International Association of Oil & Gas Producers

SPECIFICATION

IOGP S-713J

August 2025

Version 2.0

Supplementary Specification to API Standard 613 for Special-purpose Gears

NOTE This version (S-713J) of the specification document provides the justification statements for each technical requirement, but is otherwise identical in content to S-713.

JIP33 JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
2.0	August 2025	Second Edition
1.0	July 2020	First Edition

Acknowledgements

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

Foreword

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

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

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

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

This second edition cancels and replaces the first edition published in July 2020. Due to technical writing requirements leading to extensive changes, this second edition should be treated as a new document.

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List of Tables

Introduction

The purpose of the IOGP S-713 specification documents is to define a minimum common set of requirements for the procurement of special-purpose gears in accordance with API Standard 613, Sixth Edition, July 2021, Special-purpose Gears for Petroleum, Chemical and Gas Industry Services, for application in the petroleum and natural gas industries.

The IOGP S-713 specification documents follow a common structure (as shown below) comprising a specification, also known as a technical requirements specification (TRS), a procurement data sheet (PDS), an information requirements specification (IRS) and a quality requirements specification (QRS). These four specification documents, together with the purchase order, define the overall technical specification for procurement.

JIP33 Specification for Procurement Documents
Supplementary Technical Requirements Specification (TRS)

This specification is to be applied in conjunction with the supporting PDS, IRS and QRS as follows.

IOGP S-713: Supplementary Specification to API Standard 613 for Special-purpose Gears

This specification defines technical requirements for the supply of the equipment and is written as an overlay to API 613, following the API 613 clause structure. Clauses from API 613 not amended by this specification apply as written. Modifications to API 613 defined in this specification are introduced by a description that includes the type of modification (i.e. *Add*, *Replace* or *Delete*) and the position of the modification within the clause.

NOTE Lists, notes, tables, figures, equations, examples and warnings are not counted as paragraphs.

IOGP S-713D: Procurement Data Sheet for Special-purpose Gears (API)

The PDS defines application-specific requirements. The PDS is applied during the procurement cycle only and does not replace the equipment data sheet. The PDS may also include fields for vendor-provided information required as part of the purchaser's technical evaluation. Additional purchaser-supplied documents may also be incorporated or referenced in the PDS to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-713L: Information Requirements for Special-purpose Gears (API)

The IRS defines information requirements for the scope of supply. The IRS includes information content, format, timing and purpose to be provided by the supplier, and may also define specific conditions that invoke the information requirements.

IOGP S-713Q: Quality Requirements for Special-purpose Gears (API)

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

The specification documents follow the editorial format of API 613 and, where appropriate, the drafting principles and rules of ISO/IEC Directives Part 2.

The PDS and IRS are published as editable documents for the purchaser to specify application-specific requirements. The TRS and QRS are fixed documents.

The order of precedence of documents applicable to the supply of the equipment, with the highest authority listed first, shall be as follows:

a) regulatory requirements;

b) contract documentation (e.g. purchase order);

c) purchaser-defined requirements (e.g. PDS, IRS and QRS);

d) this specification;

e) API 613.

2 Normative References

Add to first paragraph

The following documents are referred to in this specification, the PDS (IOGP S-713D) or the IRS (IOGP S-713L) in such a way that some or all of their content constitutes requirements of these specification documents.

Add to section

API Recommended Practice 684, *Paragraphs Rotodynamic Tutorial: Lateral Critical Speeds, Unbalance Response, Stability, Train Torsionals, and Rotor Balancing, Second Edition, 2005*

3 Terms, Definitions, Acronyms, Abbreviations, and Symbols

3.2 Acronyms and Abbreviations

Add to section

CAS conformity assessment system

FEA finite element analysis

IRS information requirements specification

MRT mechanical running test

PDS procurement data sheet

QRS quality requirements specification

TRS technical requirements specification

3.3 Symbols

Table 1—Symbols

Add symbol "dw1"

Symbol	Term	SI Units	USC Units
d_{w1}	operating pitch diameter of pinion 2a/(u + 1)	mm	in.

Delete second occurrence of symbol "u"

Symbol	Term	SI Units	USC Units
~~u~~	~~helix angle at reference diameter~~	~~degrees~~	~~degrees~~

6 Basic Design

6.1 General

6.1.7 Sound Pressure Level

Add new section

6.1.7.6

The gear vendor shall provide the following values measured during the acceptance test run or calculated from the values measured during the acceptance test run:

— sound intensity level;

— sound power level;

— sound pressure level and its octave band spectrum at the measurement surface 1 m (3.28 ft) away from the gearbox casing;

— measurement surface identification.

Justification

The sound power level (total value and octave spectrum) is normally used to check conformity with specified values. The sound intensity level is the best value for calculating the sound power and sound pressure level for the entire shaft train by the entity responsible for the entire shaft train.

