

ADNOC GROUP PROJECTS AND ENGINEERING

CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION

Specification

AGES-SP-05-002



INTER-RELATIONSHIPS AND STAKEHOLDERS

- a) The following are inter-relationships for implementation of this Specification:
- ADNOC Upstream and ADNOC Downstream Directorates and
 - ADNOC Onshore, ADNOC Offshore, ADNOC Sour Gas, ADNOC Gas Processing, ADNOC LNG, ADNOC Refining, ADNOC Fertilisers, Borouge, Al Dhafra Petroleum, Al Yasat
- b) The following are stakeholders for the purpose of this Specification:
- ADNOC PT&CS Directorate.
- c) This Specification has been approved by the ADNOC PT&CS is to be implemented by each ADNOC Group company included above subject to and in accordance with their Delegation of Authority and other governance-related processes in order to ensure compliance
- d) Each ADNOC Group company must establish/nominate a Technical Authority responsible for compliance with this Specification.

DEFINED TERMS / ABBREVIATIONS / REFERENCES

“**ADNOC**” means Abu Dhabi National Oil Company.

“**ADNOC Group**” means ADNOC together with each company in which ADNOC, directly or indirectly, controls fifty percent (50%) or more of the share capital.

“**Approving Authority**” means the decision-making body or employee with the required authority to approve Policies & Procedures or any changes to it.

“**Business Line Directorates**” or “**BLD**” means a directorate of ADNOC which is responsible for one or more Group Companies reporting to, or operating within the same line of business as, such directorate.

“**Business Support Directorates and Functions**” or “**Non- BLD**” means all the ADNOC functions and the remaining directorates, which are not ADNOC Business Line Directorates.

“**CEO**” means chief executive officer.

“**Group Company**” means any company within the ADNOC Group other than ADNOC.

“**Standard Specification/ Guideline/Philosophy**” means ‘Centrifugal Compressors (API 617) Specification’.

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GENERAL

1. PURPOSE

- 1.1 This specification details the minimum technical requirements for Non-integrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors for applications across ADNOC Business Units. Unless otherwise stated in this specification, the supplied equipment shall comply fully with the requirements of API 617 8th Edition, September 2014 (Errata August 2016) (Ref. 1).
- 1.2 This specification shall be read in conjunction with the listed relevant equipment datasheets and the international standards referenced in Table 2. In addition, the following related appendices shall be considered as forming an integral part of this specification:-
- a. 'General Technical and Contractual Requirements for Rotating Equipment', Appendix 1 (Ref. 2)
 - b. 'QA Inspection and Testing Requirements', Appendix 2 (Ref. 3)
 - c. 'Information Requirements' Appendix 3 (Ref. 4)
 - d. 'Business Unit Specific Requirements', Appendix 4 (Ref. 5)
 - e. 'Dry Gas Seal Requirements', Appendix 5 (Ref. 6)
 - f. 'Lubrication System Design Requirements', Appendix 6 (Ref. 7)
 - g. 'Condition Monitoring System Requirements', Appendix 7 (Ref. 8)

2. SCOPE

- 2.1 This specification amends, supplements and deletes various clauses/ paragraphs of API Standard 617 8th edition. In addition, some new clauses have been added.

3. DEFINED TERMS / ABBREVIATIONS / REFERENCES

For generic Defined Terms/ Abbreviations/ References applicable to all rotating equipment refer to 'General Technical and Contractual Requirements for Rotating Equipment (Ref. 2). Terms / Abbreviations / References relating specifically to Centrifugal Compressors are included below.

3.1 List of Abbreviations

The abbreviations listed in Table 1 are those used in this document and related Appendices. Standard abbreviations for SI units of measure and abbreviations already defined in API 617 8th Edition (Ref. 1) are not shown. Refer to 'General Technical and Contractual Requirements for Rotating Equipment' (Ref. 2) for generic abbreviations applicable to all rotating equipment types.

Table 1 – List of Abbreviations

Abbreviation	Definition
AMB	Active Magnetic Bearing
EDM / ECM	Electric Discharge Machining /Electro Chemical Machining
FPFLFS	Full Pressure Full Load Full Speed
TAN	Total Acid Number
VIGV	Variable Inlet Guide Vane
VSDS	Variable Speed Drive System

4. NORMATIVE REFERENCES

The documents listed in [Table 2](#) are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Table 2 – Normative References

Ref.	Document No.	Title
1.	ANSI/API Standard 617 8th Edition, 2014	Axial and Centrifugal Compressors and Expander-compressors,
2.	Appendix 1	General Technical and Contractual Requirements for Rotating Equipment
3.	Appendix 2	QA Inspection and Testing Requirements
4.	Appendix 3	Information Requirements
5.	Appendix 4	Business Unit Specific Requirements
6.	Appendix 5	Dry Gas Seal Requirements
7.	Appendix 6	Lubrication System Design Requirements
8.	Appendix 7	Condition Monitoring and Machine Protection System Requirements
9.	API STANDARD 692	Dry Gas Sealing Systems for Axial, Centrifugal, Rotary Screw Compressors and Expanders
10.	ASME B16.20:2017	Metallic Gaskets for Pipe Flanges
11.	ASME B16.21:2016	Non-Metallic Flat Gaskets for Pipe Flanges

SECTION A - CONTRACTUAL REQUIREMENTS

5. REFERENCE DOCUMENTS

Refer to 'General Technical and Contractual Requirements for Rotating Equipment', Appendix 1 (Ref. 2) for applicable general references.

6. DOCUMENTS PRECEDENCE

Refer to 'General Technical and Contractual Requirements for Rotating Equipment', Appendix 1 (Ref. 2) for definition of Document Precedence.

The specifications and codes referred to in this standard shall, unless stated otherwise, be the latest approved issue at the time of Purchase Order placement.

7. SPECIFICATION DEVIATION/CONCESSION CONTROL

Refer to "General Technical and Contractual Requirements for Rotating Equipment", Appendix 1 for definition of Specification Deviation/ Concession Control.

8. PROCESS SAFETY REQUIREMENTS [PSR]

Where listed within this specification, the capitalised term **SHALL [PSR]** indicates a process safety requirement. There are more Process Safety requirements which have been addressed in Appendix 7 (Ref.8) and shall be considered in design of Centrifugal Compressors Condition Monitoring and Protection System.

SECTION B – TECHNICAL REQUIREMENTS

9. TECHNICAL AMENDMENTS / SUPPLEMENTS TO API 617

- 9.1 The technical amendments applicable to API 617 Process Centrifugal Compressors are listed in the tables below (Table 3 to 12 inclusive) where referenced to each section of the API 617 standard (Ref. 1). The clause numbers listed within each table and each related amendment correspond to the same clause number within the API standard, where these are already included in the existing publication. These amendments shall take precedence over the relevant sections of API Standard 617 8th Edition, 'Axial and Centrifugal Compressor and Expander-Compressors for Petroleum, Petrochemical and Natural Gas Industries, September 2014' (Ref. 1).
- 9.2 The amendments to each section are identified by the relevant clause number and the following operative descriptions shown in brackets against each related clause number to indicate the type of change, namely:

(Add)	Where words have been added to an existing API clause that has an existing clause number
(New)	Where a completely new paragraph has been added to the API
(Modify)	Where the words in an existing API clause have been modified
(Delete)	Where the API clause no longer applies

- 9.3 In the absence of any below listed technical amendments, the requirements of the API 617 8th Edition standard (Ref. 1) shall apply in full.

Table 3 - API 617 Technical Amendments: Part 1 – Section 1 – Scope

API Clause No.	Description of Change
PART 1- GENERAL REQUIREMENTS	
SECTION 1 – SCOPE	
1. (Add)	This Specification provides requirements for the design, materials, fabrication, inspection, testing, documentation and preparation for shipment of Axial and Centrifugal Compressors and Expander-Compressors (API 617).

Table 4 - API 617 Technical Amendments: Part 1 – Section 2 – Normative References

API Clause No.	Description of Change
SECTION 2 – NORMATIVE REFERENCES	
2 (Add)	The Codes, Standards and Specifications referenced in ‘General Technical and Contractual Requirements for Rotating Equipment’ (Ref. 2) and ‘Business Unit Specific Requirements (Ref. Error! Reference source not found.) shall in addition form a part of this specification. For the documents listed in ‘General Technical and Contractual Requirements for Rotating Equipment’ (Ref. 2) and ‘Business Unit Specific Requirements (Ref. 5) dated references, only the version cited applies. For undated references, the latest version of the referenced document (including any amendments) shall apply.

Table 5 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
SECTION 4 – GENERAL	
SECTION 4.3 – UNIT RESPONSIBILITY	
4.3.2 (New)	SUPPLIER shall provide guarantees for the following at certified point: a. Process performance (volumetric flow, head and power at rated duty point). b. Dry gas seal leakage. c. Power d. Secondary gas consumption (nitrogen) e. Separation gas consumption (nitrogen) f. Instrument Air consumption (for instruments and where pressurized motors are selected, for normal and max. purge quantities) g. Cooling water consumption (where applicable) and Delta P, Delta T h. Fuel gas quantity (if driver is gas turbine) i. Steam consumption (if driver is steam turbine)
4.3.3 (New) [PSR]	In the event of a design or manufacturing error, faulty material, or damage to a critical compressor part, the damaged component SHALL [PSR] be repaired or replaced using original manufacturing methods. Approval from COMPANY required on any of these methods and quality requirements will be imposed as the case may be.

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
SECTION 4.4 – BASIC DESIGN	
Part 1 4.4.1.1.1 (Add)	Compressor controls and surrounding pipework should be designed to avoid surge conditions. Surge count trips are recommended to be configured for 3 counts in 40 seconds along with counter increment based on system response (which needs to be set during site acceptance test). Anti-surge system protection parameters shall be mutually agreed with SUPPLIER during detailed design.
Part 1 4.4.1.1.2 (Add)	Performance curves shall indicate driver name plate rating (motor drivers) and turbine ISO power rating as maximum power limits. Driver rating shall be based on certified point as defined in clause 5.1.1. The determination of the thermodynamic properties of the gases and their effect on the design and performance of the unit are SUPPLIER's responsibility.
Part 1 4.4.1.1.3.1 (New)	The SUPPLIER shall confirm the ability of the compressor to operate at all other conditions specified in the data/requisition sheets. The Surge Reference Line and Surge Control Line (SCL) should ensure the surge control line should preferably be located no more than 80% of the compressor's rated capacity at rated discharge pressure conditions and all operating conditions specified in requisition are located on the right hand side of SCL and therefore the anti-surge control valve / recycle valves are still closed. Similarly, stall / choke line limitations, if any, shall be identified to define required control systems. While computing the compressor performance, internal leaks shall be considered with twice the labyrinth clearances to depict performance during operation. When the compressor is operated under closed loop recycle for significant amounts of time, the compressor shall be able to load without stoppage and venting of system volume. Any leakages from seals (such as external seal gas, nitrogen etc.) shall be considered and accordingly system design shall be carried out. The SUPPLIER shall consider necessary venting arrangement to flare through PCV as part of the overall system design.
Part 1 4.4.1.1.3.2 (New)	For compressors with side streams in excess of 15% of the total inlet flow, special or dummy stages to be utilized to ensure adequate mixing.
Part 1 4.4.1.2.1 (Modify)	The equipment package is to be designed for a life for 30 years and maximum 3 Major Overhaul (MOH) in its lifecycle and uninterrupted operation for 7 years for dirty or sour services and 12 years for dry, non-corrosive and non-fouling. MOH shall be based on equipment parameters (conditions as well as performance monitoring) and not running-hour based. Routine maintenance on seals, bearings etc. will be carried out during normal plant shutdowns and based on conditions. Clean services are the process services which are dry, non-corrosive, non-toxic and non-fouling. Required reliability of supplied compressor package shall be 99% unless specified otherwise to achieve overall plant availability targets of 98%. The SUPPLIER shall

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	indicate in the proposal the anticipated availability of the proposed unit along with supporting calculations and data.
Part 1 4.4.1.4 (Add)	Liquid injection to either the centrifugal or integrally geared compressor bodies shall not be permitted unless approved by COMPANY. For the following applications, liquid injection for may be provided by SUPPLIER: - Contaminated process gas can deposit through compressor's gas passage - To avoid making polymerization - To avoid forming hydrates - To "spike" gas in order to develop pressure if inlet mole weight drops - To avoid choking gas passage due to any physical or chemical reason For turbo-expanders, methanol injection shall be provided, where specified, on the datasheets.
Part 1 4.4.1.6 (Add) [PSR]	All electrical components SHALL [PSR] be suitable for the area classification, gas grouping and temperature classes specified by the COMPANY on the data/requisition sheets.
Part 1 4.4.1.7 (Add)	The inner casing of a barrel compressor shall be of the horizontally split design. Barrel type compressors shall be shear ring retained head design. SUPPLIER shall include in his scope hydraulic bundle puller and bundle cradle as a part of special tools. Necessary provisions shall be made to mount and align the bundle cradle so that rotor pull-out can be accomplished with no damage to the inner barrel and/or casing. The following shall also apply: - All left-handed threads shall be clearly marked. - Screw-in eye-bolts may be used only for bearing housing covers and for internal components where other lifting arrangements are impractical. - Holes for eye-bolts shall be permanently marked with the correct bolt size to be used. If this marking is impractical, bolt size information should be clearly indicated in the instruction manual.
Part 1 4.4.1.9 (Add)	EOT crane facility shall be provided by CONTRACTOR to handle the maximum weight of compressor rotor bundle (diaphragms, rotor, cradle included), motor rotor (cradle included), gearbox rotor, gearbox top casing. EOT SWL shall be sized for 150% of above max. values (to account for slings and other attachments etc.). For components which cannot be handled by shelter (internal overhead) crane. For removal of the compressor casing or complete units, complete motor / driver, complete gearbox etc. external cranes will be utilized. CONTRACTOR shall prepare detailed mechanical handling drawings including capacity of crane, crane location, lifting methods, accessibility, paved areas etc. to be submitted (as part of material handling study) and constructed accordingly.
Part 1 4.4.1.11 (Modify)	Replace "If Specified" [with] "Only when specified by COMPANY"

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
Part 1 4.4.2.1 (Modify)	The equipment's Maximum Continuous Speed (MCS) shall not be less than 105% of the synchronous speed for constant speed motor drives.
Part 1 4.4.2.2 (Add)	For variable speed motors, trip speed (shall be configured in VFD and connected to IPS system) shall be 110% of MCS. Independent trip functionality shall be provided from ESD to VFD via STO (Safe Torque Option) which shall be default feature in VFD offered by SUPPLIER. Speed discrepancy alarm shall be provided between speed signal sent by VFD and actual speed signal from field.
Part 1 4.4.2.3 (Add)	MAWP of the compressor shall be greater than the maximum pressure at the surge point at trip speed. Only when safety valves are installed on compressor discharge, shall the safety valve relief conditions (including accumulation) be used to determine MAWP.
Part 1 4.4.4 (Modify)	Delete the bullet and "If specified" from the last sentence. The SUPPLIER shall provide the preferred alignment data for smooth operation and confirm satisfactory final alignment after connection of process piping. SUPPLIER and CONTRACTOR shall cooperate in the design of pipe work and support structures, etc. in order to provide the best installation possible both operationally and from a maintenance aspect. SUPPLIER's supervisor shall be present during initial alignment check prior to main process pipe work connection to compressor and expander (in case of turbo-expander) casing and shall confirm satisfactory final module alignment after connection of process pipe work.
Part 1 4.4.6 (Add)	Spare parts shall be available for purchase and all manufacturing drawings retained throughout the service life specified in clause 4.4.1.2.1.
Part 1 4.4.7 (Add)	SUPPLIER to define the composition limits of the gases that can be used during mechanical completion / commissioning.
Part 1 4.4.8 (New)	SUPPLIER shall recommend control margins or other methods to restrict operation if continuous operation at stonewall condition is not allowed which can happen due to reduced back pressures.
Part 1 4.4.9 (New)	The offered model of the compressor should conform with the following design requirements specified through clauses 4.4.9.1 to 4.4.9.2.

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
Part 1 4.4.9.1(New)	The average Mach numbers (at any location within compressor) shall be within the normal 0.85 limit. On a case by case basis, subject to the COMPANY's approval, higher numbers may be acceptable if Computational Fluid Dynamics (CFD) results can indicate that localized stalling at the impeller eye rim is minimal and will not be affected by the specified temperature and pressure variations in the impeller inlet. Transonic conditions shall never be accepted. The gas velocity at flange main connections shall be limited to 28 m/s at any specified operating point. Maximum compressor suction gas velocity shall not exceed 35m/s. Higher inlet velocities are subject to COMPANY approval. Alternatively, demonstrated SUPPLIER experience for the referenced Mach Numbers with established / proven aerodynamic and mechanical performance may be used as justification for selection.
Part 1 4.4.9.2 (New)	SUPPLIER shall verify their design by Finite Element Analysis (FEA) for all critical components of the compressor. These components shall include casings, impellers, shafts, locations where sudden change in thickness, inlet and outlet flanges and diaphragms as a minimum and implement any recommendations observed in such analysis. This information shall be shared with CONTRACTOR and COMPANY. FEA done on similar / identical machine may be provided if the offered model is within the range.
Part 1 4.4.10(New)	For compressor designs where fluoro-elastomers (such as FKM) are utilized for split-line or shaft sealing, the maximum allowable discharge temperature shall be limited to 180°C. In any case, the maximum discharge temperature shall be limited to 200°C. For applications such as CO₂, air, nitrogen, or acid gas (CO₂+H₂S without hydrocarbon) compressors, the discharge temperature at any specified operating point shall not exceed 180°C. Discharge temperatures lower than 160°C may be requested on specific process conditions (such as higher C₆+ etc.).
SECTION 4.5 – MATERIALS	
Part 1 4.5.1.1 (Add)	Equivalent materials are not acceptable unless the composition, manufacturing process and testing methods, test conditions, acceptance criteria are identical or better to ASTM/ASME standards. SUPPLIER should provide material designation for all product contact (process wetted) parts of entire package including auxiliaries and accessories and seek approval during bid, engineering stage, before proceeding with manufacturing.
Part 1 4.5.1.3(New)	SUPPLIER shall select materials suitable for the gas composition(s) given in the data/requisition sheets. When a wet gas stream is corrosive, each stage of expansion and each stage of compression shall be fabricated in a corrosion resistant material (as a minimum stainless steel). Exceptions to this design (few impellers in higher grade materials) are subject to COMPANY approval. For details of constituents which cause corrosion, shall be as indicated on the datasheets.

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	If chlorides are present in the process gas stream (during any operating / shutdown conditions), CONTRACTOR shall consider use of CRA (Corrosion Resistant Alloy) e.g. Inconel. All materials for such application will require COMPANY approval. When mercury traces are indicated in the process gas composition, SUPPLIER shall ensure that any aluminium, aluminium- magnesium alloy, shall not come in contact with process gas.
Part 1 4.5.1.6 (Modify) [PSR]	1. For compressors handling gas containing hydrogen sulfide (H₂S) as defined by standard NACE MR0103, all components including associated systems and ancillaries in contact with the gas SHALL [PSR] comply with NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945, as applicable. a. NACE MR0175 / ISO 15156 apply to oil and gas production facilities and natural gas sweetening plants. b. NACE MR0103 / ISO 17945 applies to other applications (e.g., oil refineries, LNG plants and chemical plants). c. In many applications, small amounts of H₂S are sufficient to require materials resistant to sulfide stress corrosion cracking. When there are trace quantities of wet H₂S known to be present or if there is any uncertainty about the amount of wet H₂S that may be present, the PURCHASER should consider requiring materials that are resistant to sulfide stress corrosion cracking. 2. Hydrogen Induced Cracking (HIC) tested plate shall be used for moderate sour service as determined by COMPANY. 3. Hardness control (within the limits of NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945) of all components in contact with H₂S shall be demonstrated. 4. The MANUFACTURER shall submit all welding procedures including a cross-sectional hardness survey with the appropriate supporting Procedure Qualification Records. The welding requirements shall meet the requirements of NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945 as applicable. 5. Dissimilar metal welds shall not be used in any components in contact with H₂S. 6. The stress level of all carbon and low alloy steel components in contact with sour gas (such that NACE materials restrictions are imposed) shall be limited to 70 % of their specified minimum yield strength. The stress level of other steel alloys shall be subject to approval by the COMPANY. 7. External bolting on the casing, balance line and seal glands covered by lagging, insulation, blankets, weather shields, or similar coverings are subject to comply with NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945, as applicable. 8. Steel plate materials shall comply with the through-thickness tensile test of ASTM A770 (S3) and shall have a minimum reduction of area of 35%. 9. In dry conditions, as per the severity diagram for carbon or low alloy steel (7.2.1.2), NACE MR0175 / ISO 15156 shall be applied in case of H₂S partial pressure (ppH₂S) greater than 0.0030 bar (0.0435 psi). In sour service with wet condition with ppH₂S greater than 0.0030 bar (0.0435 psi), the failure risk

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	is due to wet H₂S. The damage mode is related to hydrogen uptake and hydrogen embrittlement. 10. NACE materials shall apply for hydrocarbons gases with ppH₂S greater than 0.0030 bar (0.0435 psi). However, any process upset conditions must be specified during selection, including future operating cases to avoid Sulfide stress corrosion cracking in operation. 11. If the pressure rating of horizontally split casings, handling gases containing hydrogen sulfide, requires a bolt design exceeding the limitations of NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945, as applicable, the MANUFACTURER may consider a barrel type casing as an alternative to modifying the horizontally split casing design. 12. Axially-split casings shall not [PSR] be used if H₂S levels in process gas are higher than 50 ppm without approval from COMPANY and if there is no proven experience from SUPPLIER for similar service. Axially-split casings are not acceptable for H₂S levels of 500 ppm and above [PSR]. Axially-split casings shall have double sealing joints to minimize leak paths.
Part 1 4.5.1.9 (Add)	Overlays are only allowed with the approval of COMPANY.
Part 1 4.5.1.10 (Add)	Risk of chloride cracking shall be established for all austenitic stainless steels used in compressor components and mitigation measures shall be put in place.
Part 1 4.5.1.11 (Add) [PSR]	For welded components with a maximum allowable temperature above 200°C , the limitations of NACE MR0175 / ISO 15156 or NACE MR0103 / ISO 17945, as applicable, SHALL [PSR] apply.
Part 1 4.5.1.14 (Add)	Plating of the shaft shall not be provided unless subject to approval by COMPANY.
Part 1 4.5.1.15 (Add)	SUPPLIER shall specify the MANUFACTURER, material, shore hardness and grade of O-rings for the approval of COMPANY. All O-rings used in process wetted parts of the compressor and seals shall be explosion decompression resistant, suitable for all process conditions (various operating, design conditions and depressurization conditions). SUPPLIERS shall include required qualification tests in certified laboratories, if the selected material is not suitable for specified composition of gas, operating conditions. SUPPLIERS shall provide previous test certificates / results of test for COMPANY review. Such material use is permitted only after successful completion of the tests and/or review of the results by COMPANY. Unless otherwise specified, the rate of de-pressurization shall be based on a 15 minutes time frame. De-pressurization rate shall assume depressurisation from maximum discharge pressure to either 7 barg or 50% of design pressure (whichever is resulting in worst case scenario). While stating the maximum depressurizing rate, SUPPLIER shall take into account the effect of depressurizing on dry gas seals also.
Part 1	(Delete) bullet and "If specified".

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
4.5.1.16 (Modify)	
Part 1 4.5.1.17 (Modify)	[Replace first sentence with] Coatings shall not be considered until other possibilities of providing suitable base material are explored and found unfeasible. If a coating is applied, it shall require prior approval from COMPANY. Coatings shall not be acceptable if SUPPLIER doesn't have proven field experience for the same in similar service. All coatings of static components, including the casing, must be repairable at site. Necessary inspection and repair method statements shall be provided as part of the SUPPLIER manuals. Sleeves or linings shall not be used as a means for adequacy of the material for the intended service. Sleeves, as required, shall be considered only for mechanical protection (scratch, indentation etc.).
Part 1 4.5.1.19 (Add)	Deposited weld metal and Heat Affected Zone (HAZ) shall meet the same impact requirements as the base metal, when impact testing of base metal is required. The weld procedure qualifications shall be impact tested and meet the requirements of base metals for the deposited weld metal and HAZ. These procedure qualifications shall be made using material with the same specification, heat treatment and grade as base material and test material thickness shall equal the thickest section of the components.
Part 1 4.5.1.19.2 (Modify)	[Delete bullet and word "If specified,"] The minimum metal design temperature shall be as indicated in the datasheet. This shall be the lowest possible temperature during expansion and/or depressurization in ESD/PSD scenarios with adequate margins. Prior to order placement, MDMT must be agreed between SUPPLIER, CONTRACTOR and COMPANY. The impact testing of material shall be at this temperature and the energy values shall be as agreed during ITP review based on the design requirements. All non-metallic parts used within compressor and seals, shall also be suitable for this temperature. The rate of depressurization shall be as indicated in datasheets.
Part 1 4.5.1.19.3 (Modify)	[In the Note, replace] "fluid pumping" by "gas compressing" and "pumped fluid" by "compressed gas".
Part 1 4.5.1.19.5 (Add)	For pressure-containing parts that can operate at a temperature of 0°C, or below, proposed materials of construction require the approval of the COMPANY. All non-metallic components shall be designed for the minimum design temperature specified on the datasheets.
Part 1 4.5.1.20 (Add)	Material specifications for equipment supporting structure, platforms, baseplate, connection & anchor bolts, etc. shall comply with Structural Steel Works AGES-SP-01-001 and Structural Design Basis AGES-SP-01-003.
Part 1 4.5.2.2	Where possible, inlet and discharge nozzles shall be forged as single piece along with casing. Nozzles, if not integral with the casing, shall be fabricated from forged components, hot formed and welded to provide the necessary profiles and transition

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API Clause No.	Description of Change
(Add)	from flange to compressor body. Cast nozzles welded to the casing are accepted subject to additional COMPANY quality control approval. If forged nozzles cannot be welded to the casing due to requested nozzle orientation and required flow angles in the nozzles / channels, cast nozzles welded to forged casing are allowed under following conditions: - Past references available - SUPPLIER provides 3.2 certification for nozzles with independent TPIA. - Approval of WPS, PQR for the joint. - Nozzles are "Set In" type and not "Set On" type. - COMPANY may impose additional NDT requirements. PAUT shall be considered along with 100% RT. - PWHT for weld joints shall be performed. - Major / minor repairs in castings are not acceptable without obtaining prior written approval from COMPANY - FEA shall be performed to indicate nozzle and casing stresses are within 70% of maximum yield strength. - Cast form and forged form material chemical composition shall be submitted to COMPANY for approval.
Part 1 4.5.2.3.2 (Modify) [PSR]	Gray cast iron Castings A48 / A278 SHALL [PSR] not be used in compressor material construction. Use of nodular cast iron (ASTM A395 / A571)/ cast steel diaphragms (static, non-pressure parts) requires COMPANY approval and may be accepted in specific gas composition and past experience / references. Additional QC requirements apply on the quality of castings, NDE, repairs etc. including 3.2 certification. This shall be agreed prior to award.
Part 1 4.5.2.5 (Add)	Casting material shall not be used for the casing.
SECTION 4.6 – CASINGS	
Part 1 4.6.1(Add)	Pressure containing casings shall not be de-rated from their design MAWP and the applied hydrostatic test pressure shall be selected accordingly. O-rings shall conform to the following requirements: - Designed for gas being compressed. - Resistant to explosive decompression. b. Compressor casing sealing surface shall have 1.6 µm (63 µin) Ra or smoother finish. For axially-split casings, O-rings shall not be used. COMPANY preference is metal to metal seals for the split line.
Part 1 4.6.1.1.4 (Add)	The design of bolting for pressure joints shall be based on the actual bolting temperature as described by ANSI/ASME B31.3.

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API Clause No.	Description of Change
Part 1 4.6.1.3 (Modify)	For air or non-flammable gas, casings shall be made of steel if the maximum allowable working pressure exceeds 700kPa.
Part 1 4.6.1.4 (Modify)	[Delete third sentence and replace with] Lifting lugs shall be provided for lifting the top half of the casing. Compressor bundle shall be equipped with rollers to facilitate bundle removal out of the casing. This roller shall be sufficiently sized to ensure reliable handling of the bundle at dismantling and re-installation. The rollers system shall facilitate easy replacement as needed. Contacting casing faces and contacting bearing housing faces shall have jackscrews to aid in parting components.
Part 1 4.6.1.7 (Add)	Bolting used for axially-split casings, radially-split barrel end covers, bearing casing pedestals and compressor attachments shall be fluoro-polymer coated to provide corrosion resistance. SUPPLIER shall indicate coating methods and technical information on coating material.
Part 1 4.6.1.7.3 (Add)	Bolting at casing joints and main process connections shall be designed to be tensioned by an approved hydraulic tensioning method, as required. Sufficient space shall be provided to facilitate the use of such equipment. The extension shall be provided with a protective steel cap.
Part 1 4.6.3.2.2 (Add)	Magnetic Particle Examination (MPE) shall be carried out on all surfaces including machined gasket sealing surfaces.
Part 1 4.6.3.2.3 (New)	For impellers, the details of inspection techniques and acceptance criteria shall be agreed upon by the SUPPLIER and the CONTRACTOR.
Part 1 4.6.4.1 (Add)	Unless otherwise specified, inlet & outlet connections for compressors shall be top-top for radially-split compressors and bottom-bottom for axially-split compressors. Other variations than indicated in this clause shall require COMPANY approval for specific application and pipe routing. All similar piping services within the skid limits shall be fully manifolded (where suitable) and installed to skid edge flange connection points.
Part 1 4.6.4.1.1 (Modify) [PSR]	All connections shall be flanged and no threaded connection SHALL [PSR] be applied for any pressure casing connection
Part 1 4.6.4.1.4 (Add)	To avoid the use of transition welds from stainless steel pipework (where applicable), short flanged carbon steel stub pipes shall be welded to the compressor casing and/ or its end closures for lubricating and seal system pipework connections.
Part 1 4.6.4.1.7	The SUPPLIER shall provide drain nozzles and valves. Compressors fitted with liquid injection facilities and compressors that require periodic washing offline shall have

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API Clause No.	Description of Change
(Add)	individual stage drains and a drain for the balance piston cavity. Casing connections for drains shall be studded and the boss design and shall be provided with flanged piping. Automated drain valves or manual drain with field acknowledgement to start the compressor shall be defined based on operating philosophy.
Part 1 4.6.4.1.8 (New)	Gaskets for RTJ flanges shall be ring type per ANSI/ASME B16.20.
Part 1 4.6.4.1.9 (New)	The following welding requirements are to be complied with by the SUPPLIER: a. Welding on the case and heads shall be completed prior to heat treatment except in instances where socket welding of piping connections to the casing has been approved by COMPANY. b. In such cases the piping may be locally stress relieved after machining. This includes temporary connections such as lifting lugs or clips for hanging lagging. c. Areas where temporary lugs or clips are removed after heat treatment shall be ground smooth and subjected to the same NDT as required for the case, with visual inspection as a minimum.
Part 1 4.6.4.1.11 (New)	Temporary connections shall not be hammered off.
Part 1 4.6.4.2.1 (Add)	Inlet and outlet connections shall be flanged type. Machined/studded main process connections and hub connector are not allowed to be used and shall be subject to COMPANY approval. Suction and discharge connection shall have welded ANSI flanges. Threading in flanges is not allowed.
Part 1 4.6.4.2.12 (Add)	Generally, spiral-wound gaskets should be used for connecting the pipework to casing connections. Refer to piping specifications for the details. A minimum hardness difference of 20 BHN shall be maintained between the flange surface and gaskets while designing the flange hardness. Gasket hardness shall be lower. In few cases (particularly when using RTJ flanges, Lens joints in high pressure services and/or when using Inconel gaskets), weld overlay may be required on the casing flange connections and SUPPLIER shall seek gasket information from CONTRACTOR and accordingly design the casing connections.
Part 1 4.6.4.2.15 (Add)	For hydrogen service, the raised face flange finish shall be between 3.2µm and 6.3µm Ra.
Part 1 4.6.4.3.4 (Add)	Slip-on, hub connectors and stub flanges are not allowed.
Part 1 4.6.4.3.5 (Modify)	[Replace with] A pipe nipple, preferably not more than 150 mm (6") long shall be used, minimum Schedule 80 and provided with a weld-neck flange. Connection to the outer pressure casing shall be by butt-welding. Inner casing drain connections may be screw threaded only if the connection is not accessible and subject to COMPANY approval.

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API Clause No.	Description of Change
Part 1 4.6.4.3.6 (Add)	Socket welded connections are not permitted where there is a possibility of crevice corrosion or in applications where there is the potential for cracking. Socket welded connections are not allowed on lube oil and dry gas seal connections. All welded connections shall be full penetration. Openings smaller than DN 25 (NPS 1) shall be reinforced. No casing connection shall be smaller than DN 20 (NPS ¾).
Part 1 4.6.4.3.8.1 (Add)	Tapped openings shall not be used for hydrocarbon service.
Part 1 4.6.4.3.8.5 (Modify)	[Delete third sentence] "Plugs that may later require removal shall be of corrosion resistant material"
Part 1 4.6.4.3.9 (New)	Openings of less than 1-inch NPS shall be reinforced boss connections of the 'Weldolet' type, involving only full penetration butt welds.
Part 1 4.6.4.3.10 (New)	Following requirements shall be applied by SUPPLIER: a. Threaded or back-welded connections shall not be used. b. Long weld neck or weld neck and nipple combinations shall be used for extending flanged connections, preferably not longer than 150 mm (6 in). c. DN 20 (NPS ¾) and DN 25 (NPS 1) shall have Schedule 160 pipe. d. DN 40 (NPS 1 ½) and larger shall have schedule 80 pipe. e. Stainless steel up to and including first valve or flange shall have schedule 80 pipe. f. Slip-on flanges shall not be used.
Part 1 4.6.4.3.12 (New)	Casing connections for drains shall be studded and boss design with flanged piping.
Part 1 4.6.4.4 (New) [PSR]	Openings in process gas containing casings that are not connected to piping SHALL [PSR] be provided with an appropriate gasket and a blind flange of the same pressure rating as the corresponding casing connection flange.
Part 1 4.6.4.5 (New)	Pressure or temperature connections shall not be placed in the main process nozzles.
SECTION 4.7 – ROTATING ELEMENTS	
Part 1 4.7.1 (Add)	Shaft ends shall be tapered and suitable for hydraulically fitted and removing couplings hubs.
Part 1 4.7.2	The SUPPLIER shall ensure that the rotor shaft sensing area is suitably protected during all phases of manufacturing and assembly of the compressor.

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API Clause No.	Description of Change
(Add)	
Part 1 4.7.3 (Add)	Combined electrical and mechanical run out shall be less than 6.35µm. Any methods to correct the run-out needs COMPANY approval.
Part 1 4.7.5 (Add)	The maximum calculated stresses at trip speed, MCS and over speed for all rotating components shall not exceed the minimum specified yield strength of the material. Average impeller stresses at maximum continuous operating speed shall be less than 70% of the material yield strength unless otherwise approved by the COMPANY. SUPPLIER shall demonstrate the limits of the specified stress values are satisfied by means of appropriate calculations (FEA).
Part 1 4.7.6 (Add)	Replaceable thrust collars shall be fitted to the shaft using a hydraulic expansion method and locked positively to avoid any axial movement. Following requirements are to be complied with: a. Thrust collars shall not be hard faced or surface hardened. b. Removable collars shall be through-hardened and have key-way fillet conforming to ASME B17.1. c. Sleeves, spacers and bushings shall be made of materials that are corrosion resistant in the specified service
Part 1 4.7.8 (Modify)	(Delete) “Or be designed so that major rotating parts need not be replaced” from first sentence.
Part 1 4.7.9 (Add)	Impellers should be preferably assembled on the shaft without being keyed such that the shrink fit shall be suitable to operating at any speed and transient condition.
Part 1 4.7.10 (Add)	If the arithmetic average pressure of suction and discharge pressures at any specified operating point is more than 250 kg/ cm2(g), in-line impeller arrangement shall be used. For other applications, where there is a preference for either in-line or back-to-back arrangements this shall be stated in the requisition. SUPPLIER shall provide in his proposal curves of suction, discharge and differential pressure versus unit loading of the thrust bearing. The curve(s) shall show, as a minimum, all operating conditions including surge and stonewall.
Part 1 4.7.10.1 (Modify)	Second sentence replace with “Impellers shall be fabricated from forged components only and be of milled (EDM / ECM) construction to achieve high polytropic efficiency”. Replace “PURCHASER” with “COMPANY”. (Add) Electro-eroded or cast or Brazed or riveted impeller or welded construction is not acceptable unless approved by COMPANY. If SUPPLIER wishes to use the same, it shall be backed by evidence of satisfactory operating experience of similar design in similar applications. For FEA requirements relating to rotating parts refer to clause 4.7.5.

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API Clause No.	Description of Change
Part 1 4.7.10.8 (Modify)	[Replace with] Metal plating of impeller bores is not permitted.
Part 1 4.7.10.9 (New)	Impeller design shall be meet the following requirements: - Mach number at the impeller eye shall be provided at the time of the proposal for the maximum molecular weight gas specified. - Design shall be supported with proven field experience or analytical analysis verification by testing. - Impeller eye inlet Mach number exceeding 0.80 shall only be used on stage combinations that have been directly tested in dimensionally exact configuration. - Stage qualification for impeller eye inlet Mach number exceeding 0.80 by interpolation, extrapolation, or scaling shall not be used.
Part 1 4.7.10.10 (New)	Material yield strength as well as the actual maximum stress level of each impeller at maximum continuous speed shall be stated in the proposal.
SECTION 4.8 – DYNAMICS	
Part 1 4.8.1.2 (Add)	A rigid shaft support system shall be provided.
Part 1 4.8.1.3 (Modify)	(Delete) "if specified" The SUPPLIER shall be responsible for ensuring that both the lateral and torsional critical speeds for individual train components and also for the entire drive train when installed at site are outside the speed ranges stated in API paragraphs 4.8.2.9 and 4.8.7.6. Supporting data to demonstrate that these margins have been accomplished shall be supplied by the SUPPLIER in collaboration with the SUB-SUPPLIERS of the train components.
Part 1 4.8.1.4.1 (Add)	Lateral analysis report shall include: - Dimensional data of the bearing design in sufficient detail to enable calculations of stiffness and damping coefficients. - Shaft geometry with sufficient detail to model the shaft including the location of bearing centerlines and mounted components. - The weight, polar and transverse moments of inertia and center of gravity of the impellers, balance piston, shaft end seals and coupling(s) with sufficient detail to conduct an independent analysis of the rotor. - The input model used for the MANUFACTURER's analysis.
Part 1 4.8.1.4.3 (Modify)	(Delete) words "If specified"
Part 1 4.8.1.5.2 (Modify)	(Delete) words "If specified"

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API Clause No.	Description of Change
Part 1 4.8.1.5.3 (Modify)	(Delete) words "If specified"
Part 1 4.8.1.6 (New)	In addition to the above requirements, the SUPPLIER shall ensure that the complete train is capable of reaching its operating speed range without giving rise to critical vibration conditions of unacceptable duration and/or magnitude, due to such factors as component vibrations, e.g. of blades at intermediate speeds, or high torque induced excitations of turbine blades or frequencies induced from VFD motors during the run-up mode of the compressor. Similarly, the complete train shall be capable of passing between its MCS and trip speed without giving rise to component vibrations of an unacceptable magnitude and/or duration.
Part 1 4.8.2.2 (Modify)	(Delete) words "If required" (Add) The critical speed and separation margin values resulting from the most unfavourable combination of the parameters under (4.8.2.4) shall be used to verify compliance with the criteria in (4.8.3).
Part 1 4.8.2.3 (Add)	An undamped critical speed map shall be provided with the proposal. The analysis shall be conducted up to 2 x 150% of MCS. Horizontal and vertical bearing properties, including minimum and maximum clearances, operating speed range from minimum operating to maximum continuous speed, trip speeds shall be superimposed on this map.
Part 1 4.8.2.4 (Add)	SUPPLIER shall detail the basis of his assumption for the excitations and damping and for fluid film stiffness used in the damped unbalance response analysis.
Part 1 4.8.2.5 (Add)	A train lateral analysis for the complete coupled train shall be performed where one of the following conditions is met- (i) train includes rigid or quill shaft coupling (ii) train includes flexible coupling with coupling spacer natural frequency within the range defined in Figure 2-9 [1] of API 684 as "train lateral recommended. (iii) Coupling lengths greater than 800 mm. This requirement may be omitted, subject to COMPANY approval. A concession to requirement for a train lateral analysis can be granted if similar equipment train configuration has been previously supplied, subject to COMPANY approval."
Part 1 4.8.2.7 (Modify)	Replace final sentence of this clause with: The magnitude of the unbalances shall be 4 times the value of U_r as calculated by Equation (3) or Equation (4).

