAFT DRIVEN		
☒ CENTRIFUGAL		
☒ ROTARY		
☒ FLANGE CONNECTED		
☐ RATED CAPACITY (m_/h)		
☐ DISCHARGE PRESS (kg/cm_G)		
☐ (BkW) @ MAX SSU		
☐ DRIVER RATING (kW)		
☒ CASING MATERIAL		
☐ SPEED		
☒ COUPLING		
☒ OSHA GUARD		
☒ MECHANICAL SEAL		

STANDBY PUMP CONTROL RESET:
○ MANUAL ○ AUTOMATIC ○ HOA SELECTOR SWITCH

SILENCERS

INLET AIR FILTER/SILENCER: (7.7)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ PIPING CONNECTION _____
☐ CLEAN DP, AS QUOTED _____ (kg/cm_)
☒ CORROSION PROTECTION _____
○ FILTER WILL BE REMOTE MOUNTED BY PURCHASER AT A DISTANCE _____ (m) FROM COMPRESSOR
○ FILTER WILL BE ELEVATED _____ (m) ABOVE GRADE

DISCHARGE BLOWOFF SILENCER: (7.8)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ FLANGE CONNECTION _____
MOUNTING ☒ HORIZONTAL ☒ VERTICAL
SUPPORTED BY ☒ PIPING ☒ OTHER _____
☐ SPL (dBA) (@ 1 m) FROM DISCHARGE OF SILENCER _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4TH ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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CONTROLS AND INSTRUMENTATION (7.4)

LOCAL CONTROL PANEL: (7.4.3)

○ ELECTRICAL AREA CLASSIFICATION:
CL _____ GR _____ DIV _____ ()

PANEL ENCLOSURE REQUIREMENT: (7.4.3.2)

☒ NEMA TYPE 4X ENCLOSURE MATERIAL: _____

☒ NEMA TYPE 7 (INDOOR EXPLOSION-PROOF FOR HAZARDOUS GAS AREAS) REQUIRED

PANEL FEATURES: (7.4.3.2)

○ VIBRATION ISOLATORS ○ STRIP HEATER ○ INTERNAL COOLING
○ WEATHERHOOD ☒ PURGE CONNECTIONS ○ OTHER _____

PURGE REQUIREMENT: (7.4.3.2)

☒ NONE ○ INSTRUMENT AIR ○ NITROGEN

☒ TYPE X--REDUCES THE CLASSIFICATION FROM DIV 1 TO NONHAZARDOUS

☒ TYPE Y--REDUCES THE CLASSIFICATION FROM DIV 1 TO DIV 2

☒ TYPE Z--REDUCES THE CLASSIFICATION FROM DIV 2 TO NONHAZARDOUS

○ TROPICALIZATION REQUIRED

☒ **INSTRUMENT SUPPLIERS:**

	MFR	SIZE & TYPE
PRESSURE GAUGES:		
TEMPERATURE GAUGES:		
LEVEL GAUGES:		
DIFF PRESSURE GAUGES:		
PRESSURE SWITCHES:		
TEMPERATURE SWITCHES:		
LEVEL SWITCHES:		
PRESSURE TRANSMITTERS:		
TEMPERATURE TRANSMITTERS:		
LEVEL TRANSMITTERS:		
CONTROL VALVES:		
PRESSURE RELIEF VALVES:		
THERMAL RELIEF VALVES:		
TEMPERATURE CONTROL VALVES:		
SIGHT FLOW INDICATORS:		
PURGE FLOW INDICATORS:		
SOLENOID VALVES:		
ANNUNCIATOR:		
TUBE FITTINGS		
_____		
_____		
_____		
_____		

SWITCH CLOSURES: (7.4.5.3.2)

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)

○ SHUTDOWN SYSTEMS ARE NOT TO BE PROVIDED WITH A MEANS TO PERMIT TESTING WITHOUT SHUTTING DOWN THE UNIT (7.4.5.3.4)

○ NON-SHUTDOWN DEVICES ARE NOT REQUIRED TO HAVE VALVING TO PERMIT REPLACEMENT DURING OPERATION

○ ISOLATION VALVES ARE REQUIRED FOR SHUTDOWN SENSING DEVICES

MISCELLANEOUS INSTRUMENTATION:

○ THROUGH FLOWING INSTRUMENT SENSING LINE REQUIRED

○ LIQUID-FILLED GAUGES ARE REQUIRED FOR AREAS SUBJECT TO VIBRATION

○ RELIEF VALVES MAY HAVE BODIES IN MATERIALS OTHER THAN STEEL ☒ RV BODY MATERIAL: _____

○ THERMAL RELIEF VALVES REQUIRED FOR COMPONENTS THAT CAN BE ISOLATED

○ FLOW INDICATOR TYPE/MATERIAL IF OTHER THAN BULLS EYE TYPE WITH STEEL BODY _____

○ PURGE REQUIRED FOR ANNUNCIATOR (7.4.3.2) NFPA 496 PURGE TYPE: ○ X ○ Y ○ Z ○ CONNECTION ONLY

○ COMBINATION BLOCK AND BLEED VALVES MAY BE SUBSTITUTED

○ _____

○ _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____

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INSTRUMENTATION SCOPE OF SUPPLY

	ELEMENT											INDICATOR						
	PROV BY		TYPE			LOCATION			INSTALL BY		PROV BY	LOCATION						
	VENDOR	PURCHASER	DIRECT READOUT	SWITCH	TRANSMITTER (1)	VENDOR PKG	LOCAL PANEL	PURCH PIPING	VENDOR	PURCHASER	VENDOR	PURCHASER	VENDOR PKG	PURCH PIPING	LOCAL PANEL	ALARM	SHUTDOWN	REPEAT SIGNAL (2)
PRESSURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
LUBE OIL DISCHARGE																		
LUBE OIL FILTER DP																		
LUBE OIL SUPPLY																		
AIR FILTER/SILENCER DP																		
TEMPERATURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
OIL COOLER INLET & OUTLET																		
COMPRESSOR PINION JOURNAL BRG																		
BULL GEAR JOURNAL BRG																		
BULL GEAR THRUST BRG																		
DRIVER JOURNAL BRG																		
DRIVER THRUST BRG																		
RESERVOIR																		
LEVEL:																		
LUBE OIL RESERVOIR																		
SEPARATOR																		
VIBRATION:																		
RADIAL VIBRATION EACH STAGE																		
RADIAL VIBRATION BULL GEAR SHAFT																		
AXIAL POSITION BULL GEAR SHAFT																		
AXIAL POSITION _____ STAGE PINION																		
RADIAL VIBRATION ON DRIVER																		
AXIAL POSITION ON DRIVER SHAFT																		
ACCELEROMETER ON GEAR BOX																		
FLOW:																		
OIL RETURN																		
SEAL GAS																		
MISCELLANEOUS:																		
STANDBY L.O. PUMP RUNNING																		
PANEL PURGE FAILURE																		
ANNUNCIATOR PURGE FAILURE																		
SURGE RECOGNITION																		
OIL HEATER ON																		
COMMON REMOTE ALARM INDICATION																		
COMMON REMOTE SHUTDOWN INDICATION																		

NOTES: 1) TRANSMITTERS SUPPLIED BY VENDOR SHALL INCLUDE SENSING ELEMENT

2) SUPPLY "REPEAT SIGNAL" FOR CONTROL ROOM ALSO

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____
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(INTER-) (AFTER-) COOLER(S) (7.6)

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

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (kg/h)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (°C)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (mPa-s)				
☐ SPECIFIC HEAT, (kJ/kg °C)				
☐ THERMAL CONDUCTIVITY, (kJ/m h °C)				
☐ LATENT HEAT, (kJ/kg °C)				
☐ INLET PRESSURE, (kg/cm_G)				
◯ VELOCITY, (m/s)				
◯ PRESSURE DROP--ALLOW/CALC, (kg/cm_)				
◯ FOULING RESISTANCE--MINIMUM (hr m_ °C/kJ)				

☐ HEAT EXCHANGED _____ (kJ/hr) MTD CORRECTED _____ (°C)
☐ TRANSFER RATE, (kJ/hr m_ °C) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

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

SKETCH: BUNDLE NOZZLE ORIENTATIONS

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

REMARKS: _____

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)

JOB NO. _____ ITEM NO. _____
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NEMA FRAME INDUCTION MOTORS TO IEEE 841

MFR _____ MODEL _____ SERIAL NO. _____ NEMA FRAME _____
DRIVEN EQUIPMENT TYPE _____ DRIVEN EQUIPMENT ITEM NO. _____ MOTOR ITEM NO. _____

○ **OPERATING CONDITIONS**

SITE DATA:
ELECTRICAL SUPPLY: VOLT _____ PHASE _____ HERTZ _____
ELECTRICAL AREA CLASSIFICATION: ○ NON-HAZARDOUS
○ CLASS _____ GROUP _____ DIVISION _____
ATMOSPHERIC MIXTURE: _____
IGNITION TEMPERATURE: _____ (°C) TEMP CODE: _____
ALTITUDE: ○ LESS THAN (1000 m) ○ _____ (m)
AMBIENT TEMPERATURE MINIMUM: _____ (°C) MAXIMUM: _____ (°C)
UNUSUAL CONDITIONS: _____

DRIVE SYSTEM:
○ DIRECT CONNECTED ○ EXTERNAL GEAR
○ OTHER _____

STARTING: (7.1.2.2)
○ FULL VOLTAGE ○ REDUCED VOLTAGE _____ %
○ LOADED ○ UNLOADED
○ VOLTAGE DIP _____ %

☐ **PERFORMANCE**

NO LOAD CURRENT, AMPS _____
FULL LOAD TORQUE, (N-m) _____
STARTS PER HOUR: _____ HOT _____ COLD
ACCELERATION TIME: _____ SEC

LOAD	CURRENT, AMP	EFFICIENCY	POWER FACTOR
FULL			
75%			
50%			
LOCKED ROTOR			

◎ **CONSTRUCTION FEATURES**

☐ NAMEPLATE (kW) _____ (rpm) _____ S.F. _____
NEMA TORQUE DESIGN: ○ A ○ B ○ C ○ D
☐ NEMA LOCKED ROTOR kVA CODE LETTER: _____

EFFICIENCY: ○ STANDARD ○ HIGH ○ PREMIUM

NOISE DESIGN: ○ STANDARD ○ LOW NOISE
○ MAX SOUND PRESSURE LEVEL (dBA) (@ 1 m) _____
☐ EXPECTED SPL (dBA) (@ 1 m) _____

ENCLOSURE: ○ TEFC ○ TENV ○ EXPLOSION PROOF
TEFC
MOUNTING: ◎ HORIZONTAL ◎ VERTICAL
◎ FOOT MOUNTED ◎ FLANGE MOUNTED
☐ SHAFT UP ☐ SHAFT DOWN

MAIN TERMINAL BOX MOUNTING LOCATION: ◎ F-1 ◎ F-2

FAN: ☐ REVERSIBLE ☐ UNI-DIRECTIONAL
○ NON-SPARKING

BEARING TYPE: ☐ BALL ☐ ROLLER ☐ SLEEVE
BRG LUBRICATION: ◎ GREASE ☐ RING OIL ○ OIL MIST
GREASE FITTING: ◎ PLUGGED ○ ALEMITE ○ OTHER _____
BRG SHIELDING: ☐ SINGLE ◎ DOUBLE ⬭ SEALED FOR LIFE

MOTOR ROTATION: (FACING END OPPOSITE SHAFT EXTENSION)
◎ CW ◎ CCW ◎ BI-DIRECTIONAL

INSULATION CLASS: ○ B ○ F ○ OTHER: _____
○ NON-HYGROSCOPIC ○ TROPICALIZED

◎ TEMPERATURE RISE: (DEFAULT IS 80°C ABOVE 40°C BY RES @ 1.0)
_____ °C ABOVE _____ °C BY _____ @ _____ S.F.

◎ MOTOR TO BE "THERMALLY PROTECTED"
◎ MOTOR TO BE "OVER TEMP PROTECTED"
☐ TYPE #1--"WINDING--RUNNING AND LOCKED-ROTOR PROTECTED"
☐ TYPE #2--"WINDING--RUNNING PROTECTED"
☐ TYPE #3--"WINDING--PROTECTED, NON-SPECIFIC"

○ SPACE HEATER REQD ☐ RATED AT: _____ WATTS
◎ VOLTS _____ PHASE _____ HERTZ _____
◎ MAX SHEATH TEMPERATURE: _____ °C
○ SEPARATE JUNCTION BOX FOR SPACE HEATER LEADS

MOTOR THRUST LOAD: ○ _____ (kg) ○ NONE
DIRECTION OF THRUST: ○ TOWARD COUPLING
○ AWAY FROM COUPLING
☐ MOTOR THRUST RATING: _____ (kg)

TESTING

IEEE TESTING: ○ OBSVD ○ WIT ○ SUBMIT CERT'D RESULTS
○ SPECIAL TESTING: _____

MISCELLANEOUS

PAINTING: ○ IEEE 841 STD ○ OTHER _____
○ _____

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JOB NO. _____ ITEM NO. _____

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ALLOWABLE PIPING FORCES AND MOMENTS (6.4)

	COMPRESSOR INLET		COMPRESSOR DISCHARGE		PACKAGE OUTLET	
	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)	FORCE, (kg)	MOMENT, (N-m)
AXIAL						
VERT						
TRANS						

ADDITIONAL DATA:

PACKAGED, INTEGRALLY GEARED CENTRIFUGAL AIR COMPRESSORS (API 672--4th ED) DATA SHEET METRIC (kg/cm2)	JOB NO. _____ ITEM NO. _____ PAGE **11** OF **11** REQ'N NO.

CENTRIFUGAL AIR COMPRESSOR PERFORMANCE CURVES

When this requisition is issued for purchase, the supplier's proposed curves for the selected compressor will be inserted here as a substitute for this sheet.

The compressor performance and characteristics as given on this performance curve will be a part of the supplier's contractual obligation within the tolerances agreed upon.