6.1.14

Delete "If specified,"

Justification

This is a mandatory document that is provided by the purchaser and allows the package vendor to comment on the interfaces. It is advantageous for the gear vendor to see the baseplate and foundation design to ensure that they understand the interfaces with mounting and how it can impact their equipment. The package vendor is responsible for collating the comments from the gearbox vendor and returning the document to the purchaser.

Add new section

6.1.23

The limits of speed, torque and duration for reverse rotation of the gear unit shall be specified.

Justification

The gear unit is part of the train and consists of driver and driven equipment. In the event of stoppage of the driver and failure of the check valve, leakage of fluid through the driven equipment can cause reverse rotation. This can damage the bearings of the gear unit. Gear elements and bearings can have unidirectional design. It is important for the operator to be aware of the limits imposed by the design of the gear unit. The purpose of this requirement is for the operator to know how long a gear unit can spin backwards if the operating conditions cause reverse rotation.

Add new section

6.1.24

Unless otherwise specified, gears shall be of the double-helical type.

Justification

The double-helical design provides a significantly reduced thrust load compared to the single-helical gear design, resulting in improved reliability.

6.2 Rating

6.2.1 Gear Unit Rated Power

Replace third sentence with

For gear units connected directly to the driver and gear units between two items of driven equipment, all modes of normal and transient operation shall be examined.

Justification

The original sentence can imply that the requirement to have all modes of normal and transient operation examined is only applicable to the second sentence of the paragraph (gear units connected directly to the driver). This replacement ensures that the requirement for gear units between two items of driven equipment in the fourth sentence is also included in the examination.

6.2.3 Minimum Gear Tooth Service Factor

Replace Table 4 title with

Table 4—Minimum Gear Tooth Service Factors (C_{SF} and K_{SF})

Justification

In API 613 fifth edition, there was only one gear tooth service factor. API 613 sixth edition, following ANSI/AGMA, has introduced two different gear service factors for the minimum specified bending service factor and the minimum specified contact stress service factor (although the same value is used). This note clarifies that Table 4 is to be used for both values (C_{SF} and K_{SF}), which consequently will result in no change from API 613 previous edition.

Add new table NOTE

Driven Equipment	Induction Motors	Synchronous and Variable Speed Motors	Steam and Gas Turbines	Reciprocating Engines
NOTE The applicable minimum gear tooth service factor value applies to both C_{SF} and K_{SF}.				

Justification

In API 613 fifth edition, there was only one gear tooth service factor. API 613 sixth edition, following ANSI/AGMA, has introduced two different gear service factors for the minimum specified bending service factor and the minimum specified contact stress service factor (although the same value is used). This note clarifies that Table 4 is to be used for both values (C_{SF} and K_{SF}), which consequently results in no change from API 613 fifth edition.

6.2.4 Minimum Tooth Hardness

Add to section

For rating purposes, the tooth hardness of through hardened gears shall not exceed 363 HBW.

Justification

This requirement ensures that the teeth do not become too brittle, with the root being overly hardened. Nitrided and carburized are case hardened and do not need a maximum value. A maximum of 363 HBW is taken from Figure 3 in API 613 fifth edition as this figure has been removed from the sixth edition. This value is still considered a recommended practice by operators.

6.2.5 Tooth Pitting Resistance Power Rating

6.2.5.5

In first paragraph, replace "Table 4, grade 2" with

Table 3, grade 2

Justification

The correct reference is Table 3, grade 2 in ANSI/AGMA 2101-D04 (or ANSI/AGMA 2001-D04 when using USC units). This replacement points to the correct reference and prevents errors in calculations.

6.3 Casings

6.3.1 Design Parameters

6.3.1.5

Add to section

Shimming shall be in accordance with API 686:2009, Chapter 7, 5.4.2.

Justification

API 686 is the recognized standard for shimming requirements.

Add to section

In accordance with API 686:2009, Chapter 7, 5.4.2.6, shimming shall not be allowed to correct for gear tooth contact.

Justification

Non-uniformed shimming should not be used to correct a machining problem. The casing should be properly machined to allow for proper gear alignment. Non-standard approaches such as shimming to fix gear element alignment can cause issues if shims are changed and local staff do not understand the effect on gear set alignment.

6.3.1.6

Add to section

If specified, thermo-structural finite element analysis (FEA) of the gear casing shall be performed.

Justification

FEA verifies that the casing is not damaged due to distortion caused by temperature, torque, and allowable external forces and moments.

Add to section

FEA shall be required for new casing configurations or casing configurations on the experience list but not yet employed at the proposed power level.

Justification

This requirement to perform FEA on new or unproven casing designs reduces the risk of finding issues on the test stand which can lead to delivery delays or being forced to accept a resonance issue.

6.3.1.8

Replace first sentence with

Internal piping material shall be 316L stainless steel and manufactured to ASTM A312/A312M welded or flanged.

Justification

316L stainless steel is preferred for piping in upstream oil and gas applications due to its superior corrosion resistance in marine environments.

Add after second sentence

The quantity of internal piping flanges shall be minimized and only permitted to facilitate maintenance.