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API Clause No.	Description of Change
Part 1 4.8.2.9 (Modify)	The damped unbalance response analysis shall indicate that the machine in the unbalanced condition described in 4.8.2.7 will meet the following acceptance criteria (see figure 2): a. If the amplification factor is less than 2.5 the response is considered critically damped and no separation margin is required. (However, verification of the unbalance response shall be made, see clause 4.8.3). b. If the amplification factor is 2.5 and above, then for fixed speed machines and variable speed machines with a control range of 80%-105% rated speed, the separation margin from all lateral modes shall be, at least: 1. 20% over the maximum continuous speed. 2. 15% below the minimum operating speed. c. If the amplification factor is 2.5 and above and the required operating range is wider than 80%-105% rated speed, the separation margins shall be subject to the COMPANY approval.
Part 1 4.8.3.1 (Add)	Based on SUPPLIER experience, the MANUFACTURER may offer an alternative shop verification procedure of the unbalanced response analysis, based on verification in a high-speed balancing installation as per API 684. This procedure shall be submitted for COMPANY approval.
Part 1 4.8.3.4 (Modify)	[Replace with] Unbalance verification test shall be performed on all rotors that are purchased as first production and SUPPLIER has no comparable previous test data.
Part 1 4.8.5.1 (Add)	Level 1 analysis shall be provided with the SUPPLIER's offer.
Part 1 4.8.5.8 (Modify)	a. For centrifugal compressor: [Replace] "ii. $\delta A < 0.1$" [with] "ii. $\delta A < 0.2$" b. For axial flow rotors: [Replace] "ii. $\delta A < 0.1$" [with] "ii. $\delta A < 0.2$" (Add) If seals that have high stiffness and/or damping characteristics (such as honeycomb seals, hole pattern or other cylindrical seals) are used for the balance piston or any other internal high pressure drop location, a Level II analysis is required. Similarly, if damped bearings are used, a Level II analysis is required.
Part 1 4.8.6.1 (Modify)	[Replace] this clause [with]: For each compressor, the MANUFACTURER shall include in the proposal the option for a Level II analysis, irrespective of the criteria in (4.8.5.8). COMPANY reserves the right to require this optional Level II analysis to be performed and shall be finalized during bid review of log decrements data provided by SUPPLIER. The SUPPLIER shall clearly indicate how the destabilizing effects are estimated including assumptions and software validation.
Part 1 4.8.6.2 (Add)	The SUPPLIER shall specify the methodology for determining the stiffness and damping coefficients for the balance piston and other high pressure drop seals. The SUPPLIER shall also include the effects of deflection on the seal, causing either divergent or convergent behaviour.

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API Clause No.	Description of Change
	Analysis shall account for aerodynamic, hydrodynamic and hysteretic cross coupled stiffness, cross coupled damping, direct stiffness and direct damping.
Part 1 4.8.6.7 (Add)	Effects of bearing clearance and preload variations within manufacturing tolerances and internal leakage control surface wear of two times design shall be shown.
Part 1 4.8.6.9 (Modify)	"[Replace with] Level II stability analysis shall show that the machine, as calculated in 4.8.6.1 through 4.8.6.8. For log decrement less than 0.2, COMPANY approval is required.
Part 1 4.8.6.11 (New)	If tilting pad journal bearings are used, the analysis shall be performed with synchronous tilt pad bearing stiffness and dampening coefficients. If the MANUFACTURER has reference data based upon sub-synchronous bearing coefficients, additional analysis shall be considered.
Part 1 4.8.7.4 (Add)	a. Torsional transients such as switch-on and terminal short circuits of all types of electric motors, as well as the start-up of variable speed motors and synchronous motors. b. Torsional excitation, harmonic frequencies from Variable Speed Drive Systems (VSDS) including the worst-case transient operation. c. Any lateral critical speed.
Part 1 4.8.7.5 (Add)	If a torsional resonance frequency lies in the unauthorized range defined in this paragraph, SUPPLIER shall seek a solution using the adaptation effect of the couplings, the gearbox and the rotor. If no solution can be found, the SUPPLIER shall demonstrate that this natural frequency cannot compromise the integrity of the shaft line. SUPPLIER shall supply the calculations for determining normal and alternating stresses in the various elements of the shaft line, in particular the most sensitive elements. The results of the analysis shall be submitted in the form of a modified Goodman diagrams and/or lifetime element calculations. The excitation assumptions shall be clearly stated as well as damping properties for COMPANY approval.
Part 1 4.8.7.7 (Add)	For VSDS motor-driven compressors, SUPPLIER shall submit his procedure for carrying out the stress analysis.
Part 1 4.8.7.8 (Modify)	Delete the first sentence and replace with: In addition to the torsional analyses required in 4.8.7.8.1 through 4.8.7.8.4, the SUPPLIER shall perform a transient torsional vibration analysis for all electric motor driven units. This shall demonstrate that the transient occurrences in the motor have no adverse effect on the complete train. The analysis shall consider but not be limited to the following transient load cases: a. switch-on of electric motors; b. 2 and 3-phase terminal short circuits of motors;

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API Clause No.	Description of Change
	c. pulse operation of variable speed motors; d. asynchronous run-up on synchronous motors; e. out of synchronous reconnection of the supply following a transient power failure.
Part 1 4.8.7.8.2 (Add)	The following design requirements shall be considered: a. Compressor SUPPLIER and driver SUPPLIER shall establish maximum transient torques that will occur in shaft system under start-up, running and fault conditions. b. Components, including coupling and fit of coupling hub on shaft, shall be designed for at least 125% of the maximum transient torques calculated by requirement 4.8.7.8.2 (a).
Part 1 4.8.7.10 (Modify)	(Delete) "If Specified" Torsional analysis shall be approved only after Full Load Full Speed / No Load Full Speed test or SAT results as applicable and subject to torque meter / stain gauge furnished by SUPPLIER.
Part 1 4.8.7.10.1 (Add)	c. Out of synchronous reconnection of supply following transient power failure.
Part 1 4.8.7.12[New]	Torsional-lateral coupling effect should be reviewed if the compressor train is supplied with geared system.
Part 1 4.8.8.2 (Add)	Following balancing procedure is to be followed: a. Rotor and coupling half shall first be balanced separately. b. After balancing the rotor without the coupling half, the job coupling half shall be mounted. c. Complete rotor with job coupling half shall then be check balanced. The relative radial position of the coupling hub to be marked on the shaft. d. Any balance correction required shall be approved by COMPANY. e. For compressors with double extended shaft, both job coupling hubs shall be mounted. The best practice is to avoid matching of the coupling to a particular shaft by balance adjustment so that couplings and shafts can be interchangeable. The best practice is to balance only the coupling half. This allows a coupling change in the field without the need to re-balance the rotor. SUPPLIER shall indicate in his proposal the speed at which multi-plane dynamic balance is performed.
Part 1 4.8.8.2.1 (Add)	For in-between bearing design compressors, this clause applies only to: • Thrust collar All other parts shall not be disassembled after balancing.
Part 1	(Delete) "If specified".

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API Clause No.	Description of Change
4.8.8.2.2 (Modify)	
Part 1 4.8.8.3.1 (Modify)	Unless otherwise specified, high speed balancing of the completely assembled rotating element in accordance with paragraph 4.8.8.4 shall take place after low speed sequential balancing.
Part 1 4.8.8.3.2 (Delete)	(Delete) API clause.
Part 1 4.8.8.4 (Modify)	[Replace with]: High speed balancing is not required for rotors which have their operating speed range below the first rotor bending critical speed. Unless otherwise approved by COMPANY, rotors operating above the first rotor bending critical speed shall be balanced at high speed in accordance with the following procedure: - After initial low speed balancing, each complete assembled rotor shall be run at 114% of the maximum continuous speed in order to promote settling of the impellers on the shaft. - After this run, the rotor shall be balanced at low-speed (below 1000 rpm) on a low speed balance bench to a balance quality according to ISO 1940, grade G2.5. - Subsequently, the rotor shall be balanced at maximum continuous speed or higher to balance quality to ISO 1940 grade G1. In addition, the relative shaft displacement at location of the bearings shall not exceed the limits of 4.8.8.8. High speed balancing shall be done with bearings which are similar to the contract/job bearings. The stiffness of the bearing supports of the high-speed balancing machine shall be as close as practicable to the actual stiffness of the compressor bearing supports. - After high-speed balancing the residual unbalance of the rotor shall be verified at low speed. It shall be within the limits of ISO 1940, grade G 2.5. If the rotor residual unbalance exceeds this limit and the corrections are made, the high-speed balancing and the low speed balance verification shall be repeated. Rotors that are balanced in accordance with the above procedure are exempt from the residual unbalance requirements of 4.8.8.4.8. If the MANUFACTURER considers alternative and / or additional balancing procedures are necessary in order to comply with Chapter 1 paragraph 4.8.8.8 during the mechanical run test, he shall submit a proposal for approval by COMPANY.
Part 1 4.8.8.4.1 (Add)	Rotordynamic analysis shall be performed on rotors that are to be balanced at speed: - The model for this analysis shall include the balance stand bearing stiffnesses and damping. - Critical speed of the rotor in the balance stand shall not approach the balancing speed, which can result in modal errors in the balancing calculation.

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API Clause No.	Description of Change
Part 1 4.8.8.4.5 (Modify)	(Delete) words “if specified”.
Part 1 4.8.8.8 (Modify)	“[Redefine] “A” as Amplitude of unfiltered vibration, in micrometers peak to peak including run-out. (Add) At critical speeds the overall unfiltered peak-to-peak amplitude of vibration including run-out shall not exceed 150% of the above limit. At any speed greater than the maximum continuous speed, up to and including the trip speed of the driver, the vibration at each probe shall not exceed 150% or 10 microns, whichever is the greater of the maximum value recorded at the maximum continuous speed. The maximum allowable casing or bearing housing vibration in any plane shall not exceed a value of 3 mm/s (rms). <i>[Clarification] The word “shop test” in the first sentence shall mean the mechanical run test (API 4.3.6), Performance test (API 4.3.8.1), Full Pressure/Full Load/Full Speed test (API 4.2.6.2), or any other full or part load run tests specified in the inquiry documents. Vibration levels shall not exceed the specified limits during any of these tests.</i>
Part 1 4.8.8.9 (Modify)	The method described in API para 4.8.8.9 for determining electrical and mechanical run-out is for the information of the SUPPLIER only for him to take necessary corrective action as deemed fit. The amplitude and phase angle of the total shaft run-out on test shall be determined by a single sweep oscilloscope based photographic record of one revolution of the shaft, whilst measuring probe and proximeter output at a speed within the range 500rpm to 700rpm when the train is coasting down. The acceptance of mechanical plus electrical run-out shall be based on the photographic record produced from both X and Y probes during coast-down.
Part 1 4.8.8.11 (Add)	This clause shall not be used without approval from COMPANY. Replace words “Equation (12)” with equation 13 (a) or 13 (b) as applicable. <i>[Replace with] The maximum allowable casing or bearing housing vibration in any plane shall not exceed one-half of the allowable value for the shaft.</i>
Part 1 4.8.8.12 (New)	Spare rotor shall be dynamically balanced to the same requirements as the rotors installed in the equipment.
SECTION 4.9 – BEARINGS AND BEARING HOUSINGS	
Part 1 4.9.1 (Add)	Following requirements are to be considered in bearing design: - SUPPLIER shall furnish calculations (not merely calculation results) for the thrust load for various scenarios including surge and impeller blockage, clearly identifying the worst-case scenario. Thrust load calculations shall take into account actual pressure profiles on the impeller surfaces. - Radial and thrust bearings shall withstand reverse rotation without damage for duration of shutdown, both controlled and emergency.

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	c. SUPPLIER shall provide loads and corresponding time limits. d. Bearing metal temperatures shall not exceed 100°C under any load conditions and at the maximum oil inlet temperatures. e. Damper bearings shall not be used in combination with a hole pattern seal or a honeycomb seal. f. Bearing design shall allow for only correct installation with marked as to their location.
Part 1 4.9.4.5 (Modify)	(Replace with:) a. Provisions for locally disconnecting bearing temperature sensors' wiring within the bearing housing shall be provided. b. Temperature detector leads shall: 1. Be protected against abrasion, chafing and vibration within the bearing housing. 2. Exit from the bearing housing through an oil tight fitting. 3. Terminate in a lead mounted on the outside of the bearing housing. c. Bearing metal temperature sensor shall be PT100, 3 wire, duplex, platinum RTDs.
Part 1 4.9.4.6(Modify)	Drilled orifices within the bearing housing for controlling lube oil flow is not permitted. Instead, lube oil supply line mounted orifices shall be provided.
Part 1 4.9.4.7 (New)	Common bearing and seal housings shall: a. Have a separation chamber drain and provisions for injection of separation gas. b. Be vented adjacent to this chamber. Venting location shall be such that separation gas flows across labyrinths on both sides of chamber.
SECTION 4.10 – SHAFT END SEALS <i>Note: Dry Gas Seal applicable requirements have been addressed in respective Appendix 5 (Ref. 6).</i>	
Part 1 4.10.1.3 (Modify) [PSR]	The maximum sealing pressure SHALL [PSR] be at least equal to the settle-out pressure +10%.
Part 1 4.10.1.6 (Add)	The compressor seal and equalizing line design shall ensure that a positive internal gas pressure is maintained within the seal chamber at all specified operating conditions
Part 1 4.10.1.9 (Modify)	Unless otherwise specified, the method of control of gas supply shall be based on PDCV for primary seal and flow for secondary and separation seals. Primary seal and secondary seal vent lines are controlled by flow or pressure. Alternate control methods require COMPANY approval.
Part 1 4.10.1.10 (Modify)	[Replace with] Dry gas seals shall be selected as first preference, unless there is no dry gas seal possible for specific application.

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	Buffer seal gas will be provided by CONTRACTOR at the conditions stated on the datasheet. The seal gas may be taken from the compressor discharge. An alternate seal-gas source may be used and may be required during start-up or shutdown. SUPPLIER shall provide all items required to control and distribute the buffer gas at start up and in normal operation. SUPPLIER shall supply a complete seal gas system for automatically conditioning, controlling and monitoring the buffer seal gas as presented by the CONTRACTOR at a single point at the package perimeter, as necessary for the expander and compressor seals. The system shall comprise, as required but not necessarily be limited to, separator with drain, heater, dual filters, pressure regulators, piping, minimum flow bypass to flare, instruments and controls. The temperature of the seal gas shall be not less than 20°C above the dew point at the pressure prevailing in the seal assembly, under all identified operating conditions in order to prevent the possibility of liquid entering or forming in the dry gas seal. Dual parallel filters (rating of 1 micron absolute) for the seal gas which can be changed over during running shall be supplied. Filters shall be sized for 1.5 times normal flow rate and all particles larger than 1 microns shall be filtered out. The filters shall be rated for turbo expander compressor casing maximum allowable discharge pressure or alternate seal gas source maximum allowable pressure, whichever is greater. Differential pressure indication and transmitter shall be provided for alarm and trip functions. The line to seal gas shall be equipped with a flow meter to provide flow indication in the control system. The basis for design and construction standards of the seal gas system shall be equivalent to that applied to the oil system with stainless steel piping required downstream of the main filter(s). With labyrinth shaft seals for the compressor seal, the sealing gas pressure shall be controlled to always maintain a positive pressure with respect to the pressure in the bearing housing to prevent the possibility of oil carry-over into the compressor during operational transients. The availability of external supplies such as N₂, Air or other gas for purging purposes shall be established and provided by CONTRACTOR for each application.
Part 1 4.10.1.12 (Modify)	[Replace] "PURCHASER" [with] "SUPPLIER".
Part 1 4.10.1.15 (New)	Seal oil systems and wet seals require COMPANY approval. Even when equipment is supplied with mechanical contact type or liquid film type seals shall allow future conversion of the shaft seals into a dry gas seal type without the need for site machining of stuffing boxes, or removal of the compressor casing from its baseplate. When seal oil systems are used, the inner or contaminated oil flow rates shall be guaranteed and the guarantee figures verified during shop tests. The shop test procedure is subject to PURCHASER review and approval. When seal oil systems are used, SUPPLIER shall confirm that the flash point and TAN of seal oil are not affected due to miscibility of process gas into oil and confirm duration for oil change. Even with

Table 6 - API 617 Technical Amendments: Part 1 – Section 4 – General

API Clause No.	Description of Change
	changes in TAN (increase) and flash point (reduction), the operation of the unit shall not be jeopardized and oil type (mineral or synthetic) accordingly defined. SUPPLIER shall indicate in his proposal the guaranteed maximum leakage rates along with corresponding seal clearances and other operating data. The test procedure shall include correction factors for the differences between seal leakage rates at “compressor normal performance guarantee point” and test conditions. Compressors equipped with mechanical contact type or liquid film type seals shall allow future conversion of the shaft seals into a dry gas seal type without the need for site machining or removal of the compressor casing from its baseplate.
Part 1 4.10.2 (Add)	Labyrinth seals shall not be used as final shaft end seals.
Part 1 4.10.3 (Modify)	[Replace with]: Oil seals for machines handling sour gases shall be designed for operation on high quality mineral oil.
Part 1 4.10.3.7 (New)	For compressors with sub-atmospheric pressures at shaft seals, provision shall be made to pressurize these seals with gas at a pressure that is higher than atmospheric.
Part 1 4.10.4.8 (New) [PSR]	The venting lines to flare and safe location SHALL [PSR] be adequately sized to avoid over pressurising of the seal/bearing housing in case of a major seal failure.
Part 1 4.10.4.9 (New) [PSR]	In the event of a total seal failure, the gas leakage rate to the flare and into atmosphere SHALL [PSR] be limited to a maximum possible level, which shall be indicated in the MANUFACTURER’s proposal.
Part 1 4.10.4.10 (New) [PSR]	If rapid depressurisation is specified, the MANUFACTURER SHALL [PSR] confirm that the shaft seals and the sealing system are suitable for this and describe the relevant design features.
SECTION 4.12 – NAMEPLATES AND ROTATION ARROWS	
Part 1 4.12.5 (Add)	Identified critical speeds and rotor responses less than 2.5 AP shall be stamped on the equipment name tag and identified as test verified.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
SECTION 5 – ACCESSORIES	
SECTION 5.1 – DRIVERS AND GEARING	
Part 1 5.1.1 (Add)	Driver power shall be at least equal to the sum of the following parameters: [[compressor gas power (at certified point) + internal labyrinth losses (with twice the leakage volumes, considering worn out labyrinths) + bearing and seal losses] *1.04 (4% API tolerance) + gearbox losses + coupling losses] * 1.1 (10% margin) Driver power shall be indicated on the datasheets, plus zero tolerance (including Performance tolerance) to avoid ambiguity. For steam turbines, the driver power defined above shall be available at minimum steam inlet supply and maximum steam outlet conditions. For gas turbine drivers, the driver power defined above shall take account of the defined inlet and outlet losses and ageing losses at site conditions.
Part 1 5.1.3 (Add)	Following requirements re to be considered sizing the driver: - Drivers with fix speed shall start the compressor from settle-out pressure or/ max suction pressure, if required. - Motor start-up torque shall be such that compressor flow at start-up prevents surge. - Compressor speed versus torque curves shall be based on the flow required to prevent surge conditions.
Part 1 5.1.6 (Add)	The power margins and site rated conditions shall be as per the inquiry documents and shall be finalized with discussions with COMPNAY. SUPPLIER shall include in his proposal torque v/s speed characteristics of the gas turbine for the range of ambient conditions and firing temperatures superimposed on compressor torque requirements. Power turbine shaft torque limit shall also be shown. The compressor-turbine unit shall be capable of being started in a controlled manner, run up to the minimum governing speed and operated to maximum continuous speed in a satisfactory manner. This should be accomplished without any constraint on continuous operation at any speed within the governed range, due to any limitations, mechanical or otherwise, associated with the gas turbine, transmission, compressor, lubrication and shaft sealing systems, associated control systems at the shop or at the site.
Part 1 5.1.7 (Modify)	[Replace with] Speed increasers and reducers shall be in accordance with API Standard 613 as amended/supplement by General Specification BGS-MV-002 and shall be sized for the maximum power and speed of the driver. The gear service factor (SF) for variable speed electric motor drivers (with VSDS) shall be 1.6 on name plate rating of driver.
SECTION 5.2 – COUPLINGS AND GUARDS	
Part 1	Coupling hubs shall be arranged for hydraulic mounting and dismounting.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
5.2.3 (Add)	
Part 1 5.2.4 (Add)	Couplings shall be provided with permanent strain gauge / alternate arrangement type torque meters for measurement and continuous monitoring (with connections to BN system) of torsional deflections / shaft twist. Coupling shall be balanced to ISO 1940 Grade G1 or better. Verification of coupling balance shall be in accordance with ISO 10441 (API 671) method 2, following clauses shall be met: - Assembly balance check - Balance repeatability check. - Torque meters shall be supplied for Gas Turbine and Steam Turbine driven applications when requested by COMPANY and connected to the Condition Monitoring System.
Part 1 5.2.5 (Modify)	(Delete) "If Specified" Replace with: For tapered fit hubs, the SUPPLIER shall supply a matched set of ring and plug gauges in conformance to API 671.
Part 1 5.2.6 (Add)	Instructions shall be provided on the safe use of supplied tools.
Part 1 5.2.9 (New)	Coupling hubs shall be arranged for hydraulic mounting and dismounting and shall have puller holes. Liberal clearance shall be provided between the coupling, guard and guard adapters, if used, in order for alignment checks to be performed without requiring removing the bottom half of the guard.
Part 1 5.2.11 (New)	Removable coupling hubs shall be non-keyed, tapered bore and hydraulically fitted.
Part 1 5.2.12 (New)	The required bolt torque and bolt and nut lubrication requirements shall be etched on each coupling hub.
Part 1 5.2.13 (New)	The following requirements are to be considered: - Compressor motor drivers with sleeve bearings shall have limited end float couplings. - When sizing driven equipment thrust bearings, the maximum thrust developed by the motor shall be accounted for.
SECTION 5.3 – LUBRICATION AND SEALING SYSTEMS	
Part 1 5.3.1 (Add)	Lube and seal oil systems shall be common as far possible unless seal oil contamination such as in H ₂ S services is unavoidable. If permanent gas contamination of oil used for oil-type seals is unacceptable and if the contaminated oil leakage is not

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	dumped to waste, equipment shall be provided for decontaminating the oil before it is returned to the system. Separate seal-oil and lube-oil systems shall be used for machines handling sour or corrosive or toxic or rich hydrocarbon gases. This requirement shall apply even if the seals are normally buffered by a clean non-contaminating gas. Compressors on sweet clean gas duties may have combined lube and seal oil systems if oil quality can be maintained for three years. When separate seal and lubricating oil systems are to be used, positive separation of the seal and bearing housings shall be provided to ensure that cross flow of seal oil into the lubricating system and vice-versa cannot occur. This shall be achieved without an external purge gas. Tell-tale drain connections shall be provided on the labyrinths separating the seal oil and lubricating oil rundown spaces. Separation of the oil streams shall be demonstrated during the shop tests. SUPPLIER shall state in his proposal the method(s) to be used to de-gas and clean contaminated seal oil to restore flash point, viscosity and other properties. SUPPLIER shall include in his scope systems required to facilitate collection, storage and subsequent disposal to waste the contaminated seal oil. Storage facilities shall be sized for at least 3 days of seal oil flows with twice the design seal clearances. SUPPLIER shall indicate in his proposal the lowest flash point for safe operation of the compressor in case of contamination.
Part 1 5.3.2 (Add)	The intention is to use the same type of oil for the machine train unless agreed otherwise by COMPANY. SUPPLIER shall indicate at least three alternate makes of suggested lube oil with their trade names / ISO Grades for use in case of non-availability of specified one in the market. ADNOC lube oils shall be used as a first preference.
Part 1 5.3.3 (Modify)	[Replace with] Refer “relevant Business Unit specific Standards” for requirements for lubrication, shaft sealing and control systems and auxiliaries. Lube Oil/Seal Gas/Seal Oil system shall be in SS316L stainless steel minimum.
Part 1 5.3.4 (New)	Auxiliary piping to compressor supplied by the MANUFACTURER shall allow removal of the entire machines or machine heads. A single oil type and viscosity grade should be selected for the complete machine train.
Part 1 5.3.5 (New)	Isolation valves shall be supplied at the suction and beyond the non-return valve and relief valve connection at the discharge end of each pump.
Part 1 5.3.6 (New)	Pumps shall be fitted with permanent strainers. The same shall be removable without dismantling of piping.
Part 1 5.3.7 (New)	The oil reservoirs shall be provided with a thyristor controlled electric heater. External level gauges with isolation and ball check valves shall be provided on reservoir. Flame arrestor shall be provided on the lube oil vent. Reservoir shall have access opening for

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	cleaning with a valve drain connection. Spare connections on the reservoir shall be flanged. SUPPLIER shall provide blind flange and valve for all spare connections. The lube oil reservoir shall be sized to handle all the volume of oil from run down tank, lube oil cooler and its associated piping.
Part 1 5.3.8 (New)	SUPPLIER shall provide a lube oil rundown tank and its accessories for the safe shutdown of the compressor package. The lube oil rundown tank shall be suitably sized to ensure supply of lube oil to the compressor package for the entire coast down period.
SECTION 5.4 – MOUNTING PLATES	
Part 1 5.4.1.2 (Modify)	In clauses 5.4.1.2.1 through 5.4.1.2.17, the term “mounting plate” refers to “Baseplate”.
Part 1 5.4.1.2.1 (Add)	(Add) Axial and lateral jackscrews shall be the same diameter as the vertical jackscrews or larger. The vertical levelling screws provided in the baseplate shall facilitate the removal of the shims or packers. If necessary, they shall be arranged together with the foundation bolts or studs in such a way that shims or packers may be withdrawn in the simplest manner without resorting to external jacking devices. API Figure 5 arrangement is required with jackscrews and packers. Centreline supports are interpreted to be plinths or pedestals upon which the compressor is mounted via its centreline support lugs. The horizontal screws are interpreted to be mounted near to the horizontal centreline level of the compressor shaft. The casing shall be supported from the baseplate by vertical supports. Shim packs for vertical alignment shall be between surfaces which do not have relative movement. Shims shall have a total thickness of at least 3 mm and be of stainless steel. Provision shall be made to support the machine whilst shims are removed and replaced. The number of shims used should be optimized and as minimum as possible.
Part 1 5.4.1.2.3.a (Modify)	[Replace] a. [with] Each mounting surface shall be machined to a finish of 3µm arithmetic roughness (Ra) or less.
Part 1 5.4.1.2.5 (Modify)	[Replace with] Unless otherwise specified, anchor bolts shall be furnished by SUPPLIER.
Part 1 5.4.1.2.9 (Modify)	[Delete the first sentence]
Part 1 5.4.2.1	(Delete) “when a baseplate is specified”. (Add) Baseplate shall be continuously seal welded. No equipment, junction boxes or control panels shall overhang the baseplate. Baseplates shall be constructed with

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
(Modify)	longitudinal steel beams and full depth crossmembers. Crossmembers must be located under the supports of the compressor, motor and gearbox modules as applicable. All components shall be within the baseplate limits including compressor-motors, gearboxes. Terminal boxes / any other mountings extending the baseplate will require COMPANY approval. Material specifications for equipment supporting structure, platforms, baseplate, connection & anchor bolts, etc. shall comply with AGES-SP-01-002, Structural Steel Works.
Part 1 5.4.2.1.1 (Modify)	(Delete) the bullet and "If specified," (Add) A drip rim type baseplate is required. Oil drains shall be designed to permit the use of screwed couplings at their lower ends to readily permit connection to a manifold pipe running beneath the surface of the baseplate. Baseplate shall be provided with a flanged drain valve of minimum 2" size. All drains shall be terminated in flanged a connection for further routing.
Part 1 5.4.2.4 (Modify)	[Replace with]: A non-slip decking (open mesh type) shall be provided on the top surface of the baseplate, covering all work and walkway areas. Additionally, a continuous drip rim shall be provided around the outside perimeter of the baseplate. Adequate drainage from the top surface plate of the baseplate shall be provided to ensure that areas do not accumulate spilled oil. Oil drains shall be designed to permit the use of screwed couplings at their lower ends to readily permit connection to a manifold pipe running beneath the surface of the baseplate. (Delete) note: After grouting, baseplate shall not be filled with cement.
Part 1 5.4.2.4.1 (Add)	(Delete) the bullet and 'If specified'. (Add) All baseplate compartments shall be self-draining and sloped towards the drain valve after installation. Baseplate shall be provided with a flanged drain valve of minimum 2" size.
Part 1 5.4.2.6 (Modify)	(Delete) the bullet and 'If specified'. (Add) Levelling pads or targets shall be provided.
Part 1 5.4.2.7 (Add)	For barrel compressors, bundle removal provisions shall be designed so that the bundle is rigidly supported from the compressor baseplate during the removal operation. The structural resonant frequencies of the baseplate shall be separated from the fundamental running frequencies of the compressor train by a minimum of 20%.
Part 1 5.4.2.8 (Add)	Baseplates and baseplate pedestals mounted on concrete foundations shall allow filling after grouting.
Part 1 5.4.2.11 (Modify)	(Delete) "If specified"

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
Part 1 5.4.2.12 (Modify)	[Replace with] The oil reservoir shall be located on the baseplate; alternatives require COMPANY approval.
Part 1 5.4.2.14 (New)	Baseplate design and layout shall consider safety, operator and maintenance ergonomics. Piping, cable conduits / trays and other auxiliary equipment shall be routed to eliminate tripping hazards. Piping and conduits shall be routed downward from the compressor into troughs below the deck level and through the side of the baseplate. Grating or decking shall cover these troughs.
Part 1 5.4.2.15 (New)	A minimum of two grounding lugs, installed diagonally at opposite ends of the baseplate, shall be provided.
Part 1 5.4.3.1 (Modify)	(Delete) "If specified" and (Add) The design of the sub soleplates shall be included in the proposal.
Part 1 5.4.3.1.6 (Add)	Soleplates shall have a minimum of four levelling jack bolts with holes drilled and tapped outside the footprint of the compressor mounting feet.
SECTION 5.5 – CONTROLS AND INSTRUMENTATION	
Part 1 5.5 (Add)	The packaged unit SUPPLIER shall comply fully with the requirements specified in "relevant Business Unit specific Standards" for Instrument Furnished with Packages. SUPPLIER standard design will not be acceptable as a reason for a concession request.
Part 1 5.5.1.1 (Add)	Instrumentation and control equipment required to protect, monitor and sequence the compressor through pressurisation, start up, operation, shutdown and depressurisation shall be provided. Supply of the system shall be as defined by COMPANY.
Part 1 5.5.1.2 (Modify)	(Delete) the bullet and words "If specified,"
Part 1 5.5.2.1 (Add)	Unit control panels not acceptable unless agreed by COMPANY. Plant DCS system shall be used for package control and the Plant IPS system shall be used for safeguarding. Refer project specific control system architecture drawings. SUPPLIER shall provide the necessary ladder logic, step wise sequences and procedures for startup, operation and shutdown. SUPPLIER shall be present at DCS, IPS SUPPLIER works to test the logic. Capacity control with adjustable inlet guide vanes shall be avoided and shall be provided only when approved by COMPANY. A suction throttle valve shall be a preferred option. Guide vanes can be acceptable only in the case of clean, dry, non-polymerizing, non-toxic and non-corrosive process gas and when suction throttling cannot be provided.
Part 1	Replace the clause with:

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
5.5.2.2 (Add)	“SUPPLIER shall include in his scope anti-surge / load-sharing / performance controllers and their configuration and configuration software. Anti-surge controllers, load sharing and performance controllers shall have a redundant system and shall be as per relevant Business Unit specific Standards. Surge control algorithm shall be invariant to process gas characteristics. SUPPLIER’S scope shall also include anti-surge cum recycle valve (sized for full flow of compressor) and, if deemed necessary consequent upon results of the dynamic simulation study, a hot gas bypass valve to prevent surge during rundown followed by a shutdown. Instrument tubing shall be minimum 3/4”. Anti-surge recycle valves shall be low noise type and noise control measures are subject to COMPANY approval. The recycle valve shall have linear characteristics and its full-stroke time shall be less than 1 sec. The response time for the control equipment shall be such as to prevent surge during any anticipated process condition including start-up, due consideration being given to the speed at which process changes or upsets can move the compressor operation towards surge. For the more complicated installations with multiple stages and side streams, or multiple units (in series or parallel) or variable speed units, an analysis of the stability of the process and anti-surge control systems is also necessary. Programming/Field verification and fine-tuning of the surge/performance and load sharing controllers shall be done by controller MANUFACTURER, under the supervision of the compressor MANUFACTURER/SUPPLIER.”
Part 1 5.5.2.4 (Modify)	Replace with: A dynamic simulation shall be performed by SUPPLIER / CONTRACTOR to confirm design parameters, alarm and trip set points, in order to ensure stable operation. The simulation shall include transient and steady state analysis to validate: - Control system response time - Anti-surge system response time - Start-up conditions to confirm drive power - Shutdown response to make sure the compressor will not surge during a trip Dynamic simulation cases and boundary shall be defined prior to award with inputs from process. Dynamic simulation study recommendations/results shall not affect the overall schedule of the equipment. As a minimum, the following cases shall be considered for the dynamic simulation of the compressor: - Scenario 1 – Anti-surge valve fail open - Scenario 2 – Blocked discharge condition - Scenario 3 – Normal shutdown from normal point when only one train is operating and when two trains are operating (applicable for multi-train operation in parallel) - Scenario 4 – Emergency shutdown from normal point (driver trip or ESD) when only one train is operating and when two trains are operating (applicable for multi-train operation in parallel)

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	• Scenario 5 – Emergency shutdown from point near to surge at MCS for 1 train and 2 trains(applicable for multi train operation in parallel) • Scenario 6 – Start-up from settle-out pressure to normal speed • Scenario 7 – Start-up from normal suction pressure to normal speed • Scenario 8 – Discharge check valve fail close • Scenario 9 – Start-up of standby compressor while the normal running train is still operational • Scenario 10 – Sudden blockage of inlet valve at normal speed and maximum speed • Scenario 11 – Any other scenario to be developed by SUPPLIER for machine protection.
Part 1 5.5.2.5 (New)	The following requirements shall be considered in the design of the anti-surge control system: - Anti-surge control system to protect the compressor during operation at low flow, malfunctions and process upsets including ESD at maximum discharge pressure shall be provided. - The anti-surge control system design shall prevent surge during compressor coast down on a normal trip at high power (greater than 75% speed). - The response time of the anti-surge controller and system components including the instrumentation, transmitters and valves and actuators shall be analysed to verify safe operation of the compressor. - The anti-surge control system response shall deal with process upsets and transient conditions that can occur. - The anti-surge control system equipment shall have indication and annunciation functions. - The anti-surge control system design shall interface with driver controls, process control valves, measurement instruments and other related instrumentation. - The driver controls and anti-surge control system shall be integrated into the same panel as the compressor controls. - Compressor and anti-surge control system shall be compatible with and provide information to, the facility control system. - If series or parallel compressor networks are proposed: - An integrated train management system (i.e. load sharing) and anti-surge control system shall be provided. - The compressor capacity control design shall increase the reliability and efficiency of the machinery and process. - Comparability review and testing of systems shall be performed. - If the process design precludes the installation of an anti-surge control system, a surge detection system shall be provided with alarm functionality and be linked to the DCS and/or a shutdown logic upon COMPANY approve configuration. - If re-rating an existing compressor with increased flow and power, a transient simulation shall be performed of the existing surge control system to validate that the existing piping system and valving can blow down without trip surge.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
Part 1 5.5.3 (Modify)	[Replace With]: See “relevant Business Unit specific Standards” for Instrumentation requirements.
Part 1 5.5.4 (Modify)	[Replace With]: Refer to relevant Business Unit specific Standards for Instrumentation requirements. (Add) Instrument and power wiring or cabling, with the exception of power supply to electric motors, shall be connected to terminal strips installed in terminal boxes. Instrument signals and wiring or cabling with different voltages or different types of signals shall be connected to separate terminal boxes. The terminal boxes shall be mounted in one central location on the baseplate. The location of the terminal boxes shall be shown on the layout drawing.
Part 1 5.5.4.1 (New)	The following requirements are to be considered in instrumentation design: a. Mercury filled temperature gauges are not acceptable. b. Junction boxes, bulkhead plates, cable transits and blind enclosures shall have individual, fixed identification tags. c. Tubing runs and multitube bundles shall be tagged at each end. d. Tubing runs less than 3m shall not be tagged. e. Tubing that passes through wall, bulkhead, or equipment that obscures one end from the other, shall be tagged at each end.
Part 1 5.5.4.2 (New)	When cabling is supplied by SUPPLIERS on the skids, cables shall be of the metal armored or braided type. They shall be installed on cable trays properly supported to minimize vibration and be segregated such as to prevent interference between voltage levels. Wherever practicable, transmitters shall be used in place of switches.
Part 1 5.5.4.3 (New)	Pressure and liquid level instruments shall be provided with block and bleed valves to permit calibration.
Part 1 5.5.5 (Add)	Refer to relevant Business Unit specific Standards for instrumentation requirements.
Part 1 5.5.5.1 (New)	As noted in Appendix 7, shutdowns voting system shall be: a. 2oo4 radial vibration b. 2oo3 axial vibration c. 2oo4 or 2oo3 based on temperature probe availability on thrust bearing and should be supplied for each side. d. 2oo2 on radial bearing temperature probe for each side
Part 1 5.5.5.2 (New)	Unless specified otherwise, systems shall be fail safe (de-energise to alarm and de-energise to trip).
Part 1 5.5.6 (Add)	Refer project specific electrical system design requirements.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
Part 1 5.5.6.1 (New)	Instrument and power wiring or cabling, with the exception of power supply to electric motors, shall be connected to terminal strips installed in terminal boxes. Instrument signals and wiring or cabling with different voltages shall be connected to separate terminal boxes. Similarly, instruments with different signal types shall be connected to separate terminal boxes. The terminal boxes shall be mounted in one central location on the baseplate. The location of the terminal boxes shall be shown on the layout drawing.
Part 1 5.5.6.2 (New)	When cabling is specified: cables shall be of the metal armored or braided type. They shall be installed on cable trays properly supported to minimize vibration and be segregated such as to prevent interference between voltage levels. SUPPLIER shall supply special cables between AMB panel and field when AMB units are supplied.
Part 1 5.5.7.1 (New)	All wire entries into the compressor casings or bearing housings shall be fully sealed against leakage into the environment and wiring conduits.
SECTION 5.6 – PIPING AND APPURTENANCES	
Part 1 5.6.1.1 (Add)	Lube oil, seal oil, buffer gas and sealing gas and other auxiliary piping shall be as a minimum 316 stainless steel.
Part 1 5.6.1.4 (Add)	For horizontally split casings, auxiliary piping connections shall be confined to the lower portion of the casing and shall be routed as close as possible to the compressor to minimize interference with normal maintenance access. For barrel-type casings the auxiliary piping on the outboard end of the casing shall be designed for easy maintenance removal. • First flange break connections shall be located as close as possible to the compressor casing. • Lube oil and seal gas supply flanges shall lie in a vertical plane to facilitate installation and checking of screens during lube oil and seal gas systems commissioning. • Where possible, the MANUFACTURER shall manifold auxiliary piping to provide a single connection for each required service, except where such manifolds would interfere with normal operating and maintenance access areas.
Part 1 5.6.1.7 (New)	SUPPLIER shall provide temporary and permanent flanged T-type / Y-type strainers with conical element for commissioning and installation on the inlet piping of compressor. All elements of strainers shall be removed after commissioning (after gas and suction piping is considered clean) for sizes 20" & below and 30" & above in line with API 686. A full-bore orifice shall be provided by compressor SUPPLIER / CONTRACTOR for adjusting piping gaps (avoiding pushing / pulling of suction pipes).