REVISION	0	1	2	3	4
DATE					
BY					
REV/APPR					

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APPLICABLE TO: ○ PROPOSAL ○ PURCHASE ○ AS BUILT

FOR _____ UNIT _____

SITE _____ NO. REQUIRED _____

SERVICE _____ DRIVER ITEM NO. _____

○ CONTINUOUS ○ INTERMITTENT ○ STANDBY (3.30) SPARED BY: _____

NOTE: INFORMATION TO BE COMPLETED: ○ BY PURCHASER ☐ BY MANUFACTURER ◎ BY PURCHASER OR MFR

GENERAL

COMPRESSOR MFR _____ MODEL (SIZE AND TYPE) _____ SERIAL NO. _____

DRIVER MFR _____ DRIVER TYPE _____ RATED (BHP) _____ RPM _____

DRIVE SYSTEM: ○ DIRECT COUPLED ○ OTHER _____ DUTY (1.2) ○ BASIC ○ SPECIAL

OPERATING CONDITIONS (6.1.9)

(ALL DATA ON PER UNIT BASIS)	RATED (3.24)	LOW AMB * (7.10.1)	MIN AMB	OTHER
○ DELIVERED FLOW, SCFM (14.7 psia & 60°F DRY)				
○ WEIGHT FLOW, (lb/hr) (WET) (DRY)				
○ INLET COOLING WATER TEMP, (°F)				
INLET CONDITIONS:				
○ PRESSURE (psia)				
○ TEMPERATURE (°F)				
○ RELATIVE HUMIDITY %				
○ MOLECULAR WEIGHT (M)				
☐ INLET VOLUME, (cfm) (WET / DRY)				
DISCHARGE CONDITIONS:				
○ PRESSURE (psia)				
☐ TEMPERATURE (°F)				
PERFORMANCE:				
☐ MAX (BHP) REQUIRED (ALL LOSSES INCL)				
☐ (BHP/100 CFM) AIR DELIVERED				
☐ INPUT SPEED (rpm)				
☐ ESTIMATED SURGE, (icfm) (@ ABOVE SPEED)				
○ MAX DP ACROSS INLET FILTER, (psi)				
DP INCLUDED IN CALCULATION ☐ YES ☐ NO				
◎ AFTERCOOLER OUTLET TEMP, (°F)				
☐ PERFORMANCE CURVE NO.				
☐ % RISE TO SURGE (6.1.12.2)				
☐ _____				
☐ _____				

* UNTHROTTLED PERFORMANCE FOR DRIVER SIZING

CONTROL SYSTEM (7.4.2)

CONTROL METHOD: (7.4.2.1)

○ CAPACITY MODULATION (CONST DISCH PRESS) (7.4.2.1 a.)
- ○ INLET THROTTLE DEVICE ○ DAMPER
- ○ GLOBE VALVE ○ BUTTERFLY VALVE
- ○ VARIABLE INLET GUIDE VANES

○ AUTOMATIC DUAL CONTROL (7.4.2.1 b.)
- ○ _____ (psig) TO _____ (psig) DISCH PRESS

○ AUTO START AND STOP (7.4.2.1 c.)
- ○ START _____ (psig) STOP _____ (psig)

○ OTHER (DESCRIBE): _____

CONTROL SYSTEM REQUIREMENTS:

○ UNIT OPERATES IN PARALLEL (7.4.2.2)
- ○ W/CENTRIFUGAL
- ○ W/ROTARY ○ W/RECIPROCATING

○ MICROPROCESSOR CAPABLE OF COMMUNICATION WITH PURCHASER'S DCS (7.4.1.4)
- ○ COMM PROTOCOL _____

CONTROL SYSTEM ALTERNATES: (7.4.1.3)

○ OTHER THAN MICROPROCESSOR BASED: _____

○ SUITABLE FOR INDOOR ONLY

○ FURNISHED BY PURCHASER

INTER- AND AFTER-COOLERS (7.6)

REMARKS: _____

AFTERCOOLER:

○ FURNISHED BY PURCHASER (7.6.1)

○ NOT NEEDED (7.6.1)

○ AIR-COOLED TYPE BY VENDOR

○ AIR-COOLED INTERCOOLERS REQD (7.6.3, 7.6.6)
- ○ FURNISHED BY PURCHASER

◎ AIR-COOLED EXCHANGER AUTOMATIC TEMPERATURE CONTROL MEANS: (7.6.6)
- ○ LOUVERS ○ VARIABLE SPEED FANS
- ○ VARIABLE PITCH FANS ○ BYPASS VALVE

◎ AIR-COOLER CONTROL MANUAL ONLY (7.6.6) BY:
- ○ LOUVERS ○ BYPASS VALVE
- ○ VARIABLE PITCH FANS

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○ LOCATION, SITE DATA (6.1.5)

LOCATION:

○ INDOOR ○ HEATED ○ UNDER ROOF
○ OUTDOOR ○ UNHEATED ○ PARTIAL SIDES
○ GRADE ○ MEZZANINE ○ _____
○ WINTERIZATION REQD ○ TROPICALIZATION REQD

SITE DATA:

○ ELEVATION _____ (ft) ○ BAROMETER _____ (psia)
○ RANGE OF AMBIENT TEMPERATURE, (°F)

	DRY BULB	WET BULB
NORMAL		
MAXIMUM		
MINIMUM		

UNUSUAL CONDITIONS:

○ DUST ○ FUMES ○ CORROSIVE CONDITIONS
○ CORROSIVES PRESENT: _____
○ CONDITIONS CAUSE STRESS CORROSION CRACKING
○ OTHER _____

AREA ELECTRICAL CLASSIFICATION: (6.1.8) T-CODE ____

○ CLASS _____ GROUP _____ DIVISION _____
○ LOCAL ELECTRICAL CODES: _____

○ UTILITY CONDITIONS:

○ **STEAM HEATING:**

INLET MIN	(psig)	(°F)
NORM	(psig)	(°F)
MAX	(psig)	(°F)
OUTLET MIN	(psig)	(°F)
NORM	(psig)	(°F)
MAX	(psig)	(°F)

○ **ELECTRICITY:**

	HEATING	CONTROL	SHUTDOWN
VOLTAGE			
HERTZ			
PHASE			

○ **COOLING WATER: (6.1.6)**

TEMP INLET _____ (°F) MAX RETURN _____ (°F)
PRESS NORM _____ (psig) DESIGN _____ (psig)
MIN RETURN _____ (psig) MAX ALLOW DP _____ (psi)
WATER SOURCE _____

○ **AIR/NITROGEN:**

MAX PRESS _____ (psig) MIN PRESS _____ (psig)
GAS COMPOSITION _____

REMARKS: _____

○ SPECIFICATIONS

NOISE SPECIFICATIONS: (6.1.3)

○ MAX ALLOWABLE SPL _____ (@ 3 Ft)
○ APPLICABLE SPEC _____
ACOUSTIC HOUSING: ○ YES ○ NO
APPLICABLE SPECIFICATIONS:
API 672 AND ○ _____
_____
○ NON-ASME WELDING IF NOT AWS D1.1: (6.10.3.5) _____
○ UNITS OF MEASURE (5.1) ○ US CUSTOMARY ○ SI ○ OTHER _____

PAINTING:

○ MANUFACTURER'S STD
○ OTHER _____
_____
BASEPLATE GROUT: (7.10.3) ○ EPOXY ○ CEMENT ○ NONE

PREPARATION FOR GROUT SURFACES: (7.10.3)

○ MFR STD ○ SSPC 6 BLAST ○ BARE FOR FIELD BLAST
○ INORGANIC ZINC SILICATE COATING
○ OTHER _____
_____

SHIPMENT: (8.4.1)

○ DOMESTIC ○ EXPORT ○ EXPORT BOXING REQD
○ OUTDOOR STORAGE OVER 6 MONTHS

☐ UTILITY CONSUMPTION (9.2.3 i.)

STEAM:

OIL HEATER: _____ (lb/hr) OTHER _____ (lb/hr)

ELECTRIC:

	(HP)	LOCKED ROTOR AMPS	FULL LOAD AMPS
MAIN LO PUMP			
AUX LO PUMP			

OIL HEATER _____ (kW) SPACE HEATER _____ (kW)
CONTROL SYSTEM LOAD: _____ (kW)

COOLING WATER:

	L.O. COOLER	INTER-COOLER	AFTER-COOLER	OTHER
QUANTITY, (gpm)				
OUTLET TEMP, (°F)				
PRESS DROP, (psi)				
TOTAL CW, (gpm)				

AIR/NITROGEN:

	INLET PRESS (psig)	QUANTITY (scfm)
SEAL SYSTEM:		
CONTROL PANEL:		
LO RESERVOIR:		
INSTR HOUSINGS:		
CONTROL SYSTEM:		
OTHER: _____		

TOTAL PURGE, (scfm) _____

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CONSTRUCTION FEATURES

☐ **COMPRESSOR SPEEDS:**

RATED INPUT: _____ (rpm) TRIP _____ (rpm)

BULLGEAR CRITICALS: 1st _____ (rpm)

PINION CRITICALS:

1st STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
2nd STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
3rd STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)
4th STG PINION	1st	_____ (rpm)	2nd	_____ (rpm)

OTHER UNDESIRABLE SPEEDS: (6.7.1.3) _____

	STAGE SPEED		IMPELLER DIAMETER		TIP SPEED	
1st STAGE	_____	(rpm)	_____	(in)	_____	(ft/min)
2nd STAGE	_____	(rpm)	_____	(in)	_____	(ft/min)
3rd STAGE	_____	(rpm)	_____	(in)	_____	(ft/min)
4th STAGE	_____	(rpm)	_____	(in)	_____	(ft/min)

☐ **IMPELLERS: (6.5.2)**

NO. OF IMPELLERS: _____ MATERIAL _____

TYPE (OPEN, RADIAL, BACKWARD LEANING, ETC.) _____

TYPE CONSTRUCTION: (6.5.2.2) _____

METHOD OF ATTACH: (6.5.2.2) _____

ROTATION, VIEWED FROM INPUT SHAFT END: ☐ CW ☐ CCW

☐ **COMPRESSOR CASING:**

MODEL _____ CASING SPLIT _____

	STG 1	STG 2	STG 3	STG 4
MATERIAL				
MAWP, (psig)				
HYDRO TEST, (psig)				
MAX OPT TEMP, (°F)				

○ MIN DESIGN METAL TEMP (6.10.5) _____ (°F)

☐ CASING HEAT TREATMENT REQUIRED (6.10.3.1.1)

☐ ULTIMATE STRESS FOR MATL (6.2.1) _____ (psi)

☐ CASTING FACTOR (6.2.1) _____

WELDED CONNECTIONS--NDT PROVIDED

☒ 100% RADIOGRAPH ☒ MAG PARTICLE ☒ LIQ PENETRANT

○ _____

☐ **COMPRESSOR BEARINGS & BEARING HOUSINGS:**

BEARING HSG MATERIAL: _____

PINION RADIAL BEARINGS: (6.8.2)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (psi)				
ACTUAL LOAD, (psi)				
BRG SPAN, (in)				

PINION THRUST BEARINGS: (6.8.3)

	STG 1	STG 2	STG 3	STG 4
BRG TYPE				
ALLOW LOAD, (psi)				
ACTUAL LOAD, (psi)				
THRUST COLLAR				

☐ **INTEGRAL GEAR HOUSING:**

MATERIAL _____ SPLIT _____

☐ **BULL GEAR: (6.5.3), (6.12.2)**

RATED POWER BASED ON TOOTH SURFACE DURABILITY: _____ (HP)

RATED POWER BASED ON TOOTH BENDING: _____ (HP)

○ MIN AGMA SERVICE FACTOR: _____ ☐ ACTUAL S.F. _____

GEAR RIM MATERIAL: _____ HARDNESS: _____

GEAR FACE WIDTH: _____ (in) GEAR CENTER MATL: _____

MECHANICAL EFFICIENCY: _____ % ISO 1328 GRADE: _____

PITCH DIA _____ (in) PITCH LINE VELOCITY _____ (fps)

☐ **PINIONS: (6.5.3), (6.12.2)**

	1st	2nd	3rd	4th
SERVICE FACTOR:				
MATERIAL:				
HARDNESS: (BHN) (R_c)				

☐ **BULL GEAR SHAFT:**

☐ REPLACEABLE ☐ INTEGRAL W/GEAR

MATL: _____ HARDNESS: _____ (BHN) (R_c)

BRG SPAN _____ (in) WEIGHT (W/GEAR) _____ (lb)

DIA @ GEAR _____ (in) DIA @ COUPLING _____ (in)

SHAFT SLEEVES AT SEALS: MATL _____

SHAFT LABYS: TYPE _____ MATL _____

BULL GEAR RADIAL BRG TYPE: _____ LENGTH _____ (in)

ALLOW LOAD _____ (psi) ACTUAL LOAD _____ (psi)

☐ **BULL GEAR THRUST BEARINGS: (6.8.3)**

LOCATION _____ TYPE _____

MFR _____ AREA _____ (in_)

THRUST COLLAR (6.8.3.6) ☐ INTEGRAL ☐ REPLACEABLE

ALLOW LOAD _____ (psi) ACTUAL LOAD _____ (psi)

GAS LOAD _____ (lb) COUPLING LOAD _____ (lb)

BEARINGS FITTED W/TEMP SENSORS (6.12.10, 6.12.11)

○ PINION RADIAL BRG ○ BULL GEAR RADIAL BRG

○ THRUST BRG _____

☒ **MAIN CONNECTIONS: (6.3)**

	SIZE	ASME RATING	FACING	POSITION
COMPR INLET				
COMPR DISCH				
PKG OUTLET				
ATM BLOWOFF				
FILTER OUTLET				

☐ **OTHER CONNECTIONS:**

	NO.	SIZE	TYPE
LUBE OIL INLET			
LUBE OIL OUTLET			
COOLING WATER INLET			
PRESSURE GAUGE			
TEMPERATURE GAUGE			
CONDENSATE DRAINS			

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VIBRATION DETECTORS: (7.4.4.5), (7.10.10)
☐ TYPE _____ ☐ MODEL _____
○ MFR _____
○ NO. AT EACH PINION BEARING _____ TOTAL NO. _____
○ NO. AT EACH DRIVER BEARING _____ TOTAL NO. _____
☐ X&Y RADIAL PROBES CAN BE MOUNTED ADJACENT TO IMPELLERS FOR:
☐ 1st STG ☐ 2nd STG ☐ 3rd STG ☐ 4th STG

OSCILLATOR-DEMODULATORS:
○ MFR _____ ☐ MODEL _____
○ MONITOR SUPPLIED BY _____
○ MFR _____ ☐ MODEL _____
○ LOCATION _____ ENCLOSURE _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (mil)
○ SHUTDOWN: ☐ SET @ ____ (mil) ○ TIME DELAY ____ SEC
○ PER API 670 (7.10.10), (7.10.11)

BEARING-TEMPERATURE MONITOR: (7.10.12)
○ REQD ○ SUPPLIED BY: _____ ○ PER API 670
○ MFR _____ ☐ MODEL _____

AXIAL POSITION MOVEMENT DETECTOR: (7.10.10, 7.10.11)
☐ TYPE _____ ☐ MODEL _____
○ MFR _____
☐ READOUT SCALE RANGE _____ ○ ALARM ☐ SET @ ____ (mil)
○ SHUTDOWN: ☐ SET @ ____ (mil) ○ TIME DELAY ____ (sec)

DYNAMICS: (6.7), (6.12)
○ CRITICAL LATERAL SPEEDS ARE PROVEN BY PRIOR UNITS (6.7.2)
○ DAMPED UNBALANCED RESPONSE ANALYSIS REQD (6.12.3)
○ TORSIONAL VIBRATION ANALYSIS OF TRAIN REQD (6.12.5)
○ RESIDUAL UNBALANCE WORKSHEET REQD (6.12.8)
☐ REMARKS _____

COUPLINGS: (7.2.1)
TYPE: ☐ DISK PAK ☐ DIAPHRAGM ○ OTHER _____
DISK MATL: ☐ STAINLESS STEEL ☐ COATED W/ _____
☐ MAKE _____ ☐ MODEL _____
○ NON-LUBE ○ LUB'D ☐ LUBRICATION _____
☐ SPACER LENGTH _____ (in) ☐ LIMITED END-FLOAT REQD
☐ CPLG RATING _____ (HP/100 r @ 1.0 S.F. ACTUAL S.F. _____
☐ SHAFT JCT RATING: @ DRIVER ____ (HP) @ INPUT SHAFT ____ (HP)
☐ MOUNTING ARRANGEMENT @ INPUT SHAFT: _____ DRIVER ____
☐ MFR MAX BORE _____ (in) PROPOSED BORE ____ (in) (7.2.1.6)
DRIVER HALF-CPLG MTD BY: ☐ DRIVER MFR ☐ COMPR VENDOR
☐ IDLING ADAPTER FOR DRIVER HALF-COUPLING REQD

PIPING REQUIREMENTS:
☐ RECOMMENDED STRAIGHT RUN OF PIPE DIA BEFORE SUCTION: _____
○ VENDOR TO OBSERVE FLANGE PARTING
○ THROUGH STUDS REQUIRED FOR PIPING FLANGES

MISCELLANEOUS:
○ VENDOR PRESENT DURING INITIAL ALIGN CHECK
○ VENDOR CHECK ALIGN AT OPERATING TEMP
○ BASE DESIGNED FOR COLUMN MOUNTING
○ THERMAL RELIEF VALVES PROVIDED BY VENDOR
○ FOR WATER-COOLED EXCHANGERS
○ FOR _____
○ PURCHASER WILL PREPARE COORDINATION MEETING AGENDA (9.1.3)