Justification

Minimizing the use of internal flanges:
- *reduces potential leakage, preventing the risk of loss of pressure leading to maldistribution of oil; and*
- *reduces the risk of fasteners and piping coming loose which can damage the internals.*

In third sentence, in both instances, replace "stainless steel" with

316L stainless steel

Justification

316L stainless steel tubing and fittings are preferred in upstream oil and gas applications due to its superior corrosion resistance in marine environments.

6.3.1.13 Filter Breather

6.3.1.13.2

In both instances, replace "Series 300 stainless steel" with

316 stainless steel

Justification

This replacement ensures that the material of construction provides adequate corrosion resistance. For oil and gas facilities installed in marine environments, 316 stainless steel offers superior corrosion resistance compared to other common Series 300 stainless steels.

6.3.1.14

Add to section

The top surface of the inspection opening shall be raised at least 25 mm (1 in.) from the gear casing.

Justification

Inspection covers are located on the top of the gear casing upper half and tend to accumulate dirt and water. This accumulation can affect the life of the gasket between the casing upper half and the inspection cover. Raising the inspection opening protects the gasket and prevents the ingress of dirt or water inside the gear casing when the cover is opened.

Add new section

6.3.1.16

Shims shall not be used between the gear housing and the bearing shell.

Justification

The use of shims between the housing and the bearing introduces flexibility into the bearing system. This flexibility could result in the loss of the intended gear mesh alignment. Shim stack up and cleanliness can become a concern for introducing flexibility. In the fabrication shop, it should be possible to machine the components for proper alignment for an emergency field adjustment. Shims may not be fractured from bending but can be subject to fatigue failure over time as gearbox loading can be high both statically and dynamically.

Add new section

6.3.1.17

Gear casings shall have provision for two earthing connections at diagonally opposite locations.

Justification

Earthing of each piece of equipment is an essential electrical system safety requirement which is not covered in API 613. Therefore, suitable provision needs to be made on the gear unit casing to carry out earthing work.

6.3.3 Bolting

6.3.3.1

Replace section with

Case bolting shall use through-bolting.

Justification

This replacement prevents the usage of cap screws and studs. Cap screws do not produce the same amount of pre-stretch compared to that achieved by the use of bolts or studs. Cap screws do not permit verification of bolt pre-stretch. It is also difficult to maintain joint tightness with cap screws. Cap screws are difficult to maintain for long-term operation.

Add to section

In locations where through-bolting is not practical, the use of studs shall require the purchaser's approval for each proposed location.

Justification

Studs provide less stretch distance and less clamping force than through-bolts and therefore their use should be kept to a minimum. This requirement ensures that studs are only used where it is not practical to use through-bolts.

Add new section

6.3.3.7

Fasteners internal to the gearbox shall be positively locked or retained.

Justification

Loose fasteners can result in high-consequence asset damage. Internal fasteners that are positively locked or retained ensure that the fasteners do not become loose with time.

6.4 Casing Connections

6.4.9 Threaded Plugs

6.4.9.2

Replace section with

Plugs shall be of 316 stainless steel material.

Justification

This replacement ensures that plugs are manufactured from a suitable corrosion-resistant material for the offshore marine environment. In addition, the original API 613 requirement is only applicable to plugs requiring removal. The requirement has been modified to be applicable to all plugs. It is not practical to ask the vendor to determine which plugs will be removed in the future.

6.4.11

Add to section

Socket-welded flanges and fittings shall not be permitted in lubricating oil service.

Justification

Socket welded fittings require a gap for expansion of components. It is challenging to ensure that oil piping with socket welded fittings is sufficiently clean to remove all weld slag and debris prior to operation. For this reason, socket welded piping, and fittings are prohibited in this service.

6.5 Gear Elements

6.5.2 Quality Assurance

6.5.2.2 Contact Checking

6.5.2.2.4

In second sentence, replace "a tooth" with

four or more teeth of the dry, degreased gear wheel at each of three locations, 120° apart (see 6.5.2.2.2)

Justification

API 613 only requires lifting contact transfer from one tooth. Lifting contact from at least three teeth at 120° apart provides a better overall view of the contact.

Add new section

6.5.2.2.5

Unmodified leads shall have a minimum contact of 80 % across the tooth length.

Justification

Gear mesh contact is critical to the reliability of the load-carrying of the gearbox, lubrication and heat transfer capabilities. API 613 does not contain a minimum contact requirement. A standardized minimum value of 80 % is derived from operators' experience. Gear mesh inspection in a loaded condition would provide a more accurate representation of contact. This inspection gives a good indication even in unloaded conditions. 6.5.2.2 does not provide a standard criterion for acceptance of unmodified leads. 6.5.2.2 is for the unloaded condition. The original API requirement is a measurement of the tooth profile. This new requirement validates both the tooth profile for unmodified leads as a secondary check and gear alignment in the casing.