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	Only conical perforated plate shall be retained for sizes 22", 24", 26" and 28" inline with API 686. This shall be suitable for high collapse pressure and design to meet operating, upset conditions, surge / reverse flow conditions etc.). Metallurgy of the perforated strainer element shall be SS316L (for non-sour applications) and Inconel 625 / 825 for sour service applications.
Part 1 5.6.1.8 (New)	Piping and conduits in the vicinity of couplings and bearing housings shall provide maximum operator and maintenance access to bearings and couplings.
Part 1 5.6.1.9 (New)	The following requirements are to be considered: a. Before fabrication, piping design shall be subject to COMPANY approval. b. For baseplate mounted units, supply headers shall have a single connection with COMPANY connection located on the skid edge. c. On-skid piping shall be supported on the skid. d. Applications that, due to space restrictions, cannot provide this requirement shall be noted in the scope of supply. e. Drains shall enter the header at a 45° angle. f. Oil drain headers shall have a blinded high point vent to aid drainage in the event of foaming.
Part 1 5.6.1.10 (New)	SUPPLIER shall confirm compliance with these international Standards in their proposal and SUPPLIER Piping Specifications shall be submitted for evaluation.
SECTION 5.7 – SPECIAL TOOLS	
Part 1 5.7.2.1 (Add)	(Delete) "If specified".
Part 1 5.7.3 (New)	SUPPLIER shall provide all necessary special tools for erection and maintenance including lifting devices for the expander compressor unit and all furnished auxiliaries.
SECTION 6 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT	
Please refer to Appendix 2 (Ref.3) to find applicable requirements in this section which have been addressed in the respective clauses.	

Table 8 - API 617 Technical Amendments: Part 2 – Section 4 – General

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
API Clause No.	Description of Change
PART 2 - NONINTEGRALLY GEARED CENTRIFUGAL AND AXIAL COMPRESSORS	
SECTION 4 - GENERAL	
SECTION 4.4 - BASIC DESIGN	
Part 2 4.4.1.1 (Modify)	[Replace with] The head-capacity characteristic curve shall be guaranteed to rise continuously at least 5% from the normal operating point to the predicted surge. For compressors operating in parallel, the head at the same flow shall not differ more than 2% at any point on the curve. The compressor, without the use of bypass, shall be suitable for continuous operation at any capacity in the range of 110% of the predicted surge capacity to the predicted maximum capacity over the speed range of minimum operating speed to maximum continuous speed. The head capacity curve shall extend to the maximum possible flow (stonewall condition). The maximum possible flow shall be no less than 115% of the capacity in any operating conditions indicated on datasheets. The compressor MANUFACTURER/SUPPLIER shall confirm the suitability of the compressor to operate continuously at the stonewall point and indicate any limitations on operating beyond the stonewall point. Stonewall capacity is defined as where decrease in polytropic head is 10% for increase in inlet volume flow by 1%.
Part 2 4.4.1.3 (New)	For cryogenic applications in particular, the temperature differential across the compressor shall be limited to 200°C.
Part 2 4.4.2.1 (New)	Impeller flow coefficients shall preferably be within the 0.01 to 0.12 range. Impeller designs with flow coefficients outside the above limits need adequate references and are normally only acceptable if adequate model testing has been done. The final acceptance of these deviations shall be subject to the COMPANY's approval. The CONTRACTOR shall ensure that these required model tests are included in the Purchase Order. Flow coefficient: $\phi = Q_1 / (D^2 * U)$ Where Q_1 = inlet volume flow m³/s U = impeller tip speed m/s
Part 2 4.4.2.2 (New)	Impeller stage head coefficients shall be within the 0.4 to 0.55 range Impeller designs with head coefficients outside the above limits need adequate references and are normally only acceptable if adequate model testing has been done. The final acceptance of these deviations shall be subject to the COMPANY's approval. The CONTRACTOR shall ensure that these model tests, if required, are included in the Purchase Order. Head coefficient: $\psi = H_p / U^2$ Where H_p = impeller stage polytropic head J/kg

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	U = impeller tip speed m/s
Part 2 4.4.2.3 (New)	Machine Mach Number Machine Mach numbers or impeller tip Mach numbers shall be less than 1.2.
Part 2 4.4.4 (New)	Shaft length-to-diameter ratio L/D shall not exceed a factor of 9, where: L = compressor bearing span in m and D = average shaft diameter under the impellers m
SECTION 4.6 – CASINGS	
Part 2 4.6.1 (Add)	The inner casing of a barrel compressor shall be of the integral cartridge horizontally split design. Barrel-type compressors shall be shear ring retained head design type.
Part 2 4.6.1.1 (Add)	Unless approved otherwise by the COMPANY, the maximum allowable working pressure of the casing and other pressure parts shall not be lower than the maximum discharge pressure developed at surge point by the compressor at trip speed and maximum suction pressure. For the system relief valve settings, refer to equipment datasheets. Relief valve set-point pressure and compressor MAWP shall be subject to COMPANY approval.
Part 2 4.6.1.2 (Modify)	[Replace with] Split pressure level casings shall not be permitted.
Part 2 4.6.1.3 (Modify)	Radially split casings shall be used for maximum allowable working pressures above 40 barg. Radially split casings shall have one end flanged only and shall be of single piece construction without split line / welding. End cover design on both sides acceptable only when proven reference lists are provided for pressure rating and service similar to requested in datasheets. Self-energizing designs of the end cover with split ring retention or similar devices are preferred and are required for discharge pressures above 170 barg for barrel casings. Where bolted covers are offered, they shall be designed to allow the use of hydraulic bolt tensioning devices which shall be provided as part of the SUPPLIER'S special tools.
Part 2 4.6.1.5 (Add)	A string of Silicone based rubber or other suitable material confined in a groove on the split line of axially-split casings may be used subject to the approval of COMPANY.
Part 2 4.6.1.6	SUPPLIER shall include in his scope hydraulic bundle puller and bundle cradle as a part of the special tools. Necessary provisions shall be made to mount and align the bundle cradle so that rotor pull-out can be accomplished with no damage to the inner

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
(Add)	barrel and/or casing. Bundle/ rotor removal system shall be provided with maximum number of components (e.g. runners/ beams) built permanently into the baseplate. Temporary structures shall not be required to mount the bundle cradle.
Part 2 4.6.1.9 (New) [PSR]	End covers of axial compressor casings in hydrocarbon service SHALL [PSR] be of a single piece construction without a split line.
Part 2 4.6.4.1 (Add)	The MANUFACTURER shall state in its proposal the actual and the maximum recommended gas velocities in each nozzle.
Part 2 4.6.4.2 (Modify)	[Replace with] All casing openings for pipe connections shall not be smaller than $\frac{3}{4}$ " and shall be welded to the casing and flanged for or, alternatively machined and studded. All welded connections shall be full penetration butt-welded. Socket welding shall not be used, except where other connection methods are not possible and subject to COMPANY approval. Unless specified otherwise, suction nozzle and side stream nozzles shall have same rating as the discharge nozzle on the same section.
Part 2 4.6.4.3 (Add)	Where flanged or machined and studded openings are impractical for oil or flammable or toxic gas connections, openings of 1" NPS or larger shall be full penetration butt weld connections, not socket weld connections. Openings of less than 1" NPS may be reinforced boss connections of the 'Weldolet' type, involving only full penetration butt welds.
Part 2 4.6.6.1 (Add)	All process nozzles and connections shall be designed to withstand five times the maximum permitted forces and moments calculated from NEMA SM 23 (~2.7*API loads). The baseplate and supporting elements shall also be designed accordingly. The SUPPLIER shall indicate in the proposal the compressor nozzle load capability.
Part 2 4.6.6.2 (Add)	The misalignment (either in vertical or horizontal direction) shall not exceed 50µm or as per SUPPLIER standard, whichever is less, for compressor operating at normal ambient temperature.
Part 2 4.6.4.4 (Add) [PSR]	Boroscopic inspection ports shall be provided at agreed locations when coatings are applied on any internal components. Coatings may be provided only with approval from COMPANY. The outer casing connections SHALL [PSR] be butt welded. Screwed connections are not acceptable.
Part 2 4.6.7.1 (Add)	Adjustable inlet guide vanes on gas centrifugal compressors and variable stators on axial compressors shall not be used unless approved by COMPANY. Only Vane less diffusers shall be considered in design. Vaned diffusers and/or low solidity vaned (LSV) diffusers should NOT be applied. Adjustable guide vanes shall only be used in clean non-corrosive services.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
Part 2 4.6.7.10 (Add)	(Add) Internal fastenings (bolts and nuts) in the flow path shall be locked in place such that on failure or coming loose, they cannot fall into and damage the equipment. SUPPLIER shall indicate in the datasheets the maximum allowable differential pressure for diaphragms between the main intermediate nozzles. The SUPPLIER shall, as part of his supply, carryout studies to assess pressure excursions due to start-up, shutdown, trip-out and blocked in settle-out pressure/temperature conditions, surging (one or more stages) and any other worst combination of pressures and temperatures. The SUPPLIER shall report to the PURCHASER the outcome of his study and, upon exhausting his (SUPPLIER'S) design solutions, shall propose any required modifications to the PURCHASER's system (including piping, valves, static equipment sizing, location and sizing of orifices etc) to ensure that the SUPPLIER's scope of supply safely operates within the overall system of the PURCHASER. SUPPLIER shall furnish in his proposal the maximum allowable differential pressure across each diaphragm, including center wall. When two process stages are provided in a single casing, the suction nozzles shall be located at either end and discharge nozzles close to stage separation wall to avoid high thermal gradient across the inter-stage separation wall.
Part 2 4.6.7.10.1 (New)	All non-return valves (check valves) in the compressor discharge process lines in centrifugal and axial compressor applications regardless of service shall be the annular flow non-slam type check valve. Two dissimilar check valves shall be provided on compressor discharge. The location shall be finalized as part of the compressor dynamic simulation.
Part 2 4.6.7.10.2 (New)	In all the cases, the stresses in the diaphragms shall not exceed 50% of the material yield value at the worst-case differential pressures including surging and depressurization. For the diaphragms between process sections, SUPPLIER shall submit along with his offer, finite element analysis to prove the adequacy of his design for the worst-case scenarios.
Part 2 4.6.7.11 (New)	At assembly, the impeller-diffuser passage overlaps and axial clearances shall be within the tolerances published by the SUPPLIER in the maintenance manuals. This shall also be verified during the strip test.
Part 2 4.6.9.1 (Add)	Close clearance seals shall be stationary labyrinths. Rotating labyrinths with stationary abraidable seals require COMPANY approval.
Part 2 4.6.9.2 (New)	Following requirements are to be considered: - Labyrinths shall be precision machined. - Labyrinth design and material selection shall be proven and supported by evidence of satisfactory operating experience at equivalent conditions. - Use of P balance drum labyrinths is to be avoided and shall be subject to COMPANY approval.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	d. Non-metallic labyrinths such as PEEK shall be used to increase polytropic efficiency and reducing internal losses, provided SUPPLIER can provide proven application references.
Part 2 4.6.10.1 (Add)	Diaphragms shall be removable from the casing or inner bundle assembly without the necessity of removing the impellers from the shaft.
Part 2 4.6.10.6 (New)	Diaphragms with internal liquid cooling shall not be used.
Part 2 4.6.10.7 (New)	Diaphragms that are horizontally-split shall be fitted with a minimum of two jackscrews to aid in separating the diaphragm from the case. Diaphragm eye bolts shall be M10 minimum.
SECTION 4.7 – ROTATING ELEMENTS	
Part 2 4.7.1.2 (Add)	Sleeves, spacers and bushings shall be made of non-galling materials.
Part 2 4.7.2.1 (Modify)	Replace the clause with: “Shafts shall be made of one-piece, heat-treated forged steel, suitably ground. Forging shall be carried out as close as possible to the final dimensions. Hot rolled bar stock shall not be acceptable.”
Part 2 4.7.3.1 (Modify)	[Add] “The balance drum shall be sized to maintain a positive load on the active thrust bearing for all operating conditions, including start-up and shutdown. A pressure transmitter is required for pressure monitoring.” [Replace] last sentence [with]: Separate flanged pressure tap connections shall be provided to indicate differential pressure from balancing chamber to lower pressure.
Part 2 4.7.3.3 (Add)	A differential pressure transmitter with DCS indication and alarm, complete with block and bleed valves shall be provided to indicate the pressure difference between the balance chamber pressure and inlet pressure. During factory tests, the balance piston flow shall be monitored, measured and recorded as a reference parameter and shall be verified during Site Acceptance Tests.
Part 2 4.7.3.4 (New)	The balance drum shall be sized to maintain a positive load on the active thrust bearing for all operating conditions, including start-up, surge conditions and shutdown. No thrust reversal shall occur under any operating and load conditions. The SUPPLIER shall provide supporting calculations, predicted balance piston leakage rates and design data. Cooling of balance line flow or external connections to process gas piping are not permitted.

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
Part 2 4.7.3.5 (New)	Labyrinths for the balancing drum shall be located in a carrier which, when needed, can be re-bored to receive 10% larger diameter labyrinths (with corresponding balancing drum).
Part 2 4.7.4.1 (New)	Single section compressors with in-line impeller arrangements shall not have more than nine impellers per casing. Two-section compressors shall not have more than eight impellers per casing. Compressors with one side stream shall not have more than seven impellers per casing. If more side streams are present, the impellers shall be reduced by one per stream. Use of double suction impellers and double flow casings require approval from COMPANY. Impellers shall be selected with MCS 13000 RPM or below. Higher MCS than 13000 RPM require COMPANY approval.
Part 2 4.7.5 (Add)	The selected axial compressor rotor and stator blading shall have proven references in similar and/or identical services. Otherwise, a verification of the blade resonances shall be performed. If, axial compressor blade design is based on theoretical Campbell and Goodman diagrams, full-scale blade testing shall be performed on a representative test rig to verify these calculations. A further verification by means of measurement of the actual blade stresses shall be performed during a Full Load test of the compressor. Test procedures are subject to approval of the COMPANY.
SECTION 4.9 – BEARINGS AND BEARING HOUSINGS	
Part 2 4.9.1 (Add)	Complete radial and thrust bearing assemblies shall be designed and manufactured by a single source.
Part 2 4.9.1.1 (Modify)	[Replace with] Hydrodynamic radial and thrust bearings shall only be provided for all compressors. When selected, copper alloy bearings shall have hardened steel inserts for support.
Part 2 4.9.1.1.1 (Add)	For process gas compressors, usage of active magnetic bearings shall be subjected to approval from COMPANY.
Part 2 4.9.1.2 (Add)	Platinum (100 Ohm, three-wire) duplex RTD's (socket type) shall be used for bearing metal temperature detection arranged as follows. Transmitters are required for all the RTDs for further connections to the machine monitoring system. - Radial bearings shall have two duplex RTD's within the expected load zone. For "load between pads" bearings the leading and trailing pads shall be fitted with RTDs. - Thrust bearings shall have four duplex RTD's on each side (active & non-active side). Minimum 3 on each side shall be provided when 4 RTDs cannot be fitted due to space limitations. Bearing metal temperature sensors shall

Table 7 - API 617 Technical Amendments: Part 1 – Section 5 – Accessories

API Clause No.	Description of Change
	not be in adjacent pads for both active and inactive sides and shall be located in highest load part of each pad.
Part 2 4.9.1.4 (New)	As noted in Appendix 7, compressors shall be provided with the following in the bearings: a. Two radial vibration displacement type probes at each radial bearing, located at an angle of 90 degrees with each other. b. Three axial position displacement probes at each thrust bearing. c. A key phasor, if gearbox transmission is used. The key phasors for both high and low speed shafts shall be installed.
Part 2 4.9.2.2 (Modify)	Radial bearings shall be of the tilting pad type. The tilting pad pivot arrangement shall permit reverse rotation at speeds up to MCS. Thrust capability of bearings while reverse rotation shall be indicated by SUPPLIER. [Replace] "PURCHASER" [with] "COMPANY".
Part 2 4.9.3.2 (Add)	Details of thrust bearing design shall be submitted for COMPANY'S review. Bearings with unit load higher than 17 bar requires COMPANY approval. Thrust bearings shall be provided with load cells and shall be connected to VMS for indication and alarm for high thrust loads.
Part 2 4.9.3.3 (Add)	SUPPLIER shall furnish calculations (not merely calculation results) for the thrust load for various scenarios including surge and impeller blockage, clearly identifying the worst-case scenario. Thrust load calculations shall take into account actual pressure profiles on the impeller surfaces.
Part 2 4.9.3.7 (Add)	When required and due to high lube oil temperatures, SUPPLIER may provide thrust bearing pads with copper alloy baked metallurgy for better heat transfer.
Part 2 4.9.4.1 (Add)	Bearings shall be isolated from the shaft seal by a ventilated air space and have labyrinths or other restrictions to prevent contamination or an interchange of sealing oil/ gas and lube oil. Contamination of lube oil by gas is not acceptable. The SUPPLIER shall demonstrate (at shop if Full Load Full Speed test is done, otherwise at site), that there is no oil leakage from the bearing housings and a pressure balance between bearing chamber and atmospheric pressure with the compressor at standstill with oil systems in use and also at MCS. If the tests are done at the shop, the correct location and elevation of oil tanks with respect to the machines shall therefore be adhered to in order to fully represent the site conditions.
Part 2 4.9.4.4 (New)	The design of the shaft and casing shall be such that space is available to fit a shaft earthing brush to overcome bearing problems resulting from electrostatic shaft voltages. Oil and instrument connections shall be in the lower half of the bearing housing to eliminate the need for removal during bearing inspection and maintenance.

Table 9 - API 617 Technical Amendments: Part 2 – Section 5 – Accessories

API Clause No.	Description of Change
SECTION 5 – ACCESSORIES	
SECTION 5.5 – CONTROLS AND INSTRUMENTATION	
Part 2 5.5.1 (Modify)	The Controls and Instrumentation used shall comply with the requirements of 5.5.1.1 through 5.5.1.7. For other Controls and Instrumentation, requirements shall be as per Part 1 and Part 2 of API STD 614.
Part 2 5.5.1.1 (New)	The dry gas seal system shall be suitably instrumented and controlled for orderly start-up, stable operation, warning of abnormal conditions and shutdown of the main equipment in the event of impending damage.
Part 2 5.5.1.2 (New)	Wherever applicable, controls and instrumentation is recommended to be as per API RP 551.
Part 2 5.5.1.3 (New)	All controls and instruments shall be located and arranged to permit easy visibility by the operators, as well as accessibility for tests, adjustments and maintenance.
Part 2 5.5.1.4 (New)	All instruments and controls other than shut down sensing devices shall be installed with sufficient valving to permit their replacement while the system is in operation. When shut-off valves are specified for shutdown sensing devices, the SUPPLIER shall provide a means of locking the valves in the open position.
Part 2 5.5.1.5 (New)	Unless otherwise specified, all controls and instrumentation shall be suitable for outdoor installation.
Part 2 5.5.1.6 (New)	Except for instrument air service, block and bleed valves are required between instruments and their isolation valves. Combination isolation/bleed valves may be used.
Part 2 5.5.1.7 (New)	Please refer to Paragraph 6.1.8 of Part 1 of API STD 614.
Part 2 5.5.2.3 (Add)	Capacity control of centrifugal compressors with adjustable inlet guide vanes shall not be applied unless approved by COMPANY. Capacity control shall be achieved by speed control as first choice. Process recycle shall be minimized and shall be used when operating conditions fall below minimum continuous speed limits (after honouring lateral and torsional separation margins). Type of speed variation (electrical, mechanical variable speed variation) shall be subject to COMPANY approval.

Table 9 - API 617 Technical Amendments: Part 2 – Section 5 – Accessories

API Clause No.	Description of Change
Part 2 5.5.4.1.1 (New)	Gauge boards shall be completely piped and wired, requiring only connections to the PURCHASER's external piping and wiring circuits.
Part 2 5.5.4.1.2 (New)	When more than one wiring point is required on a unit for controls for instrumentation, wiring to each instrument shall be provided from terminal posts in a single terminal box, which is mounted on the unit or its base
Part 2 5.5.4.1.3 (New)	All leads and posts on terminal strips, switch and instruments shall be tagged for identification.
Part 2 5.5.5.1 (New)	Alarm and trip switch settings shall not be adjustable from outside the housing. Alarm and trip switches shall be arranged to permit testing of the control circuit including, when possible, the actuating element without interfering with normal equipment operation. Unless otherwise specified, shutdown systems shall be provided with key lock switches or another suitable means to permit testing without shutting down the unit.
Part 2 5.5.5.2 (New)	SUPPLIER shall provide a transmitter for all process measurement unless approved by COMPANY. If a switch is provided, each alarm switch and each shutdown switch shall be furnished in a separate enclosure to facilitate inspection and maintenance. Hermetically sealed, single-pole, double-throw switches with a minimum capacity of 5 amperes at 120 volts AC and 1/2 ampere at 120 volts DC shall be used. Mercury switches shall not be used.
Part 2 5.5.5.3 (New)	Pressure-sensing elements shall be made of AISI STD Type 300 stainless steel. Low pressure alarms and trips, which are activated by falling pressure, shall be equipped with a valved bleed or vent connection to allow controlled depressurizing so that the operator can note the alarm set pressure on the associated pressure gauge. High-pressure alarms and trips which are activated by rising pressure shall be equipped with valved test connections so that a portable test pump can be used to raise the pressure.
Part 2 5.5.7 (Add)	As noted in Appendix-7, (Ref. 8), machinery within the compressor train including driver, gearbox and compressors shall include the following minimum vibration, position and bearing temperature detectors: a. Axial position: three probes per hydrodynamic thrust bearing. b. Radial vibration: X-Y displacement probes for each hydrodynamic radial bearing. c. Key phasors (speed and phase reference): one key phasor for each different speed shaft. d. Radial bearing temperature: 1. two duplex RTD. e. Thrust bearing temperature:

Table 9 - API 617 Technical Amendments: Part 2 – Section 5 – Accessories

API Clause No.	Description of Change
	1. four duplex RTD's on each side (active & non-active side). Minimum 3 on each side shall be provided when 4 RTDs cannot be fitted due to space limitations. f. Gearbox casing: two accelerometers on the casing.
Part 2 5.5.7.1 (Add)	As noted in Appendix 7, (Ref. 8), for radial vibration, two displacement probes 90° apart are required at each bearing. Three axial position transducers shall be provided at each thrust bearing. One shaft rotation phase reference transducer (key phasor) each shall be provided for low and high-speed side. Key phasor shall be provided on compressor side. Unless otherwise specified, voting logic for trip shall be as below: a. For radial vibration: 2oo4 comprising of all four probes (DE and NDE side). Apart from 2oo4, probe not OK shall be considered as vote to trip when probe is not functional. Logic shall include any one of four probes reading HH limit and other probes reaching H limit. b. For axial displacement: When 3 probes are fitted, trip shall be based on 2oo3. c. Where 2 probes are fitted, HH trip shall be based on 2oo2. Logic shall consider probe Not OK as a vote to trip. d. SUPPLIER shall indicate if trip on bearing temperature is required as many other events precede high bearing temperatures. Alarm, however, shall be configured. e. If a trip is recommended, voting logic for trip on bearing temperature shall be 2oo2 for each side radial bearing. f. For thrust bearing temperatures, when 3 probes are fitted on each side, logic will be 2oo3 and when 4 probes are fitted on each side, it will be 2oo4. All wire entries into the compressor casings or bearing housings shall be fully sealed to avoid leakage into the environment and wiring conduits.
Part 2 5.5.7.2 (Modify)	(Delete) the bullet and "If specified,"
Part 2 5.5.7.3 (Add)	The temperature detectors shall be in accordance with of Part 2 , clause 4.9.1.2 of this standard. It shall be supplied, installed and calibrated in accordance with API STD 670.
Part 2 5.5.7.4 (Modify)	(Delete) the bullet and "If specified,"
Part 2 5.5.7.5 (Modify)	(Delete) the bullet and "If specified,"
Part 2 5.5.7.6 (Modify)	Casing vibration instruments (probes) shall be supplied by SUPPLIER when requested. Monitors shall be part of VMS system and shall be supplied by COMPANY.

Table 9 - API 617 Technical Amendments: Part 2 – Section 5 – Accessories

API Clause No.	Description of Change
SECTION 6 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT	
Please refer to Appendix 2 (Ref.3) to find applicable requirements in this section which have been addressed in the respective clauses.	

Table 10 - API 617 Technical Amendments: Part 3 – Section 4 – General

API Clause No.	Description of Change
PART 3 - INTEGRALLY GEARED CENTRIFUGAL COMPRESSORS	
SECTION 4 - GENERAL	
SECTION 4 - BASIC DESIGN	
Part 3 4.4.1.1 (Add)	Each compressor stage head-capacity characteristic curve shall rise continuously from the rated point to predicted surge. This rise shall be sufficient to result in an increase of the pressure ratio of at least 5% when operating at the specified suction conditions. If guide vanes are provided, this requirement shall be met for each setting of adjustable inlet guide vanes or axial stator vanes. For identical compressors operating in parallel (if so stated in the data/requisition sheets), the respective heads at the same flow shall not differ by more than 2% from one another at any point on the curves. The operating stability range of each compressor stage shall be at least 25% of the rated flow. If guide vanes are provided, this requirement shall be met for each setting of adjustable inlet guide vanes or axial stator vanes.
Part 3 4.4.2 (New)	Impeller Flow Coefficients Impeller flow coefficients shall be within the range of 0.01 to 0.12
Part 3 4.4.3 (New)	Impeller Stage Head Coefficients Impeller stage head coefficients shall be within the 0.4 to 0.55 range
Part 3 4.4.4 (New)	Impeller Inlet Mach Number Average impeller inlet Mach numbers shall be less than 0.85.
Part 3 4.4.5 (New)	Machine Mach Number Machine Mach numbers or impeller tip Mach numbers shall be less than 1.2. Deviation in flow, head coefficients and Mach nos. requires COMPANY approval based on specific references, scatter plot and Kirk Donald diagrams, Fulton plots.

Table 10 - API 617 Technical Amendments: Part 3 – Section 4 – General

API Clause No.	Description of Change
SECTION 4.6 – CASINGS	
Part 3 4.6.6.1 (Add)	All process nozzles of expander and compressor and connections shall be designed to withstand as a minimum five times the maximum permitted forces and moments calculated as per NEMA SM 23 (~2.7*API loads).
Part 3 4.6.7.1 (Add)	Adjustable guide vanes shall only be used in clean non-corrosive services. VIGVs can be accepted only on COMPANY approval and prior experience verification.
Part 3 4.6.7.2 (Add)	Compressors shall be provided with vane-less diffusers. Vaned diffusers and/or low solidity vaned (LSV) diffusers shall not be applied for efficiency increase only. They should only be applied if curve stability and/or rotating stall would otherwise be a problem and if the resultant narrowing of the operating window is acceptable in the specified service. High-speed, integrally geared compressors may be provided with vaned diffusers, if this is the MANUFACTURER's standard design and subject to the COMPANY approval. Variable guide vanes shall not be provided for variable speed compressors to avoid coinciding frequencies with driver and vane pass frequencies. Use of these on variable speed units requires COMPANY approval and prior experience on such applications.
Part 3 4.6.7.3 (Modify)	(Delete) "When specified" (Add) Except for air or inert gas applications.
SECTION 4.7 – ROTATING ELEMENTS	
Part 3 4.7.2 (Add)	Sleeves shall be made of non-galling materials.
Part 3 4.7.3 (Add)	No thrust reversal shall occur at any load condition.
SECTION 4.8 – ROTATING ELEMENTS	
Part 3 4.8.3 (Add)	Lateral analysis of bull gear and pinion shall reflect the variable gear forces on the bearings (as typically done in an API STD 613 gear lateral analysis).
SECTION 4.9 – BEARINGS AND BEARING HOUSINGS	
Part 3 4.9.2 (New)	Radial bearings shall have two metal temperature sensors in the expected load zone. If tilting pad bearings are used, each temperature sensor shall be installed in a separate pad.
Part 3 4.9.3	The thrust capability of the bearing with reverse rotation shall be stated in the proposal. The MANUFACTURER/SUPPLIER shall provide all details of the rotor thrust balance

Table 10 - API 617 Technical Amendments: Part 3 – Section 4 – General

API Clause No.	Description of Change
(Add)	calculations and the associated specific thrust bearing loading in order to demonstrate compliance with the requirements of 4.9.3.4. The SUPPLIER's primary offering shall be direct lubricated low oil consumption bearings. As an alternative, the SUPPLIER may offer his standard flooded bearing design. In the proposal, the SUPPLIER shall state the power demand difference between the two thrust bearing designs, if applicable
Part 3 4.9.3.5(New)	Thrust bearings shall be arranged to allow axial positioning of each rotor relative to the casing and adjustment of the bearing clearance.
Part 3 4.9.3.6 (New)	Thrust bearings shall have five metal temperature sensors; three on the active side and two on the inactive side. Metal temperature sensors shall be located in the highest loaded part of the pad. If tilting pad bearings are used, each metal temperature sensor shall be installed in a separate bearing pad. Bearing metal temperature sensors shall be mounted in every other pad on both the active and inactive sides of the bearing.
Part 3 4.9.4 (New)	Bearing temperature measuring devices shall terminate at a terminal strip inside the bearing housing. Extension wires from the terminal strip shall be routed to SUPPLIER provided junction boxes.
SECTION 4.11 – INTEGRAL GEARING	
Part 3 4.11.3.10 (Modify)	[Replace with] Shafts shall be made of one-piece, heat-treated forged steel, suitably ground. Forging shall be carried out as close as possible to the final dimensions. Hot rolled bar stock is not acceptable.

Table 11 - API 617 Technical Amendments: Part 3 – Section 5 – Accessories

API Clause No.	Description of Change
SECTION 5 – ACCESSORIES	
SECTION 5.1 - DRIVERS	
Part 3 5.1(Add)	Integrally-gearred compressors shall not be externally-through. Use of gearbox between driver and IGC shall be avoided.
SECTION 5.5 – CONTROLS AND INSTRUMENTATION	
Part 3 5.5.2.1 (Add)	Capacity control of each compressor stage with adjustable inlet guide vanes requires the approval of the COMPANY and is only acceptable if the gas is dry, clean and non-corrosive. The application of variable diffuser vanes for capacity and/or head control is not allowed for flammable, toxic, fouling or corrosive gases. For any other gases it requires approval by the COMPANY.
Part 3 5.5.7.7 (Modify)	(Delete) “When specified”
SECTION 5.6 – PIPING AND APPURTENANCES	
Part 3 5.6.2.3 (Add)	When process heat exchangers are supplied by the SUPPLIER, shell and tube heat exchangers shall comply with Specifications, AGES-SP-06-002, AGES-SP-06-003 and air coolers shall comply with Specifications COMPANY requirements and Appendix 6, (Ref. 7).
SECTION 6 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT	
Please refer to Appendix 2 (Ref. 3) to find applicable requirements in this section which have been addressed in the respective clauses.	

Table 12 - API 617 Technical Amendments: Part 4 – Section 4 – General

API Clause No.	Description of Change
PART 4 - EXPANDER-COMPRESSORS	
SECTION 4 - GENERAL	
SECTION 4.4 - BASIC DESIGN	
Part 4 4.4.2 (Add)	The expander characteristic shall be such as to provide the swallowing capacity range as required on the specification/datasheet. The rise in discharge pressure for compressor impeller from normal operating point to surge shall be maximised in the design and shall be at least 5%. The choking capacity shall not be less than 115% of rated capacity for compressor impeller and capacity at surge shall not be more than 60% of the rated capacity at the rated speed. It should be noted particularly that the compressor has a definite process duty as well as acting as a brake for the expander and such performance duties for both expander and compressor and the combined unit shall be individually guaranteed for conditions specified in the specification/datasheet. The power requirements of the compressor shall match the available power rating of the expander with due allowance being made for the losses. It is preferable that the compressor, without the use of bypass, shall be suitable for continuous operation of any capacity in the range of 110% of the predicted surge capacity to the predicted maximum capacity over the speed range from minimum operating speed to maximum continuous speed. Surge control line should be set not less than 110% of the predicted surge capacity however shall be optimized while conducting surge test and surge controller tuning at site. The anti-surge protection system to be designed to guarantee fast action and full protection of the compressor at a safely margin not more than 10% between the actual surge line and surge control. Any deviation of the above shall be subjected to COMPANY approval. Refer to the Purchase Order and/or datasheets for any additional performance guarantee requirements. Modify first sentence of Note 4 on Figure 1 to read "The head capacity curve shall extend to the maximum possible flow (stonewall condition)". The maximum possible flow shall be no less than 115% of the capacity at the CRP.
SECTION 4.6 - CASINGS	
Part 4 4.6.1 (Add)	Pressure Containing Casings The expander/compressor shall have a radially (vertically) split casing.
Part 4 4.6.1.3 (Add)	Lifting devices shall be provided for lifting of the expander/compressor mechanical centre section. Lifting devices shall be provided for lifting of the expander/compressor cartridge.
Part 4 4.6.6.1 (Add)	All process nozzles of the expander and compressor and connections shall be designed to withstand minimum five times the maximum permitted forces and moments calculated as per NEMA SM 23 (~2.7*API loads). The baseplate and supporting

Table 12 - API 617 Technical Amendments: Part 4 – Section 4 – General

API Clause No.	Description of Change
	elements shall be designed accordingly. The SUPPLIER shall indicate in the proposal the expander and compressor nozzle load capacity. Final factor to be applied shall be jointly agreed between the SUPPLIER and CONTRACTOR prior to order.
Part 4 4.6.7.2 (Add)	The SUPPLIER shall provide in his proposal information regarding guide vane design, operating mechanism and shall provide a curve showing the effect of variation in expander throughput on efficiency.
Part 4 4.6.7.7 (Add)	The sealing arrangement shall ensure the free movement of the inlet guide vane and actuator assemblies. Actuators shall be higher-torque design (motorized preferred) with actuator movement such that all process and operating conditions are possible.
Part 4 4.6.7.8 (New)	The turbo-expander should be designed to operate efficiently even on off-design conditions to compensate for the variable operating conditions typically faced during actual operation. SUPPLIER shall provide and fit an electro-pneumatic actuator with steel casing for operation of the guide vanes. This equipment shall be designed to operate under the worst operating conditions specified on the data/requisition sheets. Nozzles shall be designed to open wide for full flow during start-up or emergency conditions. Visual indication of the guide vanes position shall be provided and a transmitter to indicate this position shall be remotely provided by the SUPPLIER. SUPPLIER shall give in his proposal a full description of the following equipment: • Overload protection in case of guide vanes blockage, • Device for balancing loads on guide vanes. • Servo-motor load curve SUPPLIER shall indicate specific design features on offered guide vanes, pin design to avoid any jamming or failure of guide pins in service, their torque capability etc. COMPANY approval shall be sought on proposed metallurgy, coatings of guide pins and guide vane design. Similarly, leak

Table 12 - API 617 Technical Amendments: Part 4 – Section 4 – General

API Clause No.	Description of Change
	shall be minimized with better packing design from actuator shafts. SUPPLIER shall supply a quick-acting expander inlet trip valve for shutting off the supply of process gas entering the expander and stopping the unit. This valve shall be of the butterfly type supplied as a loose item for installation on the CONTRACTOR'S inlet piping and shall match the piping specification and minimum operating/design temperature. SUPPLIER shall advise the maximum distance at which the trip valve can be located away from the expander inlet connection. The valve shall be complete with pneumatic actuator, solenoid valve and visual position indicator and limit switches to allow remote indication of open and shut positions. SUPPLIER shall provide the CONTRACTOR with full details of the complete valve assembly. The quick shutdown valve shall be fail to close on instrument air failure.
Part 4 4.6.7.9 (New)	The guide vanes shall be designed to minimise mechanical wear, vapour/liquid erosion and efficiency losses over the operating life of the machine. Inlet guide vanes or nozzle controls shall be engineered to produce optimum flow patterns and precise and continuous control between 0-150% of design flow. An automatic clamping device shall be provided by the SUPPLIER.
Part 4 4.6.7.10 (New)	A diaphragm serving as a heat barrier or to support and accurately locate labyrinth seals need not be horizontally split but shall be designed with mechanical integrity and ease of maintenance in mind.
SECTION 4.7 – ROTATING ELEMENTS	
Part 4 4.7.4.1.4 (New)	The SUPPLIER shall provide his standard axial thrust monitoring and automatic continuous thrust balancing system with differential pressure indicator and transmitter for alarm and shutdown. The Design and operation of the balancing system shall be described in proposal.
SECTION 4.8 – DYNAMICS	
Part 4 4.8 (Add)	Holographic techniques are available to further analyse the critical speeds and damping associated with open impellers. This is important during changes to the operating speed range or if the impeller has suffered from cracking in service.
Part 4 4.8.1.2 (Add)	A rigid-shaft rotor system shall be provided. SUPPLIER shall advise percent margin between over-speed shutdown speed and the first critical speed. SUPPLIER shall design, test and guarantee the turbo expander compressor to eliminate all "critical speeds below 125% of design speed".
Part 4 4.8.1.6 (Modify)	[Delete the bullet and the words "If specified"]
Part 4 4.8.1.7 (Modify)	[Delete the bullet and the words "If specified"]

Table 12 - API 617 Technical Amendments: Part 4 – Section 4 – General

API Clause No.	Description of Change
SECTION 4.9 – BEARINGS AND BEARING HOUSINGS	
Part 4 4.9.1.1 (Add)	Bearings shall be of SUPPLIER's standard design. It is recognized that with an overhung impeller design on a common shaft, the bearings and housing will be internal to the expander/compressor module and require removal and disassembly of the module for replacement. The SUPPLIER in his proposal shall advise the time required to break out and disassemble the expander/compressor center section to make the bearings and seals accessible for replacement. Combined one piece radial and thrust bearings are permitted. SUPPLIER shall submit in his proposal full details of the bearing designs to demonstrate they are adequate for all possible loadings and operational speeds including starting and shutdown and that they are fully proven in service. A sight flow indicator and a dual-type thermometer shall be furnished in the oil drain line from bearing housing. On LO supply lines, line-mounted orifices shall be provided to adjust oil flow to each bearing. Bearing housing mounted orifices not acceptable. Thrust load control systems should be such that it automatically compensates for off-design operation and stabilizes axial thrust.
Part 4 4.9.1.2 (Add)	Refer to project specifications / datasheets for incorporating magnetic bearings. When magnetic bearings are selected, they shall be supplied in accordance with Annex E Part 1. SUPPLIER shall offer Active Magnetic Bearing (AMB) design as first preference where SUPPLIER can demonstrate at least 5 years of successful service of magnetic bearings in similar applications. In case the SUPPLIER cannot demonstrate AMB, lubricated bearings may offer as an alternative. In case of the presence of H₂S in the gas, sweet gas should be injected to protect the active magnetic bearings. SUPPLIER shall indicate maximum acceptable levels of H₂S in the process gas for the seal system. Where there is no possibility of sweet gas in the plant, COMPANY, CONTRACTOR and SUPPLIER shall decide the acceptable way forward. Magnetic bearing insulation shall be such that there is no adverse effect on the bearings due to the presence of methanol, if injected.
Part 4 4.9.1.3 (Add)	The SUPPLIER shall submit in his proposal full details of the bearing designs to demonstrate they are adequate for all possible loadings and operational speeds including starting and shutdown and that they are fully proven in service. A sight flow indicator and a dual type thermometer shall be furnished in the oil drain line from the bearing housing. Thrust load control system should be such that it automatically compensates for off-design operation and stabilise axial thrust.
Part 4 4.9.2.3 (New)	Details of the installation of embedded temperature sensors to detect white metal surface temperatures shall be included in proposal. Embedded temperature element shall be avoided. A removable element either on the bearing or on the oil shall be used.