SHOP INSPECTIONS & TESTS: (8.1.1)
○ ADVANCE NOTIFICATION REQD _____ DAYS

	OBSERVED	WITNESSED
○ SHOP INSPECTION		
○ HYDROSTATIC (8.3.2)	○	○
○ COMBINED TEST (8.3.4), (8.5.6)	○	○
○ ASME PTC 10 TEST (8.3.4.1)	○	○
INCLUDES ○ AIR FILTER		
○ AFTERCOOLER		
○ _____		
○ GUIDE VANE TEST (8.5.12.1)	○	○
○ AT ____ NON-100% POSITIONS		
○ SOUND-LEVEL TEST	○	○
○ SPARE ROTOR TEST (8.5.12.2)	○	○
○ SPARE ROTOR MECH ONLY	○	○
○ IMPELLER OVERSPEED TEST (8.3.3)	○	○
○ POST OVERSPEED TEST NDE OF IMPELLERS (8.3.3.2)	○	○
○ RESIDUAL UNBALANCE CHECK (6.12.8)	○	○
○ OIL SYSTEM CLEANLINESS	○	○
○ CONTROL SYSTEM CHECK (8.3.4.5.5)	○	○
○ BRG, SEAL, GEAR CHECK (8.5.11.1, 6.5.11.2)	○	○
○ GEAR CONTACT CHECK (8.2.3.2)	○	○
○ CLEANLINESS CHECK--VESSELS (8.2.3.3)	○	○
○ CLEANLINESS CHECK--PIPING (8.2.3.3)	○	○
○ HARDNESS CHECK OF PINIONS (8.2.3.4)	○	○
○ OF BULL-GEAR	○	○
○ OF WELD REPAIRS	○	○
○ NDE OF MAJOR REPAIRS (8.2)	○	○
○ GEAR TOOTH MAG-PART (8.5.4)	○	○
○ FINAL INSPECTION PRIOR TO PAINT	○	○
○ INSPECTION OF PREP FOR SHIPMENT (8.4)	○	○
○ _____	○	○
○ _____	○	○

○ PRIOR DOCUMENTATION ON MAJOR REPAIRS NOT REQD (6.10.4.3)
○ RETAIN FINAL ASSEMBLY CLEARANCES (8.5.1)
○ SUBMITTAL OF INSPECTOR'S CHECKLIST (8.1.2)
SIGNED BY REP FOR: ○ PURCHASER ○ VENDOR
IF DESIGN REQUIRES DISASSEMBLY OF PINION FOR BRG INSPECTION,
○ FORGO BEARING INSPECTION BASED ON TEST DATA; OR
○ INSPECT BEARING AND RETEST (8.5.11.2)

☐ **WEIGHT:** (lb)
INTEG GEAR/COMPR _____ DRIVER _____
GEAR UPPER CASE _____ BULL-GEAR _____
1st STAGE PINION _____ 2nd STAGE PINION _____
INTERCOOLER _____ BUNDLE _____
AFTERCOOLER _____ BUNDLE _____
BASE _____ CONTROL PANEL _____
MAX FOR MAINTENANCE (IDENTIFY) _____
TOTAL SHIPPING WEIGHT _____

☐ **SPACE REQUIREMENTS,** (in)

	L	W	H
COMPLETE UNIT:			
CONTROL PANEL: (IF SEP)			
INLET FILTER-SILENCER:			
AFTERCOOLER: (IF FURN)			
OTHER: _____			

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LUBE OIL SYSTEM (6.9)

BASIC SYSTEM REQ'MNTS--NORMAL OIL FLOW

	LUBE OIL TO:	(gpm)	(psig)	(SSU @ 100°F)
☐	COMPR/GEAR			
☐	DRIVER			
☐	EXT GEAR			

☐ OIL SYSTEM PRESSURES:
SUPPLY _____ (psig) PUMP RV SETTING _____ (psig)
SYS DESIGN _____ (psig) HYDROTEST _____ (psig)

OIL COOLER:

		SHELL SIDE	TUBE SIDE
☐	OPERATING PRESS, (psig)		
☐	MAX ALLOW WORK PRESS, (psig)		
☐	MAX ALLOW TEMP, (°F)		
☒	FOULING FACTOR		

☐ SURFACE AREA _____ (ft_) DUTY _____ (BTU/hr)
☒ REMOVABLE BUNDLE TO BE FURNISHED
☐ ASME CODE STAMPED ○ DESIGNED TO TEMA _____
☒ TUBES: NO. _____ O.D. _____ (in) LENGTH _____ (in)
WALL THICKNESS _____ (in) ☐ AVG ☐ MIN
☒ MATERIALS
CHANNELS/HEADS _____ SHELL _____
TUBES _____ TUBE SHEETS _____
CHANNEL COVERS _____ TUBE SUPPORTS _____

OIL FILTERS:

☒ MICRON RATING _____ ○ NOMINAL ○ ABSOLUTE
☒ DP: (psi) CLEAN _____ DIRTY _____ COLLAPSE _____
☒ ELEMENT: MAKE _____ MODEL _____
☐ NO. ELEMENTS _____ ☒ MEDIA _____
☒ CORE MATL _____ ☒ HSG MATL _____
☐ HSG MAWP _____ (psig) ☐ MAX ALLOW TEMP _____ (°F)

OIL HEATER: ####
☒ STEAM HEATER REQD ☐ ELECTRIC HEATER REQD NO ELEC
☐ RATING _____ (BTU/hr)
☐ WATT DENSITY _____ (W/in_)

OIL RESERVOIR:

☒ RETENTION TIME _____ MIN ☐ CAPACITY _____ (gal)
☐ FREE SURFACE AREA _____ (ft_) ☐ INTERNAL BAFFLES

LUBRICANT: ☒ SYNTHETIC ☒ HYDROCARBON
☒ DESCRIPTION _____
☐ MIN ALLOW OIL TEMP _____ (°F) _____ (SSU)

☒ SYSTEM COMPONENT SUPPLIERS:

	MFR	MODEL
MAIN PUMP		
STANDBY PUMP		
ELECTRIC MOTOR(S)		
STEAM TURBINE(S)		
OIL COOLER(S)		
OIL FILTERS		
ACCUMULATOR(S)		
SUCTION STRAINERS		
CHECK VALVES		
TRANSFER VALVE(S)		
PUMP COUPLING		
PUMP RELIEF VALVES		
ELECTRIC HEATER		

PUMPS:	MAIN	STANDBY
☒ HORIZONTAL		
☒ VERTICAL		
☒ SUBMERGED		
☒ MOTOR DRIVEN		
☒ TURBINE DRIVEN		
☒ SHAFT DRIVEN		
☒ CENTRIFUGAL		
☒ ROTARY		
☒ FLANGE CONNECTED		
☐ RATED CAPACITY (gpm)		
☐ DISCHARGE PRESS (psig)		
☐ (BHP) @ MAX SSU		
☐ DRIVER RATING (HP)		
☒ CASING MATERIAL		
☐ SPEED		
☒ COUPLING		
☒ OSHA GUARD		
☒ MECHANICAL SEAL		

STANDBY PUMP CONTROL RESET:
○ MANUAL ○ AUTOMATIC ○ HOA SELECTOR SWITCH

SILENCERS

INLET AIR FILTER/SILENCER: (7.7)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ PIPING CONNECTION _____
☐ CLEAN DP, AS QUOTED _____ (psi)
☒ CORROSION PROTECTION
○ FILTER WILL BE REMOTE MOUNTED BY PURCHASER AT A DISTANCE _____ (ft) FROM COMPRESSOR
○ FILTER WILL BE ELEVATED _____ (ft) ABOVE GRADE

DISCHARGE BLOWOFF SILENCER: (7.8)

☐ MFR _____ MODEL _____
☐ DESCRIPTION _____
☐ FLANGE CONNECTION _____
MOUNTING ☒ HORIZONTAL ☒ VERTICAL
SUPPORTED BY ☒ PIPING ☒ OTHER _____
☐ SPL (dBA) (@ 3 Ft) FROM DISCHARGE OF SILENCER _____

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CONTROLS AND INSTRUMENTATION (7.4)

LOCAL CONTROL PANEL: (7.4.3)

○ ELECTRICAL AREA CLASSIFICATION:
CL _____ GR _____ DIV _____ ()

PANEL ENCLOSURE REQUIREMENT: (7.4.3.2)

◎ NEMA TYPE 4X ENCLOSURE MATERIAL: _____
◎ NEMA TYPE 7 (INDOOR EXPLOSION-PROOF FOR HAZARDOUS GAS AREAS) REQUIRED

PANEL FEATURES: (7.4.3.2)

○ VIBRATION ISOLATORS ○ STRIP HEATER ○ INTERNAL COOLING
○ WEATHERHOOD ◎ PURGE CONNECTIONS ○ OTHER _____

PURGE REQUIREMENT: (7.4.3.2)

◎ NONE ○ INSTRUMENT AIR ○ NITROGEN
◎ TYPE X--REDUCES THE CLASSIFICATION FROM DIV 1 TO NONHAZARDOUS
◎ TYPE Y--REDUCES THE CLASSIFICATION FROM DIV 1 TO DIV 2
◎ TYPE Z--REDUCES THE CLASSIFICATION FROM DIV 2 TO NONHAZARDOUS
○ TROPICALIZATION REQUIRED

◎ **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	
TEMPERATURE SWITCHES:	MFR		SIZE & TYPE	
LEVEL SWITCHES:	MFR		SIZE & TYPE	
PRESSURE TRANSMITTERS:	MFR		SIZE & TYPE	
TEMPERATURE TRANSMITTERS:	MFR		SIZE & TYPE	
LEVEL TRANSMITTERS:	MFR		SIZE & TYPE	
CONTROL VALVES:	MFR		SIZE & TYPE	
PRESSURE RELIEF VALVES:	MFR		SIZE & TYPE	
THERMAL RELIEF VALVES:	MFR		SIZE & TYPE	
TEMPERATURE CONTROL VALVES:	MFR		SIZE & TYPE	
SIGHT FLOW INDICATORS:	MFR		SIZE & TYPE	
PURGE FLOW INDICATORS:	MFR		SIZE & TYPE	
SOLENOID VALVES:	MFR		SIZE & TYPE	
ANNUNCIATOR:	MFR		SIZE & TYPE	
TUBE FITTINGS	MFR		SIZE & TYPE	
_____	MFR		SIZE & TYPE	
_____	MFR		SIZE & TYPE	
_____	MFR		SIZE & TYPE	
_____	MFR		SIZE & TYPE	

SWITCH CLOSURES: (7.4.5.3.2)

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)

○ SHUTDOWN SYSTEMS ARE NOT TO BE PROVIDED WITH A MEANS TO PERMIT TESTING WITHOUT SHUTTING DOWN THE UNIT (7.4.5.3.4)
○ NON-SHUTDOWN DEVICES ARE NOT REQUIRED TO HAVE VALVING TO PERMIT REPLACEMENT DURING OPERATION
○ ISOLATION VALVES ARE REQUIRED FOR SHUTDOWN SENSING DEVICES

MISCELLANEOUS INSTRUMENTATION:

○ THROUGH FLOWING INSTRUMENT SENSING LINE REQUIRED
○ LIQUID-FILLED GAUGES ARE REQUIRED FOR AREAS SUBJECT TO VIBRATION
○ RELIEF VALVES MAY HAVE BODIES IN MATERIALS OTHER THAN STEEL ◎ RV BODY MATERIAL: _____
○ THERMAL RELIEF VALVES REQUIRED FOR COMPONENTS THAT CAN BE ISOLATED
○ FLOW INDICATOR TYPE/MATERIAL IF OTHER THAN BULLS EYE TYPE WITH STEEL BODY _____
○ PURGE REQUIRED FOR ANNUNCIATOR (7.4.3.2) NFPA 496 PURGE TYPE: ○ X ○ Y ○ Z ○ CONNECTION ONLY
○ COMBINATION BLOCK AND BLEED VALVES MAY BE SUBSTITUTED
○ _____
○ _____

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INSTRUMENTATION SCOPE OF SUPPLY

	ELEMENT											INDICATOR						
	PROV BY		TYPE			LOCATION			INSTALL BY		PROV BY	LOCATION						
	VENDOR	PURCHASER	DIRECT READOUT	SWITCH	TRANSMITTER (1)	VENDOR PKG	LOCAL PANEL	PURCH PIPING	VENDOR	PURCHASER	VENDOR	PURCHASER	VENDOR PKG	PURCH PIPING	LOCAL PANEL	ALARM	SHUTDOWN	REPEAT SIGNAL (2)
PRESSURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
LUBE OIL DISCHARGE																		
LUBE OIL FILTER DP																		
LUBE OIL SUPPLY																		
AIR FILTER/SILENCER DP																		
TEMPERATURE:																		
COMPRESSOR SUCTION _____ STAGE																		
COMPRESSOR DISCHARGE _____ STAGE																		
OIL COOLER INLET & OUTLET																		
COMPRESSOR PINION JOURNAL BRG																		
BULL GEAR JOURNAL BRG																		
BULL GEAR THRUST BRG																		
DRIVER JOURNAL BRG																		
DRIVER THRUST BRG																		
RESERVOIR																		
LEVEL:																		
LUBE OIL RESERVOIR																		
SEPARATOR																		
VIBRATION:																		
RADIAL VIBRATION EACH STAGE																		
RADIAL VIBRATION BULL GEAR SHAFT																		
AXIAL POSITION BULL GEAR SHAFT																		
AXIAL POSITION _____ STAGE PINION																		
RADIAL VIBRATION ON DRIVER																		
AXIAL POSITION ON DRIVER SHAFT																		
ACCELEROMETER ON GEAR BOX																		
FLOW:																		
OIL RETURN																		
SEAL GAS																		
MISCELLANEOUS:																		
STANDBY L.O. PUMP RUNNING																		
PANEL PURGE FAILURE																		
ANNUNCIATOR PURGE FAILURE																		
SURGE RECOGNITION																		
OIL HEATER ON																		
COMMON REMOTE ALARM INDICATION																		
COMMON REMOTE SHUTDOWN INDICATION																		

NOTES: 1) TRANSMITTERS SUPPLIED BY VENDOR SHALL INCLUDE SENSING ELEMENT

2) SUPPLY "REPEAT SIGNAL" FOR CONTROL ROOM ALSO

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(INTER-) (AFTER-) COOLER(S) (7.6)

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

PERFORMANCE OF ONE UNIT

	SHELL SIDE		TUBE SIDE	
○ FLUID NAME				
☐ FLUID QUANTITY, TOTAL (lb/hr)				
VAPOR--IN/OUT				
LIQUID--IN/OUT				
☐ TEMPERATURE--IN/OUT (°F)				
☐ SPECIFIC GRAVITY				
☐ VISCOSITY, LIQUID (cP)				
☐ SPECIFIC HEAT, (BTU/lb °F)				
☐ THERMAL CONDUCTIVITY, (Btu/ft h °F)				
☐ LATENT HEAT, (BTU/lb °F)				
☐ INLET PRESSURE, (psig)				
◎ VELOCITY, (fps)				
◎ PRESSURE DROP--ALLOW/CALC, (psi)				
◎ FOULING RESISTANCE--MINIMUM (hr ft_°F/BTU)				

☐ HEAT EXCHANGED _____ (BTU/hr) MTD CORRECTED _____ (°F)
☐ TRANSFER RATE, (BTU/hr ft_ °F) SERVICE _____ CLEAN _____

☐ **CONSTRUCTION OF ONE SHELL**

	SHELL SIDE	TUBE SIDE
DESIGN/TEST PRESSURE, (psig)		
DESIGN TEMPERATURE, (°F)		
NO. PASSES PER SHELL		
CORROSION ALLOWANCE, (in)		
NOZZLES: INLET		
SIZE & OUTLET		
RATING VENT-DRAIN		

SKETCH: BUNDLE NOZZLE ORIENTATIONS

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

REMARKS: _____

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NEMA FRAME INDUCTION MOTORS TO IEEE 841

MFR _____ MODEL _____ SERIAL NO. _____ NEMA FRAME _____
DRIVEN EQUIPMENT TYPE _____ DRIVEN EQUIPMENT ITEM NO. _____ MOTOR ITEM NO. _____

○ OPERATING CONDITIONS

SITE DATA:
ELECTRICAL SUPPLY: VOLT _____ PHASE _____ HERTZ _____
ELECTRICAL AREA CLASSIFICATION: ○ NON-HAZARDOUS
○ CLASS _____ GROUP _____ DIVISION _____
ATMOSPHERIC MIXTURE: _____
IGNITION TEMPERATURE: _____ (°F) TEMP CODE: _____
ALTITUDE: ○ LESS THAN (3300 ft) ○ _____ (ft)
AMBIENT TEMPERATURE MINIMUM: _____ (°F) MAXIMUM: _____ (°F)
UNUSUAL CONDITIONS: _____

DRIVE SYSTEM:
○ DIRECT CONNECTED ○ EXTERNAL GEAR
○ OTHER _____

STARTING: (7.1.2.2)
○ FULL VOLTAGE ○ REDUCED VOLTAGE _____ %
○ LOADED ○ UNLOADED
○ VOLTAGE DIP _____ %

☐ PERFORMANCE

NO LOAD CURRENT, AMPS _____
FULL LOAD TORQUE, (ft-lb) _____
STARTS PER HOUR: _____ HOT _____ COLD
ACCELERATION TIME: _____ SEC

LOAD	CURRENT, AMP	EFFICIENCY	POWER FACTOR
FULL			
75%			
50%			
LOCKED ROTOR			

○ CONSTRUCTION FEATURES

☐ NAMEPLATE (HP) _____ (rpm) _____ S.F. _____
NEMA TORQUE DESIGN: ○ A ○ B ○ C ○ D
☐ NEMA LOCKED ROTOR kVA CODE LETTER: _____

EFFICIENCY: ○ STANDARD ○ HIGH ○ PREMIUM

NOISE DESIGN: ○ STANDARD ○ LOW NOISE
○ MAX SOUND PRESSURE LEVEL (dBA) (@ 3 Ft) _____
☐ EXPECTED SPL (dBA) (@ 3 Ft) _____

ENCLOSURE: ○ TEFC ○ TENV ○ EXPLOSION PROOF
TEFC

MOUNTING: ○ HORIZONTAL ○ VERTICAL
○ FOOT MOUNTED ○ FLANGE MOUNTED
☐ SHAFT UP ☐ SHAFT DOWN

MAIN TERMINAL BOX MOUNTING LOCATION: ○ F-1 ○ F-2

FAN: ☐ REVERSIBLE ☐ UNI-DIRECTIONAL
○ NON-SPARKING

BEARING TYPE: ☐ BALL ☐ ROLLER ☐ SLEEVE
BRG LUBRICATION: ○ GREASE ☐ RING OIL ○ OIL MIST
GREASE FITTING: ○ PLUGGED ○ ALEMITE ○ OTHER _____
BRG SHIELDING: ☐ SINGLE ○ DOUBLE ⬭ SEALED FOR LIFE

MOTOR ROTATION: (FACING END OPPOSITE SHAFT EXTENSION)
○ CW ○ CCW ○ BI-DIRECTIONAL

INSULATION CLASS: ○ B ○ F ○ OTHER: _____
○ NON-HYGROSCOPIC ○ TROPICALIZED

○ TEMPERATURE RISE: (DEFAULT IS 80°C ABOVE 40°C BY RES @ 1.0)
_____ °C ABOVE _____ °C BY _____ @ _____ S.F.