Add new section

6.5.2.2.6

If profile and longitudinal tooth corrections are designed into the gear set, both loaded and unloaded tooth flanks shall be checked for contact.

Justification

In the case of modified leads, verification of the unloaded side of the teeth ensures there is no unintentional rubbing at no/low load.

6.5.3 Fabrication

6.5.3.2

Add to section

Double-helical gear wheels shall be machined from a single forging.

Justification

Double-helical gears constructed from two separate forged gear wheels can result in teeth misalignment during assembly on the shaft due to manufacturing tolerances. This requirement is added to ensure that double-helical gears are machined from a single forging, preventing the risk of misalignment.

6.5.4 Shafts

6.5.4.1

Add new list section e)

e) the heat treatment of shaft forgings and hot-rolled barstock shall include stress relieving.

Justification

Heat treatment of shaft forgings and hot-rolled barstocks does not always include stress relieving. Residual stresses can affect the shaft dimensions and gear geometry after machining.

6.5.4.2 Shaft Ends

Add new section

6.5.4.2.4

If specified, the free end of the high-speed shaft shall have a square section or other suitable arrangement that can be used to turn the shaft manually after removing the bearing end cover.

Justification

This requirement provides a mechanism to easily control the manual rotation of the complete shaft line.

6.5.4.3 Rotor Shaft Sensing Areas

6.5.4.3.6

Replace section (including equations (7a) and (7b)) with

For areas observed by radial vibration probes, the combined total electrical and mechanical runout shall not exceed 6.35 µm (0.25 mils).

Justification

Equations (7a) and (7b) are based on the maximum continuous operating speed and can yield values greater than 6.35 µm (0.25 mils). Values exceeding 6.35 µm (0.25 mils) are not acceptable because this limits the buffer between normal operations and the trip value. For instance, for an 1,800 rpm shaft, the calculation according to equations (7a)/(7b) allows a 0.645 mil electrical and mechanical runout.

6.5.4.3.9

Add to section

Records of electrical and mechanical runout, for the full 360° at each probe location, shall include the phase relationship of each probe with respect to a common reference signal or location (phase indicator probe).

Justification

Having a common phase reference for both the electrical and mechanical runout through the 360° sweep of the rotor makes it possible to distinguish if excessive runout is due to electrical or mechanical runout, or if both are additive in one location on the shaft. This helps determine the most effective method for addressing the excessive runout.

6.5.4.4

Delete "If specified," from first sentence

Justification

This deletion ensures that detection equipment for torsional vibrations coming from the driver can be added later. Making this requirement mandatory provides insurance with minimal additional cost, if problems arise.

6.5.4.6

Delete "If specified," from first sentence

Justification

This requirement makes mandatory the provision to hang rotors vertically by machining the shaft to accept hanging fixtures. Vertically hanging a shaft can prevent rotor bow. The ability to vertically store rotors enables storage in climate-controlled third-party storage facilities. Balancing of horizontally stored rotors takes more time than vertically stored rotors. Machining the shaft later to permit vertical storage can be very costly. Machining of the shaft while in fabrication is of minimal cost and provides flexibility for future storage.

6.5.5 Balancing

Add new section

6.5.5.8

When a direct-end drive balance machine is utilized, the requirements of API 684:2005, 5.3.4.2 shall apply.

Justification

When a drive-plate/drive-shaft mechanism is used for balancing, these drive parts are to be rotated 180° relative to the gear rotor to demonstrate that the drive parts have no adverse effect on the balance results and residual unbalance check. This requirement is detailed in API 684. This requirement ensures that there is no error induced by the drive mechanism when balancing the rotors and aligns with a recognized standard.

6.6 Dynamics

6.6.1 General

6.6.1.3

Add to section

The damped lateral analysis report shall include the structural resonance, mode shapes and dynamic stiffnesses from the structural dynamic analysis calculations.

Justification

The structural dynamic analysis report is needed by the gearbox manufacturer and the results are used in the lateral analysis calculation. This requirement provides verification of this section by ensuring that the structural analysis is performed and reviewed by the purchaser. The effective stiffness of the structural support is to be considered in the analysis of the dynamics of the rotor-bearing-support system.

6.6.2 Lateral Analysis

6.6.2.1 General

6.6.2.1.2

In first sentence, replace "The location of all lateral critical speeds below the trip speed" with

The location and associated AF of all lateral critical speeds and critically damped speeds below the trip speed

Justification

API 613 is not clear as to whether critically damped speeds are to be considered critical speeds. It is important that critical speeds identified to be critically damped by the analysis are verified to be critically damped on the test stand.

6.6.2.2 Undamped Analysis

6.6.2.2.1

Delete "If specified,"

Justification

The undamped analysis identifies critical speeds. It is easily run using the inputs needed for the damped analysis and should not lead to additional costs. If a third-party lateral analysis is performed as a check, these results will also help calibrate the models.

6.6.2.2.2

Add new list item c)

c) minimum and maximum bearing stiffnesses, as determined by the combined effect of the design bearing clearance range and the lube oil temperature range within the range of the alarm limits.