Table 12 - API 617 Technical Amendments: Part 4 – Section 4 – General

API Clause No.	Description of Change
Part 4 4.9.3.5 (New)	SUPPLIER shall furnish calculations (not merely calculation results) for the thrust load for various scenarios including normal operation and surge, clearly identifying the worst-case scenario. Thrust load calculations shall take into account actual pressure profiles on the wheel surfaces/each section and absolute pressure shall be stated.
Part 4 4.9.4.1 (Add)	Turbo expander compressors are vertically split and may have pressurized bearing housings. Bearings shall be suitable for reverse rotation for a short time.
SECTION 4.10 – SHAFT END SEALS	
<i>Note: Dry Gas Seal applicable requirements have been addressed in respective Appendix 5, (Ref. 6).</i>	
Part 4 4.10.1 (Add)	Seal gas pressure shall be maintained positive with respect to the back of wheel pressure.

Table 13 - API 617 Technical Amendments: Part 4 – Section 5 – Accessories

API Clause No.	Description of Change
SECTION 5 – ACCESSORIES	
SECTION 5.3 – LUBRICATION AND SEALING SYSTEMS	
Part 4 5.3.1 [Modify]	[Replace with] Pressurized oil systems shall conform to Appendix Part 1 and Annex G of Part 4.
SECTION 5.5 – CONTROLS AND INSTRUMENTATION	
Part 4 5.5.1 (Modify)	[Replace with] Requirements detailed in Part 2, 5.5.7 shall be conformed to.
Part 4 5.5.1.2 (Modify)	The bullet and “If specified”. Axial position probes are not required when an automatic thrust balancing system is provided.
Part 4 5.5.2.1 (Add)	[Delete bullet and word “Unless otherwise specified,”]. (Add) Embedded temperature elements shall be avoided. Instead, a removable element either on the bearing or on the oil shall be used.
Part 4 5.5.2.3 (Modify)	[Delete bullet and word “If specified”]
Part 4 5.5.2.4 (New)	All wire entries into the expander compressor casings or bearing housings shall be provided with proper sealing against leakage.
Part 4 5.5.2.5 (New)	For temperature detection of bearing pads, replaceable type RTD's for reliable detection of temperature are preferred.

Table 13 - API 617 Technical Amendments: Part 4 – Section 5 – Accessories

API Clause No.	Description of Change
Part 4 5.5.3 (Add)	As noted in Appendix 7, as a minimum, below instruments shall be provided on both expander and compressor side for machine monitoring when AMB system is supplied: • Speed probe • Position sensor – Radial • Position sensor – Axial • Axial bearing flux • Radial bearing temperature • Axial bearing temperature
Part 4 5.5.4.1.2 (Modify)	Deleted If specified As noted in Appendix 7, over-speed trip system (electronic) based on 2oo3 voting logic shall be furnished. Necessary probes and transmitters should be considered.
Part 4 5.5.4.3.4 (Modify)	The following requirements are to be considered in the design: a. A minimum of two electric solenoid operated valves, configured in parallel, shall be provided. b. The design of the installation shall allow for testing the operation of one solenoid valve while keeping the expander compressor running and protected by the other solenoid valve.
Part 4 5.5.5.1 (Add)	SUPPLIER shall provide permanent strainers (preferably T/Y type for easy handling and mesh size) as recommended by MANUFACTURER for installation to the inlet piping of both expander and compressor.
Part 4 5.5.5.2 (Modify)	[Delete the bullet and the words “If specified,”]
Part 4 5.5.5.4 (Modify)	[Delete the bullet and the words “If specified,”]
SECTION 5.7 – SPECIAL TOOLS	
Part 4 5.7 (Add)	If hydrodynamic radial bearings are provided, then mandrels for checking the bearing clearances shall be included in the special tools.
SECTION 6 - INSPECTION, TESTING AND PREPARATION FOR SHIPMENT	
Please refer to Appendix 2 (Ref.3) to find applicable requirements in this section which have been addressed in the respective clauses.	

10. ANNEX E - MAGNETIC BEARINGS

ANNEX E (normative)

Magnetic Bearings

Amendment to API 617 8th Edition, 2014

This annex contains additional requirements shall be taken into account in design of Active Magnetic Bearings.

E.4.4.1[Add] The design shall be able to withstand for thermal shocks caused by very low temperature methanol ingress to avoid freezing.

E.4.9.2.1 [Add] The load capability shall accommodate all transient loads resulting from surge and/or stonewall operation of the compressor.

E.4.9.3.1 [Add] The load capability shall accommodate all transient loads resulting from surge and/or stonewall operation of the compressor.

E.5.2.1 [Add] SUPPLIER shall clearly indicate the cabling distance limitations between field and control room for standard installation. SUPPLIER shall provide cable adapter cabinets to enhance signals from field to control room, if required, based on the cabling length indicated by CONTRACTOR .

E.6.3.12 [Delete words "If specified,"]

E.8.1 [Add] If SUPPLIER requires some additional instruments / systems for carrying out Site Acceptance Tests, they shall clearly indicate in their proposal (pre-award) so that the CONTRACTOR carries out techno-commercial evaluation for incorporating such requests.

11. ANNEX F – DRY GAS SEAL TESTING AT MANUFACTURER'S SHOP

ANNEX F (normative)

Dry Gas Seal Testing at MANUFACTURER's Shop Amendment to API 617 8th Edition, 2014

This annex contains additional requirements that shall be taken into account in the testing of Dry Gas Seals at MANUFACTURER's shop.

When dry gas seal systems are supplied, the seal MANUFACTURER's shop test shall conform to the following minimum, requirements, addition to the requirements indicated in API 617 part 1, Annex F.

Note: design requirements for Dry Gas Seal have been specified and incorporated in a respective new Appendix 5(Ref.6), Dry Gas Seal Requirements.

1. Test Procedure

The test procedure, test gas, acceptance criteria and method for adjustment of results shall be agreed before the test. Test gas shall be Nitrogen + Helium of appropriate mixture or Helium. Testing on air requires COMPANY approval. Test gas temperature shall be at maximum supply temperature at site conditions.

Balancing of rotating components shall be achieved in accordance with API 617 / ISO 1940 Grade G 0.67.

Tests shall include Spin Test, Static Seal Test (cold as well as hot), Dynamic Test, Startup and Shutdown test, Strip-down after Dynamic Test, Reassembly & Post Strip Verification Test (Static Test) as a minimum. During test, all parameters like pressures, temperatures, flows, speeds shall be measured.

Acceptance parameters for leakage rates shall be agreed prior to testing and shall not exceed the guaranteed leakage rates for test gas. No sudden changes in leak rates are acceptable. Test pressure increments and decrements shall be in 25% (from zero to 100% maximum static / dynamic pressure values).

2. Over-speed Test

Each rotating seal assembly shall be over-speed tested to the same speed and duration as per paragraph 6.3.3.1 of this specification.

3. Static Leakage Test

Each seal face pair shall be pressurized in steps from atmospheric to the corresponding maximum sealing pressure and the stabilized leakage rate shall be checked. After achieving the design pressure test limit, the seal shall be depressurized to normal pressure and then in steps to atmospheric pressures. While testing outboard seal, inboard seal pressure shall be at stable condition (maximum static/dynamic pressures).

Hold time at each step shall be 5 minutes and 15 minutes at 100% of seal pressure (maximum static / dynamic pressure), 15 minutes at static design pressure. During test, record the parameters at each 5-minute interval.

4. Dynamic Test

- 4.1 The means for verifying the correct lift-off of seal rotating faces shall be agreed and demonstrated. Minimum lift off speed shall be verified and recorded.
- 4.2 Each seal face pair shall be dynamically tested over the range of speeds from minimum to maximum test speeds. The sealing pressure shall be up to the maximum specified differential pressure for the cartridge; and at least 70% of this maximum for each seal face pair in a multiple seal assembly.
- 4.3 The test duration shall include at least 5 minutes at each step (pressure increment / decrement to maximum static/dynamic pressures), 15 minutes at rated speed (guaranteed leak rates shall be shown here) and maximum static & dynamic seal pressures, 1 hour at maximum continuous speed, 15 minutes at minimum speed (60-70% of rated speed or lowest possible speed as per compressor datasheet), 5 minutes at trip speed (where applicable), 5 minutes at maximum test speed, 15 minutes at dynamic design pressure and rated speed. Hold time of 5 minutes shall be followed for each test pressure increments / decrements.
- 4.4 Stabilized dynamic leakage rates shall be checked and recorded.
- 4.5 The seal shall be brought to standstill, pressurized and the static leakage rate checked whilst the seal is still at operating temperature. This shall be held for 15 minutes.
- 4.6 Seal absorbed power requirements shall be computed and recorded.
- 4.7 After the dynamic test is completed, start up and shutdown tests shall be performed by varying dynamic pressures in inboard and outboard seals from zero and 100% and speeds from zero to trip speeds. Trip speed hold time will be for 15s, rated speed for 5 min. during start up and shutdown tests. During this test, maintain seal gas temperature at maximum seal gas temperature during actual operation.
- 4.8 Hot static test shall be performed at maximum seal gas supply temperature after start up and shutdown test (steps similar to 3.0, duration for 2 minutes at each step, 15 minutes at 100% static & dynamic pressures, guaranteed leak rates shall be shown here).

5. Post Test Inspection

- 5.1 After completion of the dynamic tests the seal assembly shall be disassembled to the extent necessary for inspection of the seal faces and the other sealing components.
- 5.2 The seals shall be checked for correct reassembly. This shall consist of a static leakage test per 3.0 above as a minimum.

12. BUSINESS UNIT SPECIFIC REQUIREMENTS

12.1 Business Unit Specific Requirements have been detailed in Appendix 4, Ref.(5).

SECTION C – ADDITIONAL REQUIREMENTS

13. SCOPE OF SUPPLY

Refer to the List of Materials (LOM) within the Material Requisition and/or Purchase Order.

14. QUALITY CONTROL AND ASSURANCE

Equipment shall only be purchased from SUPPLIERS approved by ADNOC Category Management. This approval indicates that the SUPPLIER has an approved Quality Management system and a proven track record in supply of this equipment type.

The SUPPLIER shall submit a proposed list of SUB-SUPPLIERS for all major components to COMPANY for approval prior to order placement.

15. MATERIAL & CERTIFICATIONS

- 15.1 For details of materials selection and associated material certification, refer to General Technical and Contractual Requirements For Rotating Equipment – Appendix 1 (Ref. 2) and QA Inspection and Testing Requirements - Appendix 2 (Ref. 3).

16. INSPECTION & TESTING REQUIREMENTS

- 16.1 The requirements for Inspection and Testing shall be specified in the QA Inspection and Testing Requirements - Appendix 2 (Ref. 3).

17. SUB-CONTRACTORS / SUB- SUPPLIERS

- 17.1 Refer to 'QA Inspection and Testing Requirements' (Ref. 3) for details regarding SUB-SUPPLIERS.

18. SPARE PARTS

- 18.1.1 The SUPPLIER shall submit details of recommended spare parts for complete package. Refer to the 'Information Requirements' (Ref. 4).

- 18.1.2 Unless otherwise specified, **Error! Reference source not found.** for capital spares shall be included in scope of SUPPLIER for centrifugal and axial compressors. For any additions / deletions, refer to project specifications.

Table 14- Capital Spares for Centrifugal and Axial Compressors

ITEM DESCRIPTION	QUANTITY
Complete assembled spare compressor rotor bundle with static aerodynamic and rotating parts	1 set for identical compressors
Set of journal bearing shell complete with bearing pads and RTDs	1 set per compressor
Set of thrust bearing shell complete with bearing pads and RTDs	1 set per compressor

Set of labyrinths	1 set per compressor
Set of tested dry gas seal cartridges for both sides, including separation seal	1 set per compressor
Complete seal gas booster unit (where applicable)	1 set for identical compressors
Metallic container suitable for pressurization with Nitrogen with regulator assembly, pressure indicator and alarm	1 set for bundle and 1 set for seals

18.1.3 Unless otherwise specified, **Error! Reference source not found.** for capital spares shall be included in scope of SUPPLIER for Expander-Compressor. For any additions / deletions, refer to project specifications.

Table 15 - Capital Spares for Turbo-Expander Compressor

ITEM DESCRIPTION	QUANTITY
Rotor for expander and re-compressor (mechanical centre section) with active magnetic bearing at each end of the shaft (radial)	1 set for identical compressors
Centralized active magnetic thrust bearings (axial)	1 set per compressor - expander
Landing bearings with all position sensors	1 set per compressor - expander
Speed sensors and RTDs	1 set per compressor - expander
Main labyrinth	1 set per compressor – expander
Sleeves	1 set for identical train
Automatic thrust balancing system valve and actuator (thrust control valve) along with position transmitter	1 set per compressor – expander
Shims, Gaskets and O-ring set	1 set per compressor – expander
Dry gas seal system, a complete dry gas seal cartridge for each end of shaft shall be supplied.	1 set per compressor – expander
Note: All spare parts shall be provided in nitrogen pressurized container or other acceptable design, duly tested as per the relevant specification.	

18.1.4 Unless otherwise specified, **Error! Reference source not found.** for capital spares shall be included in scope by SUPPLIER for Integrally Geared Compressors. For any additions / deletions, refer to project specifications.

Table 16 - Capital Spares for Integrally Geared Compressors

ITEM DESCRIPTION	QUANTITY
Complete compressor rotors including bull gear, pinions and diaphragms, labyrinths etc. (static aerodynamic and rotating parts in assembled condition without bearings and dry gas seals), excluding casing. Metallic container/s pressurized with Nitrogen to fit above parts with regulator assembly, pressure indicator and alarm. Above will be stored open to sky.	1 Set Common for multiple identical compressors
Journal and thrust bearings, complete assembly with bearing pads and RTDs for various shafts on the compressor, in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set for each installed compressor
Tested dry gas seals (including separation seal) cartridge (where fitted) for various shafts of compressors in SUPPLIER standard metallic special container suitable for long term storage inside warehouse.	1 Set for each installed compressor
Labyrinths, carbon ring seals, shaft sleeves (if not assembled as part of rotor), gaskets, O rings for main compressor in SUPPLIER standard packaging suitable for long term storage inside warehouse.	1 Set for each installed compressor
Low speed and high-speed couplings (as applicable) complete with hubs, in SUPPLIER standard packaging suitable for long term storage inside warehouse.	1 Set Common for multiple identical compressors
Critical valve trims and packing sets when supplied by compressor SUPPLIER such as hot gas bypass valve/s, anti-surge valve/s, anti-choke valve/s, suction throttle valve/s in SUPPLIER standard packaging suitable for long term storage in warehouse.	1 Set for each installed compressor
Set of IGVs and their actuator assemblies in MANUFACTURER standard packaging suitable for long term storage in warehouse.	1 Set Common for multiple identical compressors

19. PAINTING, PRESERVATION & SHIPMENT

19.1 Refer to General Technical and Contractual Requirements for Rotating Equipment – Appendix 1 (Ref. 2).

20. INSULATION

20.1 Refer to 'General Technical and Contractual Requirements for Rotating Equipment' (Ref. 2).

21. COMMISSIONING

Refer to General Technical and Contractual Requirements for Rotating Equipment – Appendix 1 (Ref. 2).

22. TRAINING

Refer to General Technical and Contractual Requirements for Rotating Equipment – Appendix 1 (Ref. 2).

23. DOCUMENTATION/MANUFACTURER DATA RECORDS

23.1 Refer to the Information Requirements – Appendix 3 (Ref. 4).

24. GUARANTEES & WARRANTY

The SUPPLIER shall guarantee in all respects the correct functioning and performance of the supplied equipment in accordance with the Purchase Order and attachments including the equipment datasheets and referenced specifications. The SUPPLIER shall also warrant the equipment against all defects and failures for the period stipulated in the Purchase Order or for not less than 12 months following site installation and commissioning; and that during this period the equipment will continue to operate as intended and to meet the specified performance, within the allowable/agreed test tolerances, without any deterioration in performance.

SECTION D – DATASHEETS AND DRAWINGS

25. DATASHEETS TEMPLATES

Refer to **ANNEX N** of 'Centrifugal Compressors for Petroleum, Petrochemical and Natural Gas Industries' API617 8th Edition (Ref. [1](#)).

26. STANDARD DRAWINGS

Refer to the COMPANY business unit Structural Design Criteria for the design of equipment supports for onshore and offshore installations.

Refer to the COMPANY business unit standard drawings for details of anchor bolts.

SECTION E – APPENDICES

APPENDIX 1: GENERAL TECHNICAL AND CONTRACTUAL REQUIREMENTS FOR ROTATING EQUIPMENT

APPENDIX 2: QUALITY ASSURANCE INSPECTION AND TESTING REQUIREMENTS

APPENDIX 3: INFORMATION REQUIREMENTS

APPENDIX 4: BUSINESS UNIT SPECIFIC REQUIREMENTS

APPENDIX 5: DRY GAS SEAL REQUIREMENTS

APPENDIX 6: LUBRICATION SYSTEM DESIGN REQUIREMENTS

APPENDIX 7: CONDITION MONITORING AND PROTECTION SYSTEM REQUIREMENTS

GENERAL TECHNICAL AND CONTRACTUAL REQUIREMENTS FOR ROTATING EQUIPMENT

Appendix 1 – AGES-SP-05-002

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1. PURPOSE

- 1.1 This Appendix provides the general technical and contractual requirements for rotating equipment and its auxiliaries, as detailed for the COMPANY (ADNOC Group). Unless otherwise stated, these requirements shall apply to all rotating equipment.
- 1.2 This Appendix should be read in conjunction with: the relevant COMPANY rotating equipment specification and associated appendices and the Equipment Datasheet for the equipment being supplied as listed in the Purchase Order.

2. DEFINED TERMS AND ABBREVIATIONS

Abbreviations means the abbreviations listed in Table 1 or other referred to documents herein.

Certified Test or Certified Inspection means an Inspection or test activity which the SUPPLIER conducts and certifies without PURCHASER involvement.

Coating MANUFACTURER means the MANUFACTURER of paint coating system to be applied to the equipment to prevent corrosion or surface deterioration to equipment component parts.

"COMPANY" means ADNOC Group.

"Concession Request" means any request for deviation from the COMPANY requirements, either by the CONTRACTOR or SUPPLIER, usually after receiving the Contract package or Purchase Order. Often, it refers to a request for authorization to use, repair, recondition, reclaim, or release materials, components or equipment already in progress or completely manufactured but which does not meet or comply with ADNOC requirements. A Concession Request is subject to COMPANY approval.

"Continuous Operation" means the intended uninterrupted period of operation. Refer to equipment specific specifications for the definition of the duration of uninterrupted period of operation. The CONTRACTOR and SUPPLIER are responsible for highlighting any equipment, auxiliary components or system requirements which shall result in the need to shut down the equipment within this time period.

"CONTRACTOR" means the party or parties who undertake(s) all, or part, of the design, engineering, procurement, construction, commissioning or management of the Project.

"Hazardous Service / Hazardous Fluid" means any service or fluid as defined within the Process document: Process Design Criteria

"Intermittent Operation" means any operation which includes intentional starts and stops, or any irregular / non-routine usage.

Major Weld Repair of a casting is defined as "major" if a repair weld has a depth of more than 50% of the wall thickness or has a length of more than 150 mm (6 in) in one or more directions, or if the total surface area of all repairs on the casting exceeds 10% of the total casting surface area. A weld repair necessitated by a leaking pressure test is also classed as "major".

"MANUFACTURER" means the Original Equipment Manufacturer (OEM) or MANUFACTURER of one or more of the component(s) which make up a sub-assembly or item of equipment assembled by the main SUPPLIER or his nominated SUB-SUPPLIER.

"SUB-CONTRACTOR" means any party engaged by the CONTRACTOR to undertake any assigned work on their behalf. COMPANY maintains the right to review all proposed Sub-CONTRACTORS; this right does not relieve the CONTRACTOR of their obligations under the Contract, nor does it create any contractual relationship between COMPANY and the SUB-CONTRACTOR.

“SUB-SUPPLIER” means the sub-contracted SUPPLIER of equipment sub-components software and/or support services relating to the equipment / package, or part thereof, to be provided by the SUPPLIER. COMPANY maintains the right to review all proposed SUB-SUPPLIERS, but this right does not relieve the SUPPLIER of their obligations under the Contract, nor does it create any contractual relationship between COMPANY and any individual SUB-SUPPLIER.

“SUPPLIER” means the party entering into a Contract with COMPANY to provide the materials, equipment, supporting technical documents and/or drawings, guarantees, warranties and/or agreed services in accordance with the requirements of the purchase order and relevant specification(s). The term SUPPLIER includes any legally appointed successors and/or nominated representatives of the SUPPLIER.

Symbols means the symbols which are defined within ‘Process Design Criteria’

Table 1 – List of Abbreviations

Abbreviation	Definition
1oo2, 2oo3, 2oo4	1 out of 2 , 2 out of 3, 2 out of 4 etc
BPVC	(ASME) Boiler Pressure Vessel Code
CFD	Computational Fluid Dynamics
CR	Concession Request
CRA	Corrosion Resistant Alloy
DBSE	Distance Between Shaft Ends
DE / NDE	Drive End / Non-Drive End
EDG	Emergency Diesel Generator
EOC	End of Curve
EPC	Engineering Procurement Construction
ESD	Emergency Shutdown
FEA	Finite Element Analysis
H ₂ S	Hydrogen Sulfide
HF	Hydrofluoric Acid
HIC	Hydrogen Induced Cracking
HRC	Measure of Hardness per the Rockwell “C” scale
HSSE	Health, Safety, Security, Environment
Hv	Vickers Hardness
ICSS	Integrated Control & Safety System
IEEE	Institute of Electrical and Electronic Engineers
IPS	Instrumented Protective System
ISO	International Organisation for Standardization
ITP	Inspection & Testing Plan
LO	Lubricating Oil

Abbreviation	Definition
MACWP	Maximum Allowable Continuous Working Pressure
MCS	Maximum Continuous Speed
MSDS	Material Safety Datasheet
MT	Magnetic Particle Examination
NCR	Non-Conformance Report
NDE or NDT	Non-Destructive Examination or Non-Destructive Testing
NGL	Natural Gas Liquid
OEM	Original Equipment Manufacturer
PAUT	Phased Array Ultrasonic Testing
PDCV	Pressure Differential Control Valve
PQR	Procedure Qualification Records
[PS]	Process Safety (Mandatory Requirement)
PSD	Process Shutdown
PSV	Pressure Safety Valve
PT	Penetrant Examination
QA / QC	Quality Assurance / Quality Control
RCC	Reinforced Cement Concrete
REI	Rotating Equipment Initiative
RT	Radiographic Examination
RTJ	Ring Type Joint
SAT	Site Acceptance Test
SPIR	Spare Parts and Interchangeability Record
SPL	Sound Pressure Level (dBA)
SWL	Safe Working Load
UT	Ultrasonic Examination

Abbreviation	Definition
VFD	Variable Frequency Drive
VI	Visual Inspection
WPS	Welding Procedure Specifications
WPQ	Welding Procedure Qualification
WPQR	Welding Procedure Qualification Record

3. NORMATIVE REFERENCES

3.1 The following normative references apply to all COMPANY rotating equipment scope:

Reference Document Number	Reference Document Name
AGES-PH-08-001	Isolation, Vent & Drain Philosophy
AGES-SP-01-002	Structural Steel Works Specification
AGES-SP-01-003	Structural Design Basis Specification
AGES-SP-04-001	Process Control System (PCS) Specification
AGES-SP-04-002	Control Valves Specification
AGES-SP-04-004	Emergency Shutdown System (SIS) Specification
AGES- SP-04-006	Instrument and Control Cables Specification
AGES-SP-02-002	Synchronous Motor Specification
AGES-SP-02-004	Adjustable Speed Drives
AGES-SP-05-001	Centrifugal Pumps (API 610) Specification
AGES-SP-05-002	Centrifugal Compressors (API 617) Specification
AGES-SP-05-003	Reciprocating Compressors (API 618 and ISO 13631) Specification
AGES-SP-05-004	General and Special Purpose Steam Turbines (API 611 and 612) Specification
AGES-SP-05-005	Gas Turbines (API 616) Specification
AGES-SP-06-002	Pressure Vessel Specification
AGES-SP-06-003	Shell & Tube Heat Exchanger Specification
American Gear Manufacturers Association AGMA	Based upon package scope of supply, additional AGMA specifications may apply
AGMA 9002	Bores and Keyways for Flexible Couplings
American Petroleum Institute (API)	Based upon package scope of supply, additional API specifications may apply
API Specification Q1	Specification for Quality Programs for the Petroleum, Petrochemical and Natural Gas Industry
API 520	Sizing, Selection and Installation Of Pressure-Relieving Devices In Refineries
API 521	Guide For Pressure-Relieving And Depressurizing Systems
API RP 551	Process Measurement Instrumentation

Reference Document Number	Reference Document Name
API 613	Special Purpose Gears for Petroleum, Chemical and Gas Industry Services
API 614	Lubrication, Shaft-sealing and Oil Control Systems and Auxiliaries
API 660	Shell-tube Heat Exchangers for General Refinery Services
API 661	Air-cooled Heat Exchangers for General Refinery Services
API 671	Special-Purpose Couplings for Petroleum, Chemical, and Gas Industry Services
API 670	Machinery Protection Systems
API 676	Positive displacement Pump – ROTARY
API 677	General – Purpose Gear Units for Petroleum, Chemical and Gas Industry Services
API RP 684	API Standard Paragraphs Rotodynamic Tutorial: Lateral Critical Speeds, Unbalance Response, Stability, Train Torsional and Rotor Balancing
API 685	Sealless Centrifugal Pumps for Petroleum, Petrochemical, and Gas Industry Process Service
API 686	Recommended Practice for Machinery Installation and Installation Design
American Society of Mechanical Engineers (ASME)	Based upon package scope of supply, additional ASME specifications may apply
ASME B31.1	Power Piping
ASME B31.3	Process Piping
ASME BPVC Section II	ASME Boiler Pressure Vessel Code – Material Specification
ASME BPVC Section V	ASME Boiler Pressure Vessel Code -Non-Destructive Examination
ASME BPVC Section VIII	ASME Boiler Pressure Vessel Code - Rules for Construction of Pressure Vessels
ASME BPVC Section IX	ASME Boiler Pressure Vessel Code - Welding and Brazing
ASME PTC 1	General instructions
American Society for Testing Materials (ASTM)	Based upon package scope of supply, additional ASTM specifications and Material designations may apply
British Standards (BS)	Based upon package scope of supply, additional BS specifications may apply
BS 3692	ISO metric precision hexagon bolts, screws and nuts

Reference Document Number	Reference Document Name
BS 4082: Part 1	Specification For External Dimensions For Vertical In-Line Centrifugal Pumps
BS EN 1834	Reciprocating Internal Combustion Engines – Safety requirements for the design and construction of engines for use in potentially explosive atmospheres
BS EN 10204	Metallic Products Types of Inspection Documents
BS EN 10241	Steel threaded pipe fittings
BSI PD 5304	Guidance on Safe Use of Machinery
Engineering Equipment & Materials Users Association (EEMUA)	
EEMUA – 140	Noise Procedure Specification
EEMUA – 141	Guide to the use of Noise Procedure Specification
International Organisation for Standardization (ISO)	Based upon package scope of supply, additional ISO specifications may apply
ISO 2954	Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Instruments for Measuring Vibration Severity
ISO 9000	Quality Management Systems - Fundamentals and Vocabulary
ISO 9004	Quality Management Guidelines for Performance Improvement
ISO 9563	Belt Drives - Electrical Conductivity of antistatic endless synchronous belts – Characteristics and Test Methods
ISO 9906	Rotodynamic pumps – Hydraulic performance acceptance tests, Grade 1, 2, 3.
ISO 10474 / EN 10204	Metallic products — Types of inspection documents
ISO 10816-1	Mechanical Vibration— Evaluation of Machine Vibration by Measurements on Non-rotating Parts
ISO 12944	Paints and varnishes - Corrosion protection of steel structures by protective paint systems
ISO 13050	Synchronous Belt Drives
ISO 15156	Materials for use in H ₂ S-containing environments in oil and gas production
ISO 17782	Petroleum, petrochemical and natural gas industries – Scheme for conformity assessment of manufacturers of special materials
ISO 19011	Guidelines for Quality and/or Environmental System Auditing
ISO 21940	Mechanical Vibration – Rotor Balancing
ISO 21457	Material Selection & Corrosion Control for oil & gas
Manufacturers Standardization Society (MSS)	

Reference Document Number	Reference Document Name
MSS SP-55	Quality standard for steel castings for valves, flanges and fittings and other piping components- visual method
National Association of Corrosion Engineers (NACE)	
NACE MR0175 / ISO 15156	Petroleum and Natural Gas Industries – Materials for use in H ₂ S containing environments in oil and gas production
NACE MR0103 / ISO 17945	Petroleum, Petrochemical and Natural Gas Industries Metallic materials resistant to sulfide stress cracking in corrosive petroleum refining environments

The following normative references are to be considered relevant for use by CONTRACTOR with relevant content to be communicated to SUPPLIERS, on an as-needed basis, within the Purchase Order.

Reference Document Number	Reference Document Name
AGES-GL-07-001	Material Selection Guidelines
AGES-SP-02-006	Electrical Engineering Design Guidelines
AGES-PH-03-001	Layout and Separation Distances Philosophy
AGES-PH-03-003	Fire Detection & Protection Philosophy
AGES- PH-03-002	Emergency Shutdown & Depressurisation Philosophy
AGES-SP-04-005	Emergency Shutdown & Depressurisation Philosophy
AGES-SP-06-001	Design Criteria for Static Equipment
AGES-GL-08-001	Process Design Criteria
AGES-SP-08-002	Flare & Blowdown Philosophy

4. CONTRACTUAL REQUIREMENTS

4.1 DOCUMENTS PRECEDENCE

4.1.1 In the event of any apparent conflict, the Order of Precedence for documents shall be as follows, in descending order of precedence:

- (i) UAE Statutory Requirements and/or Regulations, including emissions limits
- (ii) ADNOC Codes of Practice
- (iii) Equipment Datasheet(s), Drawing(s) and Project Specifications
- (iv) COMPANY Specifications
- (v) Recognised Industry or International Codes and Standards

4.1.2 Where the requirements of the Equipment Datasheet or Specification are more stringent than UAE statute or regulation, the more stringent requirement shall apply, provided that this still achieves compliance with the law or regulation.

4.1.3 The SUPPLIER shall notify the COMPANY of any apparent conflict between the equipment specification and the equipment datasheet, or the equipment datasheet and local or statutory regulation. Resolution and/or clarification of the apparent conflict shall be obtained from the COMPANY, in writing, prior to proceeding with design or manufacture of the equipment.

4.2 SPECIFICATION DEVIATION AND CONCESSION CONTROL

4.2.1 Deviations

Deviations from the requirements of the Purchase Order are only acceptable where the SUPPLIER has listed in their quotation the requirements they cannot, or do not wish to, comply with and the COMPANY and CONTRACTOR have accepted, in writing, the deviations, before the order is placed.

In the absence of a list of agreed deviations, it will be assumed that the SUPPLIER complies fully with the requirements of the Purchase Order.

4.2.2 Concessions

Any proposed, post award technical deviations to the Purchase Order and its attachments including, but not limited to, the Datasheets and Narrative Specifications shall be sought by the SUPPLIER only through the Concession Request procedure, as set out in Appendix 2 – Quality Requirements – of the relevant equipment specification.

If, in the experience/knowledge of SUPPLIER and/or Sub-SUPPLIER, any requirements of the specification create, or have a potential to create, unsafe (for personnel or plant) or less reliable function during any operation (including start-up, upset or emergency operations), it is solely the SUPPLIER's responsibility to bring, in writing, such situations to the attention of the CONTRACTOR. If no situations have been identified in writing, it will be construed that equipment and services will be provided as per the specification.

Any proposed deviation or exception to the defined Process Safety requirements [PSR], as defined in Section 8 of the equipment specifications, shall require approval from ADNOC's "Ultimate Technical Authority".

4.3 ALTERNATIVE DESIGNS

- 4.3.1 The SUPPLIER may submit, in their proposal, alternative designs for consideration by CONTRACTOR / COMPANY, provided that this design satisfies all relevant statutory & legislative requirements, as well as all manufacturing, material and operating requirements as per the equipment specification and datasheet.
- 4.3.2 The SUPPLIER's base proposal shall be as per the requirements of the enquiry package; this proposal may be supplemented by an additional proposal with alternative designs, clearly listing deviations to the enquiry. Proposals with only alternative designs are not acceptable. Alternative designs shall offer either improved reliability of the equipment or process scheme or reduced operational and/or maintenance cost to the COMPANY. Lifecycle cost for alternative designs shall be evaluated accurately by SUPPLIER and provided within their proposal. Reduced lead or delivery time alone shall not be reason to consider alternative designs. Alternative designs are subject to COMPANY approval.
- 4.3.3 The SUPPLIER shall supply a reference list for the offered equipment as part of their proposal.

4.4 PROTOTYPE DESIGNS

- 4.4.1 No new prototype, unproven equipment, nor equipment built to unknown manufacturing standards shall be offered. The equipment model incorporating "same as quoted" major components (as an example, impellers, casings, rotor configurations, bearings, shaft seals) shall have been proven in a similar environment (desert sand storms, dusty, hot, humid and salt laden atmosphere) and in similar operating conditions (flows, pressures, temperatures, powers, speeds) and service. The equipment model and its components shall be in the regular production range of the MANUFACTURER.
- 4.4.2 At least three machines similar in all major respects to those proposed shall have been manufactured and tested by the proposed MANUFACTURER at the proposed manufacturing plant, within the last 10 years and shall continue to be in trouble-free service. These three machines shall each have individually completed 3 years / 25,000 hours of satisfactory operation in a continuous process plant without any major problems or modifications.
- 4.4.3 The SUPPLIER shall list in their proposal all changes in parts, components or design which are not proven in similar machines produced for the last 10 years or which have not acquired at least 3 years / 25,000 hours in operation. These changes are specifically subject to the COMPANY's approval and proven alternatives may be requested.
- 4.4.4 SUPPLIER/MANUFACTURER shall declare in their proposal to the COMPANY, their intention to use any unconventional methods to manufacture any item or component or "new" SUB-SUPPLIER whom they are nominating for the subject purpose for the first time. Use of unconventional methods and "new" SUB-SUPPLIERS is subject to COMPANY approval. For qualification of new SUPPLIERS, the SUPPLIER should have supplied at least 3 similar machines and have 3 years / 25,000hr continuous operation in similar operating conditions.

4.5 STANDARDISATION

- 4.5.1 SUPPLIER shall indicate in their proposal the names, manufacturing addresses and scope of supply of their SUB-SUPPLIERS. The SUB-SUPPLIER list requires COMPANY approval for each Purchase Order. No part of the order shall be sub-ordered without the prior written agreement of the COMPANY. COMPANY shall have the right to substitute a nominated SUB-SUPPLIER for any reason including rationalization, experience in similar service or technical superiority.

4.5.2 SUPPLIER shall standardize as much as possible across the project equipment, auxiliaries and ancillaries. SUPPLIER shall provide all information within their proposal which they feel has the potential to minimize the inventory of spare parts or the reduction of variety of equipment.

4.5.3 All ancillary items such as couplings, filters, seals, instruments etc. shall be in accordance with the individual project's approved SUPPLIER list.

4.6 QUALITY CONTROL (QA/QC) AND CERTIFICATION

4.6.1 The requirements for Quality Control and Quality Assurance shall be specified in the COMPANY equipment specifications 'Quality Assurance, Inspection and Testing Requirements' Appendix 2.

4.6.2 The requirements for Material Identification and Certification shall be specified in the COMPANY equipment specifications 'Quality Assurance, Inspection and Testing Requirements' Appendix 2.

4.6.3 All electrical and instruments, JB's, marshalling cabinets etc., control items shall be IECEx certified (based on respective hazardous area classification requirements). The SUPPLIER is responsible for ensuring the certification. This will enable the CONTRACTOR to obtain ECASEx certificates for those items in UAE by payment of necessary verification fees. ATEX certification not acceptable unless approved by COMPANY. Specific waivers are required in case where items cannot get IECEx certification.

4.7 INSPECTION & TESTING REQUIREMENTS

4.7.1 The requirements for Inspection and Testing Requirements shall be specified in the COMPANY equipment specifications 'Quality Assurance, Inspection and Testing Requirements' Appendix 2.

4.8 SUPPLIER RESPONSIBILITIES

4.8.1 SUPPLIER shall ensure that all equipment, and any free-issue equipment, is properly integrated into the whole installation in order to meet the applied specifications. Their responsibilities shall include, but not be limited to:

- Obtaining information required for fulfilling their obligations
- Ensure relevant integration of the equipment package into the overall plant design. This includes review of the relevant PIDs, equipment layout, and where possible a basic review of other equipment and instrumentation whose interface affects the performance of his equipment.
- Communicating necessary data, specifications and other documents with their Sub-SUPPLIER(s).
- Negotiating physical interfaces, if any.
- Guaranteeing design, stability and performance of the complete equipment installation.
- Dimensional compatibility.
- Shaft system critical speeds and vibration, lateral and torsional analysis.
- Noise level limitations.
- Acceptability of externally imposed loads.
- Arrangement of auxiliary systems shall permit removal of main equipment for maintenance with minimal removal of ancillaries
- Defining static and dynamic loads on foundations and support structures. Design verification of support structures and foundations
- Standardizing all components within the train and its utility requirements (such as oil type/grade, etc.)
- Integration of control systems.
- Advising CONTRACTOR of the firm requirement of utilities (type and quantity) within 2 months or earlier as specified in the Purchase Order.
- Providing all software, software configuration/programming/troubleshooting devices for all controllers such as speed, anti-surge, performance, load sharing, machine control, etc.

- Completion of "Maintenance Management System" datasheets for their and their Sub-SUPPLIERS' equipment.
- Technical assistance to CONTRACTOR in defining control, shutdown and logic requirements to be incorporated by CONTRACTOR in CONTRACTOR's control and emergency shutdown (ESD) system.
- Provide, or arrange to provide, all required assistance during installation, testing and commissioning.
- Ensure that software and communication links shall match and compare with other equipment/systems without any problems.