○ MOTOR TO BE "THERMALLY PROTECTED"
○ MOTOR TO BE "OVER TEMP PROTECTED"
☐ TYPE #1--"WINDING--RUNNING AND LOCKED-ROTOR PROTECTED"
☐ TYPE #2--"WINDING--RUNNING PROTECTED"
☐ TYPE #3--"WINDING--PROTECTED, NON-SPECIFIC"

○ SPACE HEATER REQD ☐ RATED AT: _____ WATTS
○ VOLTS _____ PHASE _____ HERTZ _____
○ MAX SHEATH TEMPERATURE: _____ °C
○ SEPARATE JUNCTION BOX FOR SPACE HEATER LEADS

MOTOR THRUST LOAD: ○ _____ (lb) ○ NONE
DIRECTION OF THRUST: ○ TOWARD COUPLING
○ AWAY FROM COUPLING
☐ MOTOR THRUST RATING: _____ (lb)

TESTING

IEEE TESTING: ○ OBSVD ○ WIT ○ SUBMIT CERT'D RESULTS
○ SPECIAL TESTING: _____

MISCELLANEOUS

PAINTING: ○ IEEE 841 STD ○ OTHER _____
○ _____

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ALLOWABLE PIPING FORCES AND MOMENTS (6.4)

	COMPRESSOR INLET		COMPRESSOR DISCHARGE		PACKAGE OUTLET	
	FORCE, (lb)	MOMENT, (ft-lb)	FORCE, (lb)	MOMENT, (ft-lb)	FORCE, (lb)	MOMENT, (ft-lb)
AXIAL						
VERT						
TRANS						

ADDITIONAL DATA: _____

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CENTRIFUGAL AIR COMPRESSOR PERFORMANCE CURVES

When this requisition is issued for purchase, the supplier's proposed curves for the selected compressor will be inserted here as a substitute for this sheet.

The compressor performance and characteristics as given on this performance curve will be a part of the supplier's contractual obligation within the tolerances agreed upon.

ANNEX B—REFERENCED DOCUMENTS

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

API

Std 541	*Form-Wound Squirrel Cage Induction Motors—250 Horsepower and Larger*
Std 546	*Brushless Synchronous Machines—500 kVA and Larger,* Second Edition
Std 611	*General-Purpose Steam Turbines for Petroleum, Chemical, and Gas Industry Services,* Fourth Edition
Std 614	*Lubrication, Shaft-Sealing, and Control-Oil Systems and Auxiliaries for Petroleum, Chemical and Gas Industry Services,* Fourth Edition *Chapter 1—General Requirements* *Chapter 3—General Purpose Oil Systems*
Std 617	*Axial and Centrifugal Compressors and Expander-Compressors for Petroleum, Chemical and Gas Industry Services,* Seventh Edition
Std 670	*Machinery Protection Systems,* Fourth Edition

AGMA[1]

6011	*Specification for High Speed Helical Gear Units*
9002	*Bores and Keyways for Flexible Couplings (Inch Series)*

ASME[2]

B1.1	*Unified Inch Screw Threads (UN and UNR Thread Form)*
B16.1125	*Cast Iron Pipe Flanges and Flanged Fittings Classes 25 and 250*
B16.5	*Pipe Flanges and Flanged Fittings NPS 1/2 Through NPS 24 Addenda A*
B16.11	*Forged Fittings, Socket-Welding and Threaded*
B16.42	*Ductile Iron Pipe Flanges and Flanged Fittings Classes 150 and 300*
B16.47	*Large Diameter Steel Flanges NPS 26 Through NPS 60 Addenda A*
	Boiler and Pressure Vessel Code *Section VIII, Division 1* *Section IX*
PTC-10	*Performance Test Code on Compressors and Exhausters*

ASTM[3]

A275/A275M	*Standard Test Method for Magnetic Particle Examination of Steel Forgings*
A278/A278M	*Standard Specification for Gray Iron Castings for Pressure-Containing Parts for Temperatures Up to 650 Degrees F (350 Degrees C)*
A 395/A395M	*Standard Specification for Ferritic Ductile Iron Pressure-Retaining Castings for Use at Elevated Temperatures*
A536	*Standard Specification for Ductile Iron Castings*
A515/A515M	*Standard Specification for Pressure Vessel Plates, Carbon Steel, for Intermediate- and Higher-Temperature Service*
E94	*Standard Guide for Radiographic Examination*
E186	*Standard Reference Radiographs for Heavy-Walled (2 to 4 1/2-in. (51 to 114-mm) Steel Castings*
E446	*Standard Reference Radiographs for Steel Castings up to 2 in. (51 mm) in Thickness*

AWS[4]

D1.1/D1.1M	*Structural Welding Code - Steel Errata*

IEC[5]

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[1]American Gear Manufacturers Association, 1500 King Street, Suite 201, Alexandria, Virginia 22134.
[2]ASME International, 3 Park Avenue, New York, New York 10016-5990.
[3]American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, Pennsylvania 19428-2959.
[4]American Welding Society, 550 N.W. LeJeune road, Miami, Florida 33135.
[5]International Electrochemical Commission, 1 rue de Varembe, Geneva, Switzerland.

IEEE[6]

841 *Standard for Petroleum and Chemical Industry—Severe Duty Totally Enclosed Fan-Cooled (TEFC) Squirrel Cage Induction Motors—Up to and Including 370 kW (500 hp)*

ISO[7]

261 *ISO General Purpose Metric Screw Threads—General Plan Second Edition*
262 *ISO General Purpose Metric Screw Threads—Selected Sizes for Screws, Bolts and Nuts Second Edition*
286-2 *ISO System of Limits and Fits—Part 2: Tables of Standard Tolerance Grades and Limit Deviations for Holes and Shafts First Edition*
724 *ISO General-Purpose Metric Screw Threads—Basic Dimensions Second Edition*
773 *(Withdrawn) Rectangular or Square Parallel Keys and Their Corresponding Keyways (Dimensions in Millimetres)*
775 *(Withdrawn) Cylindrical and 1/10 Conical Shaft Ends First Edition*
11328-2 *Cylindrical Gears—ISO System of Accuracy—Part 2: Definitions and Allowable Values of Deviations Relevant to Radial Composite Deviations and Runout Information*
3448 *Industrial Liquid Lubricants—ISO Viscosity Classification Second Edition*
6708 *Pipework Components—Definition and Selection of DN (Nominal Size) Second Edition*
7005-1 *Metallic Flanges—Part 1: Steel Flanges First Edition;*
7005-2 *Metallic Flanges—Part 2: Cast Iron Flanges First Edition*
8501 *Preparation of Steel Substrates Before Application of Paints and Related Products - Visual Assessment of Surface Cleanliness*
8821 *Mechanical Vibration—Balancing—Shaft and Fitment Key Convention First Edition*
10436 *(Pending) Petroleum and Natural Gas Industries—General-Purpose Steam Turbines Second Edition*
10438-1 *Petroleum and Natural Gas Industries—Lubrication, Shaft-Sealing and Control-Oil Systems and Auxiliaries—Part 1: General Requirements*
10438-3 *Petroleum and Natural Gas Industries—Lubrication, Shaft-Sealing and Control-Oil Systems and Auxiliaries—Part 3: General Purpose Oil Systems*
5389 *Turbocompressors—Performance Test Code*

MSS[8]

SP55 *Quality Standard for Steel Castings for Valves, Flanges and Fittings and Other Piping Components Visual Method for Evaluation of Surface Irregularities*

NEC[9]

Article 110

NEMA[10]

SM23 *Steam Turbines for Mechanical Drive Service*
250 *Enclosures for Electrical Equipment (1000 Volts Maximum)*

NFPA[11]

496 *Standard for Purged and Pressurized Enclosures for Electrical Equipment*

SSPC[12]

SP6 *Commercial Blast Cleaning NACE No. 3-2000 (Steel Structures Painting Manual, Ch 2—Surface Preparation Specs.)*

TEMA[13]

[6]Institute of Electrical and Electronics Engineers, 445 Hoes Land, Piscataway, New Jersey 08855-1331.
[7]International Organization for Standardization, ISO publications available from the American National Standards Institute, 1, rue de Varembé, Case postale S6 CH-1211, Geneva 20, Switzerland.
[8]Manufacturers Standardization Society of the Value Fittings Industry, Inc., 127 Park Street, N.E., Vienna, Virginia 22180.
[9]National Electrical Code: National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269.
[10]National Electrical Manufacturers Association, 1300 North 17th Street, Arlington, Virginia 22209.
[11]National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts 02269.
[12]Steel Structures Painting Council, 40 24th Street, Suite 600, Pittsburgh, Pennsylvania 15222.
[13]Tubular Exchange Manufacturers Association, 25 North Broadway, Tarrytown, New York 10591.

ANNEX C—(INFORMATION ON ROTORDYNAMIC ANALYSIS)

C.1 General

Note: Refer to API Publication 684, *Tutorial on the API Standard Paragraphs Covering Rotor Dynamics and Balancing: An Introduction to Lateral Critical and Train Torsional Analysis and Rotor Balancing,* for more information on rotor dynamics.

C.1.1 In the design of rotor-bearing systems, consideration should be given to all potential sources of periodic forcing phenomena (excitation) that should include, but are not limited to, the following sources:

a. Unbalance in the rotor system
b. Oil-film instabilities (whirl)
c. Internal rubs
d. Blade, vane, nozzle, and diffuser passing frequencies
e. Gear-tooth meshing and side bands
f. Coupling misalignment
g. Loose rotor-system components
h. Hysteretic and friction whirl
i. Boundary-layer flow separation
j. Acoustic and aerodynamic cross-coupling forces
k. Asynchronous whirl
l. Electrical line frequency.

Note 1: The frequency of a potential source of excitation may be less than, equal to, or greater than the rotational speed of the rotors.

Note 2: When the frequency of a periodic forcing phenomenon (excitation) applied to a rotor-bearing-support system coincides with a natural frequency of that system, the system will be in a state of resonance. A rotor-bearing-support- system in resonance may have the magnitude of its normal vibration amplified. The magnitude of amplification and, in the case of critical speeds, the rate of change of the phase-angle with respect to speed, are related to the amount of damping in the system.

C.1.2 For the purposes of this standard, critical speeds and other resonant conditions of concern are those with an amplification factor (AF) equal to or greater than 6.5

C.1.3 Resonances of structural support systems that are within the vendor's scope of supply and that affect the rotor vibration amplitude should not occur within the specified operating speed range or the specified separation margins (see C.2.10). The effective stiffness of the structural support should be considered in the analysis of the dynamics of the rotor-bearing-support system (see C.2.4c)

Note: Resonances of structural support systems may adversely affect the rotor vibration amplitude.

C.1.4 The vendor who is specified to have unit responsibility for the complete drive train communicates the existence of any undesirable running speeds in the range from zero to trip speed. This can be illustrated by the use of Campbell (forced frequency) diagrams for individual machines and/or for the complete train. When such has been specified for Special Duty service, these diagrams should be submitted for purchaser review and included in the instruction manual. (see Annex D, Item 41).

Note: Examples of undesirable speeds are those caused by the rotor lateral criticals of concern, system torsionals, and blading modes.

C.2 Lateral Analysis

C.2.1 Unless previously derived and confirmed by actual tests of a given design, critical speeds and their associated amplification factors should be determined by means of a damped unbalanced rotor response analysis.

C.2.2 Unless known from previous tests of a given design, the location of all critical speeds below the trip speed should be confirmed on the test stand during the mechanical running test (see C.3.1). The accuracy of the analytical model should be demonstrated (see C.3).

C.2.3 Before carrying out the damped unbalanced response analysis, the vendor should conduct an undamped analysis to identify the undamped critical speeds and determine their mode shapes located in the range from zero to 125% of trip speed. For any new designs, the results of the undamped analysis should be furnished. The presentation of the results should include:

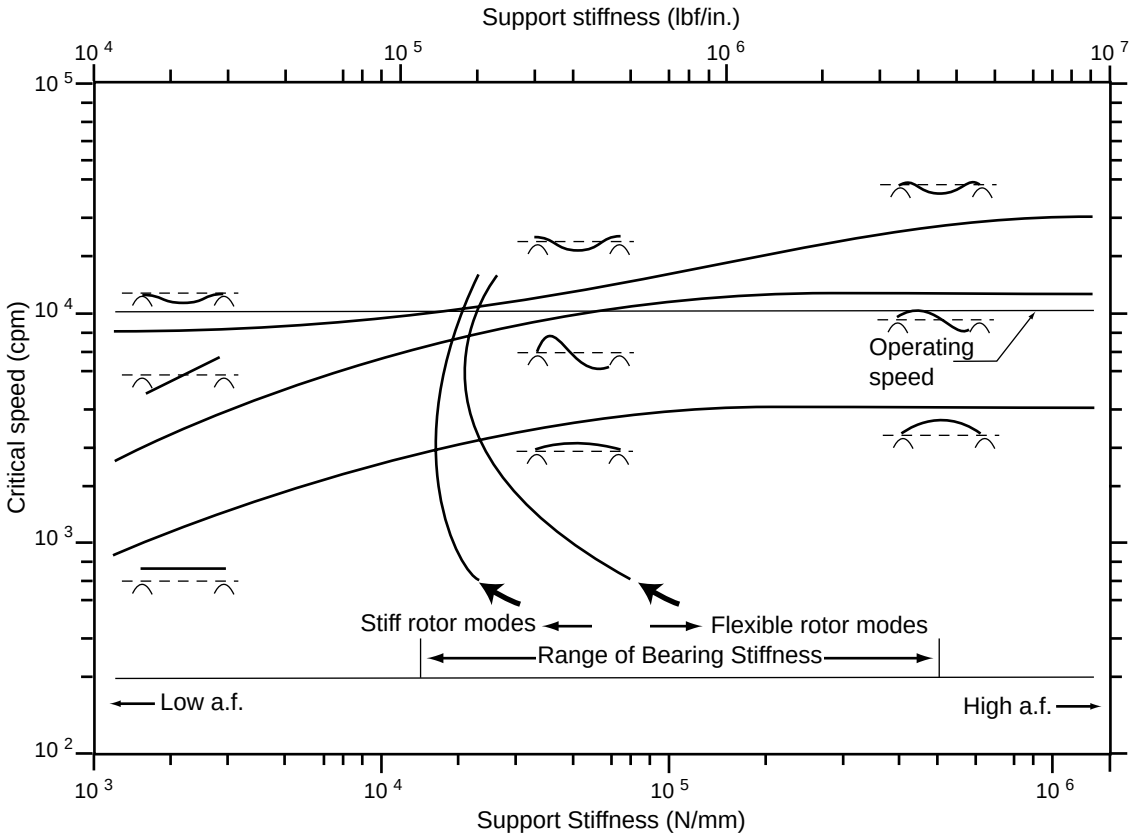


Figure C-1—Undamped Unbalanced Response Analysis

Note: For machinery with widely varying bearing loads and/or load direction such as overhung style machines, the vendor may propose to substitute mode shape plots for the undamped critical speed map and list the undamped critical speed for each of the identified modes.

a. Mode shape plots (relative amplitude vs. axial position on the rotor).
b. Critical speed-support stiffness map (frequency vs. support stiffness). Superimposed on this map should be the calculated system support stiffness'; horizontal (kxx), and vertical (kyy), (See Figure C-1.)