Justification

This requirement ensures that the full range of clearance and temperature effects is taken into account and that the critical speed separation margins are considered for the worst-case scenarios. This can be implied by the list item a) requirement to include the bearing oil film stiffness, though this can lead to a more limited range of effects if interpreted that way.

6.6.2.2.3

Add new list item c)

c) bearing dynamic stiffness curves for the 10 %, 50 % and 100 % power levels to be plotted as in Figure 5.

Justification

The bearing load is dependent upon both the rotor weight and the gear power level. The undamped analysis needs to account for the varying load on the journal bearings at the power levels required. This plot allows all the three power levels to be seen as in Figure 5.

6.6.2.3 Damped Unbalanced Response Analysis

6.6.2.3.1

Add to list item e)

Damped rotor analysis shall include the normal operating point of the driven equipment and any other specified operating conditions (see 6.2.2).

Justification

Special-purpose gear units are utilized for critical applications. Damped rotor lateral analysis is essential to demonstrate by calculations that the gear unit rotors provide adequate separation margin from the rotor critical speeds, acceptable vibration levels and stable operating conditions.
Rotor bearing dynamic response is dependent upon power loading as well as the speed at which it operates. When there are many operating conditions defined in the duty specification, with various loading and operating conditions, it is essential to analyze these conditions and ensure that the separation margin is acceptable.
This requirement specifically refers to the reporting of the operating loading and the separation margin at the operating speed in addition to the reporting of the 10 %, 50 % and 100 % power loading required by API 613. Rotordynamic analysis is not linear, and the three power loading curves (10 %, 50 % and 100 %) may not be representative of the operating load.
The original list item e) requires analysis of the load ranges which include the lowest feasible loads that should occur on the test stand. For machines that can run lightly loaded, it is desirable to ensure that the low-load condition does not lead to vibration issues resulting from unloaded bearings.

6.6.2.3.5

Add new list section d)

d) If the AF of any rotor at a particular critical speed and at any given operating condition is greater than or equal to 2.5, the operating speed of any other gearbox rotor shall not be within ±10 % of that critical speed (cross talk between gear and pinions).

Justification

Vibration energy is transferred by gear tooth contact from one rotor to the other. This requirement maintains a typical margin of 10 %. 10 % is considered an adequate margin and is consistent with API 684 for low damping criteria. There can be more than two shafts and cross-talk can happen between any of the rotors.

6.6.2.4 Stability Analysis

6.6.2.4.5

Delete "For some rotors," from second sentence

Justification

This deletion clarifies that stability analysis with the minimal load conditions is to be performed for all rotors.

6.6.2.4.6

Replace "final log decrement greater than 0.1" with

log decrement greater than 0.1 for all conditions defined in 6.6.2.4

Justification

This replacement clarifies that the stability analysis is for each individual calculated log decrement (see all load conditions in 6.6.2.4), not a single final log decrement.

6.7 Bearings and Bearing Housings

6.7.1 General

6.7.1.3

In first sentence, replace "at rated speed" with

at all operating conditions

Justification

The bearing design temperature is within the control of the supplier by their bearing selection, and lower temperatures mean higher reliability and service life of the gear and lubricating oil.

6.7.1.5

Delete "When specified," from first sentence

Justification

Ultrasonic testing is typically the non-destructive testing performed to verify the proper bonding between the babbitt and backing material.

6.7.3 Thrust Bearings

6.7.3.2

Add new list section e)

e) be removable without the need to remove the gear rotor.

Justification

Removing the rotor to access the thrust bearing adds significant downtime and maintenance activities. Additionally, there is an increased risk of damaging the rotor during removal and re-installation.

6.7.3.7

Add to section

For replaceable thrust collars, an interference fit shall be provided.

Justification

Both key thrust collars and tapered fit collars are acceptable collar designs. Both collar designs require an interference fit between the thrust collar and the shaft. This requirement clarifies that both types of collars are acceptable and require an interference fit.

6.7.4 Bearing Housings

6.7.4.6

Replace list item c) with

c) two radial probes per radial bearing;

Justification

Radial vibration probes provide information for monitoring and analyzing the condition of the machine. Vibration signals from both shaft ends are needed for a complete overview of the dynamic operation of the machine and for troubleshooting.

6.8 Lubrication

Add new section

6.8.7

Orifice sizes for bearing and spray nozzle lube oil supplies shall be indicated on the general arrangement drawing.

Justification

It is important that these orifice sizes are documented so that restriction orifices are appropriately installed and any changes can be tracked.

6.9 Materials

6.9.2 Welding

6.9.2.1

Add before first sentence

Welding of rotating parts shall not be permitted.

Justification

Welding of rotating parts is not permitted as these components are highly stressed and are operating under dynamic loading. Welding introduces additional stresses, uncontrolled residual stress under centrifugal loading and uncertainty in gear mesh alignment in the welded components.