- 4.8.2 SUPPLIER shall independently compute, and thereby verify, the physical properties of the process medium as originally defined on the project datasheets and shall take full responsibility for amendment and resolution of any design features affected. SUPPLIER shall state in the equipment datasheets the values of all physical properties of process fluids used in their calculations, indicating the state equations used.
- 4.8.3 The SUPPLIER shall assist the CONTRACTOR during initial installation, alignment check and start-up. The initial start-up procedure shall be thoroughly documented by the SUPPLIER and supplied in the equipment's installation manual, to be supplied prior to acceptance of the equipment. It shall be the SUPPLIER's responsibility to advise the CONTRACTOR of training requirements needed for COMPANY personnel to safely and most efficiently operate and maintain their equipment.
- 4.8.4 The SUPPLIER and CONTRACTOR shall mutually agree responsibility for documenting and distributing "Minutes of the Meeting" for all meetings pertinent to the supplied equipment to which they are party. Typed copies of these minutes shall be submitted for mutual agreement, in the agreed format, within the specified duration but not longer than 3 days from the meeting. Following review, the originator of the minutes shall either correct and resubmit the minutes for agreement, or distribute the accepted minutes, within 2 working days.
- 4.8.5 The SUPPLIER shall provide spare parts as stipulated in COMPANY equipment specification and where listed in the Purchase Order.
- 4.8.6 The SUPPLIER shall provide special tools as stipulated in this Appendix and where listed in the Purchase Order.
- 4.9 SUBCONTRACTORS/SUBSUPPLIERS
- 4.9.1 The SUPPLIER/MANUFACTURER (as appropriate) shall assume overall unit responsibility and guarantee for the equipment package and auxiliaries.
- 4.9.2 The SUPPLIER/MANUFACTURER shall transmit all relevant Purchase Order documents, including specifications and subsequent modifications to the specifications to their SUB-SUPPLIER(s).
- 4.9.3 The SUPPLIER/MANUFACTURER shall ensure all specified requirements are satisfied by their SUB-SUPPLIER(s).
- 4.9.4 The SUPPLIER/MANUFACTURER shall obtain and transmit all SUB-SUPPLIER(s) warranties to the CONTRACTOR and COMPANY in addition to the overall system / equipment warranty.
- 4.9.5 On the spare parts list, the SUPPLIER/MANUFACTURER shall include SUB-SUPPLIER's(s') actual part number(s) for any sub-supplied parts, so that the COMPANY may directly source replacements from the SUB-SUPPLIER.

4.10 SPARE PARTS

4.10.1 Pre-Commissioning (i.e. Construction), Start-up (i.e. Commissioning) and Capital Spares, shall be provided in accordance with the requirements of COMPANY equipment specifications and as defined in the Purchase Order. Details of these shall be contained within the SUPPLIER's proposal.

4.10.2 SUPPLIER shall provide the price for two years operational spares offer along with their proposal.

The following minimum requirements shall apply:

4.10.3 Spare parts shall be dimensionally and metallurgically identical to original parts, except that single stage centrifugal pump spare impellers shall be furnished with full diameter. Spare parts shall be subjected to the same level of quality control, inspection and testing as the job parts.

4.10.4 Spare parts shall be readily usable by replacing in the equipment, except that single stage centrifugal pump impellers may need trimming.

4.10.5 Instrument spares shall be readily usable by replacement in the equipment. If special jumpers or address switches need to be changed, those shall be ready-made for the specific application and shall be listed clearly on the spare part, packing documents with reference to the project number and machine contract number.

4.10.6 SUPPLIER shall specify whether or not any electronic chips need to be changed or reprogrammed. If there is a need, the chips (Eproms or others) shall be supplied ready programmed as a separate spare part with full reference to their electronic boards.

4.10.7 Spare parts shall be available for purchase and all manufacturing drawings retained throughout the specified 30 years' service.

4.10.8 Spare parts shall be packaged, preserved and delivered in accordance with the requirements herein and any additional requirements prescribed in the Purchase Order. Furthermore, the SUPPLIER shall provide detailed storage, maintenance and preservation requirements for all supplied spares included specific long-term requirements for Capital Spares

4.10.9 Following award of Purchase Order all spares shall be listed by SUPPLIER under the SPIR submission and SUPPLIER shall indicate delivery, price and details of interchangeability for each part with the supplied equipment.

4.11 SPECIAL TOOLS

4.11.1 SUPPLIER shall provide all special tools required for installation, commissioning, disassembly and reassembly of the equipment. A list of the tools to be provided shall be included within the SUPPLIER's proposal and shall include, but not be limited to, the following items as applicable to the equipment type:

- a) Two sets of non-metric tools
- b) One set of bundle puller of each type,
- c) One bundle cradle and rotor stand for each bundle
- d) Tools for removal of gas turbine core engine, gas generator, power turbine & load coupling
- e) Mechanical seal removal tools
- f) Hydraulic clutch tools
- g) Bolt tensioning and torque devices
- h) Hydraulic tools for removing and assembling couplings hubs, thrust discs etc. (one set per service is required)
- i) Software (including any third-party software) configuration devices for all controllers, I/O modules. Software (including any third-party software) for reconfiguration of operator interface

- j) Diagnostic software and hardware for all electronics
- k) CONTRACTOR as well as technician level diagnostic software for all machine condition / performance monitoring, machine condition / performance evaluation
- l) Borescopes and light sources for all machinery designed to use such facilities
- m) Proof load tested spreader bars for all special purpose equipment and as required by CONTRACTOR
- n) Any special tools required to dismantle instrument items
- o) Special test clamps or leads for electronic / instrument checks, if any
- p) Brackets for installation of laser alignment tools (requirement to provide laser alignment tools shall be on a project by project basis)

4.11.2 For two identical units, one set of special tools shall be provided.

4.11.3 For multi-unit installation of three or more identical units, two sets of special tools shall be provided.

4.11.4 Tools provided for use during operation shall be suitable for the specified area classification

4.12 PAINTING

4.12.1 Painting and protective coating(s) shall be applied in accordance with the specified requirements within the relevant COMPANY Business Unit Standard(s).

4.12.2 All exterior component parts, including stainless steel parts, but excluding finished machined surfaces, shall be painted in accordance with the project defined painting requirements as specified in Purchase Order. All protective coating system(s) used shall have a minimum service life of at least 7-8 years based on the specified site environmental conditions. The paint coating type, number of coats and thickness shall be as specified in COMPANY Standards.

4.12.3 Unless otherwise specified, atmospheric conditions in offshore and coastal environments (<50km from the coast) shall be considered to be corrosivity category C5-M, as per Part 2 of ISO 12944, whilst onshore (≥50km from the coast) environments shall be considered as corrosivity category C3, as per ISO 12944.

4.13 PRESERVATION & SHIPMENT

4.13.1 Preparation of equipment for transportation shall conform to the packing, marking, and shipping instructions identified in the Purchase Order. Preservation and shipment requirements will be stipulated in the equipment datasheet and project specification(s). However, as a minimum, the following requirements shall be applied:

The SUPPLIER shall ensure that all equipment is clean, sealed, protected and packed suitably for international shipment to ensure that all equipment will remain undamaged during transit and subsequent outdoor storage at the installation site for a minimum period of twelve (12) months or commissioning. The equipment packaging shall include adequate preservation to ensure that it will not require unpacking or disassembly, nor be subject to any deterioration during site outdoor storage prior to installation. Suitable protection shall be applied, which shall include, but not be limited to:

- a) Covering flanged openings with metal cover plates and protecting exposed shaft ends against physical damage
- b) Applying adequate bracing
All temporary bracing/supports shall be marked "Remove before Equipment Commissioning and Start-up" and painted in red/white coloured stripes
- c) Capping and securing open pipe/tube ends
Female connections shall be plugged with solid metal pipe plugs, male connections shall be protected with full metal pipe caps
- d) Boxing separately, all loose and spare parts.

- e) Capital spare parts shall be suitable for 4 years storage in metallic containers, open to the sky. *Pieces of equipment and spares shall be identified by item number and service and marked with CONTRACTOR's order number, tag number and weight, both inside and outside of each contained. Spare parts shall also be tagged as "Spare". A bill of materials shall be supplied within each package / container of parts*
- f) Covering exposed and machined surfaces, including bolting, with a coating of rust inhibiting compound. Spraying or coating internal metal surfaces with suitable rust preventative prior to shipment, which can be removed with liquid de-greaser.
All openings shall be tagged to indicate the rust preventative applied
- g) Mechanical seals, drive couplings, carbon rings, packed glands and other similar rotating seals shall be removed prior to shipment and packed separately, utilising suitable preservation and protection. Packing of mechanical seals and bearing assemblies shall be suitable to ensure these parts are fully protected from ingress of dust, sand, dirt, moisture or other foreign matter.
- h) Seal chambers shall be protected from entry of foreign material.
- i) Each item, crate, bag, etc., shall be identified in accordance with the marking requirements specified in the Purchase Order.
- j) Marking containers clearly to indicate whether they should be stored in the horizontal or vertical position
- k) Marking containers clearly to demonstrate requirements for air conditioning
- l) Clearly highlighting any equipment requiring re-preservation and the incidence of re-preservation in the packing list and on tags attached to the packaging. A procedure for re-preservation shall be supplied along with the delivery.
- m) ADNOC Grade oils shall be specified

4.13.1 Equipment or materials that contain or are coated with any of the following shall be prominently tagged at openings to indicate the nature of contents and precautions for shipping, storage and handling:

- Insulating Oils
- Corrosion Inhibitors
- Antifreeze Solutions
- Desiccants
- Chemical Substances
- Hydrocarbon Substances

4.13.2 Regulated substances shall have a Material Safety Datasheet (MSDS), which shall comply with regulations for MSDS preparation specified by the entity with jurisdiction and shall include a statement that the substance is considered hazardous by regulation. If a product is exempt from regulation, a statement to that effect shall be included. Before shipment, the MSDS shall be forwarded to the receiving facility and at shipment, MSDS in protective envelope shall be attached to the outside of the shipment.

4.13.3 Supplied vapour-phase inhibitor or silica gel crystals shall be easily accessible for removal. The bags shall be attached with stainless steel wire and their locations indicated with corrosion resistant tags fixed with stainless steel wire.

4.13.4 Long term storage instructions shall be prepared for all spare parts. Spare rotors for pumps, compressors and turbines shall be supplied in nitrogen pressurized metallic containers. Such containers shall be fitted with N2 blanketing provision, nitrogen cylinder, pressure indication, safety devices and audio-visual alarm to indicate loss of nitrogen pressure. Rotors shall be stored vertically to avoid sagging issues. However, the container shall have provision to allow support in both vertical and horizontal position.

4.13.5 Bearings and seals shall be removed prior to shipment and stored within separate long-term storage containers.

4.13.6 All Capital spares shall be packaged suitable for long term storage without having to reopen for condition monitoring.

4.13.7 SUPPLIER shall be responsible for the adequacy of preparation for shipment, to ensure that supplied equipment reaches the storage facility or plant (as appropriate) in the same condition as inspected and accepted prior to shipping.

4.13.8 The COMPANY shall reject any equipment received in a lesser condition to that accepted prior to shipping. Any costs associated with the return, repair or replacement of the equipment shall be the responsibility of the SUPPLIER.

4.13.9 Sea Transportation Loads (where applicable) shall be advised on a project by project basis.

4.13.10 Maximum transportation envelope and weight limit shall be advised on a project by project basis.

4.13.11 Packaging for offshore installations shall be applied as follows:-

- a) Depending on overall layout, shelters for weather protection may be designed to enclose a number of units or individual units of machinery. For individual units, the shelter may be supplied by SUPPLIER and directly mounted on the machinery skid.
- b) Installation and commissioning plans shall minimise the amount of time the equipment is installed offshore before start-up because of susceptibility to corrosion. If the time shall be excessive then long term preservation shall be initiated to protect the equipment.

4.14 DOCUMENTATION/MANUFACTURER DATA RECORDS

The SUPPLIER shall submit the required project documentation and Manufacturing Data Records as specified within the COMPANY 'Information Requirements – Appendix 3 (Ref. 4) and the relevant equipment datasheet. The detailed format of documents shall be specified on a project basis in line with the relevant COMPANY Business Unit Standards.

4.15 GUARANTEES & WARRANTY

4.15.1 Refer to relevant COMPANY equipment specifications and project datasheets for details of the required guarantees and warranties.

5. TECHNICAL DESIGN REQUIREMENTS

5.1 General

Operational Requirements

- 5.1.1 Equipment, including any auxiliaries, offered and supplied for Continuous Operation or Intermittent Operation shall be designed, manufactured, transported and installed to achieve a minimum service life of 30 years and at least 40,000 hours (5 years) of uninterrupted operation. Any equipment specific requirements relating to required years of uninterrupted operation, are defined in the relevant equipment specifications. If additional features are necessary to satisfy this requirement, the SUPPLIER shall list these in their offer. All replacement parts such as wear rings, throat bushes and seals shall have a minimum service life of 5 years to meet these criteria.
- 5.1.2 Equipment shall be sufficiently robust to withstand, without damage, the results of occasional abnormal conditions of limited duration.
- 5.1.3 Equipment specified for either continuous or intermittent service shall be capable of 3000 starts in 30 years unless otherwise specified on the equipment datasheet.
- 5.1.4 Equipment shall be suitable for the specified operation across the whole of the specified operating range, without the use of bypass, recirculation, venting or flaring.
- 5.1.5 Standby equipment- The requirements for standby equipment will be specified on the equipment datasheet.
 - 5.1.5.1 All standby units shall be capable of quick, full-load start-up on demand – whether manual or automatic – without jeopardizing safety or plant operation. This requirement shall also apply to restarts from a shutdown, following resolution of the shutdown conditions.
 - 5.1.5.2 Running and standby equipment shall be designed to start the stand-by before stopping the main equipment. System pressure, piping and process shall be designed to cater for both master and standby equipment running at the same time for a short period at changeover or test. Standby equipment shall have master/slave changeover facilities at field and remotely from the central control system.

Layout and Maintenance Requirements

- 5.1.6 All equipment shall be designed to permit rapid and economical maintenance, with all left-handed threads being clearly marked.
- 5.1.7 As far as practicable SUPPLIER and CONTRACTOR shall ensure the equipment layout, shall be arranged to avoid dismantling of suction and discharge pipework, steel support structures, or accessories (e.g. seal pots, exchangers, cable trays, junction boxes, etc.) during equipment maintenance and/or overhaul activities.
- 5.1.8 Couplings shall have unhindered access from both sides for their removal, alignment and for condition monitoring of machine bearings etc.
- 5.1.9 Equipment baseplates or skids shall be sized and designed, as much as possible, to provide safe and easy operation and maintenance access. Overly compact designs which do not permit safe access shall not be accepted. Minimum walk space within the skid for packaged equipment shall be at least 0.7 m. Baseplates / skids / flooring shall be fabricated with a non-slip surface and capable of withstanding loads associated with operation and maintenance.

- 5.1.10 Site equipment local manual trip mechanism(s) shall be safely and easily accessible with direct approaches without any hindrance or step overs. Where electric motor driven auxiliaries are provided as part of the equipment package local emergency stop stations shall be installed adjacent to each electric motor.
- 5.1.11 All major rotating equipment will have a dedicated facility for lifting by electrically operated cranes. All other rotating equipment shall have provision for safe and free access to appropriate lifting equipment (cranes, forklifts, etc.). EOT (electric overhead travelling) crane SWL shall be sized for 150% of maximum values, to allow for slings and other attachments. CONTRACTOR, with input from SUPPLIER, shall prepare a material handling study, which shall include detailed mechanical handling drawings, including capacity of crane, crane location, lifting methods, accessibility, paved areas etc.
- 5.1.12 Any maintenance item heavier than 15 kg shall be provided with lifting lugs or similar fixed lifting point(s). Screw-in eyebolts are only acceptable for internal components where other lifting arrangements are impractical. Lifting equipment will be provided for all items over 15 kg.
- 5.1.13 All medium/large filter housings and small knockout drums shall have self-supported covers over hand/manway access and/or filter element removal openings.

5.2 Reliability

- 5.2.1 Equipment and its auxiliaries shall be conceived, configured, designed, manufactured, transported, installed and commissioned to achieve the specified overall plant availability throughout the specified life of the installation. Equipment reliability shall be at least 99%.
- 5.2.2 The SUPPLIER shall provide an estimate of their equipment's reliability, based upon their design, as part of their proposal.

5.3 Location & Site Conditions

- 5.3.1 Unless specified for offshore use, equipment will be located in a desert environment with high ambient air temperatures, sand and dust storms, highly humid salt laden atmosphere, near to coastal areas. Equipment specified for offshore use will be located in a marine, saliferous environment with high ambient air temperatures.
- 5.3.2 All equipment shall be tropicalized and capable of operating unattended and in the open, including in direct sunlight, unless otherwise specified.
- 5.3.3 The SUPPLIER shall provide specific written confirmation of compliance with the specification for outdoor sun-exposed equipment.
- 5.3.4 The SUPPLIER shall recommend in the proposal any additional provisions not specified by the COMPANY that are required to satisfy the operating conditions.
- 5.3.5 Roofing shall not be considered as an indoor environment.
- 5.3.6 Local gauge boards and instruments shall be fitted with sunshades.

5.4 Noise Control

- 5.4.1 The SUPPLIER shall submit guaranteed maximum sound pressure and sound power level data for the equipment at each octave band, together with any other relevant information as required. The sound pressure level (SPL) from the driven equipment, gearbox, driver and associated auxiliaries shall not exceed the value specified in the equipment datasheet or a maximum of 85dBA at 1 metre in all directions, whichever is less.

- 5.4.2 The SUPPLIER shall indicate any special noise attenuation measures required to meet the noise limits specified on the equipment datasheet. ISO 3740[7], ISO 3744[8] and ISO 3746[9] may be consulted for guidance." Furthermore, the COMPANY Business Unit specific noise insulation material specifications shall apply.
- 5.4.3 If acoustic attenuation treatment is required to satisfy the specified noise limit, the SUPPLIER shall confirm full details of any measures proposed the predicted treated and untreated noise levels, together with associated cost impact(s). The supply of noise enclosures may also require the provision of associated fire extinguishing system(s) and additional fire and gas detection instrumentation, inside and/or outside the enclosure. This is subject to COMPANY approval.
- 5.5 Casings**
- 5.5.1 Pressure retaining casings shall not be fabricated in any form of cast iron.
- 5.5.1 For large and/or high-speed turbo-machinery, provisions shall be made by the SUPPLIER for verification of hot alignment during operation using optical instruments. SUPPLIER shall ensure that there is sufficient space available for installing benchmark 5/16-inch (8.0 mm) dowel pins on each side of bearing housings and casings, as close to the shaft centerline as possible and that observation of the optical measurement scales is unobstructed. SUPPLIER's representative shall participate in final alignment in the field Refer to Appendix 2 of equipment specifications for details of SAT requirements.
- 5.5.2 Internals of casings shall be positively locked in place, such that on failure or coming loose they cannot fall into and damage the equipment.
- 5.5.3 Connections on the upper half of the casing of axially split machinery are not acceptable without the approval of COMPANY.
- 5.5.4 Casing openings for pipe or auxiliary connections shall be not less than ¾" NPS and shall be flanged. Threaded connections shall not be used. Where flanged openings are impractical on weldable casings, openings of 1" NPS or larger shall be full penetration butt weld connections, not socket weld connections.
- 5.6 Main Process Connections**
- 5.6.1 When the main process connections are flanged, they shall be fully drilled. No threading in the flanges is allowed. As a minimum, where API standards are specified, all process connection flanges shall be ANSI Class 300# rating.
- 5.6.2 Flat-faced flanges shall not be accepted.
- 5.6.3 Where flanged openings are impractical due to space limitations or process conditions, such as Hazardous Service(s), openings of 1" NPS or larger shall be full penetration butt weld connections, not socket weld connections.
- 5.6.4 A pipe nipple, preferably not more than 150 mm (6 inches) long shall be used, minimum Schedule 80, and provided with a weld-neck flange. Connection to the outer pressure casing shall be by butt-welding.
- 5.6.5 Tapped openings on casings containing process streams that are not connected to piping shall be flanged or plugged, using solid round-headed steel plugs per ANSI B16.11, and seal-welded.
- 5.6.6 RTJ flanges shall be used for hydrogen and all sour service applications on flange ratings of PN 110 (ASME Class 600) and above

5.7 Auxiliary Pipework & Instrument Connections

- 5.7.1 All SUPPLIER auxiliary pipework interface connections including all drains, vents and utility supply/return lines shall be located at the edge of the baseplate(s) and shall include an isolation valve and blind flange. Unless approved otherwise, a single connection is required for each category of fluid service.
- 5.7.2 All instrument and control connections shall comply with instrument connection standards for their fittings and glands. They shall be located in a safe place away from rotating, hot and hazardous parts. They shall have easy and safe access for individual operation and maintenance purposes.

5.8 External Forces and Moments

- 5.8.1 Specific values for allowable forces and moments on main process nozzles shall be included in individual equipment specifications and the equipment datasheet and these will be used during bid evaluation.
- 5.8.2 For packaged equipment with SUPPLIER piping and with CONTRACTOR tie-in connections, SUPPLIER's allowable loads and moments shall be followed. SUPPLIER shall anchor their pipework on skids close to battery limit connections. SUPPLIER shall carry out stress analysis within their skids and reports shall be submitted as part of their package documentation.
- 5.8.3 If SUPPLIER's stress analysis indicates that loadings will exceed the allowable limits, the SUPPLIER shall consider rerouting, rearrangement and/or support of their equipment. The SUPPLIER shall notify the COMPANY prior to undertaking any modification. If these remedial measures do not sufficiently reduce the expected loadings, the SUPPLIER shall approach the CONTRACTOR and COMPANY to establish whether the additional loading can be absorbed into the tie-in connections, without causing loss of integrity or performance.
- 5.8.4 All equipment shall be capable of safely withstanding, without reduction in performance, all anticipated forces and moments acting across the whole of the operating range of equipment as defined on the datasheet.

5.9 Rotating Elements

- 5.9.1 SUPPLIER shall, jointly with driver MANUFACTURER (driven machine MANUFACTURER if generator application), establish the maximum transient torque that will occur in all rotating components under start up, running, and fault conditions. Detailed requirements shall be stipulated in the COMPANY equipment specifications. In the event that meeting this requirement requires an increase to the equipment frame size, the COMPANY shall be informed and confirm their acceptance prior to undertaking any amendments to the design.

5.10 Bearings and Bearing Housings

- 5.10.1 Cooling coils shall not be provided as means of bearing oil cooling.
- 5.10.2 Bearing housing shall be fitted with adequate bearing guards to minimize ingress of atmospheric dust and sand. Labyrinth seals alone are not considered adequate. On large machines, capability for air/nitrogen purge at bearing housing labyrinths shall be provided.
- 5.10.3 Unless anti-rotation devices are provided in accordance with 7.1.5 of this Appendix, sleeve or tilting-pad radial and thrust bearings shall be capable of withstanding reverse rotation for a short period of time without damage. The SUPPLIER shall advise in the proposal the estimated duration and maximum speed the bearing can withstand without damage in a reverse rotation mode.
- 5.10.4 Bearing rating shall be based on the highest oil temperature conditions resulting from continuous operation at the maximum ambient temperature specified. Hydrodynamic bearings shall be sized to limit babbit temperature at the location of the temperature sensors. The maximum bearing metal temperatures under

any load conditions and at the maximum specified oil inlet temperature and worst specified ambient and cooling conditions, is defined in the relevant COMPANY rotating equipment specification.

5.10.5 Permanently sealed bearings shall not be acceptable for any equipment.

5.11 Shaft Seals

5.11.1 Seals shall be capable of removal on site without moving the driving or driven equipment, including gear boxes.

5.11.2 Unless anti-rotation devices are provided shaft seals shall be bi-directional. The SUPPLIER shall comment in the proposal the estimated duration and maximum speed the seals can withstand without damage in a reverse rotation mode.

5.12 Vibration and Balancing

5.12.1 The SUPPLIER shall demonstrate, by appropriate calculation, that the design does not suffer harmful resonance excited by any harmonic speed. If this is not available, a frequency test shall be performed to demonstrate that the equipment is free from harmful resonance.

5.12.2 Balancing procedures shall be such that rotor and coupling interchangeability can be achieved without the need for rebalancing. This will require rotors to be first balanced without couplings, and then to be check balanced with coupling hubs mounted.

5.12.3 Relative radial position of the coupling hubs with respect to shaft to be clearly marked to avoid assembly errors.

5.12.4 Standards for balance and vibration are specified in applicable COMPANY equipment specifications. For other rotating equipment types, the requirement within the applicable API standard shall take precedence.

5.12.5 Balance procedures shall be such that balance repeatability can be ensured. Balance procedures and results are subject to COMPANY approval.

5.12.6 Unless more stringent values are specified elsewhere, vibration amplitude at any non-synchronous speed at any operating condition shall not exceed 10% of the allowable vibration at synchronous speed.

5.12.7 Where non-contact vibration probe system are installed, the SUPPLIER shall indicate in their proposal the permissible alarm and trip values for the safe running of the machine.

5.13 Lube Oil Systems

5.13.1 Details of the lubrication system design requirements for specific equipment types are defined in the relevant COMPANY equipment specifications.

5.13.2 Grease lubricated bearings shall not be accepted unless otherwise indicated on the equipment datasheet, with the exception of electric motors, air cooler fans and pumps with power ratings up to 100kW, where grease lubricated bearings can be accepted subject to COMPANY approval.

5.13.3 All bearing lubrication systems shall be capable of operating in extreme site conditions without loss of bearing system reliability or integrity. Reliable and well proven bearing guards / isolators are required.

5.13.4 Oil mist lubrication shall not be used, with the exception of applications within the ADNOC Refinery Business Group where oil mist lubrication can be offered and can be used if approved by the COMPANY.

5.13.5 Grades of lubricating and sealing oils/grease shall be minimized and compatible with existing COMPANY plants / equipment. Utilisation of ADNOC Grade lubricating oil and grease is mandatory unless the specific grade is not manufactured by ADNOC. Lubricant type shall be stamped or etched on the equipment nameplate.

5.13.6 If the driver and driven equipment both require pressure lubrication, then a common pressure lubrication system shall be provided.

5.13.7 Lube oil coolers shall be designed in accordance with the relevant COMPANY static equipment specifications and referenced standards.

5.14 Materials

5.14.1 SUPPLIER may offer alternative materials to those specified in the requisition if, based on his experience, these would be better suited for the application. The use of any alternative materials is subject to the written approval of COMPANY metallurgist. Following placement of a Purchase Order by COMPANY, any proposed deviations to the specified requirements must be submitted to CONTRACTOR/COMPANY by means of a formal Concession Request identifying full technical details of the proposed deviation together with the associated cost and schedule impact.

5.14.2 All pressure retaining castings shall have the material designation embossed or engraved on each part.

5.14.3 SUPPLIER shall select materials suitable for the process fluid composition(s) given in the data/requisition sheets for all cases.

5.14.4 For equipment handling fluids containing aqueous hydrogen sulfide in concentrations of 50 ppm H₂S or greater, all components including associated systems and ancillaries in contact with the fluid as well as the external bolting on the casing and seal glands shall conform to the requirements of MR0175/ISO 15156 or NACE MR0103/ISO 17945 as applicable. Ferrous materials not covered by MR0175/ISO 15156 or NACE MR0103/ISO 17945 shall have a maximum hardness of 248 Hv10. This hardness limitation also applies to the heat affected zone of welds. Steel plate materials shall comply with through-thickness tensile test per ASTM A770 S3 and shall have a minimum reduction of area of 35 percent.

5.14.5 Copper and copper alloys shall not be used in the presence of hydrocarbons containing H₂S, acetylene, ammonia or ammonium chloride.

5.14.6 The use of internal weld overlays or internal coatings on equipment, pipework, tanks or pressure vessels, shall be subject to agreement by COMPANY and/or CONTRACTOR. If used, internal coatings shall be applied according to the coating MANUFACTURER's recommended preparation method and coating application procedure in accordance with the specified requirements within the relevant COMPANY business unit standard(s). An integrity pull test shall be performed to ensure correct adhesion of the internal coating.

5.14.7 The minimum quality bolting material for pressure joints shall be ASTM A193, Grade B7 for carbon steel and A193 Grade B8M for stainless steel. For NACE/sour service, bolting shall be ASTM A193 B7M. Specific external and internal bolting material requirements as required to suit the environmental conditions or fluid service will be specified within the equipment datasheets.

5.14.8 Close tolerance mating parts, such as shaft sleeves, that are made from galling materials and that cannot be disassembled by hydraulic or thermal expansion techniques shall not rely on anti-seizure compound. These items shall have a suitable thin metal plating to prevent galling. In the proposal, the SUPPLIER shall fully describe the type of plating and the method of deposition.

- 5.14.9 For all instrument and control items provided with the equipment package, SUPPLIER shall select materials suitable for the process fluid composition(s) given in the data/requisition sheets. Material shall also fit with the process temperature and pressure ratings. Instrument tubing materials shall comply with following parameters
- For non sour service (instrument air, hydraulic oils, lube oil, Nitrogen etc. and process fluids falling under non sour criteria): SS316L tubes and fittings.
 - For sour service without chlorides: Inconel 825 with SS316L fittings.
 - For sour service with chlorides: Inconel 625 with SS316L fittings
 - Any other metallurgy shall be defined during FEED phase of project (based on respective project philosophy and process conditions) and requires COMPANY approval
- 5.14.10 For further requirements relating to Materials certification, traceability and testing refer to Appendix 2 "Quality Assurance Inspection and Testing Requirements" within each of the COMPANY equipment specifications.
- 5.14.11 Neither grey cast iron nor nodular (ductile) cast iron shall be used for pressure containing parts but nodular (ductile) cast iron may be offered for non pressure retaining parts, subject to COMPANY approval.
- 5.15 Thermal Insulation**
- 5.15.1 Thermal Insulation shall be applied to equipment and pipework in accordance with the project agreed philosophy and relevant COMPANY business unit standard(s).
- 5.15.2 Personnel protection shall be provided for all equipment and piping operating at 60°C or above, where there is potential for contact between personnel and hot surfaces
- 5.16

6. ACCESSORY REQUIREMENTS FOR ROTATING EQUIPMENT

6.1 Drivers

- 6.1.1 All expected combinations of operating conditions shall be considered in defining the maximum power requirement for the driven machine. Maximum power shall be defined at the driver coupling, and shall include all transmission losses.
- 6.1.2 Detailed startup procedures shall be jointly developed by COMPANY, CONTRACTOR and SUPPLIER. The SUPPLIER shall define restricted speed ranges and allowable rates of loading and ensure that adequate driver torque is available and the control system is fine-tuned. Unless agreed otherwise, it shall be assumed that starting will be with rated conditions specified on the datasheets.
- 6.1.3 Electric motors shall comply with the relevant specification and the equipment datasheet. However, where there is no margin specified, a margin of 10% over the end of curve power absorbed shall be employed.
- 6.1.4 The complete unit shall be able to withstand, without damage, the effects of a fully loaded shutdown of the unit (against safety relief valve set pressure, including accumulation and/or maximum continuous speed). In case of an electric motor driver (either fixed or variable speed), the complete unit shall be able to withstand, without damage, the effects of a 2 or 3 phase short circuit.

6.1.5 Anti-rotation devices shall be provided if reverse rotation is not acceptable for the driver or driven equipment as per original design.

6.1.6 Motorized barring devices shall be provided for heavy duty and critical machinery, according to equipment types and as defined in the COMPANY equipment specifications.

6.2 Gears

6.2.1 SUPPLIER shall strive to eliminate the need for gearing systems by offering proven direct driven machinery. Gear box bearings and casings shall be provided with vibration and temperature monitors. Job gearboxes shall be used during shop tests of driver and/or driven machinery where complete unit test is requested.

6.2.2 Where proposed, gearing systems shall conform to the requirements of the individual rotating equipment and gearing specification.

6.2.3 Epicyclic units shall not be supplied without the prior approval of COMPANY and will only be considered where epicyclic units form an integral or standard feature of the equipment.

6.2.4 Gear units located between two items of driven equipment shall have a rating of at least 110% of the maximum power required by the driven equipment

6.2.5 Gears for use with variable speed electric motor drivers shall have service factor increased by at least 20% to allow for the effects of pulsating torque. Service factor shall be above motor nameplate rating.

6.2.6 Gear units shall safely withstand any transient torsional loads imposed during start-up, during re-acceleration after power interruption or short circuit, or due to mal-synchronisation of the driver or driven equipment.

6.2.7 Gearboxes shall be adequately sealed to prevent ingress of contaminants.

6.2.8 Gearboxes shall be fitted with an adequately sized filter-breather such that oil vapours shall not condense or accumulate on the gearbox casing.

6.2.9 All special purpose gearbox oil drains shall be provided with connections for on-line oil analysis and monitoring.

6.2.10 When integral thrust collars are provided, the design shall be arranged such that, if necessary, they can be replaced by separate shrunk-on thrust collar.

6.2.11 Gearboxes shall be dowelled under the high-speed pinion. SUPPLIER shall provide any special tools necessary for dowelling to be carried out on site.

6.3 Couplings, Guards

6.3.1 Couplings shall be selected with a minimum service factor of 1.5 applied to the SUPPLIER's rating, with the understanding the coupling rating may be subject to further review because of torsional and lateral studies.

6.3.2 Couplings shall safely withstand any transient torsional loads imposed during start-up, during re-acceleration after power interruption or short circuit, or due to non-synchronisation of the driver and driven equipment.

6.3.3 Standards for balance and vibration are defined in the individual COMPANY equipment specifications. Where no standard is specified, couplings shall be balanced to ISO 21940 Grade G1 or better.

- 6.3.4 Couplings for special purpose machinery shall comply with API 671 latest edition where this is a required within the COMPANY equipment specification or the relevant API. These couplings shall be used during equipment shop tests.
- 6.3.5 All flexible couplings shall be of a design in which the spacer piece is positively constrained from flying out in the event of failure of the flexible elements. All coupling components shall be of non-sparking type and in brass.
- 6.3.6 All moving parts shall be guarded in accordance with BSI PD 5304 or an appropriate national standard. The coupling guard shall be permanently fixed and shall be sufficiently rigid to ensure that rubbing cannot result from deflection caused by normal body mass (90 kg) applied horizontally or vertically.
- 6.3.7 No section of the transmission shall be left unguarded. Where ventilation or need to observe the guarded area dictates the use of perforated sheet or wire mesh, the design and construction of the guard shall prevent manual contact with moving parts.
- 6.3.8 Transmission guards shall be weatherproof. Guards shall be made of brass. Coupling guard temperatures, measured on the outside surface, shall not exceed 70°C. The use of oil spray to achieve this temperature limit is not allowed.

6.4 Baseplates

- 6.4.1 Unless otherwise specified, the baseplate shall be common for the complete train - comprising of driver(s), gear(s) and the driven equipment and shall be continuously welded.
- 6.4.2 No equipment, junction boxes or control panels - or their supporting structure - shall overhang the base plate. Motor junction boxes may overhang to the extent needed for cable entry.
- 6.4.3 Deflection of the baseplate while lifting shall not exceed the figures quoted in the COMPANY equipment specifications.
- 6.4.4 Shims shall be stainless steel and shall conform to the recommendations of API RP 686, Part VII: 5.4.2.
- 6.4.5 Requirements for a grouted or non-grouted type design are defined in the COMPANY equipment specifications. Where grout is to be used, it shall not be filled within the base frame and grout shall be applied only under baseplate bottom flange. The Installation CONTRACTOR shall take responsibility for filling grout without any air pockets. Quality selection of grout shall be such that for the entire design life of the equipment (i.e 30 years) it will not crack or loosen up or deteriorate during pump operation, causing vibration issues in pumps.
- 6.4.6 Baseplates for packaged equipment specified for offshore mounting shall be designed in accordance with Z0-TS-S-06010 – Steel Work for Mounted Equipment Packages.

6.5 Controls & Instrumentation

- 6.3.9 Except where unsuitable due to system limitations (speed of response, complexity of calculation etc.), control of rotating equipment shall be incorporated within the installation's Integrated Control and Safety System (ICSS). Equipment shall be provided with a local emergency stop button and a display panel for duplication of key data sent to control system.
- 6.3.10 Where equipment control cannot be fully integrated into the ICSS: equipment shall be integrated into ICSS system as much as possible and shall have access to a Fire & Gas system, Machine Monitoring system, Performance / Anti-surge and Load Sharing system as applicable. Any standalone systems shall transmit redundant data to the plant control system.

6.3.11 SUPPLIER and CONTRACTOR shall mutually agree the integration of package control system (ICSS) including review of the following documentation.

- CONTRACTOR's P&IDs
- Control and protection systems throughout operating conditions (including startup and shutdown, all normal operation and emergency shutdowns)
- Anti-surge and reverse rotation protection
- Over-pressure protection
- Differential pressure protection

6.3.12 All electronic instrumentation (except transmitters, I/P converters) shall be suitably protected from the environment (all outdoor instrumentation shall be adequately protected by sunshade(s) and installed far from heat, vibration, liquids and noise source) or located in the main control room(s). If electronic instrumentation is required to be located in the field, these shall be used in local panels with dual air conditioners rated for the area classification.

6.4 **Wiring/Cabling**

6.4.1 Instrument and power wiring or cabling, with the exception of power supply to electric motors, shall be connected to terminal strips installed in terminal boxes. Instrument signals and wiring or cabling with different voltages shall be connected to separate terminal boxes. The terminal boxes shall preferably be mounted in one skid edge location on a baseplate. The location of the terminal boxes shall be shown on the layout drawing. Design shall allow for easy access for construction cables and junction box termination, maintaining cable / junction box segregation throughout.

6.4.2 Instrument cables shall be of the metal armoured or braided type. Cables shall be secured with stainless steel cable ties at suitable intervals and cable trays provided with cover.

6.4.3 The cable trays within the equipment package/baseplate/skid shall be extra heavy-duty type, hot dip galvanized and painted to prevent corrosion of the protective zinc coating. Cable trays shall be covered. Cables shall be installed in cable trays properly supported to minimize vibration and be segregated such as to prevent interference between voltage levels.

6.4.4 All instrument tubing shall be routed in a safe way, not obstructing any other equipment or operation access. Extension wires or cables shall be run inside a metal conduit suitable for the environmental conditions.

6.4.5 Junction boxes, gauge boards and field instrument panels shall be located at the skid edge in a safe place, easily accessible from back and front, away from vibration and heat sources. They shall also be fitted with stands / brackets and sunshades.

6.4.6 Instrument in direct contact with the process fluids (gases, oils, etc.) shall have proper sealing to prevent any leaks at the most severe operating conditions. They shall have the proper isolation valves and logic override (if it is required) to remove them and replace/calibrate at running conditions.

6.4.7 Changing individual instrument items shall not require changing or removal of any other mechanical parts (e.g. changing bearing pad for faulty impeded temperature element).

6.4.8 Instrument panels and field equipment shall have a protective coating applied in accordance with the relevant COMPANY Business Unit Standards for painting and coating.

6.4.9 Machine control package shall maximize graphic presentation within the ICSS system. Graphics shall include but not be limited to seal and lube oil loops, buffer and fuel gas systems, cooling water and air paths, start-up and shutdown steps, anti-surge control, etc.

6.4.10 Control system shall maximize field equipment redundancy (transmitters, switches, servos, etc.). Redundancy is required for trip and shutdown items as detailed in the COMPANY equipment specifications and wherever felt critical by SUPPLIER and CONTRACTOR.

6.5 Condition & Performance Monitoring

6.5.1 Requirements for condition and performance monitoring shall be specified in the COMPANY equipment specification and datasheets.

6.5.2 All wire entries into the equipment casing(s) or bearing housing(s) shall be provided with proper sealing against leakage.

6.6 Piping & Appurtenances

6.6.1 Valves shall not be installed without piping spools in between.

6.6.2 All interconnecting piping and valves shall be arranged such that all equipment is safely accessible for maintenance and/or removal (or removal of valve internals) without dismantling of the piping.

6.6.3 All isolation valves 2" and above (including battery limit valves), control valves and ESD valves shall have free and safe access by mobile crane and shall have platform access for operation and maintenance.

6.6.4 All piping systems connected to equipment or a piping system of a higher design class shall match the higher class for all connecting components, up to and including the first block valve, mating flange or spool piece.

6.6.5 Piping into equipment / equipment vessels shall be adequately supported to ensure that no nozzle will be subjected to any stress that could disturb the proper alignment, the internal clearances, or otherwise in any way impact the equipment to an extent that could jeopardize its efficiency, its trouble-free operation or the equipment's monitoring.

6.6.6 Auxiliaries associated with the equipment, such as seal pots, pressure control valves, pressure gauges, thermal gauges etc. shall be freely accessible.