C.2.4 The damped unbalanced response analysis should include but should not be limited to the following:

Discussion: The following is a list of items the analyst is to consider. It does not address the details and product of the analysis that is covered in C.2.7 and C.2.8.

a. Rotor masses, including the mass moment of coupling halves, stiffness, and damping effects (for example, accumulated fit tolerances, fluid stiffening and damping).
b. Bearing lubricant-film stiffness and damping values including changes due to speed, load, preload, range of oil temperatures, maximum to minimum clearances resulting from accumulated assembly tolerances, and the effect of asymmetrical loading which may be caused by partial arc admission, gear forces, side streams, eccentric clearances, etc.
c. For tilt-pad bearings, the pad pivot stiffness.
d. Support stiffness, mass, and damping characteristics, including effects of frequency dependent variation. The term "support" includes the foundation or support structure, the base, the machine frame and the bearing housing as appropriate. For machines whose bearing support system stiffness values are less than or equal to 3.5 times the bearing oil film stiffness values, support stiffness values derived from modal testing or calculated frequency dependent support stiffness and damping values (impedances) should be used. The vendor should state the support stiffness values used in the analysis and the basis for these values (for example, modal tests of similar rotor support systems, or calculated support stiffness values).

Note: The support stiffness should in most cases be no more than $8{,}75 \times 10^6$ N/mm (5×10^6 lbs/in).

Discussion: Guidelines are used to define whether or not bearing support stiffness should be considered. While modal testing of the actual bearing support system would be preferred, an analytical analysis (such as FEA) is permitted.

e. Rotational speed, including the various starting-speed detents, operating speed and load ranges (including agreed-upon test conditions if different from those specified), trip speed, and coast-down conditions.
f. The influence, over the operating range, of the hydrodynamic stiffness and damping generated by the rotor gas and oil seals.
g. The location and orientation of the radial vibration probes which should be the same in the analysis as in the machine.
h. The potential cross-excitation of other operating rotors in an integrally geared machine.

C.2.5 In addition to the damped unbalanced response analysis requirements of C.2.4, for machines equipped with rolling element bearings, the vendor should state the bearing stiffness and damping values used for the analysis and either the basis for these values or the assumptions made in calculating the values.

C.2.6 The effect of other equipment in the train is rarely necessary to be included in the damped unbalanced response analysis. A train lateral analysis should only be performed if the drive train is rigidly coupled to the compressor.

Note: In particular this analysis should be considered for machinery trains with rigid couplings.

C.2.7 A separate damped unbalanced response analysis should be conducted for each critical speed within the speed range of 0 to 125% of trip speed. Unbalance or side load should analytically be placed at the locations that have been determined by the undamped analysis to affect the particular mode most adversely. For the translatory (symmetric) modes, the unbalance should be based on the sum of the journal static loads and should be applied at the location of maximum displacement. For conical (asymmetric) modes, an unbalance should be added at the location of maximum displacement nearest to each journal bearing. These unbalances should be 180° out of phase and of magnitude based on the static load on the adjacent bearing. Figure C-1 shows the typical mode shapes and indicates the location and definition of U for each of the shapes. The magnitude of the unbalances should be four times the value of U as calculated by Equation 2.

In SI units

$$U = 6350\ W/N \tag{2}$$

In Customary units

$$U = 4\ W/N$$

where

U = Input unbalance for the rotor dynamic response analysis in g-mm (ounce-in.),

N = Operating speed nearest to the critical speed of concern, in revolutions per minute,

W = Journal static load in kg (lbs), or for bending modes where the maximum deflection occurs at the shaft ends, the overhung mass (that is the mass of the rotor outboard of the bearing) in kg (lbs). See Figure C-1.

C.2.8 As a minimum, the unbalanced response analysis should produce the following:

a. Identification of the frequency of each critical speed in the range from zero to 125% of the trip speed.
b. Frequency, phase and response amplitude data (Bode plots) at the vibration probe locations through the range of each critical speed resulting from the unbalance specified in C.2.7.
c. The plot of deflected rotor shape for each critical speed resulting from the unbalances specified in C.2.7, showing the major-axis amplitude at each coupling plane of flexure, the centerlines of each bearing, the locations of each radial probe, and at each seal throughout the machine as appropriate. The minimum design diametrical running clearance of the seals should also be indicated.
d. Additional Bode plots that compare absolute shaft motion with shaft motion relative to the bearing housing for machines where the support stiffness is less than 3.5 times the oil-film stiffness.

C.2.9 Additional analyses should be made for use with the verification test described in C.3. The vendor should determine the location of the unbalance. Any test stand parameters that influence the results of the analysis should be included.

C.2.10 The damped unbalanced response analysis should indicate that the machine would meet the following separation margins:

a. If the amplification factor (AF) at a particular critical speed is less than 2.5, the response is considered critically damped and no separation margin is required.
b. If the amplification factor at a particular critical speed is 2.5 or greater and that critical speed is below the minimum speed, the separation margin (SM) (as a percentage of the minimum speed) should not be less than the value from Equation 3 or the value 16 which ever is less.

$$SM = 17\left(1 - \frac{1}{AF - 1.5}\right) \tag{3}$$

c. If the amplification factor at a particular critical speed is equal to 2.5 or greater and that critical speed is above the maximum continuous speed, the separation margin (as a percentage of the maximum continuous speed) should not be less than the value from Equation 4 or the value of 26 which ever is less.

C.2.11 The calculated unbalanced peak to peak amplitudes (see C.2.8 Item b) should be multiplied using the correction factor calculated from Equation 5.

$$SM = 10 + 17\left(1 - \frac{1}{AF - 1.5}\right) \tag{4}$$

where

$$CF = \frac{A_1}{A_{4x}} \tag{5}$$

where

CF = Correction Factor

A_1 = Almplitude limit, calculated using Equation 6 in microns (mils peak to peak.)

A_{4X} = Peak to peak amplitude at the probe location per requirements of C.2.8 Item c in microns (mils peak to peak).

In SI units:

$$A_1 = 25\sqrt{\frac{12000}{N}} \tag{6}$$

In Customary units

$$A_1 = \sqrt{\frac{12000}{N}}$$

where

N = operating speed nearest to the critical speed of concern, in revolutions per minute.

C.2.12 The calculated major-axis, peak-to-peak, unbalanced rotor response amplitudes, corrected in accordance with C.2.11 at any speed from zero to trip speed should not exceed 75% of the minimum design diametrical running clearances throughout the machine (with the exception of floating-ring seal locations). For machines with abraidable seals, the response amplitude to the running clearance should be mutually agreed.

Note: Running clearances may be different than the assembled clearances with the machine shutdown.

C.2.13 If the analysis indicates that the separation margins still cannot be met or that a non-critically damped response peak falls within the operating speed range and the purchaser and vendor have agreed that all practical design efforts have been

exhausted, then acceptable amplitudes should be mutually agreed upon by the purchaser and the vendor, subject to the requirements of C.3.3

C.3 Unbalanced Rotor Response Verification Test

C.3.1 For previously untested designs, an unbalanced rotor response test should be performed as part of the mechanical running test (see 8.3.4), and the results should be used to verify the analytical model. The actual response of the rotor on the test stand to the same arrangement of unbalance as was used in the analysis specified in C.2.9 should be the criterion for determining the validity of the damped unbalanced response analysis. To accomplish this, the requirements of C.3.1.1 through C.3.1.6 should be followed:

C.3.1.1 During the mechanical running test (see 8.3.4), the amplitudes and phase angle of the shaft vibration from zero to trip speed should be recorded. The gain of any analog recording instruments used should be preset before the test so that the highest response peak is within 60 – 100% of the recorder's full scale on the test-unit coast-down (deceleration).

Note: This set of readings is normally taken during a coastdown, with convenient increments of speed such as 50 rpm. Since at this point the rotor is balanced, any vibration amplitude and phase detected should be the result of residual unbalance and mechanical and electrical runout.

C.3.1.2 The location of critical speeds below the trip speed should be established.

C.3.1.3 The unbalance that was used in the analysis performed in C.2.9, should be added to the rotor in the location used in the analysis. The unbalance should not exceed 8 times the value from Equation 2.

C.3.1.4 The machine should then be brought up to the operating speed nearest the critical and the indicated vibration amplitudes and phase should be recorded using the same procedure used for C.3.1.1.

C.3.1.5 The corresponding indicated vibration data taken in accordance with C.3.1.1 should be vectorially subtracted from the results of this test. It is necessary that probe orientation be the same for the analysis and the machine for the vectorial subtraction to be valid.

C.3.1.6 The results of the mechanical run including the unbalance response verification test should be compared with those from the analytical model specified at C.2.9.

C.3.2 The vendor should correct the model if it fails to meet either of the following criteria:

a. The actual critical speeds determined on test should not deviate from the corresponding critical speeds predicted by analysis by more than 5%. Where the analysis predicts more than one critical speed in a particular mode (due for example to the bearing characteristics being significantly different horizontally and vertically or between the two ends of the machine), the test value should not be lower than 5% below the lowest predicted value nor higher than 5% above the highest predicted value.

Note: It is possible, particularly on electric motors, that the vertical and horizontal stiffness are significantly different and the analysis will predict two differing critical speeds. Should the operating speed fall between these critical speeds, these two critical speeds should be treated separately, as if they resulted from separate modes.

b. The actual major axis amplitude of peak responses from test, including those critically damped, should not exceed the predicted values. The predicted peak response amplitude range should be determined from the computer model based on the radial probe locations of each rotor.

Discussion: The amplification factor has been removed as a verification test criterion since when the conditions of frequency (Item a) and amplitude (Item b) are satisfied the computer model is calibrated. Additionally, with split criticals and broad response curves, related to highly damped rotors, the actual amplification factor using test data may be difficult to calculate. This diminishes the value of calculating the amplification factor from test data as a valid comparison tool. The 45° probe mounting has a tendency to distort the data in the case of a split critical by showing a broad critical rather than two distinct criticals. This distortion can be corrected by electronically rotating the probes to true vertical and horizontal to permit the visualization of the true response.

Contrary to test data, the amplification factor may be accurately calculated from the computer model, which then sets the required separation margins

C.3.3 If the support stiffness is less than 2 times the bearing oil film stiffness, the absolute vibration of the bearing housing should be measured and vectorially added to the relative shaft vibration, in both the balanced (C.3.1.1) and in the unbalanced (C.3.1.4) condition before proceeding with the step specified in C.3.1.5. In such a case, the measured response should be compared with the predicted absolute shaft movement

C.3.4 The verification test of the rotor unbalance should be performed only on the first rotor tested, if multiple identical rotors are produced.

C.3.5 The vibration amplitudes and phase from each pair of x-y vibration probes should be vectorially summed at each vibration response peak after correcting the model, if required, to determine the maximum amplitude of vibration. The major-axis amplitudes of each response peak should not exceed the limits specified in C.2.12.

C.4 Additional Testing

C.4.1 Additional testing is required (see C.4.2) if, from the shop verification test data (see C.3) or from the damped, corrected unbalanced response analysis (see C.3.3), it appears that either of the following conditions exists:

Discussion: When the analysis or test data does not meet the requirements of the standard, additional more stringent testing is required. The purpose of this additional testing is to determine on the test stand that the machine will operate successfully.

a. Any critical response will fail to meet the separation margin requirements (see C.2.10) or will fall within the operating speed range.
b. The clearance requirements of C.2.12 have not been met.

C.4.2 Unbalance weights should be placed as described in C.2.7; this may require disassembly of the machine. Unbalance magnitudes should be achieved by adjusting the indicated unbalance that exists in the rotor from the initial run to raise the displacement of the rotor at the probe locations to the vibration limit defined by Equation 6 (see C.2.11) at the maximum continuous speed; however, the unbalance used should be no less than twice or greater than 8 times the unbalance limit specified in C.2.7 Equation 2. The measurements from this test, taken in accordance with C.3.1.1 and C.3.1.2, should meet the following criteria.

a. At no speed outside the operating speed range, including the separation margins, should the shaft deflections exceed 90% of the minimum design running clearances.
b. At no speed within the operating speed range, including the separation margins, should the shaft deflections exceed 55% of the minimum design running clearances or 150% of the allowable vibration limit at the probes (see C.2.11).

C.4.3 The internal deflection limits specified in C.4.2 Items a and b should be based on the calculated displacement ratios between the probe locations and the areas of concern identified in C.2.12 based on a corrected model if required. Actual internal displacements for these tests should be calculated by multiplying these ratios by the peak readings from the probes. Acceptance will be based on these calculated displacements or inspection of the seals if the machine is opened. Damage to any portion of the machine as a result of this testing should constitute failure of the test. Minor internal seal rubs that do not cause clearance changes outside the vendor's new-part tolerance do not constitute damage.

C.5 Level I Stability Analysis

C.5.1 A stability analysis should be performed on the initial design of all centrifugal compressors rotors except those rotors whose maximum continuous speed is below the first critical speed in accordance with C.2.3 as calculated on rigid supports. For this analysis, the machine inlet and discharge conditions should be at the rated condition unless the vendor and purchaser mutually agree upon another operating point.

Note: Level I analysis was developed to fulfill two purposes: First, it provides an initial screening to identify rotors that do not require a more detailed study. The approach as developed is conservative and not intended as an indication of an unstable rotor. Second, the Level I analysis specifies a standardized procedure applied to all vendors similar to that found in C.2. (Refer to API 684 1.6 for a detailed explanation.)

C.5.2 The model used in the Level I analysis should include the items listed in C.2.4 together with the effects of squeeze film dampers and oil seals when used.

C.5.3 All components should be analyzed using the mean value of oil inlet temperature and the extremes of the operating limits for clearance.

C.5.4 When tilt pad journal bearings are used, the analysis should be performed with synchronous tilt pad coefficients.

C.5.5 For rotors that have quantifiable external radial loading (e.g. integrally geared compressors), the stability analysis should also include the external loads associated with the operating conditions defined in C.5.1. For some rotors, the unloaded (or minimum load) condition may represent the worst stability case and should be considered.

C.5.6 The anticipated cross coupling, Q_A, present in the rotor is defined by the following procedures:

For centrifugal compressors:

The parameters in Equation 7 should be determined based on the specified operating condition in C.5.1.

$$Q_A = \frac{HP * B_c * C}{D_c * H_c * N} * \frac{\rho_d}{\rho_s} \tag{7}$$

Equation 7 is calculated for each impeller of the rotor. Q_A is equal to the sum of Q_A for all impellers.

C.5.7 An analysis should be performed with a varying amount of cross coupling introduced at the center of gravity of the stage or impeller for single overhung rotors. For double overhung rotors, the cross coupling should be placed at each stage or impeller concurrently and should reflect the ratio of the anticipated cross coupling, Q_A, calculated for each impeller or stage.

C.5.8 The applied cross coupling should extend from zero to the minimum of:

a. A level equal to ten times the anticipated cross coupling, Q_A.
b. The amount of the applied cross coupling required to produce a zero log decrement, Q_0. This value can be reached by extrapolation or linear interpolation between two adjacent points on the curve.