In first paragraph, replace "Welding of rotating parts and other highly stressed parts" with

Welding of highly stressed parts

Justification

Welding of rotating elements is not permitted as these components are highly stressed and operate under dynamic loading. Welding introduces additional stresses, uncontrolled residual stress under centrifugal loading and uncertainty in gear mesh alignment in the welded components. This replacement aligns with the new requirement added before the first sentence of this section.

6.9.2.3

Add to section

Weld repairs shall be defined as major when the depth of the cavity after the preparation for repair exceeds 20 % of the wall thickness or 25 mm (1 in.), whichever is smaller, or when the extent of the cavity exceeds 65 cm² (10 in.²).

Justification

API 613 specifies purchaser approval for major weld repairs but does not provide a definition or criterion for major vs minor defect. This definition of major weld defect is consistent with IOGP S-615 and many of the major operating companies' current requirements for gearboxes.

6.9.3 Heat Treatment

6.9.3.1

Add to section

For each gear element, a plot of hardness versus case depth showing the following shall be provided:

a) hardness from the surface of the base metal through the case;

b) final tooth surface location after finish machining with measurement interval spacing depicting the hardness transition below the final tooth surface location.

Justification

This requirement provides inspection evidence that the final hardness and base metal hardness of case-hardened teeth are appropriate to provide sufficient ductility in the base with hardness on the surface. It also provides the records from 6.9.3.1 to the purchaser.

7 Accessories

7.2 Couplings and Guards

7.2.7

Add to section

If an integral-flanged shaft end is not furnished and a complete unit test is not specified, the gear vendor shall trial fit the coupling hubs on the gear shafts.

Justification

This requirement removes the risk of a gear unit being shipped to site without having checked that the coupling hub purchased by the vendor with train responsibility can be installed.

7.4 Controls and Instrumentation

7.4.1 General

7.4.1.5

Add to section

Junction boxes shall not be mounted on the top half of the gearbox.

Justification

Mounting of junction boxes on the bottom half of the casing, the baseplate or off baseplate prevents them from obstructing maintenance activities and allows for final conduit runs to protect the leads.

8 Inspection, Testing, and Preparation for Shipment

8.1 General

8.1.2 Purchaser's Participation in Inspection and Testing

8.1.2.5

Add after "After"

the specified

Justification

The term "advanced notification" is subjective. The purchaser's representative should have access to perform inspection during any operating hours of the vendor's or sub-vendor's facility even when not previously scheduled. This requirement allows the purchaser to specify the notification time frame.

8.1.3

Replace third sentence with

The purchaser and the gear vendor shall establish the required time frame of notifications for witnessed and observed inspections and tests.

Justification

Witness notification timing is to be agreed at the project level by both the purchaser and the vendor (e.g. considering different travel requirements to reach the location).

8.2 Inspection

8.2.2 Material Inspection

8.2.2.6 Rotating Elements

8.2.2.6.1

Delete section 8.2.2.6.1

Justification

This section provides requirements for welding rotating elements, and section 6.9.2.1 amendment now prohibits welding of rotating parts.

Add new section

8.2.2.6.4

Plating repair of shafts shall be prohibited.

Justification

Plating has failed on shafts multiple times and therefore is not an approved shaft repair method.

8.3 Testing

8.3.2 Mechanical Running Tests

8.3.2.1 Mechanical Test Requirements

Add new section 8.3.2.1.0 before section 8.3.2.1.1

8.3.2.1.0

The following records shall be made available before the start of the mechanical run test:

a) tooth contact check record;

b) plots of mechanical and electrical run out;

c) residual unbalance records;

d) test stand shaft alignment (face, rim and axial spacing) for each test setup;

e) as-built clearances;

f) results of the gear quality check as per 6.5.2.1.

Justification

These records are held at the manufacturing facility and are part of the manufacturing record book. The review of this documentation allows the purchaser to verify that the testing or inspection of the bulleted items meets the acceptance criteria prior to the start of testing.

8.3.2.1.6

Add to section

The lube oil supply pressure shall be a permissive prior to the start of the gear box.

Justification

This requirement prevents the gearbox from running without oil and subsequent damage to gear elements and bearings.

Add to section

The gear shall be automatically shut down on low lube oil pressure.

Justification

This requirement protects the gear elements from damage and delayed delivery.

8.3.2.2 Performing Running Tests

8.3.2.2.2

Replace first paragraph with

The gear unit shall be operated at maximum continuous speed for 4 hours uninterrupted.

Justification

The purpose of the uninterrupted 4 hour test is to provide consistent load levels and identify early life failures through prolonged testing. Interrupting the test or unloading the gear during the test can reduce heat buildup and mask potential issues. The test duration of 4 hours applies to both fixed and variable speed applications.

In first sentence of second paragraph, replace "at any time during the test duration of 4 hours" with

at the end of the uninterrupted 4 hour test

Justification

The purpose of the uninterrupted 4 hour test is to provide consistent load levels and identify any early life failures from this prolonged test. Interrupting the test or unloading the gear during the test can reduce heat buildup and mask potential issues.