6.6.7 System auxiliaries shall be arranged such that the dismantling of one shall not necessitate the removal of any other items of equipment and shall not affect alignment of the machine.

6.6.8 Temporary strainers/blinds etc., if used, shall be tagged "temporary".

6.6.9 All joints in auxiliary piping shall be flanged.

6.6.10 Unless impractical, accessories shall not be placed on the machine skid and shall be self-supported.

7. BUSINESS UNIT SPECIFIC CROSS REFERENCE

The following references apply to equipment supplied to specific ADNOC Business Unit

7.1 ADNOC Gas Processing

Reference Document Number	Reference Document Name
DGS 00 001	Basic Engineering Design Data
DGS 0000 001	Positive Material Identification Of Equipment And Piping
DGS 0000 003	Minimum Shop Inspection and Certification Requirements
DGS 0000 007	Field Services Installation Of Rotating Equipment

Reference Document Number	Reference Document Name
DGS 0000 008	Requirement Of Manufacturing Record Books For Non-Pressure Vessel Equipment
DGS 0000 009	Spare Parts Requirements
DGS 0180 001	Flare Details – (Amendments/Supplements to API STD 537)
DGS 0180 002	Flare System Design Basis
DGS 0710 001	Air Cooled Heat Exchanger (Amendments And Supplements To API Std. 661)
DGS 0710 002	Air Cooled Heat Exchanger – Design Criteria
DGS 1000 001	Rotating Equipment - Minimum General Requirements
DGS 1000 002	Rotating Equipment - System Integration
DGS 1000 005	Heavy duty couplings
DGS 1000 006	Amendments, Supplements to API-682 (Shaft sealing systems for Centrifugal and rotary pumps)
DGS 1180 001	Special Purpose Gear units
DGS 1300 030	Process and Utility Field / Shop Pressure Testing
DGS 1300 040	General Piping Process and Utility Design, Layout & Drawing
DGS 1300 060	Piping Flexibility Analysis
DGS 1300 175	Galvanizing
DGS 1300 185	Fabrication, Handling and Installation of Process and Utility Piping
DGS 1300 190	Traceability of Shop and Field Fabricated Piping Materials
DGS 1510 001	DCS Operating and Control Philosophy
DGS 1510 006	Instrument Numbering Rules
DGS 1511 001	Alarm Philosophy
DGS 1511 021	Distributed Control System
DGS 1511 032	Instrumentation Design Criteria
DGS 1511 033	Instrumentation Furnished with Packaged Equipment
DGS 1511 036	Instrument and Thermocouple Cables
DGS 1511 041	Flow Elements and Meter Runs
DGS 1511 042	Flow Instruments
DGS 1511 043	Instrument Installation Design
DGS 1511 044	Instrument Storage and Calibration
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DGS 1511 046	Inspection and Testing of Instrument and Instrument Systems
DGS 1511 050	Programmable Logic Controllers (PLC)
DGS 1511 062	Machine monitoring Control System
DGS 1511 070	Anti-surge and Performance Control
DGS 1511-076	Safety Instrumented Function (SIL Classification and Implementation)
DGS 1541 001	Control Valves
DGS 1543 002	ESD and On/Off Valves
DGS 1545 001	Pressure Relief Devices
DGS 1550 001	Functional Loop Diagrams
DGS 1630 013	Electrical items on Packaged Equipment
DGS 1630 025	D.C. UPS System
DGS 1630 027	Electric Motors Cage-Induction and Synchronous (Cage-Induction requirements are applicable and Synchronous motor requirements are superseded by AGES-SP-005)
DGS 3335 001	Lubrication, Shaft-Sealing And Control Oil Systems for Special-Purpose Application (Amendments/Supplements to API Std 614)
DGS 6000 002	Equipment Noise Control
DGS 6300 001	Welding, NDE of Piping Systems
DGS 1783 004	Grouting

Reference Document Number	Reference Document Name
DGS 1883 001	Structural Steel Fabrication
DGS 1884 001	Structural Steel Erection
DGS 6000 002	Equipment Noise Control
DGS 6300 003	Welding, NDE for Pressure Vessels and Heat Exchangers
DGS 6500 010	Hot Insulation for Piping and Equipment
DGS 6600 010	Painting Part A (Painting Of New Metallic Structure)
DGS 6710 001	Preservation and Export Packing
DGS MX 001	Painting
DGS MN 001	Insulation
DGS MU 010	Acoustic Insulation for Pipes, Valves and Flanges
OEX ST 002	Maintenance Standard
DGS PU 018	Steam Tracing for Equipment, Instruments and Piping
DGS-PE-010/011	Basic Engineering Design Data
STD 1781-002-001	Anchor Bolts Material-Fabrication-Marking
STD 1781-002-002	Anchor Bolt Type T
STD 1781-002-003	Anchor Bolt Type R
STD 1781-002-004	Anchor Bolt Type S
STD 1781-002-005	Anchor Bolts Material-Fabrication-Marking
5295 PS 1511 85	Safeguarding and Instrumented Protective Functions for Rotating Equipment

7.2 ADNOC LNG

Reference Document Number	Reference Document Name
EP GIS 36-250	Specification for Material Requirements for Sour Service in Exploration and Production Operations
GIS 06-601	Specification of Coating for Metal Surfaces
GIS 06-602	Specification for Coating and Painting of SUPPLIER Equipment
GIS 12-101	Specification for Low Voltage Switchgear and Control gear (IEC)
GIS 12-102	Specification for Low Voltage Metal Enclosed Switchgear (IEEE C37.20.1)
GIS 12-151	Specification for Low Voltage Power and Control Cable (IEC)
GIS 12-152	Specification for Low Voltage Power and Control Cable (NEMA)
GIS 12-153	Specification for High Voltage Power Cable (IEC)
GIS 12-154	Specification for High Voltage Power Cable (NEMA)
GIS 12-155	Specification for Instrumentation Cable (IEC)
GIS 12-156	Specification for Instrumentation Cable (NEMA WC 57)
GIS 12-157	Specification for Optical Fibre Cable (IEC)
GIS 12-158	Specification for Optical Fibre Cable (ANSI)
GIS 12-201	Specification for Low Voltage Induction Motors (IEC)
GIS 12-202	Specification for Totally Enclosed Fan Cooled Squirrel Cage Induction Motors up-to 500 HP (IEEE 841)
GIS 12-203	Specification for High Voltage Induction Motors (IEC)
GIS 12-204	Specifications for Medium Voltage Induction Motors (API 541)
GIS 12-206	Specification for Synchronous Motors (API 546)
GIS 12-801	Specification for Power Generators (IEC)
GIS 12-802	Specification for Power Generators (API 546)
GIS 14-011	Guidance on Practice for Noise Control
GIS 15-011	Noise Control
GIS 26-102	Double Pipe Heat Exchangers

Reference Document Number	Reference Document Name
GIS 26-103	Specification for Air-Cooled Heat Exchangers (ISO 13706 or API 661)
GIS 30-251	Specification for Instrument Tubing and Fittings - Metric units
GIS 30-252	Specification for Instrument Tubing and Fittings - Customary units
GIS 30-253	Specification for Field Instruments
GIS 30-351	Specification for Actuators for On/Off Valves (IEC)
GIS 30-352	Specification for Actuators for On/Off Valves (ANSI)
GIS 30-651	Specification for Control Panel Design
GIS 31-016	Specification for Analysers
GIS 34-305	Specification for Diesel engines
GIS 34-306	Specification for Natural gas engines
GIS 34-501	Specification for Special Purpose Gear Units (API 613)
GIS 34-502	Specification for General Purpose Gear Units (API 677)
GIS 34-503	Specification for Special Purpose Couplings (ISO 10441 or API 671)
GIS 34-504	Specification for General Purpose Couplings. (ISO 14691)
GIS 34-701	Specification for Lubrication, Shaft Sealing, and Oil Control Systems and Auxiliaries (ISO 10438 or API 614)
GIS 34-705	Specification for Machinery Protection Systems API 670
GIS 34-801	Machinery Installation and Installation Design (API 686)
GIS 36-250	Specification for Material Requirements for Sour Service in Exploration and Production Operations
GIS 36-102	Hardness Testing, Post Weld Heat Treatment, Stress Relief, and Pickling for Pressure Vessels, Piping, and Other Components
GIS 36-103	Specification for Positive Materials Identification (PMI)
GIS 40-103	General Engineering Specification for Packaged Equipment (Excluding US Requirements)
GIS 40-104	General Engineering Specification for Packaged Equipment (US)
GIS 42-103	Specification for Fabrication, Assembly, Erection, and Inspection of Pipework (ASME B31.3)
GIS 46-010	Specification for Pressure Vessels
GP 12-45	Electrical for Packaged Equipment
GP 30-65	Control Panels
GP 30-70	Control and Instrumentation in Vendor Packaged Equipment
GP 32-12	Quality Management for Manufacturing – Rotating Equipment
GP 36-26	Materials for Sour Service in Petroleum Refining Environments
GP 42-10	Piping Systems (ASME B31.3)
GP 50-10	Quality Management

7.3 ADNOC OFFSHORE

Reference Document Number	Reference Document Name
API RP 552	Transmission Systems
API RP 553	Refinery Valves and Accessories for Control and Safety Instrumented Systems
ASTM A923	Standard Test Methods for Detecting Detrimental Intermetallic Phase in Duplex Austenitic / Ferritic Stainless Steels
ASTM E562	Standard Test Method for Determining Volume Fraction by Systematic Manual Point Count
ASTM G48	Standard Test Methods for Pitting and Crevice Corrosion Resistance of Stainless Steels and Related Alloys by Use of Ferric Chloride Solution

Reference Document Number	Reference Document Name
BS EN 10204	Metallic Products – Types of Inspection Documents
Standard Norge (SN) NORSOK M-650	Qualification of manufacturers of special materials
A0-IG-P-SP-003	Specification for Spun Hot Dip Galvanization & Polytetrafluoroethylene (PTFE) Coating of Nuts/Bolts and Fasteners
A0-ENG-N-SL-001	Status List for ADNOC Offshore Technical Standard Documents
CP-102	Inspection & Testing Requirements for New Equipment and Materials in Manufacture
GDL-003	Integrity & Safety Assurance of Temporary Equipment prior to Mobilization
GDL-008	Guidelines for Spare Parts Management
GDL-009	Project Deliverables
GDL-040	Concession Request
GDL-058	Management of Third Party Agencies (TPA) Services
GDL-070	Management of Change (MOC - Applications)
MNL-01	ADMA-OPCO Painting Manual
PRO-104	Magnetic Particle Inspection Procedure
PRO-108	Procedure for Liquid Penetrant Inspection
PRO-110	Part 1 Procedure for Pressure Testing of Piping Systems
PRO-110	Part 2 Procedure for Pressure Testing of Pressure Vessels
PRO-151	Material Preservation
SP-1002	Preservation of New Materials & Equipment
SP-1009	Specification For Requirements for Projects Contractor Quality System
SP-1020	General Specification for Protective Coating
SP-1031	Quality Control Personnel for Fabrication & Construction
SP-1050	Part 3 Specification for Mechanical Design Criteria Part 3: Rotating Machineries
STD-00 Part-1	Measurement Units
STD-00 Part-2	Site Condition and Data
STD-100	Approval of Materials of Manufacture Mechanical Equipment
STD-126	Bolting for Piping
STD-127	Gaskets for Flanged Joints
STD-148	Low Voltage Motors
STD-149	High Voltage Induction Motors
Z0-TS-Z-01010	General Data on Environmental and Climatic Conditions at ZADCO Facilities
Z0-TS-M-01010	General requirements for Skid Mounted Equipment Packages
Z0-TS-S-06010	Specification for Structural Steelwork for Skid Mounted Equipment Packages
Z0-TS-E-01040	General Electrical Requirements in Package Unit Equipment (Skid Mounted)
Z0-TS-E-01050	General Procedures for Inspection, Testing & Commissioning of Electrical Equipment for Offshore Facilities
Z0-TS-E-01060	General Procedures for Inspection, Testing & Commissioning of Electrical Equipment for Onshore Facilities
Z0-TS-E-07010	AC Electrical LV Motors for Onshore Facilities
Z0-TS-E-07020	AC Electrical LV Motors for Offshore Facilities
Z0-TS-E-07030	AC Electrical HV Motors for Onshore Facilities
Z0-TS-E-07040	AC Electrical HV Motors for Offshore Facilities
Z0-TS-J- 01030	Package Unit Instrumentation

Reference Document Number	Reference Document Name
Z0-TS-K-02010	General Process and Utility Data for offshore facilities
Z0-TS-K-02020	General Process and Utility Data for onshore facilities
Z0-TS-M- 02010	Unfired Pressure Vessels: Design
Z0-TS-M- 02020	Unfired Pressure Vessels: Fabrication
Z0-TS-M- 02030	Pressure Vessels Details
Z0-TS-M-06020	Centrifugal Pumps Package
Z0-TS-P-03010	Specification for Piping Design and layout
Z0-TS-P- 03020	Specification for Piping Details
Z0-TS-P- 04010	Specification for Fabrication, Erection & Testing of Pipework C.S.
Z0-TS-P- 04020	Specification for Fabrication, Erection & Testing of Pipework S.S.
Z0-TS-P- 05010	Piping Material Specification
Z0-TS-U-01010	Vendor Document Requirement Schedule for Packaged Equipment
Z0-TS-Y-02010	Specification for Protective Coating System
GIS 14-011	Guidance on Practice for Noise Control
GIS 34-501	Specification for Special Purpose Gear Units (API 613)
GIS 34-503	Specification for Special Purpose Couplings (ISO 10441 or API 671)
GIS 34-701	Specification for Lubrication, Shaft Sealing, and Oil Control Systems and Auxiliaries (ISO 10438 or API 614)
GIS 34-705	Specification for Machinery Protection Systems API 670

7.4 ADNOC ONSHORE

Reference Document Number	Reference Document Name
EM 30.99.95.0006	ADCO Guidelines for Submission of Electronic Documentation
EP 30.99.90.0024	Preparation of Supplier's/Vendor's Engineering Drawings and Documents
EP 30.99.90.0001	Drawing Design and Numbering Systems
ES 30.99.00.0001	Tag plates for Field and Indoor Equipment
ES 30.99.37.0013	ADCO Engineering Specification – Painting & Coating of New Equipment
EP 30.99.97.0006.1	Projects Quality System Requirements (Manufacturing, Construction & EPC)
31.10.00.31-Gen	Noise Control (Amendments /Supplements to ISO 15664)
31.21.70.31-Gen	Air Cooled Heat Exchangers (Amendments/Supplements to ISO 13706)
31.29.00.10-Gen	Installation of rotating equipment
31.29.00.11-Gen	Condition Monitoring of Rotating Equipment
31.29.00.32-Gen	Petroleum and natural gas industries - High-speed special-purpose gear units (amendments / supplements to ISO 13691)
31.29.00.36-Gen	Flexible Couplings for Mechanical Power Transmission – Special Purpose Applications. (Amendments / Supplements to ISO 10441)
31.29.60.32-Gen	Lubrication, Shaft-Sealing and Control Oil Systems and Auxiliaries for Petroleum, Chemical and gas Industry Services (Amendments / Supplements to ISO 10438)
32.31.00.32-Gen	Instruments for Measurement and Control
32.31.09.31-Gen	Instrumentation for Equipment Packages
32.29.20.10-Gen	Safeguarding and Instrumented protective functions for rotating equipment

Reference Document Number	Reference Document Name
33.66.05.31-Gen	Electric Machines – Cage induction Types (Amendments/Supplements to IEC 60034-1 and IEC 60034-14)
70.10.70.11-Gen	Preservation of New and Old Equipment Standing Idle
70.10.80.11-Gen	Cleaning of Equipment
70.10.90.11-Gen	Spare Parts
S 68.004	Earthing boss for steel structures, tanks, vessels etc.
31.29.02.11-Gen	Pumps – Type Selection

7.5 ADNOC REFINING

Reference Document Number	Reference Document Name
ANSI B4.1	Preferred Limits & Fits for Cylindrical Parts
ASME B46.1	Surface Texture
BS PD 5304	Guidance on Safe Use of Machinery
ISO 2954	Mechanical Vibration of Rotating and Reciprocating Machinery - Requirements for Instruments for Measuring Vibration Severity
ISO 9906	Rotodynamic pumps – Hydraulic performance acceptance tests, Grade 1, 2, 3.
ISO 19011	Guidelines for Quality and/or Environmental System Auditing
DGS-EE-009	D.C. UPS System
DGS-EU-002	Electric Items On Packaged Equipment
DGS-IS-011	Machine Condition Monitoring
DGS-IU-007	Instrumentation Furnished With Package Units
DGS-MA-001	Oil Mist Lubrication System
DGS-MD-001	Vessel Design Basis
DGS-MG-003	Centrifugal Pumps for General Service (non API)
DGS-MG-004	Positive Displacement Rotating Pumps (Amendments/Supplements To API 676)
DGS-MM-001	Electric Motors – Cage – Induction And Synchronous Type (Cage-Induction requirements are applicable and Synchronous motor requirements are superseded by AGES-SP-005)
DGS-MP-001	Air Cooled Heat Exchangers Design Criteria
DGS-MP-002	Air Cooled Heat Exchange Equipment
DGS-MU-001	General Equipment Requirements
DGS-MU-002	Preservation And Export Packing
DGS-MU-003	Spare Parts
DGS-MU-004	Lubrication Requirements
DGS-MU-006	Minimum General Requirements
DGS-MU-007	Minimum Requirements for Integration of equipment
DGS-MU-009	Equipment Noise Control
DGS-MU-010	Acoustic Installation for Pipes, Valves and Flanges
DGS-MU-011	Installation of Rotating Equipment
DGS-MU-012	Requirements For Manufacturing Data Report for Non-Pressure Vessel Equipment
DGS-MU-013	Criticality Rating System
DGS-MU-014	Minimum Shop Inspection And Certification Requirements
DGS-MU-016	Special Purpose Couplings
DGS-MU-017	Shaft Sealing Systems for Centrifugal and Rotary Pumps (Amendments/Supplements to API 682)

Reference Document Number	Reference Document Name
DGS-MU-018	Overrunning Clutches
DGS-MV-001	Lubrication, Shafting-Sealing And Control Oil System (Amendments/Supplements to API 614)
DGS-MV-002	Special Purpose Gear Units (Amendments/Supplements To API 613)
DGS-MV-004	Synchronous AC Generators 1250 kVA and above
DGS-MV-006	General Purpose Gear Units (Amendments/Supplements to API 677)
DGS-MW-004	Material and Fabrication Requirements for Carbon Steel Piping and Equipment in Severe Service.
DGS-MW-006	Positive Material Identification Of Equipment And Piping
DGS-MW-007	Welding and Inspection requirements for equipment not covered by recognised standards and/or codes
DGS-MX-001	Painting
DGS-PE-010	Basic Engineering Design Data for Abu Dhabi Refinery
DGS-PE-011	Basic Engineering Design Data Ruwais Refinery East
DGS-PU-001	General Piping - Process and Utility Design, Layout and Drawing
DGS-PU-003	Technical Specification for Piping Systems

7.6 BOROUGE

Reference Document Number	Reference Document Name
EEMUA Publication 107	Recommendations for the Protection of Diesel Engines Operating in Hazardous Areas
BGS-EU-002	Electrical Items on Packaged Equipment
BGS-IS-011	Machine Condition Monitoring
BGS-IU-007	Instrumentation Furnished with Packaged Units
BGS-IU-023	Local Control Panels
BGS-ME-002	Shell and Tube Heat Exchangers
BGS-MU-002	Preservation and Export Packing Procedure
BGS-MU-003	Spare Parts
BGS-MU-006	Rotating Equipment – Minimum General Requirements
BGS-MU-007	Rotating Equipment – System Integration
BGS-MU-009	Equipment Noise Control
BGS-MU-013	Criticality Rating System
BGS-MU-014	Minimum Shop Inspection and Certification Requirements
BGS-MM-001	Electric Motors Cage-Induction and Synchronous (Cage-Induction requirements are applicable and Synchronous motor requirements are superseded by AGES-SP-005)
BGS-MV-001	Lubrication, Shaft-Sealing and Control Oil Systems for Special-Purpose Application (Amendments/Supplements to API Standard 614)
BGS-MV-002	Special Purpose Gear Units
BGS-MV-003	Diesel Fuel Compression Ignition Engines
BGS-MX-001	Painting
TID-PR-028	Concession and Waiver Procedure

QUALITY ASSURANCE, INSPECTION AND TESTING REQUIREMENTS

FOR

CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION

Appendix 2 – AGES-SP-05-002

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1. SCOPE

To specify quality management, materials selection and certification, welding and NDT, manufacturing inspection and testing requirements for the supply of centrifugal compressors to AGES-SP-05-002 'Centrifugal Compressors (API 617) Specification' comprising:

- a) SECTION I – QUALITY ASSURANCE AND CONFORMITY ASSESSMENT
- b) SECTION II – INSPECTION AND TESTING REQUIREMENTS
- c) SECTION III – SHOP FABRICATION AND NDT
- d) SECTION IV – SHOP TESTING AND SITE ACCEPTANCE TESTS
- e) SECTION V – API 617 TECHNICAL AMENDMENTS

2. NORMATIVE REFERENCES

For the purposes of this document, the documents referenced in KBR-23-SPE-0001 and those listed below, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) at the time of award applies.

Table 1 – Normative References

Ref.	Document No.	Title
1.	ISO 9001:2015	Quality Management Systems - Requirements
2.	API Specification Q1	Specification for Quality Management System Requirements for Manufacturing Organizations for the Petroleum and Natural Gas Industry
3.	ASME B31.1	Power Piping
4.	ASME B31.3	Process Piping
5.	ASME Section II.A:2019	Materials – Part A – Ferrous Materials Specifications
6.	ASME Section II.B:2019	Materials – Part B – Non-Ferrous Materials Specifications
7.	ASME VIII Division 1	ASME Boiler and Pressure Vessel Code, Section VIII Division 1 Rules for Construction of Pressure Vessels
8.	ASME Section IX:2019	Welding, Brazing and Fusing Qualifications
9.	30-99-00-8517-1, Rev 0	COMPANY Specification – Equipment/Materials Criticality Rating
10.	ISO 10005: 2018	Quality Management – Guidelines for Quality Plans

3. TERMS AND DEFINITIONS

For the purpose of using this document, the terms and definitions given in API 617 8th Edition Centrifugal Compressors for Petroleum, Petrochemical and Natural Gas Industries and AGES-SP-05-002, Centrifugal Compressors (API 617) Specification shall apply.

The term **INSPECTION CLASS** where used within this document shall be taken to mean the same as **INSPECTION LEVEL** as used within 'COMPANY Specification – Equipment/Materials Criticality Rating' (Ref. 9).

4. ABBREVIATIONS

4.1 Abbreviations

The following abbreviations are only used within this document.

All other noted abbreviations used herein are defined within Appendix 1 – 'General Technical and Contractual Requirements for Rotating Equipment'.

<u>Abbreviation</u>	<u>Definition</u>
ASNT	American Society of Non-Destructive Testing
AWS	American Welding Society
CAS	Conformity Assessment System
C of C	Certificate of Conformity
FCAW	Fluxed Cored Arc Welding
GTAW	Gas Tungsten Arc Welding
MCAW	Metal Cored Arc Welding
MDMT	Minimum Design Metal Temperature
HRC	Rockwell Hardness
iFAT	Control System Factory Acceptance Test (Simulated)
MRB	Manufacturing Record Book
PIM	Pre-Inspection Meeting
PTC	Performance Test Code
RFI	Radio Frequency Interference

SECTION I – QUALITY ASSURANCE AND CONFORMITY ASSESSMENT

5. QUALITY ASSURANCE AND QUALITY CONTROL

5.1 General

- 5.1.1 The SUPPLIER shall operate a quality management system established for the supply of products or services which shall conform to ISO 9001, API Specification Q1 or equivalent quality management system standard agreed with the purchaser.
- 5.1.2 The SUPPLIER's quality management system shall have in effect at all times a QA/QC program which clearly identify the established lines of authority and responsibility of those responsible for the SUPPLIER's quality management system. Those persons responsible for quality management functions shall have ultimate authority to enforce quality assurance within the SUPPLIER's organisation and to identify, assess and implement corrective actions (CA) to deficiencies in the quality management system and to monitor the continued effectiveness of all corrective actions.
- 5.1.3 The SUPPLIER shall submit a copy of his corporate Quality Plan and valid ISO 9001 or equivalent certificate to the CONTRACTOR/COMPANY with his quotation for review prior to award. If SUPPLIER'S QA/QC program and facility, where the work is to be performed, is ISO 9001 certified and still valid, then only a copy of the SUPPLIER'S valid ISO 9000 certificate is required. If SUPPLIER'S facility is not ISO 9001 certified, the CONTRACTOR may at his discretion conduct a QA audit in accordance with ISO 9001 audit requirements, unless the SUPPLIER can provide evidence that he is operating a quality management system in accordance with ISO 9001 or equivalent quality management system international standard.
- 5.1.4 ISO 9001 Clause 8.1 and ISO 10005 may be used as a basis for the development of quality plans for specific applications, processes or products. API Spec Q2 may be used as a basis for the development of Service Quality Plans.
- 5.1.5 Quality control and associated inspection activities by the SUPPLIER on his SUB-SUPPLIER's will address both internally and externally sourced processes, products and services.
- 5.1.6 The SUPPLIER's inspection and test plan(s) shall include provisions for COMPANY/CONTRACTOR inspection; see Section 7, as specified in the datasheet or purchase order.
- 5.1.7 Irrespective of the **INSPECTION CLASS** defined within the purchase order, the SUPPLIER shall remain fully responsible for the operational planning and control of the supplied documentation, material sourcing, fabrication, manufacturing, inspection and test activities in order to ensure full conformity of the supplied products and services with the specified requirements. Refer to ISO 9001, sub-sections 8.1 and 8.2.
- 5.1.8 The SUPPLIER shall ensure that all applicable QA/QC inspection and test requirements specified by the CONTRACTOR are included within the sub-orders to his SUB-SUPPLIERS to ensure full compliance to the purchase order requirements. If requested by COMPANY/CONTRACTOR, the SUPPLIER shall provide clear evidence of the required QA/QC surveillance of SUB-SUPPLIER activities.
- 5.1.9 The SUPPLIER shall submit certified reports of production tests as soon as the tests are completed satisfactorily.
- 5.1.10 The COMPANY/CONTRACTOR reserve the right to inspect materials and workmanship at all stages of MANUFACTURE and to witness any or all tests at the SUPPLIER's and/or SUB-SUPPLIER's premises. A dedicated inspection and test plan (ITP) shall be developed by the SUPPLIER as outputs to operational planning and to ensure quality control of the products or services to be provided by the SUPPLIER and his SUB-SUPPLIERS.

5.1.11 The SUPPLIER shall provide the CONTRACTOR with a copy of the manufacturing Inspection and Test Plan (ITP) for review and inclusion of any mandatory COMPANY/CONTRACTOR required witness points no less than 30 days after contract award or prior to the Pre-Inspection Meeting (PIM), whichever comes first. The inspection and test plan (ITP) shall specify the individual tasks to be performed, the procedures used and associated acceptance criteria to be applied by the SUPPLIER, SUB-SUPPLIER and/or MANUFACTURER to ensure that the materials or services are delivered in full conformity with the specified requirements.

5.2 Criticality Assessment

A criticality assessment shall be carried out by the CONTRACTOR prior to order placement to determine the Criticality Rating of the equipment package or materials to be purchased. The applicable Criticality Rating (CR) shall then be assigned by CONTRACTOR to each piece of equipment and identified within the purchase order issued by COMPANY or CONTRACTOR.

The method used by COMPANY or CONTRACTOR to determine the Criticality Rating (CR) will be in accordance with COMPANY Specification 'Equipment / Materials Criticality Rating' (Ref. 9) which will be stated in the respective Purchase Order. The criticality rating assigned by COMPANY shall be used by the SUPPLIER to determine the required INSPECTION CLASS for the equipment. However, ALL process centrifugal gas compressors will be deemed to be **INSPECTION CLASS I** regardless of the operating conditions.

Based on the stated **INSPECTION CLASS**, the SUPPLIER shall ensure that the minimum required level of inspection and testing identified by Table 2 – Inspection Requirements and [Table 7 – Inspection & NDT Minimum Requirements](#) shall be reflected within the SUPPLIER's Inspection and Test Plan (ITP) to be submitted to COMPANY.

5.3 Quality Control Requirements

Based on the specified **INSPECTION CLASS**, the SUPPLIER shall ensure that the required level of QA/QC is implemented in accordance with "Table 2 – Inspection Requirements" and that the minimum requirements for material certification and non-destructive examination are implemented according to "Table 7 – Inspection & NDT Minimum Requirements" throughout all stages of MANUFACTURE and testing. All related verification, inspection and testing activities shall be reflected within the SUPPLIER's Inspection and Test Plan (ITP) to be submitted to COMPANY.

5.4 Quality Audits

COMPANY or CONTRACTOR reserves the right to audit the QA/QC system and manufacturing processes operated by the SUPPLIER or his SUB-SUPPLIER(s) and that such processes are being applied to the equipment/package in accordance with Quality Management Systems – Requirements (Ref. 1) and Quality Management – Guidelines for Quality Plans (Ref. 10). The COMPANY may at their discretion employ their own expertise or a nominated third party employed by the COMPANY for this purpose. Usually such an audit will be limited to major rotating equipment rated at 1 MW and above, or which has been assessed to be **INSPECTION CLASS I**.

The timing of such an audit will be mutually agreed but normally when SUPPLIER has completed the aerodynamic or rotor dynamic design and following submission of piping and instrumentation diagrams (P&IDs) and preliminary General Arrangement (GA) drawings. During such an audit, the SUPPLIER shall make available all relevant in-house fabrication and/or component drawings, data, design studies, analyses, and any other information the auditors feel is necessary to complete their task.

In the event of a conflict between any clarification, analyses or recommendations made by the audit team and the corresponding calculations, analyses, etc., made by SUPPLIER, every effort shall be made to resolve such a conflict and arrive at a mutually acceptable solution. Where mutual agreement cannot be reached, COMPANY reserves its right to insist that the SUPPLIER implements the recommended

corrective action(s) identified during the audit. SUPPLIER shall implement the action whilst retaining full technical responsibility for any corrective actions taken which shall be to his own cost.

5.5 Control of Non-Conforming Products and Services

Any non-conformance with specified requirements identified by or to the SUPPLIER prior to or during the delivery of the products and services shall be corrected by the SUPPLIER in order to satisfy the minimum specified requirements, except where the PURCHASER's formal acceptance of the non-conformance is agreed in accordance with purchase order conditions. See ISO 9001, 8.2.3, 8.2.4, 8.5.6 and 8.7.

5.6 Evidence and Records

Inspection and test plan(s), procedures, methods and inspection/test records shall be provided in accordance with Sections 5 through to Section 7 of this document and according to the agreed timing stipulated in the Information Requirements, Appendix 3.

5.7 Non-Conformance Records

Details of non-conformances raised by COMPANY or CONTRACTOR against the technical requirements prior to or during the delivery of the products or services will be identified as a Non-Conformance Record (NCR). Each NCR shall be managed by the SUPPLIER or his SUB-SUPPLIERS in accordance with ISO 9001 Clause 8.7. The associated records typically include; description of non-conformance, analysis and disposition, method of correction and implementation and full details of any retesting or inspection taken to demonstrate subsequent conformance to the specified requirements.

5.8 Concession Requests

In some cases, with prior agreement by COMPANY, a non-conforming condition may be submitted to COMPANY/CONTRACTOR in the form of a Concession Request (CR) in accordance with the concession management procedure defined within the Contract. The formal submission of a Concession Request seeking COMPANY agreement to accept a deviation from the contracted scope or technical requirements may be raised as a result of material or service availability, obsolescence, innovation or beneficial non-conformance.

Concession Requests may typically be raised by the SUPPLIER during the contract execution. A summary with a summary report detailing concessions raised, submission date, status (i.e. in progress, rejected or accepted), together with related impact on cost and delivery shall be provided with SUPPLIER monthly progress reports and finalised at contract closeout to ensure that final contract stage payment is adjusted accordingly.

5.9 Sub-Suppliers

The SUPPLIER shall assume unit responsibility and shall provide all required material and performance warranties and guarantees for the completely assembled package and auxiliary equipment.

The SUPPLIER shall be held solely responsible to ensure that all applicable QA/QC, inspection and test requirements and other technical requirements specified by the CONTRACTOR within the Purchase Order are included within the sub-orders to his SUB-SUPPLIERS to ensure full compliance to the purchase order requirements. If requested by COMPANY/CONTRACTOR, the SUPPLIER shall provide clear evidence of the required QA/QC surveillance of SUB-SUPPLIERS activities.

The SUPPLIER shall submit all relevant SUB-SUPPLIER drawings and engineering data to the CONTRACTOR in accordance with the 'Information Requirements' – Appendix 3.

6. CONFORMITY ASSESSMENT SYSTEM

6.1 General

- 6.1.1 Conformity assessment includes but is not limited to documentation review, factory inspection and testing and design validation activities.
- 6.1.2 Assessment activities may be undertaken at the SUPPLIER or SUB-SUPPLIER's premises, virtually by video link, desktop sharing or by review of information formally submitted for acceptance or for information. The type of conformity assessment (W, O, S or R) is defined in sections 6.2 to 6.5 inclusive is indicated against the required **INSPECTION CLASS** as indicated in [Table 2 – Inspection Requirements](#) in Section 7.
- 6.1.3 The SUPPLIER's ongoing performance and ability to satisfy the specified requirements will be routinely monitored and assessed during execution of the scope of works and where appropriate, corrective action requested, and conformity assessment activities increased or decreased consistent with pre-defined criticality and risk to the project.
- 6.1.4 The SUPPLIER is required to demonstrate that the requirements relating to quality control of the supplied materials, software and associated documentation to the PURCHASER are fulfilled.
- 6.1.5 There are two different levels of assessment of the SUPPLIER's quality control activities by the purchaser (second party) or independent body (third party) which are based on a defined 'Criticality Assessment' of the supplied equipment and an evaluation of the SUPPLIER's experience and capability to provide the product or service in accordance with the applicable specifications, codes and standards. The applicable **INSPECTION CLASS** is specified by the purchaser in the equipment datasheet. **INSPECTION CLASS I** reflects the highest risk and associated extent of verification.
- 6.1.6 The SUPPLIER shall ensure that the required information is submitted to the PURCHASER where required "For Acceptance" or "For Information" and by the agreed time(s) specified within the 'Information Requirements' Appendix 3. The submission of the required information shall be managed in a timely manner by the SUPPLIER to reflect the information review period(s) agreed with PURCHASER. The SUPPLIER shall allow sufficient time within the manufacturing/fabrication schedule for review of all submitted information and incorporation of client comments so as not to incur delay to the agreed contractual delivery dates.

6.2 Witnessed Test or Inspection (W)

Inspection or test for which 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 (ANSI/API Std 617 8th Edition, clause 3.1.6.6).

6.3 Observed Inspection or Test (O)

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, regardless of whether the PURCHASER or his representative is present (ANSI/API Std 617 8th Edition, clause 3.1.34).

6.4 Surveillance (S)

Observation or monitoring by the PURCHASER or PURCHASER's representative of the SUPPLIER's or SUB-SUPPLIER's manufacturing or fabrication activities, associated operations, coating processes, material certification or other associated product design information.

Assessment activities may be undertaken at a SUPPLIER or SUB-SUPPLIER's premises, virtually by video link, desktop sharing etc. or by review of information formally submitted for acceptance or for information.

6.5 Information Review (R)

Review of the SUPPLIER's product design information by the PURCHASER or PURCHASER's representative to determine conformity to the specified requirements.

SECTION II – INSPECTION AND TESTING REQUIREMENTS

7. INSPECTION AND SURVEILLANCE REQUIREMENTS

This section defines the required minimum level of inspection for the supplied equipment based on the applicable INSPECTION CLASS. For API 617 centrifugal compressors **INSPECTION CLASS I** will apply in all cases. INSPECTION CLASS II and III do not apply.

The SUPPLIER shall include the required design validation, manufacturing controls, materials inspection and testing in accordance with the specified INSPECTION CLASS when developing the relevant quality plans and inspection and test plans. The minimum levels of inspection are defined within [Table 2 – Inspection Requirements](#).

The SUPPLIER shall submit certified reports of production tests and shop tests as soon as the tests are completed satisfactorily.

The COMPANY or CONTRACTOR reserves the right to inspect materials and workmanship at all stages of MANUFACTURE and to witness any or all tests. The SUPPLIER shall provide the COMPANY/CONTRACTOR with a copy of its Inspection and Test Plan (ITP) for review and inclusion of any mandatory COMPANY/CONTRACTOR inspection and witness points no later than 30 days after award and prior to the Pre-Inspection Meeting (PIM).