C.5.9 A plot of the calculated log decrement, δ, for the first forward mode should be prepared for the minimum and maximum component clearances. Each curve should contain a minimum of five (5) calculated stability points. The ordinate (y-axis) should be the log decrement. The abscissa (x-axis) should be the applied cross coupling with the range defined in C.5.8. For double overhung rotors, the applied cross coupling will be the sum of the cross coupling applied to each impeller or stage.

A typical plot is presented in Figure C-2. Q_0 and δ_A are identified as the minimum values from either component clearance curves.

C.5.10 Level I screening criteria

For centrifugal compressors:

If any of the following criteria apply, a Level II stability analysis should be performed:

a. $Q_0/Q_A < 2.0$.
ii. $\delta_A < 0.1$.
iii. $2.0 < Q_0/Q_A < 10$ and CSR is contained in Region B of Figure C-3.

Otherwise, the stability is acceptable and no further analyses are required.

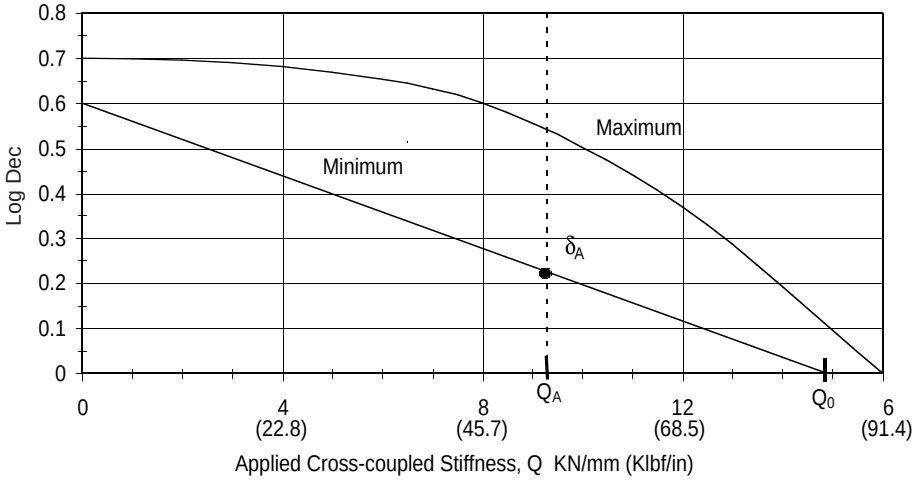


Figure C-2

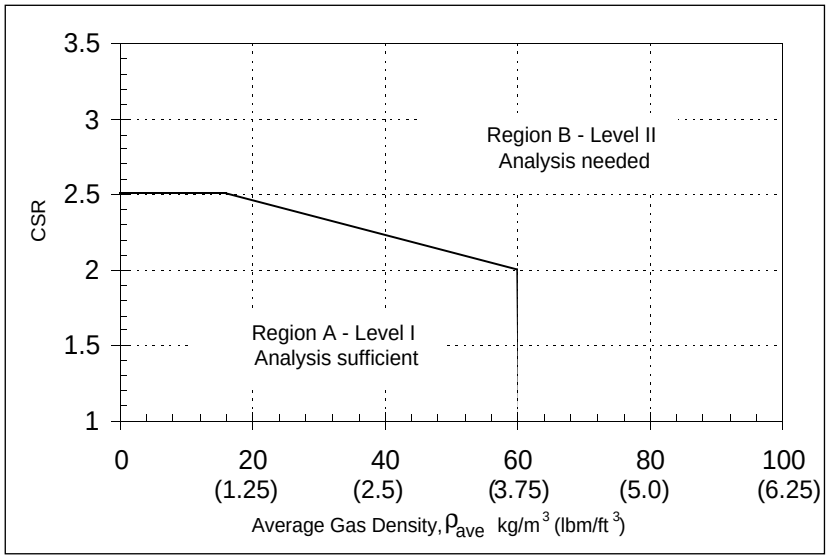


Figure C-3

C.6 Level II Stability Analysis

C.6.1 A Level II analysis, which reflects the actual operating behavior of the rotor, should be performed as required by C.5.10.

C.6.2 The Level II analysis should include the dynamic effects from all sources that contribute to the overall stability of the rotating assembly as appropriate. These dynamic effects should replace the anticipated cross coupling, Q_A. These sources may include, but are not limited to, the following:

a. Labyrinth seals
b. Balance piston
c. Impeller/blade flow
d. Shrink fits
e. Shaft material hysteresis.

It is recognized that methods may not be available at present to accurately model the destabilizing effects from all sources listed above. The vendor should state how the sources are handled in the analysis.

C.6.3 The Level II analysis should be calculated for the operating conditions defined in C.5.1 extrapolated to maximum continuous speed. The modeling requirements of C.5.2, C.5.4 and C.5.5 should also apply. The component dynamic characteristics should be calculated at the extremes of the allowable operating limits of clearance and oil inlet temperature to produce the minimum log decrement.

C.6.4 The frequency and log decrement of the first forward damped mode should be calculated for the following conditions (except for double overhung machines where the first two forward modes must be considered):

a. Rotor and support system only. (Basic log decrement, δ_b)
b. For the addition of each group of destabilizing effects utilized in the analysis.
c. Complete model including all destabilizing forces. (Final log decrement, δ_f)

C.6.5 Acceptance criteria

The Level II stability analysis should indicate that the machine, as calculated in C.6.1 thru C.6.3, should have a final log decrement, δ_f, greater than 0.1.

C.6.6 If after all practical design efforts have been exhausted to achieve the requirements of C.6.5, acceptable levels of the log decrement, δ_f, should be mutually agreed upon by the purchaser and vendor.

This stability analysis section represents the first uniform methodology specified for centrifugal compressors, steam turbines and axial and/or radial flow rotors. The analysis method and the acceptance criteria specified are unique in that no vendor has used

these exact methods to evaluate the susceptibility of their equipment to subsynchronous instability. When these requirements are included within a specification, all vendors are expected to analyze their rotors accordingly. However, it should be recognized that other analysis methods and continuously updated acceptance criteria have been used successfully since the mid-1970's to evaluate rotordynamic stability. The historical data accumulated by machinery vendors for successfully operated machines may conflict with the acceptance criteria of this specification. If such a conflict exists and a vendor can demonstrate that his stability analysis methods and acceptance criteria predict a stable rotor, then the vendor's criteria should be the guiding principle in the determination of acceptability.

Symbols

B_c = 3

B_t = 1.5

C = 9.55 (63)

D_c = Impeller diameter, mm (in.)

D_t = Blade pitch diameter, mm (in.)

H_c = Minimum of diffuser or impeller discharge width per impeller, mm (in.)

H_t = Effective blade height, mm (in.)

HP = Rated power per stage or impeller, Nm/sec (HP)

CSR = Critical speed ratio is defined as:

$$CSR = \frac{\text{maximum continuous speed}}{\text{first undamped critical speed on rigid supports (FCSR)}}$$

N = Operating speed, rpm

Q_A = Anticipated cross coupling for the rotor, KN/mm (Klbf/in) defined as:

$$Q_A = \sum_{t=1}^{s} q_{Ai} \tag{9}$$

Q_0 = Minimum cross coupling needed to achieve a log decrement equal to zero for either minimum or maximum component clearance.

Q_A = Cross coupling defined in Eq. 7) or 8) for each stage or impeller, KN/mm (Klbf/in)

S = Number of stages or impellers

δ_A = Minimum log decrement at the anticipated cross coupling for either minimum or maximum component clearance.

δ_b = Basic log decrement of the rotor and support system only.

δ_f = Log decrement of the complete rotor support system from the Level II analysis.

ρ_d = Discharge gas density per stage or impeller

ρ_s = Suction gas density per stage or impeller

ρ_{ave} = Average gas density across the rotor, kg/m^3 (lbm/ft^3)

Definitions

Stability analysis is the determination of the natural frequencies and the corresponding logarithmic decrements of the damped rotor/support system using a complex eigenvalue analysis.

Synchronous tilt pad coefficients are derived from the complex frequency dependent coefficients with the frequency equal to the rotational speed of the shaft.

Stage refers to an individual turbine or axial compressor blade row.

Hysteresis or internal friction damping causes a phase difference between the stress and strain in any material under cyclic loading. This phase difference produces the characteristic hysteric loop on a stress-strain diagram and thus, a destabilizing damping force.

Minimum clearance for a tilt pad bearing occurs at the maximum preload condition. These can be calculated using the following formulas:

$$\text{Preload}_{max} = 1 - \frac{\text{Bearing Radius}_{min} - \text{Shaft Radius}_{max}}{\text{Pad Bore}_{max} - \text{Shaft Radius}_{max}}$$

$$\text{Bearing Clearance}_{min} = \text{Bearing Radius}_{min} - \text{Shaft Radius}_{max}$$

For maximum clearance at minimum preload:

$$\text{Bearing Clearance}_{max} = \text{Bearing Radius}_{max} - \text{Shaft Radius}_{min}$$

$$\text{Preload}_{min} = 1 - \frac{\text{Bearing Radius}_{max} - \text{Shaft Radius}_{min}}{\text{Pad Bore}_{min} - \text{Shaft Radius}_{min}}$$

C.7 Torsional Analysis

C.7.1 For synchronous motor-driven units and units including gears, units comprising three or more coupled machines, or when specified, the vendor having unit responsibility should ensure that a torsional vibration analysis of the complete coupled train is carried out and should be responsible for directing any modifications necessary to meet the requirements of C.6.2 through C.6.6.

C.7.2 Excitation of torsional natural frequencies may come from many sources that may or may not be a function of running speed and should be considered in the analysis. These sources should include but are not limited to the following:

a. Gear characteristics such as unbalance, pitch line runout, and cumulative pitch error
b. Cyclic process impulses
c. Torsional transients such as start-up of synchronous electric motors and generator phase-to-phase or phase-to-ground faults
d. Torsional excitation resulting from electric motors, reciprocating engines, and rotary type positive displacement machines
e. Control loop resonances from hydraulic, electronic governors, and variable frequency drives
f. One and two times line frequency
g. Running speed or speeds
h. Harmonic frequencies from variable frequency drives.

C.7.3 The torsional natural frequencies of the complete train should be at least 10% above or 10% below any possible excitation frequency within the specified operating speed range (from minimum to maximum continuous speed).

C.7.4 Torsional natural frequencies at two or more times running speeds should preferably be avoided or, in systems in which corresponding excitation frequencies occur, should be shown to have no adverse effect.

C.7.5 When torsional resonances are calculated to fall within the margin specified in C.6.3 (and the purchaser and the vendor have agreed that all efforts to remove the critical from within the limiting frequency range have been exhausted), a stress analysis should be performed to demonstrate that the resonances have no adverse effect on the complete train. The assumptions made in this analysis regarding the magnitude of excitation and the degree of damping should be clearly stated. The purchaser and the vendor should mutually agree upon the acceptance criteria for this analysis.

C.7.6 In addition to the torsional analyses required in C.6.2 through C.6.5, the vendor should perform a transient torsional vibration analysis for synchronous motor driven units, variable frequency motors, and turbine generators sets. The purchaser and the vendor should mutually agree upon the acceptance criteria for this analysis.

ANNEX D—VENDOR DRAWING AND DATA REQUIREMENTS

This annex consists of a distribution record (schedule), followed by a representative description of the items that are presented numerically in the schedule.

DESCRIPTION

The following numbered items correspond to the "Description" portion of the preceding "Packaged, General Purpose Integrally Geared Centrifugal Air Compressors Vendor Drawing and Data Requirements."

1. Certified dimensional outline drawings and list of connections, including the following:
   a. Size, type, rating, location, and identification of all customer connections
   b. The weight of the package and approximate overall erection and maintenance handling weights of equipment and subassemblies that weigh more than 130 kilograms (300 pounds)
   c. Principal dimensions including overall package, maintenance clearances, dismantling clearances, and those required for the piping design
   d. Shaft centerline height
   e. Direction of rotation for the bull-gear shaft
   f. Location of the center of gravity and lifting points
   g. Allowable piping loads
   h. Vendor recommendation for piping, including requirements for straight length of air inlet piping or for straightening vanes where applicable.

2. Cross-sectional drawings and bill of materials, including a listing of all parts

3. Control, alarm, and trip settings (pressures and recommended temperatures).

4. Shaft-coupling assembly drawings and bills of materials, including the following:
   a. The make, size, and type of the couplings
   b. Mounting procedure
   c. Shaft-end gap and tolerance
   d. Coupling guards.

5. Sealing air system schematics and bills of materials, including the following:
   a. Gas flows and control-valve (regulator) settings
   b. Pipe and valve sizes
   c. .Instrumentation, safety devices, and control schemes
   d. List of purchaser connections (if any).

6. Foundation loading diagram including dimensions of baseplates complete with the following:
   a. Diameter, number, and locations of bolt holes; thickness of the metal through which the bolts must pass; and recommended clearance
   b. Weights and centers of gravity for major components.

7. Cooling or heating schematic and bill of materials including cooling or heating media, fluid flows, pressure, pipe and valve sizes, instrumentation, and orifice sizes.

8. Lube oil schematic and bill of materials including the following:
   a. Oil flows, temperatures, and pressures at each use point.
   b. Control, alarm, and trip settings (pressure and recommended temperatures).
   c. Pipe, valve, and orifice sizes.
   d. Instrumentation, safety devices, control schemes, and wiring diagrams.

9. Lube oil system assembly and arrangement drawing(s) including size, rating, and location of all customer connections.

10. Electrical, instrumentation and control schematics, wiring diagrams, and bill of materials for all systems. The schematics shall show all control settings, alarm, and shutdown limits (set points). Drawings shall include, but not be limited to the following:
    a. Electrical one-line diagram
    b. Elementary (schematic) wiring diagram.

c. Interconnecting wiring/tubing diagrams.
d. Conduit/wiring installation plans and details

11. Electrical and instrumentation arrangement drawings, including junction box location drawing and lists of connections.
12. ISA data sheets for all instruments.
13. Tabulation of utility requirements (may be on as built purchaser data sheets).
14. Motor performance & electrical data and curves
15. Motor terminal box details and wiring instructions
16. Curves showing discharge pressure and brake horsepower plotted against delivered inlet flow at rated conditions. Performance curves shall indicate surge and rated capacity.
17. Curves showing performance characteristics at other specified inlet conditions.
18. Curve showing the effects of inlet guide vanes at off- design inlet conditions.
19. Mechanical running test logs, including but not limited to the following:
    a. Oil pressures and temperatures.
    b. Vibration, including (where applicable) an x-y plot of amplitude versus revolutions per minute during start-up and coast-down.
20. Certified hydrostatic test logs.
21. Material certificates of compliance or mill test reports of items as agreed upon in the precommitment or pre inspection meetings.
22. Dimensional drawings for all major auxiliary equipment or components.
23. Data sheets applicable to proposals, purchase, and As-built.
24. Noise data sheets.
25. Installation manual describing requirements and recommendations for installation of the package.
26. Operating and maintenance manuals covering the compressor package including all auxiliary equipment, controls and instrumentation (see 9.3.5.3)
27. Spare parts list with stocking level recommendations in accordance with 9.3.4.
28. Preservation, packaging and shipping procedures.
29. Material Safety data sheets

SPECIAL DUTY

40. Sizing calculations for control valve, relief valve, and orifice plates.
41. Damped unbalanced response analysis.
42. Technical data manual, including the following (see 9.3.6.4):
    a. As-built purchaser data sheets, per Item 32.
    b. Certified performance curves, per Items 17-19.
    c. Drawings, in accordance with 9.3.2.
    d. Spare parts list in accordance with 9.3.5.
    e. Utility data, per Item 16.
    f. Applicable reports, per Items 20, 21, 22.
43. Lateral critical speed analysis report, including but not limited to the following:
    a. Complete description of the method used.
    b. Graphic display of critical speeds versus operating speed.
    c. Graphic display of bearing and support stiffness and its effect on critical speeds.
    d. Graphic display of rotor response to unbalance (including damping).
    e. Journal static loads.
    f. Stiffness and damping coefficients.
    g. Tilting-pad bearing geometry and configuration, including the following:

1. Pad angle (arc) and number of pads.
2. Pivot offset.
3. Pad clearance (with journal radius, pad bore radius, and bearing-set bore radius).
4. Preload.