8.3.2.2.3

Delete "for the first hour and every 30 minutes" from first sentence

Justification

This deletion results in more data from the test stand by recording readings every 15 minutes throughout the duration of the test. Vibration data records should provide continuous data, and more frequent operational data can help in identifying vibration anomalies.

8.3.2.2.7 Critical Speed Test Results

8.3.2.2.7.2

Replace section with

The following plots of data recorded during the coast down tests in 8.3.2.2.7.1 shall be provided:

a) Bode plots for radial vibration probes;

b) polar plots for radial vibration probes;

c) Bode plots for accelerometers;

d) waterfall plots for shaft vibration;

e) waterfall plots for casing vibration;

f) shaft centerline plots with bearing clearance and bearing temperature sensor locations indicated.

Justification

Machine critical speeds and casing resonance conditions are detected using Bode and polar plots and shown on shaft vibration waterfall plots. Such plots are produced during run up and coast down of the gear unit. Proximity probes (radial vibration on bearings) and accelerometers (casing vibration) including waterfall plots are best suited for specific frequency ranges and fault diagnoses. The radial vibration and shaft centerline plots provide information about the shaft movement and the accelerometers detect high-frequency vibration data such as gear mesh forcing frequencies.

Add new section

8.3.2.2.7.3

The actual critical speeds determined on the mechanical running test shall not deviate from the corresponding critical speed ranges predicted by analysis (see 6.6.2.3.4) by more than ± 5 %.

Justification

This requirement is added to be consistent with API rotor dynamic requirements on accuracy of critical speed prediction. See API 684-1:2019, specifically SP6.8.3.2 a) for the reference to ± 5 %.

If the actual critical speeds from the mechanical running test deviate by more than ± 5 % from the ranges predicted by analysis, the vendor and the purchaser shall agree on modifications to the rotor dynamic analysis.

Justification

This requirement is added to be consistent with the API rotor dynamic requirements on accuracy of critical speed prediction. See API 684-1:2019, specifically SP6.8.3.2 a) for the reference to ± 5 %. The agreement needs to be reached between the vendor and the purchaser due to the requirement needs to be evaluated on a case-by-case basis.

NOTE Where the discrepancy is not tolerable, rotor and bearing modifications can be required.

8.3.2.2.8

Delete "If specified," from first sentence

Justification

Conducting a mechanical run test by varying the lube oil pressure and temperature is required in all cases to demonstrate that the gear can operate through the minimum and maximum temperature and pressure conditions of the lube oil.

8.3.2.2.15

Delete "If specified,"

Justification

Real-time vibration data records are mandatory and to be included in mechanical running test records.

Add to section

Real-time vibration data recordings shall start with the initial (internal) shop run, even if not witnessed or observed.

Justification

This requirement ensures that all vibration data is collected to enable troubleshooting if issues arise. It also provides data to the purchaser for reference if, in the future, vibration issues arise (i.e. balance changes).

Add new section

8.3.2.2.18

The machine shall not be removed from the test stand until the test results have been accepted or otherwise agreed.

Justification

This requirement ensures that if a machine does not pass the test, a retest can be performed without lost time. There can be cases when a test fails, and the gear needs to be repaired or modified prior to repeating the test.

8.3.2.3 Inspection Following Test

8.3.2.3.2

Add to section

The gear contact pattern shall be photographed.

Justification

Photographic evidence of the hard blue transfer is needed to record the results.

Add to section

A thin coat of hard bluing shall be reapplied for any subsequent testing.

Justification

Reapplication of the hard bluing provides contact results for future tests or field operations.

Add to section

The contact area shall be at least 80 % of the expected value based on the test load.

Justification

API 613 does not contain a minimum contact requirement. A standardized minimum value of 80 % of the expected contact is derived from typical contact check requirements. This is an opportunity to verify the modified lead performance, and the acceptance criteria is set at 80 % of the expected contact. Based on the load of the test, full design contact cannot be achieved for modified leads. Accordingly, the acceptance criterion is based on the expected contact surface. Gear mesh contact is critical to the reliability of the load-carrying of the gearbox, lubrication and heat transfer capabilities.

8.3.4 Optional Tests

8.3.4.2 Full-speed/Full- or Part-load Test

8.3.4.2.1

Add after first paragraph

If full-speed/full-load or full-speed/part-load testing is specified, the vendor shall describe in the proposal the extent of compliance with this requirement.

Justification

Not all test stands can comply with a full load. This requirement allows the purchaser to assess the capability of the vendor's facility and test stands at the proposal stage.

In first sentence of second paragraph, replace "4 hour test" with

5 hour test

Justification

The purpose of the test is to gather performance data across the load range. 4 hours are insufficient. This requirement ensures a small amount of data at 10 % (1 hour) and 70 % (1 hour) with a longer endurance run (3 hours) at full load to provide better data.