Table 2 – Inspection Requirements

Item No.	WORK, MANUFACTURING OR TEST ACTIVITY	Governing Document	INSPECTION CLASS		
			I	II	III
1	Planning and Control Activities				
1.1	Quality plan	(ISO 9001, 8.1, ISO 10005)	R		
1.2	Inspection and Test Plan (ITP)	(ISO 9001, 8.1 and ISO 10005, New Standard Part 1, 6.1.7)	R		
1.3	Kick-off meeting (KOM) and Pre-Inspection Meeting (PIM)		W		
2	Design and Development Activities				
2.1	Design verification review as required Review that MANUFACTURE is against accepted revision of documents.	(ISO 9001, 8.3)	R		
2.2	Weld procedure specification (WPS) and procedure qualification records (PQR).	(ANSI/API Std 617, Part 1, Para 4.5.2.3.1) or as specified in New Standard, 4.5.1.19 Note: *For INSPECTION CLASS I, "W" witnessed activity shall apply for Super Duplex Stainless Steel (SDSS) and high nickel alloys.	R*		
2.3	Non-destructive examination (NDE) procedures.	(ASME BPVC V, Non-destructive examination: NDE procedures in accordance with ASME V and	R*		

Item No.	WORK, MANUFACTURING OR TEST ACTIVITY	Governing Document	INSPECTION CLASS		
			I	II	III
		acceptance criteria in accordance with ASME VIII Div. 1.) or as specified in Section 8.6 Note: *For INSPECTION CLASS I, "W" witnessed activity shall apply for Super Duplex Stainless Steel (SDSS) and high nickel alloys.			
2.4	Selection of raw materials used in the construction of compressor parts. Compile Bill of Materials (BOM) for complete assembled unit.	(ANSI/API Std 617, Parts 1, 2, 3 & 4, Para 4.5 and Parts 2, 3 & 4, Annex D) and as specified in New Standard, Section 4.5.	R		
3	Control of External Supply				
3.1	External supply scope, risk assessment and controls.	(ISO 9001, 8.4)	R		
4	Materials and Component Manufacturing				
4.1	Material certification and traceability.	(ANSI/API Std 617, Para 4.5.1.18.1 and New Standard Section 4.5)	S		
4.2	Surfaces of castings.	(ANSI/API Std 617, 4.5.2.1)	O		
4.3	Compliance of welding materials.	(ASME BPVC.II Part C)	S		
4.4	Fabrication				
4.4.1	Baseplate MANUFACTURE.	(ANSI/API 617, Parts 1-4, Para 5.4 and New Standard, Section 5.4) flatness and coplanarity of baseplate equipment mounting pads	O		
4.5	Inspection, testing and verification activities.	(ANSI/API Std 617, Parts 1-4, Para 6.0 and 8.3 and New Standard, Section C)			
4.5.1	All welders have been qualified on approved welding procedures.	(ANSI/API Std 617, Part 1, Para 4.5.2.3.1) or as specified in New Standard, 4.5.1.6	R		
4.5.2	Weld repair procedure (excluding major weld repairs).	(ANSI/API Std 617, 4.5.2.1 and New Standard, 4.6.2.3.1)	R		
4.5.3	Weld repair procedure (major) maps and other specified documentation.	(ANSI/API Std 617, 4.5.4.2 and New Standard, 4.6.2.3.1)	W		
4.5.4	Inspection of major weld repairs.	(ANSI/API Std 617, 4.5.4.2 and New Standard, 4.6.2.2)	W		

Item No.	WORK, MANUFACTURING OR TEST ACTIVITY	Governing Document	INSPECTION CLASS		
			I	II	III
4.5.5	Non-destructive examination personnel performing non-destructive examinations are qualified and certified.	In accordance with the requirements of Article 1, Section V of ASME BPVC and New Standard, Section 8.6	R		
4.5.6	Pressure casing inspection including all welds associated with the casing.	(ANSI/API Std 617, 6.2.2 and New Standard, Section 8.6). Inspection timing (ANSI/API Std 617, 6.1.1 & 6.1.2)	O		
4.6	Non-destructive examinations of component parts.	(ANSI/API Std 617, 6.2.2)	O		
4.7	Positive material identification.	(ANSI/API Std 617, Part 1, Para 4.5.1.18 and New Standard, 4.5.1.18.1)	O		
4.8	Verify that the heat treatments, including PWHT, have been performed.	(ASME IX, Sec IX) ANSI/API Std 617, 4.5.3.2.1 and New Standard)	R		
4.9	Shaft and rotors.	(ANSI/API Std 617, Part 1, Para 4.7, 4.7.10, 4.8.8.2.1 including Equation 3 or Equation 4) and New Standards Section 4.7	O		
4.10	Dry Gas Seals	Refer to Annex F			
4.11	Rotating component balancing.	(ANSI/API Std 617, Part 1, Para 4.8.8 and New Standards, Section 4.7)	R		
4.12	Wear rings and running clearance verification.	(ANSI/API Std 617, Table 6) and New Standards, Section 4.7 & 4.9)	R		
4.13	Cleanliness check prior to final assembly.	(ANSI/API Std 617, Part 1, Para 6.2.1.5 and New Standard)	O		
4.14	Inspection and test equipment calibration certificates.		R		
4.15	Hydrostatic testing activities.	(ANSI/API Std 617, Part 1, Para 6.3.2 and New Standard)	W		
4.16	Auxiliary equipment testing.	(ANSI/API Std 617, Part 1, Para 6.3.7.5, Part 2, Para 6.3.3.2 & Part 3, Para 6.3.3.2 and New Standard 8.3.4.6)	O		
4.17	Performance testing.	(ANSI/API Std 617, Part 1, Para 6.3.7.1 and New Standard)	W		
4.18	Mechanical run testing.	(ANSI/API Std 617, Part 1, Para 6.3.5, Part 2, Para 6.3.1 & Figure 4, Part 3, Para 6.3.1 & Part 4, Para 6.3.3 and New Standard)	W		

Item No.	WORK, MANUFACTURING OR TEST ACTIVITY	Governing Document	INSPECTION CLASS		
			I	II	III
4.19	Sound level testing.	(ANSI/API Std 617, Part 1, Para 6.3.7.4 and New Standard)	W		
4.20	Complete unit testing.	(ANSI/API Std 617, Part 2, Para 6.3.3.2 & Part 3, Para 6.3.3.2 and New Standard)	W		
4.21	Bearing housing resonance test.	(ANSI/API Std 617, 4.8.7 and New Standard)	W		
4.22	Structural resonance test.	(ANSI/API Std 617, 4.8.7 and New Standard)	W		
4.23	Disassembly after testing.	(ANSI/API Std 617, 8.3.3.8 and New Standard)	W		
4.24	Hydrodynamic bearing inspection after testing.	(ANSI/API Std 617, Part 3, 6.3.7.2.1 and Annex E and New Standard)	W		
4.25	Surface preparation and painting.	(ANSI/API Std 617, Part 1, Para 4.5.2, 5.4.1.2.14, 5.2.1.4.15 and 6.4.3.1 and New Standard)	O		
5	Release of Product or Service.				
5.1	Final Inspection. Verify conformity to PO including as applicable				
5.1.1	Complete skid overall dimensions including holding down bolt hole and connection sizes and locations.	Equipment General Arrangement Drawings and P&IDs (Accepted by COMPANY)	W		
5.1.2	Couplings and guards.	(ANSI/API Std 617, Part 1, Para 5.2 and New Standards, 4.8.8.2)	W		
5.1.3	Compressor nameplate and rotation arrows.	(ANSI/API Std 617, Part 1, Para 4.12 and New Standards, 4.12)	W		
5.2	Loose ship items, spares and special tools as applicable.		W		
5.3	Test moments My and Mz to be applied in combination to compressor Suction and Discharge Nozzles (but not both nozzles simultaneously).	(ANSI/API Std 617, Parts 2,3 & 4, Annex F).	W		
5.4	Preparation of preservation, packing and storage (including loose ship items, spares and special tools).	(ANSI/API Std 617, Part 1, 6.4 and New Standards, Section C)	W		
5.5	Final documentation review.	New Standards Appendix 2 "Information Requirements"	R		
5.6	Inspection release note.		W		

Item No.	WORK, MANUFACTURING OR TEST ACTIVITY	Governing Document	INSPECTION CLASS		
			I	II	III
W is witness point, O is observed point, S is surveillance and R is review of documentation. Definitions are provided in Clause 3.					

SECTION III – SHOP FABRICATION AND NDT

8. MATERIALS

8.1 General

- 8.1.1 Refer to 'General Technical and Contractual Requirements', Appendix 1 for general requirements relating to materials for all rotating equipment.

8.2 Manufacturing Data Records

- 8.2.1 The SUPPLIER shall keep the manufacturing data available for examination by the CONTRACTOR or his representative upon request. The manufacturing data shall be kept for at least 30 years.

8.3 PMI Testing

- 8.3.1 Positive Material Identification (PMI) testing is required for all alloy pressure-containing materials, piping components, and heat exchanger tubes.
- 8.3.2 The extent of PMI testing for all alloy parts shall be 100% unless otherwise agreed with COMPANY. Any proposed reduction to the extent of PMI is subject to COMPANY approval.
- 8.3.3 Positive material identification shall be carried out in accordance with relevant COMPANY business unit standards. The SUPPLIER shall submit a report including copies of test instrument calibration certificate(s) to provide verification that the alloying element percentages of materials are in accordance with the proposed recognised material specification.

8.4 Pressure Containing Parts

- 8.4.1 All steel castings shall meet the requirements of ASME Section VIII, Division 1, Appendix 7.
- 8.4.2 Plates from which pressure-containing components are to be cut, forged, rolled or formed in any other manner, shall be subject to systematic ultrasonic inspection for laminations in accordance with ASTM A578-S9.
- 8.4.3 All pressure casings for compressors shall be forged material. All welds in the casing, including those in piping attached to the casing, shall be examined radiographically or ultrasonically. Radiographic examination (RT) shall be performed in accordance with ASME V, Part. 2 and acceptance criteria shall be according to ASME VIII Div. 1, UW-51. UT shall be in accordance with ASME V, Part. 4 and acceptance criteria shall be in accordance with ASME VIII Div. 1, UW-53". In addition, all welds in the casing shall be examined by MT or PT (non-ferrous material) on both external and internal surfaces to the maximum extent possible. MT shall be performed in accordance with ASME V Article 7 with acceptance criteria in accordance with ASME SEC VIII Division 1, Appendix 6. PT shall be performed in accordance with ASME V Article 6 with acceptance criteria in accordance with ASME VIII Division 1, Appendix 8. All non-destructive examination(s) shall be carried out after PWHT has been completed.
- 8.4.4 Permanent weld backing bars are unacceptable. Temporary backup bars must match the chemical composition of the base metal being welded. Welding filler metal shall be similar with respect to the chemistry, corrosion resistance, and physical properties of the base metal being welded. Temporary backing bars shall be removed before performing RT.
- 8.4.5 The ASME Welding Procedure Specifications (WPS), Procedure Qualification Records (PQR), and Welder Qualifications Records shall be available to the CONTRACTOR for review upon request or submitted for review and approval to CONTRACTOR as specified in the requisition. Welding of piping shall conform to

relevant COMPANY business unit standards. Review of WPS, PQR and NDE procedures is mandatory for all equipment under INSPECTION CLASS 1, sour service applications, duplex stainless steel and other superior CRA materials.

- 8.4.6 Destructive mechanical tests, including impact tests if required, shall be carried out on test blocks after all heat treatments have been performed, including those for possible repairs.
- 8.4.7 All connecting nozzles (if any) to the casing(s) shall be "set through" type and shall be subject to 100% RT or UT and MT/PT examined for the entire length in accordance with section 8.4.3.

8.5 Welding Consumables

- 8.5.1 Welding consumables should be stored in their original unopened packaging in an area shielded from the elements. The SUPPLIER shall follow the MANUFACTURER's recommended procedures relating to storage, handling and re-conditioning of electrodes according to type. The following summary below provides guidelines as to the proper storage of stick electrodes, flux-cored wires, metal-cored wires, and solid wires (MIG wire and TIG cut length).
- 8.5.2 Low Hydrogen Electrodes (stick electrodes) shall be classified per AWS as EXX15-X, EXX16-X, and EXX18-X. These electrodes must be dry to perform adequately. MANUFACTURERS typically supply these electrodes in hermetically sealed containers which provide proper protection under good storage conditions. Open containers of low hydrogen electrodes must be stored in a cabinet at 120°C – 150°C.
- 8.5.3 Moisture resistant coatings ("R" designation) have higher resistance to moisture pick up but should be stored in the same manner. The "R" designation allows for more exposure time before the electrode needs to be re-dried. It is recommended that low hydrogen electrodes without the "R" designation be supplied twice per shift to stay below the permissible 4 hours of exposure. AWS D1.1 Structural Welding Code Table 5.1 specifies allowable atmospheric exposure which can be seen below.
- 8.5.4 Low hydrogen electrodes may be re-dried if they exceed exposure limits following the MANUFACTURERs recommended procedures. It is critical to avoid drying electrodes at temperatures above those recommended. Also, longer hold times at lower temperatures is not equivalent as holding the right temperature for the specified time. For additional information on storing and re-drying low-hydrogen electrodes read Storing and Re-drying Low Hydrogen Electrodes.
- 8.5.5 Where non-low hydrogen electrodes are exposed to humid air for long periods of time the welding characteristics may be affected. If moisture appears to be causing problems, it is recommended to store open containers in cabinets heated to 38°C – 49°C.
- 8.5.6 The MANUFACTURERs shall supply metal cored and fluxed wires in packages that provide proper protection when stored indoors with a relative humidity not higher than 70%. It is important to store in areas that minimize temperature variations to avoid condensation on the consumables.
- 8.5.7 Materials shall be stored in the original, unopened packaging in a covered dry location until it's time to use. For applications in which the weld metal hydrogen must be kept under a specific amount (usually 8mL/100g H₂ or lower) only use product supplied in hermetically sealed packaging.
- 8.5.8 For storage of FCAW and MCAW wires that have been opened the recommendations below shall be followed:-
- Use within a week of opening original packaging
 - Do NOT expose open wires to damp conditions or extreme temperature changes
 - When not in use place wire back in its original packaging (bag and box) and seal as best as possible
 - Discard any wire that has been exposed to moisture and shows signs of rust.

- e) Flux-cored wire should not be left out in the open when not in used as it is prone to moisture pick up.

8.5.9 Solid wires and GTAW electrodes are not as susceptible to moisture pick up, however they shall be stored in similar fashion as noted above. Store in unopened container until it is time to use. Store in areas protected from rain and snow, avoid severe fluctuations in temperature and protect from condensation. Discard if wire shows rust on its surface.

8.5.10 Reference shall be made to AWS D1.1/D1.1M: 2015 Structural Welding Code – Steel

8.6 Weld Procedure Specifications, Weld Procedure Qualification Records and Weld Maps

8.6.1 Welding

Fabrication and welding shall be carried out in accordance with ASME BPVC, Section IX. The minimum requirements relating to shop fabrication including WPS, WPQR and welder qualifications, PWHT, NDT procedures, NDT operator qualifications, impact testing, sour service requirements and weld repairs are detailed in the following sections [8.6.2](#) to [8.6.8](#).

8.6.2 Weld Procedure Specification and Weld Procedure Qualification Records

The SUPPLIER shall submit a WPS and associated WPQR for each different weld type forming part of the fabricated sections of the equipment or package. The SUPPLIER shall provide detailed weld map(s) to clearly identify each weld and to show the location and type of the proposed weld referencing the Weld Procedure (WPS) and associated Weld Procedure Qualification Record (WPQR) in each case.

8.6.3 Welder Qualification

Each welder shall be qualified to perform the required welding process using a qualified and approved Weld Procedure Specification (WPS). The welder's name, welder identification no., WPS number, weld location and NDT method used shall be recorded on a separate weld map for each fabricated item in accordance with the applicable code requirements. Shop fabrication procedures including WPS, WPQRs, WQs, NDE procedures, NDE reports and associated weld maps will be subject to approval by a nominated third-party inspection authority when specified in the purchase order.

8.6.4 Post Weld Heat Treatment

Post Weld heat Treatment (PWHT) shall be carried out in accordance with the applicable WPS and WPQR. Heat treatment records shall be submitted within the Manufacturing Record Book (MRB) which shall identify the time chart of measured temperature and duration of heat treatment.

8.6.5 NDT Operator Qualifications

Qualification and certification of all NDT operators shall be according to Recommended Practice No. SNT-TC-1A & CP-189 Personnel Qualification and Certification in Non-Destructive Testing or EN ISO 9712. Operators shall be ASNT Level 1, 2 or 3 in accordance with the ASME V Article 1 requirements for each NDE process, material/weld thickness, weld location and type of weld under examination.

8.6.6 Impact Testing

Impact testing shall be carried out on all welds in low temperature service at the Minimum Design Metal Temperature (MDMT) in accordance with ASME Code Section VIII Division 1, UG-20(b), UCS-66(a), UCS-66(b) and UCS-68(c). The Charpy v notch energy values obtained shall satisfy the minimum impact test values specified within ASME BPVC, Section VIII Division 1, UCS-67 'Impact Tests of Welding Procedures'. Impact testing mandatory for sour service applications irrespective of MDMT indicated on

datasheets. If the MDMT is greater than -15°C, the required test temperature(s) and impact energy values shall be mutually agreed with COMPANY at the proposal stage.

All materials in low temperature service shall undergo impact testing at or below the specified MDMT. The respective original material certificates shall record full details of the Charpy impact energy values obtained in accordance with BSEN10204:2004.

8.6.7 Sour Service Requirements

All materials intended to be in contact with sour liquids or H₂S shall conform in all respects to MR0175/ISO 15156 or NACE MR0103/ISO 17945 and references therein.

8.6.8 Major Weld Repairs

Prior to performing any weld repair on wrought material or any major* weld repair on cast material, the MANUFACTURER shall submit details of the proposed weld repairs for COMPANY approval, along with the relevant WPS and PQR. In the event of major weld repairs being required, weld repair maps showing location and major dimensions of weld repair cavities, applicable qualification records, drawings, photographs, heat treatment procedures, further NDE procedures and detailed records of all repairs shall be submitted to COMPANY for review and approval.

No repairs/modifications of any type (minor or major) shall be done after equipment has been released for shipment. Both major and minor repairs shall be reported to COMPANY.

a) For weld repairs on pressure containing parts, the following shall apply:

1. COMPANY approval shall be obtained before any major weld repair is carried out.
2. All repairs shall meet the inspection requirements and acceptance standards of the original material. Major repairs shall be inspected by the COMPANY which shall be notified at least one week in advance of starting the repair.
3. Repair procedures for major* weld repairs are subject to approval of the COMPANY. Repair welder qualifications shall be reviewed and approved by CONTRACTOR.
4. The total quantity of weld metal deposited shall be less than 10% of the mass of the casing. This shall be determined by weighing the casing before and after weld repairs. Where the quantity of weld repair exceeds 10% of the mass of the casting, the repair shall not be acceptable.
5. Weld repairs shall be suitably heat-treated if this is specified in the relevant material specification and/or manufacturing standard. A major* weld repair shall always be followed by a heat treatment.
6. Details of all major* weld repairs and the heat treatment shall be recorded and reported to the COMPANY.

*NOTE: A weld repair of a casting is defined as "major" if a repair weld has a depth of more than 50% of the wall thickness or has a length of more than 150 mm in one or more directions, or if the total surface area of all repairs on the casting exceeds 10% of the total casting surface area. A weld repair necessitated by a leaking pressure test is also classed as "major".

b) The repair of leaks and defects in pressure-containing castings is not allowed by peening or burning-in, or by impregnation with plastics or cement compounds. Repair by welding or by plugging shall be undertaken only when permitted by the material specification and/or manufacturing standard, and then, only in accordance with the procedures detailed in this and relevant specifications (see d below).

- c) Weldable grades of castings may be repaired by welding subject to the following criteria:
 - 1) Criteria as per a. above.
 - 2) The repair welding procedures and the repair welder's qualifications shall be in accordance with ASTM A488 or ASME Section IX.
 - 3) Other criteria may exist in applicable Specifications.
- d) Repair by Plugging
 - 1. The need for repair by plugging shall be reported to COMPANY before any repair is carried out.
 - 2. Nodular iron may be repaired by plugging within the limits specified in ASTM A395. The drilled holes for plugs shall be carefully examined by dye penetrant to ensure removal of all defective material.
 - 3. All necessary repairs by plugging not covered by ASTM shall be subject to approval by COMPANY.
 - 4. Details of all repairs by plugging shall be recorded and included in the manufacturing report.
- e) When defects are found which necessitate a major* weld repair, the casting shall be inspected to the next more severe inspection class unless the initial inspection was already the highest.

8.7 Non-Destructive Examination

The extent of Non-Destructive Examination (NDE) to be applied to the equipment/package is defined in [Table 7 – Inspection & NDT Minimum Requirements](#) included in Section 10. The procedures and acceptance criteria are given in the following paragraphs.

Prior to starting fabrication activities, the SUPPLIER shall submit NDT procedures to COMPANY for approval.

8.7.1 Radiographic Examination (RT)

a) RT of castings shall be performed in accordance with ASME Section VIII, Division 1, Appendix 7. Critical sections of each casting (including regions of abrupt section changes, weld ends, areas adjacent to feeders and raisers) shall be fully radiographed. Where such sections cannot be radiographed, UT shall be substituted (also in accordance with ASME Section VIII, Division 1, Appendix 7). Acceptance standards for castings shall be in accordance with

Table 3 below.

The SUPPLIER shall submit, for COMPANY'S approval, details of the critical sections proposed to receive RT/UT. All personnel performing and interpreting the results of the various NDE techniques shall possess appropriate nationally recognized qualifications.

b) RT of welds shall be in accordance with ASME Section VIII, Division 1, UW-51. Coverage shall be 100 percent.

Table 3 – Acceptance Criteria for Castings

SECTION THICKNESS (mm)		<25	25 TO 50	51 (and above)
Defect Category		Degree of Severity		
A	Gas Porosity	2	3	3
B	Sand and Slag	2	3	3
C	Shrinkage (All Types)	2	2	2
D, E	Cracks and Hot Tears	Not Acceptable		

8.7.2 Ultrasonic Examination (UT)

a) UT of welds shall be in accordance with ASME Section VIII, Division 1, Appendix 12. Coverage shall be 100%. Phased Array Ultrasonic Test (PAUT) or Time of Flight Diffraction (TOFD) method shall be employed for all casing and nozzle welds.

b) UT of wrought material shall be in accordance with ASME Section V, Article 5. The Acceptance Criteria shall be as follows:

1) Austenitic forgings (Reference ASME Section V, SA-745)

- QL-1 for straight beam, t = 0 to 75 mm.
- QL-2 for straight beam, t = 76 to 200 mm.
- QA-2 for angle beam, all thicknesses

2) Non-austenitic forgings (Reference ASME Section V, SA-388)

For straight beam examination, back reflection method, no areas shall have a loss of 95 percent for more of the reference back reflection.

For straight beam examination, reference block method, there shall be no indications equal to or larger than the indication received from the reference block constructed with the following flat-bottomed holes:

- 1.5 mm for t = 0 to 37 mm.
- 3 mm for t = 38 to 150 mm.
- 6 mm for t = 151 mm and greater.

For angle beam examination, there shall be no indications equal to or larger than the indication received from the reference notch or amplitude reference line.

3) Plate Material

Acceptance criteria in accordance with ASME Section V, SA-435 and SA-577, depending on the purpose.

4) Tubular Material

Acceptance criteria in accordance with ASME Section V, SE-213, in which the calibration notch shall take the following form:

- Shape shall be rectangular.
- Depth shall be maximum 5 percent of the nominal wall thickness.
- Length shall be 25 ± 5 mm.
- Width shall be no greater than twice the depth

5) Castings

Castings shall be UT examined in accordance with SA 609. Manual UT and RT may be substituted by AUT (TOFD and Phased Array) subject to approval by COMPANY.

8.7.3 Magnetic Particle Examination (MT)

MT shall be applied to all accessible surfaces, including those exposed by machining. Indications shall be investigated by light grinding (1 mm maximum depth).

MT of castings shall be performed in accordance with ASME Section VIII, Division I, Appendix 7.

MT of welds and wrought material shall be performed in accordance with ASME Section VIII, Division 1, Appendix 6.

8.7.4 Penetrant Examination (PT)

PT shall only be performed when specified MT is not possible; in which case it shall be done in accordance with ASME Section VIII, Division 1, Appendix 7 (castings) or Appendix 8 (welds and wrought material - all services to be examined).

8.7.5 Visual Inspection (VI)

VI shall be performed in accordance with ASME V, Article 9. All surfaces (including welds) shall be inspected. Acceptance criteria for pressure-containing steel castings shall be in accordance with MSS SP-55. Acceptance criteria for other parts shall be in accordance with the material specification and the MANUFACTURER'S documented procedures. VI acceptance criteria of welds shall be in accordance with ASME VIII Division 1.

8.8 Allowable Linear Defects

The maximum size of liner defects permitted within forgings and castings is defined by Table 4 below.

Table 4 – Maximum Size of Linear Defects

Criteria	Maximum linear defect - mm (in)		
	Less than 13mm (0.5in)	13mm to 25mm (0.5 to 1in)	Greater than 25mm (1in)
QL1 forgings and castings machined surfaces	5mm (0.2in)	5mm (0.2in)	5mm (0.2in)
QL2 and QL3 forgings and castings	5mm (0.2in)	10mm (0.4in)	15mm (0.6in)

8.9 Repair Techniques

The following repairs (whether at shop or site) need prior approval of COMPANY. If CONTRACTOR and/or SUPPLIER proceed with the repair without obtaining prior COMPANY approval, the subject part/item/component shall automatically be rejected by the COMPANY'S inspector.

- Major* weld repairs
- Repairs to leaking pressure-containing parts.
- Straightening of shafts
- Rectification of fits/tolerances/clearances by the application of metal coatings or overlays.
- Repairs (of any type) to rotating parts.
- Repairs necessitated by internal rubs for any reason.
- Repairs/alterations to bearings.
- Repairs/alterations to shaft sealing systems.
- Alterations to control system and/or its software.

8.10 NDE Acceptance Criteria

NDE Acceptance Criteria for each type of inspection shall be applied in accordance with the methods defined by Table 5 below.

Table 5 – NDE Acceptance Criteria

Inspection	Methods	Acceptance Criteria	
		Fabrications	Castings
RT	ASME Code Section V, Article 2	ASME Code Section VIII, Division 1, UW-51 (for 100% radiography) and UW-52 (for spot radiography)	Procedure and acceptance standards shall conform to ASME VIII Division 1, Appendix 7.
UT	ASME Code Section V, Article 5 & Article 23	ASME Code Section VIII, Division 1, Appendix 12	Procedure and acceptance standards shall conform to ASME VIII Division 1, Appendix 7
MP testing ¹	ASME Code Section V, Article 7 & Article 25	ASME Code Section VIII, Division 1, Appendix 6	Procedure shall conform to ASME VIII Division 1, Appendix 7. Acceptance standard shall conform to ASME VIII Division 1, Appendix 7, except that maximum size of linear indications shall conform to Table 4.
LP testing	ASME Code Section V, Article 6 & Article 24	ASME Code Section VIII, Division 1, Appendix 8	Procedure shall conform to ASME VIII Division 1, Appendix 7. Acceptance standard shall conform to ASME VIII Division 1, Appendix 7, except that maximum size of linear indications shall conform to Table 4
VI	ASME BPVC, Section V, Article 9	In accordance with the material specification and the MANUFACTURER's documented procedures and ASME VIII Division 1	Cast surfaces of component pressure boundaries shall conform to MSS SP 55, except that: -Type 1 defects will not be permitted -Defects in excess of plates "a" and "b" for type II through type XII will not be permitted ²
¹ LP testing may be substituted for MP testing, if MP testing is not feasible ² Refer to ASME B16.5, paragraph 5.1.4			

8.11 NDE Records

Detailed non-destructive examination reports shall be included in the MRB describing the procedure used, results obtained for visual, radiographic, ultrasonic, magnetic particle, and dye-penetrant examinations.

All inspection and test reports shall be signed and dated by an authorized operator and identify components tested, location, heat-treated condition, and other requirements per Project specifications. The above

reports shall be available for inspection at the SUPPLIER's works by CONTRACTOR or by COMPANY upon giving due notice of inspection at each stage of MANUFACTURE/fabrication.

9. MATERIAL CERTIFICATION AND TRACEABILITY

9.1 Material Certificates

- 9.1.1 The SUPPLIER shall furnish material certification for individual components of Centrifugal Compressors in accordance with the minimum requirements specified in Table 6 – Material Certification for Compressor Parts. Material inspection certificates shall be provided in accordance with Table 1 of ISO 10474:2013 or Table A.1 of EN 10204:2004.

Table 6 – Material Certification for Compressor Parts

EQUIPMENT COMPONENT / MATERIAL	CERTIFICATE TYPE required as per BSEN10204:2004
All pressure retaining and stress bearing parts including attachments (casing, end covers, main process nozzles & casing bolts)	3.1
Rotating components (shaft, impeller, sleeves), Internals (inner barrel diaphragms, guide channels, labyrinths, etc.)	3.1
Shaft seals, bolting, All other auxiliary piping, valves, flanges & connections	3.1
Non-pressure parts	3.2
Structural steelwork, baseplates	3.1
Gaskets	2.2
Non-metallic materials	2.2

Notes

1) If specified on equipment datasheets, Type 3.2 certification shall be provided for materials subject to weld overlay or for special metallurgy such as SSDS, Inconel, Monel, Hastelloy, etc. or where application is considered critical.

2) Type 3.2 certification shall be provided for casing nozzles if they are in "cast" form and welded to forged casing.

3) For other metallic parts including base plates and structural steel components, Type 3.1 certification is acceptable.

- 9.1.2 The SUPPLIER shall provide either original material certificates or true verified copies of the original material certificate(s) or mill certificates which shall contain the original "date stamp" and verifying signature of the SUPPLIER's QA/QC inspector. Unverified copies of certificates are not acceptable.
- 9.1.3 Stockist certificates are not acceptable unless they are accompanied by copies of the original works certificate.
- 9.1.4 The certificates shall be in English language or shall include an English translation. Metric units shall be used. The certificates shall be complete, legible and suitable for subsequent microfilming and photocopying. The certificates, combined if necessary, shall represent the material in the final condition.

9.1.5 The different types of material certificate are defined as follows in accordance with BSEN 10204:2004 or ISO 10474:2013.

9.2 Material Traceability and Marking

9.2.1 All pressure retaining castings shall have the material designation embossed or engraved on each part.

9.2.2 Marking is required for all pressure casings and for component parts requiring Type 3.1 or 3.2 material certificates. Parts with a wall thickness in excess of 5 mm, except those items MANUFACTURED from austenitic stainless steel or from nickel alloys, shall be legibly marked by hard-die stamping on to a painted background at a place clearly visible later. Pipes should be marked at a point approximately 250 mm from one end.

9.2.3 Only low-stress stamps (dot-type or round-nosed with minimum radius of 0.25 mm) shall be used for hard-die stamping.

9.2.4 For items MANUFACTURED from austenitic stainless steel or nickel alloys, and for items with a wall thickness of 5 mm or less, the marking shall be applied by stencil using a water-insoluble ink which contains no injurious substances such as metallic pigments, sulfur, sulfides or chlorides which could attack or harmfully affect the material.

9.2.5 The stamping/marking shall include:

- Material MANUFACTURER'S symbol and, where applicable, the independent inspector's symbol; these symbols shall be identical to the symbols on the material certificate.
- Material identification.
- Heat, charge or batch number to relate to the material certificate.
- Heat treatment symbol or code, where applicable.
- Non-destructive testing symbol or code, where applicable.
- Size and schedule, where applicable.
- Hydrostatic test pressure, where applicable.

Note: Where the size of the item does not permit complete marking, the above identification marks may be substituted by a unique code which is fully traceable to the material certificate for the item.

10. NDT AND MATERIAL CERTIFICATION REQUIREMENTS

The following table defines the minimum levels of NDT that shall apply for the components of API Centrifugal Compressors.

Table 7 – Inspection & NDT Minimum Requirements

Equipment Component	Required Inspection (Notes)
Compressor casing – cast	VI, RT or UT and MT or PT (Notes 2 & 4)
Compressor casing – wrought (forgings, plates and tubulars)	VI, RT or UT and MT or PT (Notes 2 & 4)
Compressor casing – fabricated	VI, UT and MT or PT and RT (Notes 2 & 4)
Compressor inner barrel	VI, RT or UT and MT or PT (Note 2)
Welds - full penetration welds including aux. pressure piping	VI, RT or UT and MT or PT (Note 3)
Welds - fillet welds, flange surfaces, gasket sealing surfaces	VI, MT or PT
Diaphragms, guide channels	VI, MT or PT (Note 2)
Labyrinths	VI
Shaft	VI, UT and MT or PT (Note 2 & 4)
Impellers	VI, RT or UT and MT or PT (Notes 2 & 4)
Shaft sleeves, balance piston	VI, MT or PT
Bearing housing, bearings	VI, MT or UT
Shaft seals	VI of sealing surfaces (Note 5)

Notes

1. VI = Visual Examination; MT = Magnetic Particle Examination; PT = Liquid Penetrant Examination (fluorescent); RT = Radiographic Examination; UT = Ultrasonic Examination (phased array). Hardness testing, impact testing as applicable. All Radiographs shall be digitized and cross reference to part numbers and NDE records shall be ensured while submitting manufacturing data book.
2. Both raw material and finished component requires inspection (as applicable).
3. For LO and utility auxiliary systems, RT/UT shall be 10%. For process connections RT/UT shall be 100%.
4. 100% RT or UT shall be applied for casing, shaft and impellers.
5. For other metallic components, refer to API 692 and other metallurgical inspections as required.

SECTION IV – SHOP TESTING AND SITE ACCEPTANCE TESTS

11. FACTORY INSPECTION AND TESTING

11.1 General

- 11.1.1 Inspection and testing shall comply with this specification, datasheets and requisition. COMPANY reserves the right to assign a third-party inspector to attend/observe/witness any or all the inspection and testing activities at SUPPLIER'S or SUB-SUPPLIER'S shop. Testing requirements shall be construed to apply for each item. No sample or random testing is allowed.
- 11.1.2 Only measuring equipment that can be demonstrated to have been previously calibrated satisfactorily and still be within its documented calibration period (interval) shall be used for inspection and testing.
- 11.1.3 The SUPPLIER shall notify all his SUB-SUPPLIERS of inspection and testing requirements in accordance with the submitted ITP and related controlling specifications.
- 11.1.4 Tests other than witnessed and observed may also be attended by CONTRACTOR or his representative. COMPANY and/or CONTRACTOR or their representatives shall not be barred from attending a "Non-Witnessed" test and evaluating its outcome. Any test noted as "Required" without any further definition shall be understood to be "Non-Witnessed".
- 11.1.5 Sub-orders issued by SUPPLIER to SUB-SUPPLIERS shall include the relevant specifications provided by the PURCHASER where applicable to the materials and equipment to be purchased.

11.2 Pre-Inspection Meeting

- 11.2.1 A Pre-Inspection Meeting shall be held at the SUPPLIER's works prior to start of manufacturing of all compressors. Additional PIMs may be held at the SUB-SUPPLIER's works where necessary dependent on scope of work of the package. The purpose of the Pre-Inspection Meeting (PIM) is to review the extent of the SUPPLIER'S quality assurance, design activities and shop inspection, which shall be confirmed prior to MANUFACTURE. As a minimum it shall include, but need not be limited to the following main items in accordance with Table 2 – Inspection Requirements: -
- a) Planning and Control Activities
 - b) Design and Development Activities
 - c) Control of External Supply
 - d) Materials and Component Manufacturing
 - e) Fabrication
 - f) Inspection, Testing and Verification Activities
 - g) Release of Product or Service
 - h) Final Inspection. Verify conformity to PO including as applicable

The test procedures to be used for each test shall be submitted for review by COMPANY at least 6 weeks prior to the scheduled test activity.

11.3 Hydrotest/Helium Test

- 11.3.1 For cast pressure components, the duration of the hydrostatic test shall be a minimum of 30 minutes or time suitable for performing inspection whichever is higher.
- 11.3.2 For all stainless steels, the chloride content in the test water shall not exceed 30ppm.

11.3.3 For carbon and alloy steels, the chloride content of water used for hydrostatic test shall not exceed 50 ppm chlorides. If water with a chloride content of between 30ppm and 50ppm is used, the component shall be drained and rinsed with water containing no more than 2ppm chlorides and thoroughly dried.

11.3.4 Helium leak test is required for pressure containing casings when the molecular weight of process gas is 12 or less. Helium test shall be performed only after successful hydrostatic test.

11.4 Control System Simulated Test (iFAT)

Control system panels containing operator HMI, controls software (PLCs), power supplies (PSUs), ventilation fans and associated 19" equipment racks shall undergo simulated iFAT prior to main equipment performance test. The simulated function test of unit control panel shall include a test of interfaces to other control and monitoring systems. The test shall be completed at the control panel SUPPLIER's facility before the panel is shipped to the compressor SUPPLIER test facility, if a complete string test is being performed.

This test shall include but not limited to: -

- Simulate all alarms and trips
- Start-up sequence
- Shutdown sequence
- Different modes of operation
- Mimic displays (HMI)
- All peripherals (printers, servers, etc...)
- Control functions
- Protection and ESD logic

11.5 Performance Test

11.5.1 The SUPPLIER shall carry out a performance test on each compressor. The SUPPLIER shall submit a detailed test procedure (at least 8 weeks prior to the test) describing the relevant test conditions and details of proposed test recordings to be made in order to obtain the flow rate-head and flow rate-efficiency curves. The test procedure shall indicate all corrections to be made to allow the performance curves under site conditions to be derived from the measured test data. In the performance test procedure, the MANUFACTURER shall quantify all flows and correction factors for inter-stage losses, balance losses and other such losses to be considered. The performance procedure including these calculations shall be subject to COMPANY approval.

11.5.2 During performance testing original internal clearances and tolerances shall be maintained. However, if identical compressors (not operating in parallel) are ordered at the same time, this test is required by COMPANY on only one compressor.

11.5.3 The SUPPLIER shall guarantee the performance of the equipment in accordance with AGES-SP-05-002, Centrifugal Compressors (API 617) Specification and according to the test tolerances specified within API 617 8th Edition.

11.5.4 Performance testing shall be carried out in accordance with the relevant ASME PTC 10 Type 2 performance test code. Composition of test gas shall be agreed as part of test procedures. Surge flow of the compressor shall be clearly measured during the Type 2 test at speed(s) corresponding to the certified point(s), and at maximum continuous speed and minimum operating speed. Balancing line flow shall be measured during the ASME PTC 10 type 2 test and compared to design values.

11.5.5 The performance test shall demonstrate the compliance of the aerodynamic performance with the specified requirements. For all variable speed compressors, the surge line shall be established between minimum and maximum continuous speeds by means of additional points. Choke limits also shall be established for MCS, min speed and rated (and or 100%) speed points. During the performance test, coast down time

shall be recorded and this shall be verified against indicated value (used for sizing the lube oil system). For compressors having side stream, a minimum of eight points on the curve shall be verified. Compressors with side streams shall have a minimum of eight temperature probes installed in each stage to determine the stage exit temperatures. Test bench instrumentation and set up shall be agreed before the test as part of procedures including measurement of pressure and temperatures at various locations.

11.5.6 When multi-section compressors are supplied, each section shall be tested and shall meet the performance tolerances described. For compressors handling side loads, the required performance for each compressor section shall be agreed upon at the post award meeting. For variable speed compressors, a minimum of 6 test points shall also be taken at maximum continuous speed and again at minimum operating speed.

11.5.7 No correction shall be made for Reynolds number deviation. In the performance test procedure, the SUPPLIER shall quantify all flows and correction factors for inter-stage losses, balance losses, and other such losses to be considered. For compressors handling side loads, the required performance for each compressor section shall be agreed upon at the post-award meeting. For variable-speed compressors, a minimum of 5 test points shall also be taken at maximum continuous speed and again at minimum operating speed. Stabilisation shall be achieved between test points. Typically, 30 minutes interval between test points.

11.5.8 For variable speed units, a minimum of 5 test points at each equivalent speed (including surge and overload) shall be taken at the following:

- a. Normal operating speed
- b. Specified rated (100%) speed
- c. Maximum continuous speed
- d. Minimum operating speed

11.5.9 For compressors with VIGVs, a minimum of 5 test points (including surge and overload) shall be taken at the following settings:

- a. Minimum
- b. Guarantee
- c. Maximum
- d. Two additional points between minimum and guarantee

11.5.10 Surge line testing or additional speed lines shall be tested for variable speed machines. The following additional points shall be included in the test as follows:

- a. 3 points at minimum speed line
- b. 3 points for intermediate speed
- c. 3 points at 100% speed line
- d. 3 Points on MCS line

11.5.11 During performance testing original internal clearances and tolerances shall be maintained. No increased balance drum clearance with subsequent correction is allowed. The following flows of the Dry Gas seal shall be measured during the performance test:

- a. Dynamic seal leakage during the test.
- b. Static leakage after the test.
- c. Seal gas and buffer gas flows.

The dynamic seal leakage measurement shall be performed at a speed and sealing pressure as close as possible to the conditions of the seal MANUFACTURER's shop test. The measured leakage rates may

be adjusted for differences in conditions (e.g. pressure, temperature and speed) between the performance test and seal SUPPLIERS' shop test after agreement between the seal MANUFACTURER, SUPPLIER and COMPANY prior to the test.

11.6 Mechanical Running Test

11.6.1 The mechanical run test (MRT) shall be carried out for each compressor and spare rotor over a minimum duration of four (4) hours after temperature stabilization. A test bed oil sample shall be taken before and after each mechanical run test as applicable. An analysis of each oil sample shall be included in the test report.

11.6.2 During this test, the lubricating oil and seal oil temperature shall be held for a minimum period of 60 minutes at the temperature corresponding to the minimum allowable viscosity, and for 60 minutes at the temperature corresponding to the maximum allowable viscosity. Oil pressures and temperatures and bearing temperatures shall be measured and recorded throughout the test.

11.6.3 Internal rubs causing clearances that exceed 50% of the tolerances specified by the SUPPLIER'S design documents shall be cause for design review, rectification of reasons causing rubs and re-test.

11.6.4 Spare coupling, seals and bearings shall be installed during the mechanical run test of the spare rotor or the spare rotor bundle.

11.6.5 Spare gear rotors shall undergo all the tests specified for main gear rotors.

11.7 Complete Unit Test

11.7.1 Where specified in the equipment datasheets, the complete package including all ancillary components and systems such as lube/seal oil systems, seals, couplings, control panel(s) shall be used during the complete unit test and the machinery train should be run for test purpose. Such a test, if done at MANUFACTURER's facility, shall be declared to be a string test.

11.7.2 If a complete unit test is specified, only the motor driven unit shall be subject to the complete unit test requirement. Motor driven compressor complete unit tests shall be performed with the job lube oil system, job seals and seal system.