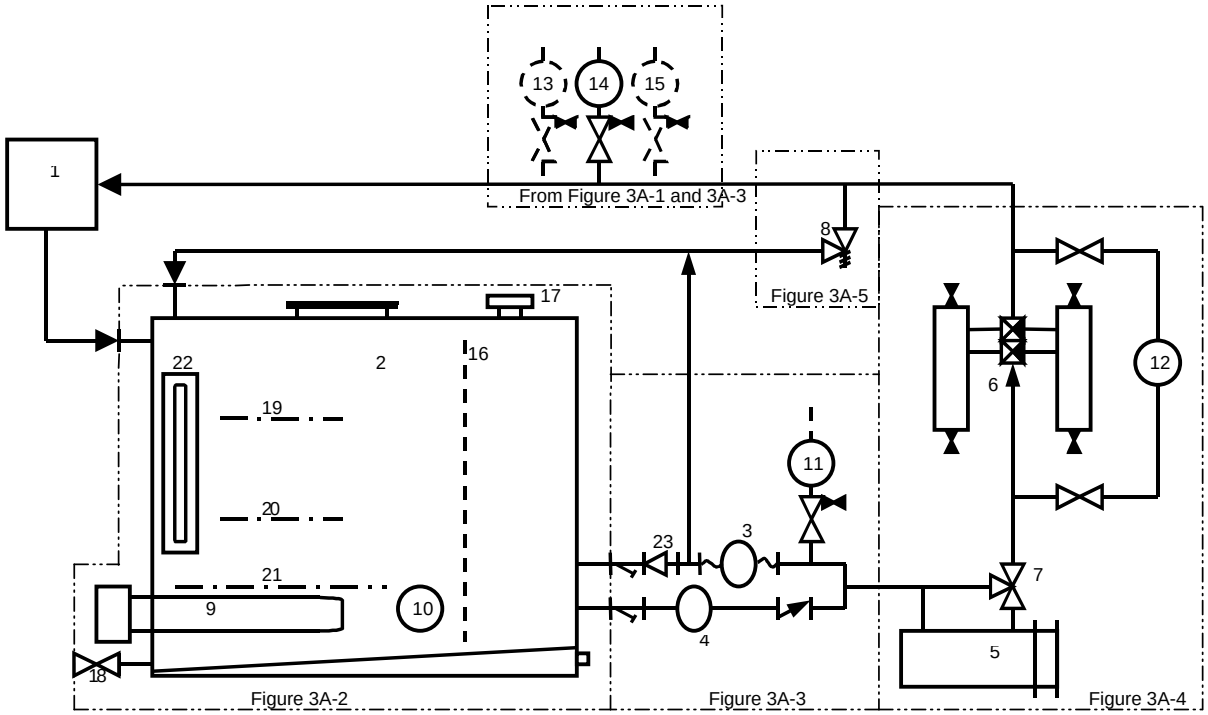
44. Torsional critical speed analysis report, including but not limited to the following:
    a. Complete description of the method used.
    b. Graphic display of the mass elastic system.
    c. Tabulation identifying the mass moment and torsional stiffness of each component identified in the mass elastic system.
    d. Graphic display of exciting forces versus speed and frequency.
    e. Graphic display of torsional critical speeds and deflections (mode-shape diagram).
    f. Effects of alternative coupling on analysis.
45. Curves and data for an operational five point performance test.
46. Curves and data for an optional unthrottled performance test.
47. Data from optional vibration sweeps.
48. Project specific IOMI Manual(s) - typical not acceptable.
49. Transient torsional analysis of all units using synchronous motors.

ANNEX E—LUBRICATION SYSTEM SCHEMATIC

This annex contains a schematic for lubrication systems. The notes and key to symbols in Figure E-1 are shown in Table E-1. This plan represents the default system. Other variations and systems are available and may be specified by the purchaser and mutually agreed upon by the purchaser and the vendor.

Table E-1—Lube-oil System Requirements

API 614-4th, Ch.3, App. A Figures	Options / Adds	API 672 Requirements / Resolution of API 614 Fig. 3A options
3A-1 Minimum requirements for general purpose oil systems	Note	Superseded by 672-4th Annex E, Fig. 1
3A-2 Reservoir	Option 1	A level switch is not required
	Option 2	A temperature indicator with thermowell is required
	Option 3	(When specified an electric immersion heater is required
	Option 4	Additional connections are required for: 1. System pressure control valve return 2. Independent suction connection with strainer for Aux. Pump
	Option 5	One tapped grounding lug is required
	Option 6	Gauge glass shall be armored
	Add 1	A vent connection with air eductor or motorized oil demister shall be provided
	Add 2	A minimum 50 mm (2 nps) flanged drain connection with valve and blind shall be provided at the low end
3A-3 Pumps	Option 1	One 100% auxiliary oil pump is required
	Option 2	Block valves are not required
	Option 3	A separate pre/post lube oil pump is not required
	Option 4	(When specified, a pressure switch shall be provided for direct initiation of aux. motor start. Otherwise, the start signal shall come from the microprocessor.
	Option 5	(Pressure transducers are standard unless transmitters or switches are specified.
	Add 1	(When specified, a separate sensor shall be provided for shutdown signal
	Add 2	A means for priming the shaft -driven pump with the discharge of the aux. pump shall be provided
3A-4 Filters and coolers	Option 1	One oil cooler is required
	Option 2	Duplex filters are required
	Option 3	(When specified, a three-way constant temperature control valve with bypass line shall be provided
	Option 4	A two or three way variable temperature control valve is not required
	Option 5	A temperature switch is NOT required
	Option 6	A single transfer valve with cooler and filter in parallel with separate TCV is not required
	Option 7	A differential pressure indication is required from the microprocessor
3A-5 Pressure control	Option 1	A pressure relieving valve is required if a pump can be blocked in (may be integral w/pump)
	Option 2	A pressure regulator (relief-valve type) is standard. A direct acting back-pressure control valve is optional
	Option 3	Block valves around the PCV / regulator are not required
	Option 4	A globe bypass valve is not required



Key

1 Rotating Equipment
2 Reservoir
3 Shaft Driven Main Oil Pump
4 Motor Driven Standby Oil Pump (3A-3 Option 1)
5 Oil Cooler (3A-4 Option 1)
6 Duplex Oil Filter (3A-4 Option 2)
7 Temperature Control Valve (3A-4 Option 3)
8 Pressure Regulator (3A-5 Option 1,2,3,& 4)
9 Heater (3A-2 Option 3)
10 Temperature Indicator (3A-2 Option 2)
11 Pump Discharge Pressure Signal
12 Differential Pressure Signal (3A-4 Option 7)
13 Aux Pump Start Signal (3A-3 Opt. 4)
14 Low Pressure Alarm Signal
15 Low Pressure Shutdown Signal (3A-3 Add. 1 Option)
16 Reservoir Internal Baffle
17 Breather (3A-2 Add. 1)
18 Drain Valve (3A-2 Add. 2)
19 Maximum Operating Level
20 Minimum Operating Level
21 Pump Suction Loss Level
22 Level Gauge
23 Provision for priming (3A-3 Add. 2)

Figure E-1

ANNEX F—REQUIREMENT FOR DETERMINING RESIDUAL UNBALANCE

F.1 Scope

This appendix describes the procedure to be used to determine residual unbalance in machine rotors. Although some balancing machines may be set up to read out the exact amount of unbalance, the calibration can be in error. The only sure method of determining residual unbalance is to test the rotor with a known amount of unbalance.

F.2 Definition

Residual unbalance is the amount of unbalance remaining in a rotor after balancing. Unless otherwise specified, it shall be expressed in gram-millimeters or ounces-inches.

F.3 Maximum Allowable Residual Unbalance

F.3.1 The maximum allowable residual unbalance per plane shall be calculated using Equation 6.12.7 of this standard.

F.3.2 If the actual static weight load on each journal is not known, assume that the total rotor weight is equally supported by the bearings. For example, a two-bearing rotor weighting 6000 pounds would be assumed to impose a static weight load of 3000 pounds on each journal.

F.4 Residual Unbalance Check

F.4.1 GENERAL

F.4.1.1 When the balancing machine readings indicate that the rotor has been balanced to within the specified tolerance, a residual unbalance check shall be performed before the rotor is removed from the balancing machine.

F.4.1.2 To check residual unbalance, a known trial weight is attached to the rotor sequentially in six (or twelve, if specified by the purchaser) equally spaced radial positions, each at the same radius. The check is run in each correction plane, and the readings in each plane are plotted on a graph, using the procedure specified in F.4.2.

F.4.2 PROCEDURE

F.4.2.1 Select a trial weight and a radius that will be equivalent to between one and two times the maximum allowable residual unbalance (that is, if U_{max} is 2 ounces-inches, the trial weight should cause 2 to 4 ounces-in. of unbalance).

F.4.2.2 Starting at the last known heavy spot in each correction plane, mark off the specified number of radial positions (six or twelve) in equal (60- or 30-degree) increments around the rotor. Add the trial weight to the last known heavy spot in one plane. If the rotor has been balanced very precisely and the final heavy spot cannot be determined, add the trial weight to any one of the marked radial positions.

F.4.2.3 To verify that an appropriate trial weight has been selected, operate the balancing machine and the note units of unbalance indicated on the meter. If the meter pegs, a smaller trial weight should be used. If little or no meter reading results, a larger trial weight should be used. Little or no meter reading generally indicates that the rotor was not balanced correctly, the balancing machine was not sensitive enough, or that a balancing machine fault exists (i.e., a faulty pickup). Whatever the error, it must be corrected before proceeding with the residual unbalance check.

F.4.2.4 Locate the weight at each of the equally spaced positions in turn, and record the amount of unbalance indicated on the meter for each position. Repeat the initial position as a check. All verification shall be performed using only one sensitivity range on the balance machine.

F.4.2.5 Plot the readings on the residual unbalance work sheet and calculate the amount of residual unbalance (see Figure F-1). The maximum meter reading occurs when the trial weight is added at the rotor's heavy spot; the minimum reading occurs when the trial weight is opposite the heavy spot. Thus, the plotted readings should form an approximate circle (see Figure F-2). An average of the maximum and minimum meter readings represents the effect of the trial weight. The distance of the circle's center from the origin of the polar plot represents the residual unbalance in that plane.

F.4.2.6 Repeat steps described in F.4.2.1 through F.4.2.5 for each balance plane. If the specified maximum allowable residual unbalance has been exceeded in any balance plane, the rotor shall be balanced more precisely and checked again. If a correction is made in any balance plane, the residual unbalance check shall be repeated in all planes.

F.4.2.7 For stack component balanced rotors, a residual unbalance check shall be performed after the addition and balancing of the first rotor component, and at the completion of balancing the entire rotor, as a minimum.

Note: This ensures that time is not wasted and rotor components are not subjected to unnecessary material removal in attempting to balance a multiple component rotor with a faulty balancing machine.

Equipment (rotor) no.: _____

Purchase order no.: _____

Correction plane (inlet, drive-end, etc. use sketch): _____

Balancing speed: _____ rpm

N Maximum allowable rotor speed: _____ rpm

W W eight of journal (closest to this correction plane): _____ lbs.

U_{max} = Maximum allowable residual unbalance =
4 3 *W*/ *N* (6350 *W*/ *N*)
4 3 _____ lbs. / _____ rpm _____ oz.-in. (gm-mm)

Trial unbalance (2 3 U_{max}) _____ oz.-in. (gm-mm)

R Radius (at which weight will be placed): _____ inches

Trial unbalance weight = trial unbalance/*R*
_____ oz.-in./_____ inches = _____ oz. (gm)

Conversion information: 1 ounce = 28.375 grams

TEST DATA

Position	Amplitude	Angular Position
1		
2		
3		
4		
5		
6		
Repeat 1		

ROTOR SKETCH

TEST DATA GRAPHIC ANAL YSIS

Step 1: Plot data on the polar chart (Figure F-1 continued). Scale the chart so the largest and smallest amplitude will fit conveniently.

Step 2: With the compass, draw the best fit circle through the six points and mark the center of this circle.

Step 3: Measure the diameter of the circle in units of scale chosen in Step 1 and record. _____ units

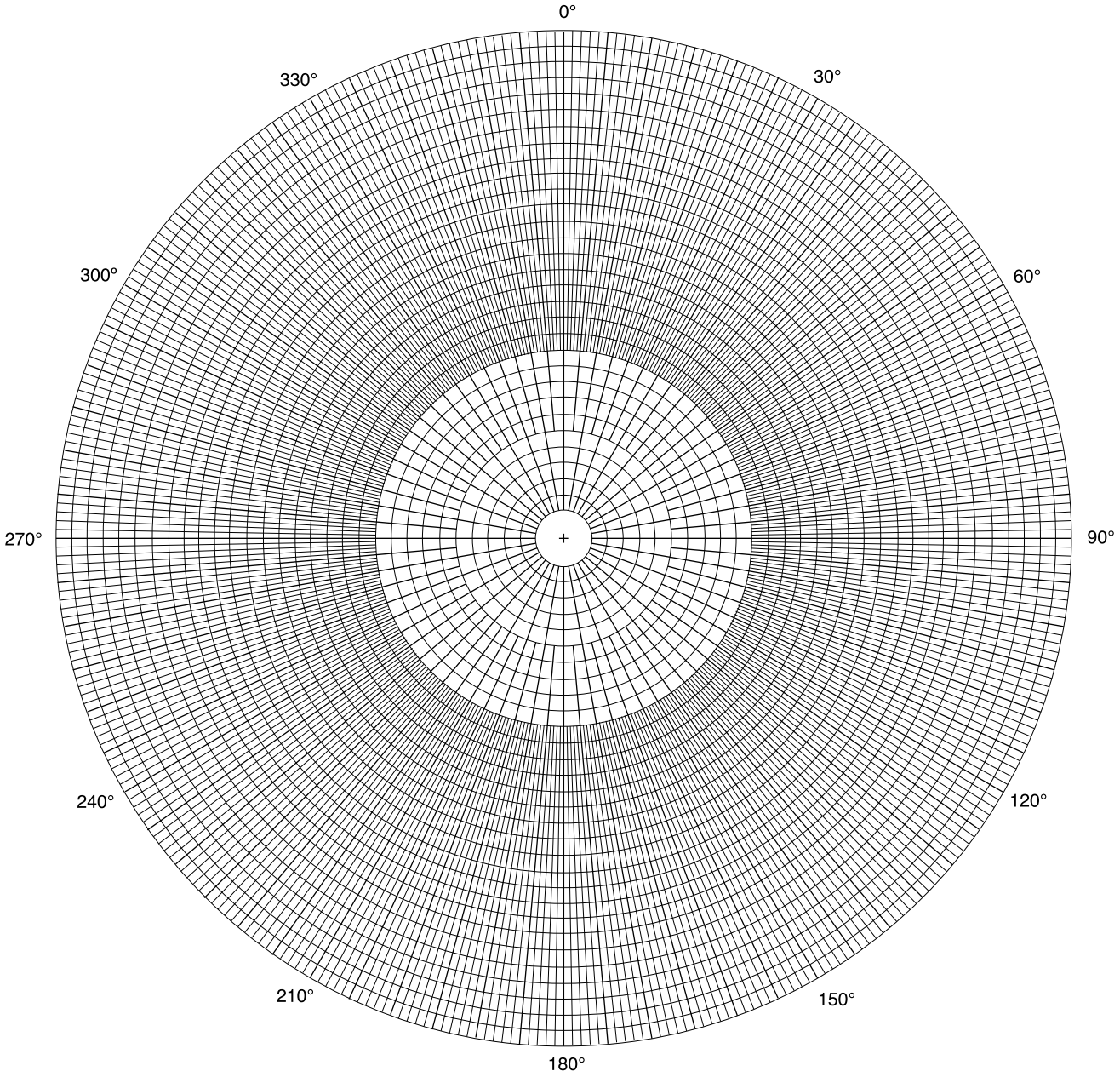
Step 4: Record the trial unbalance from above. _____ oz.-in. (gm-mm)

Step 5: Double the trial unbalance in Step 4 (may use twice the actual residual unbalance). _____ oz.-in. (gm-mm)

Step 6: Divide the answer in Step 5 by the answer in Step 3. _____ Scale Factor

You now have a correlation between the units in the polar chart and the gm-in. of actual balance.

Figure F-1—Residual Unbalance Worksheet



The circle you have drawn must contain the origin of the polar chart. If it doesn t, the residual unbalance of the rotor exceeds the applied test unbalance. Proceed with the balancing machine sensitivity check before rebalancing is attempted.