Replace second sentence of second paragraph with

Unless the gear unit is to be string tested or unless otherwise specified, the gear unit shall be tested as close as possible to field operating conditions by running full-speed/full-load tests in accordance with the following:

a) full-speed/full-load tests sequentially run at 10 % load (1 hour), 70 % load (1 hour), and 100 % load (3 hours) where 100 % load is equal to gear rated power.

b) when the gear cannot be tested at the gear vendor's shop at full-speed/full-load, full-speed/part-load test sequentially run at 10 % load for 1 hour, and the maximum load available for 4 hours.

Justification

The gear is to be tested to the highest load possible of the design load to ensure no mechanical issues when the shafts are loaded into the bearings. This test in the vendor's shop provides the best proof of performance.
The requirement for an additional hour in item a) for the varying load test is to provide enough time for temperature stabilization at each load and to allow time for lube oil supply temperature and pressure variation along with stabilization of readings.
When the gear cannot be tested at the gear vendor's shop at full-speed/full-load, the requirements for a full-speed/part-load test are provided by item b).

8.3.4.4 Sound-level Test

Add to section

The sound-level test shall be mandatory.

Justification

A sound-level test is mandatory for special-purpose gearboxes because of their inherently high noise level.

Add new section

8.3.4.6 String Test

8.3.4.6.1

If the gear is string tested and is driven by a train with an adjustable speed drive, the gear shall be tested at speeds within the operating speed range where resonances are predicted by the torsional analysis.

Justification

This requirement ensures that the torsional response of the train at any identified resonances is tested, and verifies the torsional analysis and torsional load fluctuation.

8.3.4.6.2

This portion of the test shall identify the actual torsional and lateral resonant speed, and the vibratory response of the gear unit, including changes in non-synchronous vibration.

Justification

This requirement ensures that the torsional response of the train at any identified resonances is tested, and verifies the torsional analysis and torsional load fluctuation.

8.4 Preparation for Shipment

8.4.1

Delete "including blocking of the rotor if necessary" from first sentence

Justification

Locking is the preferred method for all shipments. This deletion prevents the use of blocking rather than locking

Add before list item a)

Gear rotors shall be locked in position for shipment to prevent damage from rotation or axial movement of shafts.

Justification

Locking the rotors helps to prevent bearing and gear damage in transit.

In list item a), replace "blocked" with

locked

Justification

Locking is the preferred method for all shipments. This replacement ensures the use of blocking rather than locking.

Add new list item d)

d) a prominent warning sign identifying the presence of the locking device and including instructions for its safe removal shall be affixed to the outside of the gearbox.

Justification

The gear can be damaged on start-up if the locking device is not removed beforehand. Displaying prominent signage reduces the risk of the locking device not being removed.

9 Vendor's Data

9.1 General

9.1.2

Replace section with

The contents of IOGP S-713L shall be used to define requirements for proposals, contract documentation and vendor data content.

Justification

IOGP S-713L takes precedence as the source for all documentation requirements but takes some of its requirements from Annex D.

Annex A
(informative)

Special-purpose Gear Unit Datasheets

Add to start of Annex A

IOGP S-713D shall be used as the purchaser's datasheet during proposal stages.

Justification

IOGP S-713D is to be used as the PDS for special-purpose gears as part of the IOGP S-713 set of specification documents (see the introduction of this specification). IOGP S-713D is only used during the procurement phase.

Annex E
(normative)

Vendor Drawing and Data Requirements

Add to start of Annex E

Vendor drawings and data shall be provided in accordance with IOGP S-713L.

Justification

IOGP S-713L is to be used as the IRS for special-purpose gears as part of the IOGP S-713 set of specification documents (see the introduction of this specification). IOGP S-713L takes precedence as the source for all documentation requirements and takes some of its requirements from this annex.

Annex G
(informative)

Gear Tooth Quality Inspection

G.3 Modified Tooth Flanks

G.3.1 Helix Modification (Lead Modification)

G.3.1.2

In NOTE, replace "Table 4" with

6.2.8.1

Justification

This replacement points to the correct reference and prevents errors in calculations.

Bibliography

Add to start of Bibliography

The following documents are informatively cited in the text of this specification, API 613, the PDS (IOGP S-713D) or the IRS (IOGP S-713L).

Add to Bibliography

[49] API Technical Report 684-1 *, *API Standard Paragraphs Rotordynamic Tutorial: Lateral Critical Speeds, Unbalance Response, Stability, Train Torsionals, and Rotor Balancing, First Edition, 2019*

[50] IOGP S-615 *, *Supplementary Specification to API Standard 610 for Centrifugal Pumps*

[51] ISO 15664, *Acoustics — Noise control design procedures for open plant, First Edition, 2001*

[52] ISO/IEC Directives, Part 2, *Principles and rules for the structure and drafting of ISO and IEC documents*

[53] ISO 19901-5, *Petroleum and natural gas industries — Specific requirements for offshore structures — Part 5: Weight control during engineering and construction, Third Edition, 2021*

* Cited in IOGP S-713J only.

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