If the circle does contain the origin of the polar chart, the distance between origin of the chart and the center of your circle is the actual residual unbalance present on the rotor correction plane. Measure the distance in units of scale you choose in Step 1 and multiply this number by the scale factor determined in Step 6. Distance in units of scale between origin and center of the circle times scale factor equals actual residual balance.

Record actual residual unbalance _____ (oz.-in.)(gm-mm)

Record allowable residual unbalance (from Figure F-1) _____ (oz.-in.)(gm-mm)

Correction plane _____ for Rotor No. _____ (has/has not) passed.

By _____ Date _____

Figure F-1—Residual Unbalance Worksheet (continued)

Equipment (rotor) no.: *C-101*

Purchase order no.: _____

Correction plane (inlet, drive-end, etc. use sketch): *A*

Balancing speed: *800* rpm

N Maximum allowable rotor speed: *10,000* rpm

W W eight of journal (closest to this correction plane): *908* lbs.

U_{max} = Maximum allowable residual unbalance =
4 3 *W*/ *N* (6350 *W*/ *N*)
4 3 *908* lbs. / *10,000* rpm *0.36* oz.-in. (gm-mm)

Trial unbalance (2 3 U_{max}) *0.72* oz.-in. (gm-mm)

R Radius (at which weight will be placed): *6.875* inches

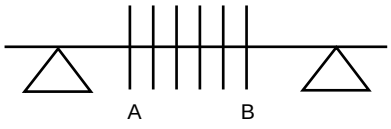
Trial unbalance weight = trial unbalance/ *R*
0.72 oz.-in. / *6.875* inches = *0.10* oz. (gm)

Conversion information: 1 ounce = 28.375 grams

TEST DATA

Position	Amplitude	Angular Position
1	*16.2*	*0¡*
2	*12.0*	*60¡*
3	*12.5*	*120¡*
4	*17.8*	*180¡*
5	*24.0*	*240¡*
6	*23.0*	*300¡*
Repeat 1	*16.2*	*0¡*

ROTOR SKETCH



C-101

TEST DATA GRAPHIC ANAL YSIS

Step 1: Plot data on the polar chart (Figure F-2 continued). Scale the chart so the largest and smalles t amplitude will fit conveniently.

Step 2: With the compass, draw the best fit circle through the six points and mark the center of this circle.

Step 3: Measure the diameter of the circle in units of scale chosen in Step 1 and record. *35* units

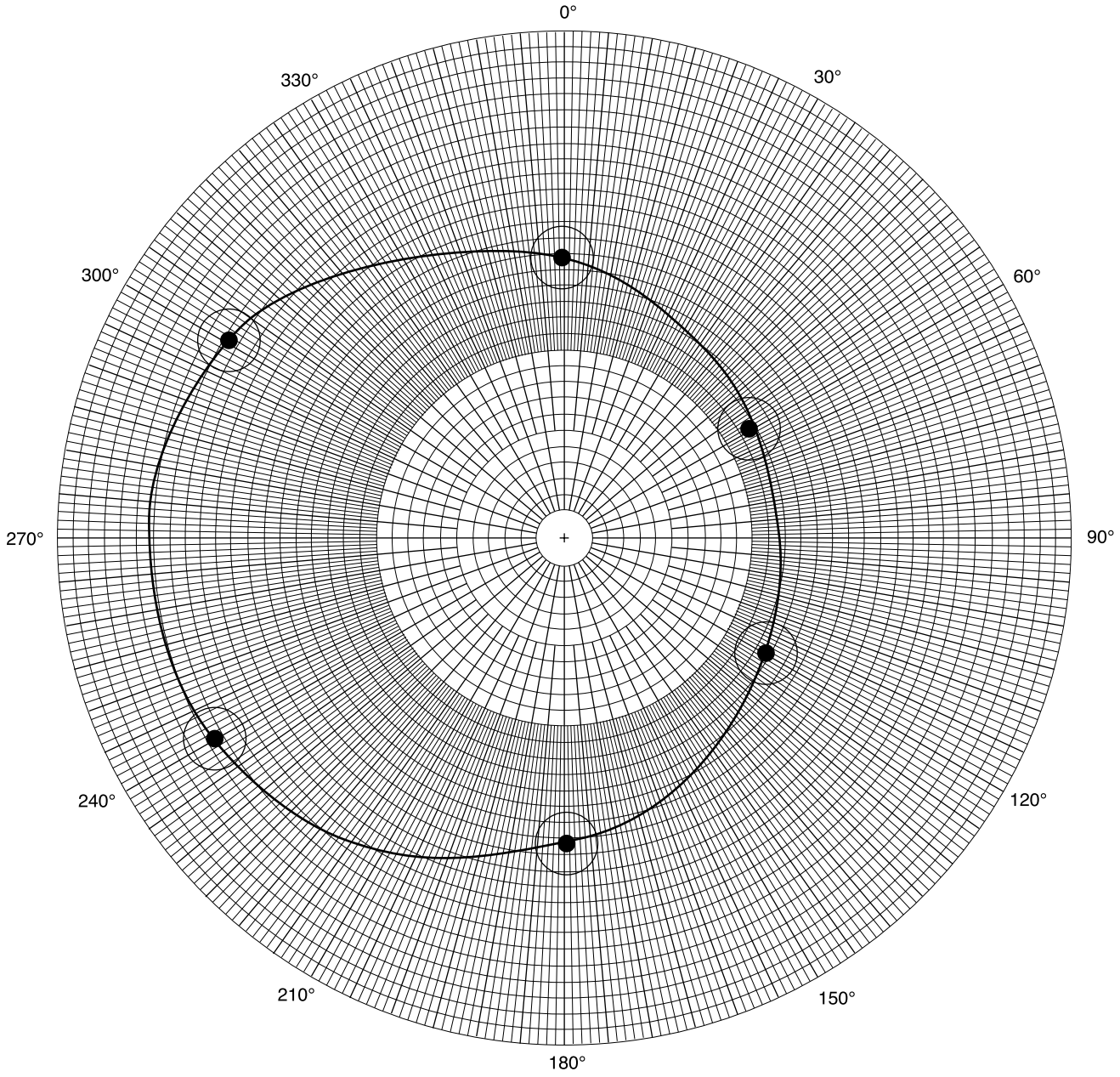
Step 4: Record the trial unbalance from above. *0.72* oz.-in. (gm-mm)

Step 5: Double the trial unbalance in Step 4 (may use twice the actual residual unbalance). *1.44* oz.-in. (gm-mm)

Step 6: Divide the answer in Step 5 by the answer in Step 3. *0.041* Scale Factor

You now have a correlation between the units in the polar chart and the gm-in. of actual balance.

Figure F-2—Sample Calculations for Residual Unbalance



The circle you have drawn must contain the origin of the polar chart. If it doesn t, the residual unbalance of the rotor exceeds the applied test unbalance. Proceed with the balancing machine sensitivity check before rebalancing is attempted.

If the circle does contain the origin of the polar chart, the distance between origin of the chart and the center of your circle is the actual residual unbalance present on the rotor correction plane. Measure the distance in units of scale you choose in Step 1 and multiply this number by the scale factor determined in Step 6. Distance in units of scale between origin and center of the circle times scale factor equals actual residual balance.

Record actual residual unbalance *6.5 (0.041) = 0.27* (oz.-in.)(gm-mm)

Record allowable residual unbalance (from Figure F-2) *0.36* (oz.-in.)(gm-mm)

Correction plane *A* for Rotor No. *C-101* (has/has not) passed.

By _____ Date *11-16-92*

Figure F-2—Sample Calculations for Residual Unbalance (continued)

ANNEX G—INSPECTOR'S CHECKLIST

The levels indicated in Table G-1 may be characterized as follows:

– Level 1 is typically used for packages and basic services;

– Level 2 comprises optional performance and material requirements and is more stringent than level 1;

– Level 3 items should be considered for packages in special duty services.

The required inspection shall be indicated in the first column as:

– C - Certification only;

– O - Observed inspection;

– W - Witnessed inspection.

Notes:

[a] Check against certified dimensional outline drawing

[b] When specified in contract.

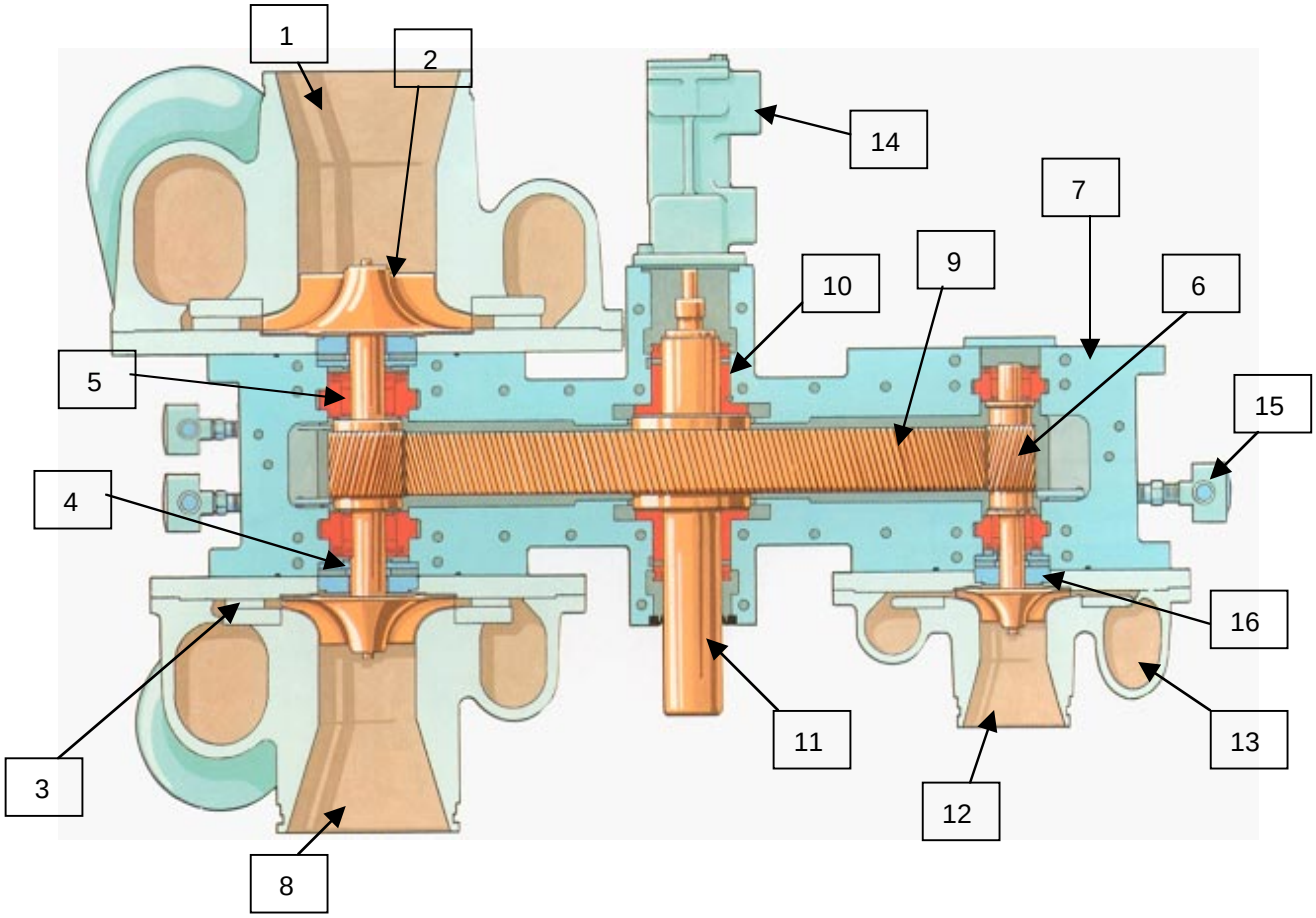
Table G-1—Inspector's Checklist

Inspection required C, O, or W	Item	API 672 paragraph number	Date inspected	Inspected by	Status
	Level 1 - Basic				
	Package scope	contract, 6.1.4			
	Auxiliary systems per design	contract, auxiliary system schematics			
	Overall dimensions and connection locations[a]				
	Anchor bolt layout and size[a]				
	Motors and electrical components area classification	6.1.8			
	Casing connections: nozzle size, rating and finish[a]	outline drawing, 6.1.10, 6.3			
	Bolting	6.1.11			
	Rotor balancing	6.7.4.1			
	Vibration within acceptance criteria	6.7.4.3			
	Lubrication system reservoir internal coating and cleanliness	6.9.4			
	Equipment nameplate data	6.11.4			
	Rotation arrows	6.11			
	Jackscrews on driver feet	7.1.1.6			
	Couplings proper type	7.2.1			
	Coupling guards with sufficient protection and sufficiently rigid	7.2.2			
	Baseplate with major components supported	7.3			
	Lifting lugs included and identified	7.3.3, 8.4.3			
	Mounting surfaces within tolerances	6.1.13, 7.3.5			
	Conduit routing, properly supported, properly shielded	7.4.1.5, 7.4.1.6, 7.4.6.5			
	Instrument control panel scope	7.4.3.1, 5.4.3.2			
	Annunciator panel scope and function	7.4.5.2			
	Segregated instrument and control wiring from electrical power wiring	7.4.6.3			
	Piping fabrication and installation	7.5			

Table G-1—Inspector's Checklist (Continued)

Inspection required C, O, or W	Item	API 672 paragraph number	Date inspected	Inspected by	Status
	Inlet air filter/silencer scope and construction materials	7.7			
	Pre-test static gear contact pattern	8.2.3.2			
	Hydrostatic tests	8.3.2			
	Impeller over-speed test	8.3.3			
	Combined mechanical performance test	8.3.4			
	Preparation for shipment	8.4.1			
	Storage preservation instructions	8.4.2			
	Rust prevention				
	Painting				
	Shipping documents and tags				
	Level 2 - Intermediate (Add to Level 1)				
	Copies of sub-vendor purchase order				
	Material certification				
	Non-destructive examination (components)				
	Hydrotest witnessed				
	Rotating elements balancing witnessed				
	Building records (runouts, clearances)				
	Performance and Mechanical tests Witnessed				
	Inspection of cleanliness of internals	8.2.3.1			
	Level 3 - Special (Add to Level 1 and 2)				
	Special devices used for maintenance	6.12.1			
	Confirm damped unbalanced response analysis	6.12.4			
	Dynamic, component balancing	6.12.6, 6.12.7			
	Residual unbalance check	6.12.8			
	Stainless steel oil reservoir	6.12.13			
	Drain rim decking under drive train components[b]	7.10.2			
	Proper preparation of grouted surfaces[b]	7.10.3			
	Provisions for phase reference[b]	7.10.7			
	Gear axial position probe provision[b]	7.10.8			
	Gear casing accelerometer mounting provisions[b]	7.10.9			
	Vibration and axial position probe transducers[b]	7.10.10			
	Vibration and axial position probe monitors[b]	7.10.11			
	Bearing temperature monitors[b]	7.10.12			
	Alarm and shutdown devices separate?[b]	7.10.14			
	Pilot lights on electrical circuits[b]	7.10.15			
	Stainless steel oil piping throughout[b]	7.10.18			
	Oil-actuated control valves vented back to reservoir[b]	7.10.19			
	All piping components of steel	7.10.20			
	Special cooler materials	7.10.21			
	Coolers TEMA C with removable channel covers[b]	7.10.22			
	Documentation for clearances	8.5.1			
	Impellers radiographed and inspected	8.5.2, 8.5.3			
	Non-synchronous vibration within tolerance[b]	8.5.9			
	Post test inspection[b]	8.5.11			
	Spare rotor mechanical test	8.5.12.2			

ANNEX H—GUIDE TO NOMENCLATURE



Key

1. First Stage Inlet
2. Impeller
3. Diffuser
4. Oil seal
5. Pinion journal/thrust bearing
6. Pinion
7. Gear casing
8. Second Stage Inlet
9. Gear Wheel (Bull Gear)
10. Gear Wheel Journal/Thrust Bearing
11. Input (drive) shaft
12. Third stage inlet
13. Third stage discharge
14. Shaft driven main oil pump
15. Vibration instrument
16. Air Seal

Figure H-1

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