11.7.3 Unless otherwise specified, a complete unit test for first unit (for identical compressors) shall be performed and if successful then driver and compressor (shaft line) only to be tested for the other identical units.

11.7.4 If first unit complete unit test was not satisfactory (i.e. fails in terms of operating and mechanical performance) then all units shall undergo complete unit test. This test is in addition to the individual equipment/component test.

11.7.5 A No Load Full Speed (NLFS) string test shall be conducted in the following cases:-

- a. Trains with Mechanical Variable speed gearboxes
- b. Trains above 25MW driver rating
- c. Gas turbine drivers
- d. Steam turbine drivers where shop facilities exists to test them.

11.7.6 A full load, full speed, full power (FLFSFP) test shall be conducted in the following cases:-

- a. CO2 compressors above 200 barg discharge pressures
- b. Injection compressors above 400 barg
- c. Prototype compressors (and/or first time use in ADNOC included, such as seal less compressors, high speed compressors without gearboxes etc.)

11.7.7A complete unit test is always required for Gas Turbine drives when turbine SUPPLIER is different from compressor SUPPLIER (including manufacturing location). For trains containing such drive systems, provisions shall be made for torsional vibration measurements during testing to check for torsional resonances and to verify the SUPPLIER'S torsional analysis; this may be, for example, with strain gauges on the coupling. Full package, no/part load full speed shall include below job accessories as a minimum:

- a. Compressor and complete drive train equipment (such as gearbox, drive motor, drive turbine and their important auxiliaries).
- b. LO System including cooler (using flexible hose connections between LO unit and coolers).
- c. Complete dry gas seal system, seal conditioning units (where applicable) and seal panel.
- d. All instrumentation within SUPPLIER scope.
- e. ASC / Performance monitoring system and other panels when supplied.
- f. Complete driver controls (such as VFD system).
- g. Shop control systems shall be used for gathering performance data.

11.7.8 Complete unit test is required for one unit in a set of similar compressors. If, due to logistics and schedule requirements, any of the components cannot be shipped, assembled for complete unit tests, deletion of those items require COMPANY approval.

11.7.9 Complete unit test (string test) shall be specified only for the following:

- a) GT driven (FL-FS-FP),
- b) ST driven (FL-FS-FP) if steam available at SUPPLIER workshop
- c) Mechanical Variable speed drive (NL-FS) and
- d) Prototype irrespective of type of driver FL-FS-FP test.

11.8 Sound Level Test

Sound level test shall be performed on the equipment in accordance with ISO 3744 and ISO3746 to meet the limits specified in the equipment datasheets. A sound level test shall be performed for first unit of each type.

11.9 Auxiliary Equipment Tests

11.9.1 All auxiliary equipment shall undergo a full functional test prior to integration with the compressor package.

11.9.2 All control panels shall undergo shop radio frequency interference (RFI) and “burn-in” tests.

11.9.3 All lube systems shall undergo a 4 hours mechanical run test.

12. SITE ACCEPTANCE TESTING

The EPC CONTRACTOR shall carry out site acceptance test (SAT) based on following guidelines under supervision of the SUPPLIER. The SUPPLIER shall develop various operating scenarios and agree the acceptance procedures and acceptance criteria during project execution. All such criteria must be fulfilled during SAT.

A preliminary version of the proposed SAT procedure shall be issued by the SUPPLIER with the Proposal. Agreement on a formal list of SAT acceptance criteria shall be established between SUPPLIER, CONTRACTOR and COMPANY PRIOR to Purchase Order Award. This agreed list of criteria will form part of the Purchase Order Agreement. The details of the SAT Procedure can be developed post-award but the list of acceptance criteria parameters shall not be revised without written mutual agreement between SUPPLIER, CONTRACTOR and COMPANY.

The site acceptance test (SAT) must fully demonstrate that the equipment performs at site in a satisfactory manner and is able to meet all specified contractual requirements. The site acceptance test procedure shall be submitted for COMPANY review/comments in advance of commencement of test program.

Prior to overall plant performance/reliability/acceptance test, an uninterrupted 72 hours SITE ACCEPTANCE TEST is to be performed for each complete machinery package and its auxiliary system(s). During this test, CONTRACTOR and SUPPLIER shall demonstrate that the system including driven machinery, drivers, control and auxiliary systems (lube, seal systems) functions (meeting the contractual performance requirements including vibrations, bearing pad temperatures etc.) throughout the agreed operating range.

The intention of the test is to verify the equipment performance at site against the original expected and factory tested performance. The measured absorbed power, flow and head shall be within agreed tolerances based on the specified design parameters and required utilities. After collection of field data, the OEM shall verify site performance against certified / rated conditions and provide as-built performance curves. If performance falls short, SUPPLIER shall make good and resolve deficiencies to satisfaction of COMPANY.

Contractor shall submit Site Acceptance Test (SAT) procedures for COMPANY review prior to commencement of the tests.

At the time of the above tests, all insurance/capital spares and commissioning spares shall be available at site. Equipment shall not be released for testing/operation unless these spares are available at site. Any spare parts issued by COMPANY to the CONTRACTOR shall be replaced with new spares by the CONTRACTOR.

The SAT is not considered as an ASME PTC 10 Type 1 or Type 2 test. The intention of the test is to verify compressor performance at site against the original expected and factory tested performance. Measurement tolerances of anti-surge system field instruments (flow, pressure and temp.) shall be taken into consideration while defining SAT acceptance criteria. Overall absorbed power, flow and polytropic head shall be within agreed tolerances apart from other machine parameters and utilities. After collection of field data, OEM must perform similitude calculations to verify site performance against certified / rated point and provide as-built performance curves. If performance falls short, SUPPLIER shall make good and resolve deficiencies to satisfaction of COMPANY.

The SUPPLIER's representative must be available on site during the SAT period to coordinate and resolve any unplanned deficiencies. During this period, major equipment SUB-SUPPLIERS for anti-surge valve, gearbox and main driver shall also be present.

The compressor is to have attained steady and stable operation conditions prior to starting the test run. It is imperative that the compressor train components, auxiliaries, fine tuning of control system, calibration of all instruments, setting of vibration probes is done satisfactorily during this period. This shall be in SUPPLIER's scope. Machine monitoring system and data gathering system shall be in place and

SUPPLIER shall ensure functional requirements of the same. Calibration record of all the measuring instruments meeting with norms of the test shall be in place.

The initial surge control line should be set not less than 110% of the predicted surge capacity during detailed design. During the surge mapping, this margin shall be reduced/optimized as much as possible based on the response of the system and ASV in order to achieve energy optimization and increasing the operating region.

SAT is expected to be carried out in an uninterrupted manner. Any failure /trip will result in restarting the train ignoring the earlier clocked hours. The SUPPLIER shall carry out SAT at site based on following guidelines in [Table 8](#).

After satisfactory completion of SAT, the COMPANY representative shall sign the 'System Acceptance Note' to confirm acceptance of the system for operation and the subsequent sustained performance test.

Table 8 – Site Acceptance Test Requirements

Test Description	Test Data Collection	Acceptance Criteria
Control System Functionality	- All sequencing, logic functioning & set point checked. - Full functional tests to verify that all components (hardware, software and interfaces) and equipment are functioning as desired. - Full Input-Output tests for all I/O signals from the field and other systems - Full serial link communication tests with other devices and systems.	- All alarm & trip setting, sequencing & trip logic as per approved documents - As per approved documents and drawings - As per approved documents and drawings - As per approved documents and drawings.
Starting	Starting Torque/Current.	As per datasheet.
Starting, acceleration to rated speed	- Check all systems for correct sequence during start - Check for unusual noises and vibration during start.	- Starting sequence is correct with smooth acceleration - No unusual noises and vibration during start.
- Operate the compressor at the design/guarantee point for at least 4 hours. - Operate the compressor for one hour with maximum oil temperatures.	Record & print a set of all operating process parameters, mechanical parameters of equipment and auxiliaries - vibration, bearing temperature, oil temperatures, oil flows, oil pressure, seal gas flows,	All operating parameters shall be within the system normal or operating design value. During compressor operation, there shall be no unusual noise, leakage of gas, air

Test Description	Test Data Collection	Acceptance Criteria
- Start the compressor in depressurized condition after PSD/ESD initiation - Run the compressor for a minimum of 4 hours or until stabilization of all parameters - Loaded start of the compressor (with settle out / full pressure of compressor casing) without depressurizing after 3-4 hours of stoppage - Compressor on continuous recycle for a period of 8 hours. - Check performance of Anti-surge valve (ASV) and other control valves such as anti-choke valves, inlet guide vanes, suction throttle valves, hot gas bypass valves, etc. - Operate units in parallel to existing Steam Turbine Driven compressors and perform load sharing, performance control etc. based on conditions as available at site during test - Perform anti surge mapping and develop as tested performance curves - Hard surge test under SUPPLIER supervision (BN, ASC & machine SUPPLIERS shall be present), define / replot surge limit lines, optimize surge control margins, fine tune various controllers and signals	temperatures, utility flows / temperatures etc. - Collect the gas sample periodically and ascertain Thermodynamic properties - Compressor operation shall be closely observed for unusual noise, leakage of air or oil, excessive vibration, overheating, or any indication of malfunction during all runs, including acceleration, loading, unloading and deceleration. - Using portable data collector to collect a set of vibration signatures and transient (coast-up & coast-down and during surge mapping) data. - Obtain the compressor performance map from MMS. - Record noise level for every major equipment	or oil, excessive vibration, overheating, or any indication of malfunction. - Vibration signatures collected shall be normal and meet the acceptance limits - Performance of the compressor shall be as predicted. The performance at guarantee point shall be compared with guaranteed values on the datasheet. All utility consumptions are expected to be within guaranteed values. - A comprehensive report shall be prepared in 3 copies that will include all the data collected, performance curves, comparison table of predicted performance & actual at site, vibration, temperature & utility data, summary of concerns and remedial measures to be undertaken.
Normal Stop	Verify correct sequencing of all systems	Recycle valves opens
Emergency Stop two numbers One ESD and one PSD Depressurization cycle after 3-4 hours of ESD/PSD on process gas.	- Verify correct sequencing of all systems during shutdown. - Listen for unusual noises during coast down. - Observes the time it takes to vent the unit to zero pressure	- Recycle valve opens - No unusual noises during coast down - Correct lube pump operation

Test Description	Test Data Collection	Acceptance Criteria
	during depressurization cycle which will be initiated after 3-4 hours.	- Suction and discharge valves close - Blow down valve opens when the package pressurization time times out
Surge mapping for compressor	Collect various process inputs	To be in close match of similar to as tested curves at works. Produce "as tested" curves after SAT.
Motor Purging (where applicable)	Record and print pressure and flow of purging air	All operating parameters shall be within the system normal or operating design value. During motor purging, there shall be no unusual noise, leakage of air or oil, excessive vibration, or any indication of malfunction. Purging shall ensure that internal pressure is at least 0.5 mbar above the pressure outside.
Utility Consumptions	Measure and record dry air, instrument air, nitrogen purge and cooling water consumptions	All utility consumptions shall be within guaranteed values

Site acceptance test of unit on actual process gas shall be preceded by test run of equipment in closed loop. This test run shall be performed in closed loop with hydrocarbon (process) gas. However, for sour gas application this run shall be conducted either with sweet gas prior to establishing performance on sour gas. For refrigerant compressor application this run shall be conducted with nitrogen. During this test, the anti-surge valve shall be replaced by a spool piece equipped with an orifice, supplied by the Contractor / Supplier. The minimum duration of this test run shall be 4 hours during which the essential parameters of the package are monitored.

After the successful test run, actual process gas shall be introduced for SAT, after agreement with COMPANY and after replacing orifice on with ASV.

1. Site acceptance test (SAT) must satisfactorily demonstrate that the equipment performs at site in a fully satisfactory manner and is able to meet all contractual parameters. Test procedure shall be submitted for company review/ comments well in advance of commencement of test program.
2. SUPPLIER shall prepare procedures indicating description of test, data collection points and their acceptance criteria and shall include various scenarios such as starting, acceleration to rated speed,

normal stop, process shutdown, emergency shutdown, control system functionality, surge mapping, auxiliary systems functionality etc.

3. SUPPLIER representative must be available on site during the sat period to coordinate and resolve any unplanned deficiencies. During this, OEM shall be present (like ASV SUPPLIER, seal SUPPLIER, GB SUPPLIER, motor and VFD system SUPPLIER, ASC, turbine SUPPLIER and other auxiliary system SUPPLIERS etc.)
4. Duration for SAT shall be 72 hours of smooth running, after obtaining confirmation from the company that the compressor has attained a steady and stable operation conditions following the commissioning and prior to starting the test run. It is imperative that the compressor train components, auxiliaries, fine tuning of control system, calibration of all instruments, setting of vibration probes is done satisfactorily during this period. This shall be in SUPPLIER scope. Machine monitoring system and data gathering system shall be in place and SUPPLIER shall ensure functional requirements of the same. Calibration record of all the measuring instruments meeting with norms of the test shall be in place.
5. SAT is expected to be carried out in an uninterrupted manner. Any failure /trip will result in restarting the train ignoring the earlier clocked hours.
6. Compressor performances evaluation: the analysis of the guarantee point(s) shall be done through the capture of three (3) test points (one on the guarantee flow / flow coefficient, one on the guarantee flow minus 4% and one on the guarantee flow plus 4%.
7. Verification of the compressor operating range shall be done on the iso-speed of the guarantee point. In case of multiple guaranteed points, this step of the test shall be conducted for the point having the highest rotating speed. Five (5) test points will be captured (three on the guarantee point as per the above, one close to the surge control line without anti-surge valve opening and one at the maximum flow).
8. SAT is expected to be carried out in an uninterrupted manner. Any failure /trip will result in restarting the train ignoring the earlier clocked hours. During site acceptance tests:
 - i. Operate the compressor at the Design / Guarantee point for at least 4 hours.
 - ii. Operate the compressor for one hour with maximum oil temperatures by stopping cooler fans / controlling oil bypass valves in LO system
 - iii. Start the compressor (with compressor in depressurized condition) with fuel gas pressurization after PSD/ESD initiation.
 - iv. Run compressor on start-up fuel gas or other start up gas for a minimum of 4 hours or until stabilization of all parameters.
 - v. Loaded start of the compressor (with settle out / full pressure of compressor casing) without depressurizing after 4 hours of stoppage
 - vi. Compressor on continuous recycle for a period of 8 hours
 - vii. Check performance of Anti-surge valve and hot gas bypass valves when supplied
 - viii. Perform anti surge mapping by surging the unit under controlled manner and develop as tested curves. Surge mapping shall include hard surge under controlled manner, verification of surge control valves response, fine tuning of controllers such as ASC/TSC/VFDs etc. to achieve optimization of surge control lines and surge limit lines. Necessary system SUPPLIERS and compressor OEM shall be present during this test. MMS SUPPLIER shall also present to collect vibration data from field during such exercise.
 - ix. Run the compressor at various operating cases as allowed by COMPANY operations (minimum of 4 hours at each of the operating case, after stabilization)
 - x. During the test, gas samples shall be analysed and recorded.
9. The following tables summarize the mechanical acceptance criteria for the centrifugal compressor, the gearbox (if any), the gas turbine, electrical motor and the base plate which are applicable to the whole complete unit string test (including site acceptance test). Final agreed values shall be indicated as part

of Site acceptance test procedures based on ISO 10816 / ISO 7913 and shall be approved by COMPANY.

Table 9 – Acceptable Vibration Limits for Compressor, Gearbox and Electric Motor

Centrifugal Compressor Radial Vibrations (μm pk To pk Unfiltered)	Gearbox High / Low speed shaft / Power turbine radial Vibrations (μm pk to pk unfiltered)	Electric motor Radial vibrations (μm pk to pk unfiltered)
38.1 OR 66% of alarm limit chosen based on ISO 7913 / ISO 10816, Part 6	$25.4 \times \sqrt{(12000/N)} \times \sqrt{2}$ OR 38.1 OR 66% of alarm limit chosen based on ISO 7913 / ISO 10816	50 OR 66% of alarm limit chosen based on ISO 7913 / ISO 10816

Any stable discrete, non-synchronous vibration exceeding 20% of the allowable vibration as defined above shall be cause of rejection of the package. Any unstable non-synchronous vibration shall be cause of rejection of the package.

Table 10 – Acceptable Limits for Absolute Vibrations

		On bearing housings mm/s RMS Value indicated below or 75% of alarm value	On connecting points of equipment to base plate mm/s RMS
Gas Turbine	Aero Design	GG: 6.3, PT: 4.5	2.3
	Other	4.5	
Compressor		4.5	
Gearbox		2.3	
Motor		2.3	
In all directions and from 10Hz up to 1000 Hz			

Piping and piping component vibration shall be the least of the following:

- 0.25 mm (0.010 in) peak-to-peak displacement;
- 25 mm/s (1 in/s) peak velocity;
- 2 g's peak acceleration.

Table 11 – Centrifugal compressor, gas turbine, gearbox (if any) journal and thrust bearing temperatures

Oil inlet temp °C	ΔT on bearing return lines	Bearing metal temperature °C						
		Compressor		Gearbox		Power turbine		Electric motor
		Journal	Thrust	Journal	Thrust	Journal	Thrust	Journal
50	25	85	90	90	90	85	90	80
68 (Note *)	25	100	100	100	100	100	100	95

Note*: Considering maximum ambient of 58°C, Lube Oil supply temperature is expected to be between 65-68°C when using air cooled Lube Oil cooler. In any case, bearing metal temperature alarm shall be set at 115°C with trip set at 125°C. For self-contained bearing housings, max. oil temperature shall be limited to 85°C.

10. On completion of SAT, the SUPPLIER shall produce as-built performance curves based on data collected, including surge mapping data.

SECTION V – API 617 TECHNICAL AMENDMENTS

13. TECHNICAL AMENDMENTS TO API 617 8TH EDITION

The information contained below in [Table 12](#), Table 13, Table 14 and Table 15 details the technical amendments to API 617 8th Edition relating specifically to QA/QC, Welding, NDT, Inspection and Testing of centrifugal compressors.

Table 12 – API 617 Technical Amendments – Part 1

API 617 Clause No. (Part 1)	Description of Change
Part 1 4.6.3.2.3 (New)	Unless agreed otherwise in writing, connections and attachments welded to the casing, and welded casings, shall be subject to 100% radiography. Items agreed in writing which will not produce an interpretable film when radiographed, either by reason of geometry or obstruction of radiation source shall be examined by ultrasonic testing.
Part 1 4.7.4 (Add)	Before final assembly, parts subject to magnetising during MANUFACTURE shall be demagnetised such that residual magnetic flux is less than 0.0005 Tesla (5 Gauss) including: a. Rotors. b. Rotor components. c. Couplings. d. Cases. e. Diaphragms. f. Closure heads.
Part 1 6.1.1 (Add)	SUPPLIER shall notify all his sub-suppliers of inspection and testing requirements in the sub-orders.
Part 1 6.1.6 (Add)	SUPPLIER shall complete the inspector checklist.
Part 1 6.2.1.1 (Modify)	Replace the first sentence of the clause with.... "SUPPLIER shall keep the data listed below available for examination by the CONTRACTOR, COMPANY or his appointed representative. The data shall be kept for at least 20 years or shall be offered to the COMPANY after 5 years."
Part 1 6.3.1.2 (Add)	The SUPPLIER shall notify ADNOC Offshore not less than 10 working days before the date the equipment will be ready for testing. If the testing is rescheduled, the SUPPLIER shall notify ADNOC Offshore not less than 5 working days before the new test date.
Part 1 6.3.1.3 (Add)	a. Prior to scheduled testing, the procedure shall be approved by COMPANY. b. A complete schedule of testing shall be submitted including planned test dates and expected duration. c. Procedures shall include: 1. List of parameters to be measured, monitored, and recorded. 2. Number of operating points and the expected range for each point. 3. Test agenda. 4. Personnel assignments and responsibilities.

API 617 Clause No. (Part 1)	Description of Change
	5. Applicable test code (as agreed). 6. Acceptance and rejection criteria. 7. Type of performance test, method of computation, test gas, tolerances, estimate of potential errors and uncertainties, etc. 8. List of test instruments with calibration procedures. 9. Driver and coupling provisions. 10. HSSE plan, including risk assessment and mitigation measures.
Part 1 6.3.3.1.4 (Add)	When modifying a compressor to reduce head, it is important that the efficiency is maintained.
Part 1 6.3.3.2 (Add)	30 minutes or till completion of witness inspection by relevant methods, applicable for all package (such as seal gas system, LO system etc.) Chart recorders shall be used during testing. Hydrotest shall be performed at 1.5*MAWP.
Part 1 6.3.2.3 (Modify)	Replace the first sentence with.... "For austenitic stainless steel, the chloride level on hydro-test water shall be maximum of 50 ppm. This is also applicable for other corrosion resistant alloys (SDSS, 6Mo, Inconel, Cu/Ni etc.).
Part 1 6.3.3.1 (Modify)	Replace the first sentence with..... "After final machining, each impeller shall be subjected to an over-speed test of at least 115% of maximum continuous speed for a minimum duration of three (3) minutes. When requested, impeller over-speed test value shall be based on maximum allowable speed for that impeller design. For fixed-speed machines, over-speed value shall be 121% of rated speed. The test speed shall be sufficient to reach at any location of impeller bore the same equivalent stress level induced at any location of impeller bore by any operating conditions including the stresses induced by the maximum interference fit. This test speed shall be clearly indicated in the datasheet and test procedure. Over-speed test values shall be indicated for each impeller as a certificate from the MANUFACTURER." Any permanent deformation of any bore diameter over 0.01 mm shall be cause for rejection. Any permanent deformation of the other critical dimension shall be cause for rejection. Repair procedures such as Chromium coating, plating or Plasma deposit are prohibited to recover the original bore diameter in case of permanent deformation.
Part 1 6.3.5.9.6 (Add)	During this test, the lubricating oil and seal oil temperatures shall be held for a minimum period of 60 minutes at the temperature corresponding to the minimum allowable viscosity (corresponding to max. oil inlet temperature at site conditions) and for 60 minutes at the temperature corresponding to the maximum allowable viscosity. Oil pressures and temperatures and bearing temperatures shall be measured and recorded throughout the test. Variable speed compressors shall be checked for rotor dynamic behavior for the entire range speed range during this temperature variations. Test bed oil sample shall be taken at the time of MRT and its analysis included in the test report. Refer to Section 11.6 of this document (Appendix 2).
Part 1 6.3.5.11 (Add)	Shaft seals shall be removed for inspection following a successful MRT and performance tests in presence of seal SUPPLIER. If the testing has given rise to doubts on the performance of internal labyrinths same shall be dismantled and inspected. Re-assembled seal (if no issues found) shall be used to perform

API 617 Clause No. (Part 1)	Description of Change
	"assembled compressor leak test". If seals are found with any issues, then those shall be repaired / refurbished / replaced and retested as per agreed procedures and approval by COMPANY. Those seals shall be used in Assembled compressor leak tests. Only oil film type shaft seals shall be removed for inspection following a successful running test; not mechanical contact type nor dry gas seals. If the testing has given rise to doubts on the performance of internal labyrinths same shall be dismantled and inspected. Dismantling of pressure containing parts requires successful repetition of gas leakage test, clause 4.3.7.
Part 1 6.3.7.1 (Modify)	[New] The contract seals shall be used during the performance test. In applications with dry gas seals, the following shall be measured during the performance test: ▪ Dynamic seal leakage during the test. ▪ Static leakage before and after the test. ▪ Seal gas and buffer gas flows. ▪ Separation gas flows. The dynamic seal leakage measurement shall be performed at a speed and sealing pressure as close as possible to the conditions of the seal MANUFACTURER's shop test (see Annex F API Std 617). The measured leakage rates shall be simulated to predict the leakage in actual running conditions. The leakage rates may be adjusted for differences in conditions (pressure, temperature and speed etc.) between the performance test and seal MANUFACTURER's shop test by means agreed between the MANUFACTURER and COMPANY prior to the test. The seal shall be acceptable if the adjusted leakage rates are within 150% of the accepted seal MANUFACTURER's shop test results and the seal gas and buffer gas flows are within the allowable range. This is acceptable to COMPANY on the basis that the guaranteed leakage rates are double the normal values based on twice the normal clearances or 66% of alarm values. [New] During performance testing the original internal clearances and tolerances shall be maintained. Increasing the clearances of the balance drum and/or other close clearance points with a subsequent performance correction is not permitted.
Part 1 6.3.7.2 (Add)	Refer to Site Acceptance Testing, Section 12 of this document (Appendix 2).
Part 1 6.3.7.2.3 (New)	A PTC 10 type -1 shall be carried out only when • High discharge pressure above 450 barg • CO2 high pressure compressors (beyond 200 bar) • Prototype and/or first time use by COMPANY • Impeller design not with in the MANUFACTURE range of production • Gas density beyond reference impeller design • Compressors with side loads two (2) and above
Part 1 6.3.7.3 (Modify)	[Add] This test is always required when the molecular weight of process gas is 12 or less or very sour gases when specified in datasheet. For gases with higher molecular weight, the requirement of this test will be specified in the enquiry documents. Helium test shall be performed only after successful hydrostatic test. Helium test pressure shall be decided and agreed during bid evaluation but a minimum of 8 barg shall be used if not indicated on the equipment datasheets. All the "O" rings and gaskets used during the Helium test shall be replaced prior to the

API 617 Clause No. (Part 1)	Description of Change
	shipment. Leak test method (submerged or bubble type) shall be agreed prior to order placement.
Part 1 6.3.7.4 (Modify)	[Add] Sound level test is required for all applications, which shall be performed in accordance with the relevant specifications. This shall be repeated during the site acceptance test.
Part 1 6.3.7.5 (Modify)	[Delete] the bullet and [add]: Dry gas seals shall be tested individually at full speed and full pressure at the seal MANUFACTURER'S facilities in accordance with Appendix H. Lube-oil systems shall be tested for functionality at respective SUPPLIER works. All auxiliary components shall be tested at SUPPLIER / SUB-SUPPLIER works based on approved quality assurance / control plans as per respective DGS, international standards and COMPANY approved ITPs. SUPPLIER shall furnish the test procedures of auxiliary systems and control system for review.
Part 1 6.3.7.6 (Modify)	[Add] This test shall be performed after successfully completing rotor mechanical and performance tests. For dry gas seals, the gas test shall be performed before the post-test inspection. For liquid seals, the gas test shall be performed after the post-test inspection. The level of disassembly will be mutually agreed between the COMPANY and the SUPPLIER during ITP approval.
Part 1 6.3.7.7 (Modify)	[Add] Unless otherwise specified, full load-full pressure-full speed test shall be carried for the following scenario: • For high pressure compressor, above 450 barg. • Where Level II stability analysis is required. Unless otherwise specified, full load, full pressure and full speed test shall be carried out based on guidelines provided in I.2 of Annex-I of API 617. If I.2 is not possible, then the test shall be carried out as per I.3. SUPPLIER to state explicitly in their proposal, which Type (I.2 or I.3) test they have offered and agree with COMPANY before order.
Part 1 6.3.7.8 (Modify)	[Add] Post-test inspection of hydraulically fitted couplings shall be performed only when job couplings are used. This is applicable for complete unit test only as for other tests, shop couplings are generally used.
Part 1 6.3.7.9 (Modify)	[Add] Spare parts shall undergo the same level of inspection and testing as for main components. Spare coupling, diaphragm, seals and bearings shall be installed during the mechanical run test. Spare gear rotors, if ordered, shall undergo all the tests specified for main gear rotors. For spare rotor MRT compulsory. Performance test can be excluded; however, SAT shall be conducted with spare rotor. If the first machine of one type is delivered before the spare rotor is available, the factory tested rotor shall be removed from the first machine after delivery to site and the spare rotor shall be installed and tested as part of the SAT. The original factory tested rotor will then be kept as a spare.
Part 1 6.4.1 (Modify)	[Delete bullet and replace] "6 months" with "12 months or the commissioning date, whichever is the higher". [Add] Packaging and preservations procedures shall be compatible with site environment and are subject to COMPANY approval. The equipment shall be shipped in the minimum possible number of baseplate sections.

API 617 Clause No. (Part 1)	Description of Change
Part 1 6.4.1.1 (Add)	Preparation for export shipment shall be done by the Supplier in the shop following a mutually agreed preparation procedure.
Part 1 6.4.1.2 (Add)	a. Bracing, supports and temporary rigging connections shall be provided to prevent damage during transit, lifting or unloading. b. Temporary supports or bracing shall be tagged or painted yellow to indicate removal is required upon permanent installation.
Part 1 6.4.3 (Modify)	[Add] Any device used for shop test only shall be removed before shipment.
Part 1 6.4.3.1 (Modify)	[Add] Paint system must be capable of withstanding environmental conditions at site and shall meet requirements as per the relevant painting specifications.
Part 1 6.4.3.2 (Modify)	[Add] "which shall be subject to the approval of the CONTRACTOR, COMPANY or an authorized representative.
Part 1 6.4.3.3 (Modify)	[Add] During the application of the rust preventive to the internals, the shaft shall be rotated slowly to ensure complete coating of all bearing and impeller surfaces. All openings shall be sealed immediately after coating. [Add] Rust preventative that is used on the process side of the unit shall: a. Be compatible with the process gas. b. Not require solvent cleaning prior to commissioning.
Part 1 6.4.3.4 (Modify)	[Add] "which shall be subject to the approval of CONTRACTOR or an authorized representative. [Add] Bearings and seal assemblies shall be fully protected from rusting and entry of moisture and dirt.
Part 1 6.4.3.5 (Modify)	[Add] a. Large diameter flanges of DN 250 (NPS 10) and above, shall use 10mm (3/8 in) thick full-size steel covers with gaskets and one full size bolt for every other hole. b. A rust inhibitor shall be applied to carbon steel flange faces. c. Rust inhibitor shall be easily removed with commonly available solvent.
Part 1 6.4.3.6 (Modify)	[Add] a. Tapped openings shall be plugged in conformance to ANSI/ASME B16.11, but with 32mm (1 1/4 in) extension and 12 chrome material. b. Open ends of tubes and pipes shall be capped for protection, waterproof tape shall not be used.
Part 1 6.4.3.10.1 (Modify)	[Delete] "If Specified" [Add] Single lift is preferred during shipment of equipment. However, in case of single lift is not possible, the equipment shall be shipped in the minimum possible number of baseplates. The fit-up and assembly of machine mounted piping and intercoolers shall be completed in the SUPPLIER's shop prior to shipment. Lifting gears including spreader bars, etc. shall also be supplied by the SUPPLIER. (Add) The requirements of ADNOC Offshore SP-1002 shall be applied.
Part 1 6.4.3.11	[Delete] the bullet and "when specified,"

API 617 Clause No. (Part 1)	Description of Change
(Modify)	
Part 1 6.4.3.12 (Modify)	[Delete] - Not Applicable
Part 1 6.4.3.13 (Modify)	[Replace with] Fit-up and assembly of machine mounted piping and intercoolers shall be completed in SUPPLIERS shop prior to shipment.
Part 1 6.4.3.14 (Modify)	[Add] Exposed shaft ends, and bearings journals shall be protected against physical damage. Shipment bearing shall be installed on compressor prior to shipment. The subject bearing shall be replaced by the working one after equipment installation.
Part 1 6.4.3.15 (Modify)	[Add] Where vapor-phase inhibitor (VPI) or silica gel crystals in bags are installed in large cavities, either for inhibiting corrosion or absorbing moisture respectively, they must be in an accessible area for easy removal. The bags shall be attached with Stainless Steel wire and their locations indicated with corrosion resistant tags also fixed with Stainless Steel wire and their locations indicated with corrosion resistant tags also fixed with Stainless Steel wire.
Part 1 6.5 (Modify)	[Add] The quality management system shall conform to ISO 9001, API Specification Q1, or other agreed internationally recognised standard to ensure that the products and services provided conform to the requirements for SUPPLIER quality identified in the Purchase Order.

Table 13 – API 617 Technical Amendments – Part 2

API 617 Clause No. (Part 2)	Description of Change
Part 2 6.1.6 (Modify)	[Delete] "If Specified"
Part 2 6.2.1 (Modify)	[New] The third-party inspection and certification requirements shall be carried out as stipulated in ADNOC Offshore Code of Practice CP-102 and also refer to table shown below, for various Non-Destructive Testings' (NDT) that has to be carried out on the different components of the compressor.
Part 2 6.3.1.1.10 (Modify)	Replace this clause with... "The equipment shall be operated at speed increments of approximately 500 rpm from zero to the MCS and run at the MCS until bearing metal temperatures and shaft vibrations have stabilized."
Part 2 Figure 4 (Modify)	Replace Figure 4 with the following..... The graph shows Speed (Steps of 500 RPM) on the Y-axis and Time on the X-axis. The speed profile starts at 0, increases in steps (~30% per step), reaches Max. Continuous Speed, and then fluctuates between 0 and Max. Continuous Speed. Key points include Compressor Trip Speed, Max. Continuous Speed, and reading points R. A legend explains the numbered steps: 1 Conduct slow roll Shaft Run out check 2 Acceleration 3 Deceleration 4 First Hot restart 5 Second hot restart
Part 2 6.3.1.1.13 (Add)	After the shutdown / ramp down to zero speed, two hot starts shall be carried out. The first hot start shall be immediately after the machine records zero speed to MCS and stay at MCS for 15 minutes and ramp-down to zero speed. This stop sequence shall be by pressing the ESD. Second hot start shall be 40-45 minutes after completion of first hot start. Increase speed to MCS, stay at MCS for 15 minutes and ramp down. This shall be by normal stop methods. Coast down time shall be recorded during MRT at point 3 (deceleration) and after second hot start (item 5).
Part 2 6.3.1.2.1 (Modify)	Delete the last sentence and replace with.... "The measured unfiltered vibration shall not exceed the limits of clause 4.8.8.8 of Chapter 1 as amended by this specification and shall be recorded throughout the operating speed range.

API 617 Clause No. (Part 2)	Description of Change
	[Add] Test bed oil sample shall be taken at the time of MRT and its analysis included in the test report. Oil system performance shall be recorded at each speed increase from minimum to maximum in steps of 500rpm using test bench instrumentation and local gauges as applicable. Similarly, vibration readings shall be recorded for each step."
Part 2 6.3.1.2.2 (Add)	Copies of sweep plots (frequency vs. displacement) shall be included in the SUPPLIER's test report. These sweeps shall be made minimum, normal, rated and maximum continuous speeds. Journal orbits shall be recorded at maximum continuous speed. Vibration phase readings shall be related to the fixed shaft phase references.
Part 2 6.3.1.2.3 (Modify)	Replace this clause with..... "The mechanical running test shall verify that the lateral and torsional critical speeds and vibration levels conform to the requirements of (4.8.2). When these are not confirmed, or the critical speed(s) cannot be clearly identified then the unbalance response test requirements of (4.8.3) shall apply. These measurements shall be made at minimum, normal, rated and maximum continuous speed."
Part 2 6.3.1.2.4 (Add)	Frequency spectrum analysis for each channel of vibration shall be made at each stabilized point of test and the hard copy submitted in the SUPPLIER'S test report. As a minimum, these sweeps shall be made at minimum, normal, rated and maximum continuous speeds. Immediately before the mechanical run test, the shaft run-out shall be measured at the location of each proximity probe.
Part 2 6.3.2.2 (Add)	The leakage test of the compressor shall be carried out with the dry gas seals installed after successful MRT and performance test. The test shall be conducted at the MAWP.
Part 2 6.3.2.3 (Modify)	Delete the bullet and the words "If specified". Add.... "Test duration shall be for 30 minutes, or the time taken to complete the verification of leaks, whichever is higher and shall be carried out at MAWP. Refer also to Part 1, clause 6.3.7.3.
Part 2 6.3.3 (Modify)	Replace with.... "Refer to Section 11 of this document (Appendix 2) for details of required tests."
Part 2 6.3.3.1 (Modify)	Replace with.... "Refer to Section 11.5 of this document (Appendix 2) for details of performance test."
Part 2 6.3.3.1.1 (Add)	Replace with.... "Refer to Section 11.5 of this document (Appendix 2) for details of performance test."
Part 2 6.3.3.1.1.1 (New)	Replace with.... "Refer to Section 11.5 of this document (Appendix 2) for details of performance test."

API 617 Clause No. (Part 2)	Description of Change
Part 2 6.3.3.1.1.2 (New)	Replace with.... "Refer to Section 11.5 of this document (Appendix 2) for details of performance test."
Part 2 6.3.3.1.2 (Modify)	Replace with.... "Refer to Section 11.5 of this document (Appendix 2) for details of performance test."
Part 2 6.3.3.1.3 (Modify)	Replace with.... "For variable speed compressors, a speed other than the normal speed may be used if necessary to achieve the specified performance and performance tolerances, provided the adjusted speed and those of all operating conditions meet the criteria specified in paragraph 2.9. Additionally, the maximum continuous speed shall remain at least 5% above the 100% speed and the trip speed margins specified in 4.4.2.2 (Part 1) shall be maintained. At the guaranteed (or certified) points(s) for each compressor section: • Speed: $\pm 2\%$ allowable adjustment but not to exceed 100% (rated) speed. • Absorbed gas power: expected +4% • Polytropic head: expected $\pm 0\%$ after speed adjustment. • Inlet volume flow: expected $\pm 0\%$. In addition, and after the speed adjustment, the following tolerances shall be also verified: • Inlet volume flow at surge: expected +0% on predicted surge point flow. • Polytropic head at surge: expected $\pm 2\%$ on predicted head rise. • Inlet volume flow at stone wall: expected -0%. • Polytropic head at stone wall: expected -3%. Complete compressor shaft line. The complete shaft line speed shall be determined so as to reach the overall polytropic head value with zero tolerance, Inlet mass flow: expected $\pm 0\%$, Compressor shaft end power: expected +4%. • The driver shall be capable to deliver the power required. • If design point speed or MCS change is required due to performance test observations, the original design requirements related to speed shall be confirmed to be still valid and applicable documents and reports shall be updated to reflect new speed ranges. Example documents that shall be updated include as a minimum: Lateral and Torsional Rotor dynamic reports respecting separation margins, impeller overspeed testing and impeller dynamic analysis, train overspeed limits and protection.
Part 2 6.3.3.1.4 (Modify)	Replace with.... "For variable speed compressors, a speed other than the normal speed may be used, if necessary, to achieve the specified performance and performance tolerances, provided the adjusted speed and those of all operating conditions meet the criteria specified in paragraph 2.9. Additionally, the maximum continuous speed shall remain at least 5% above the 100% speed and the trip speed margins specified in 4.4.2.2 (Part 1) shall be maintained."

API 617 Clause No. (Part 2)	Description of Change
Part 2 6.3.3.1.5 (Modify)	Replace last sentence with.... "The horsepower at the specified capacity and actual head shall not exceed 104% of the guaranteed value. For constant speed machines, tolerance of +3% acceptable on polytropic head."
Part 2 6.3.3.1.7 (Add)	The spare rotor shall be ordered by CONTRACTOR along with the main order. The MRT and Performance Test shall be done on the spare rotor. Below spare rotor tests can be waived only with written approval of COMPANY after evaluating risk of not performing such tests. This waiver is considering fact that when spare rotors alone are ordered or refurbished in future, casings will not be available for complete testing. a. MRT, if first rotor has successfully undergone MRT and performance test. b. Performance test, if first rotor has successfully undergone MRT and performance test. Above are subject to: a. Spare rotor is balanced at high speed in accordance to this DGS and API requirements and results are similar to main rotor. b. Assembly, trial fit, rotation and float tests are carried out. c. Any deviations / doubts observed in MRT or performance test are noticed in main rotor, spare rotor shall undergo both MRT and performance tests.
Part 2 6.3.3.1.9 (Add)	For train with multiple compressors, the performance guarantee (head and capacity) and its tolerance shall be applicable for each compressor (section). Power consumption tolerance may apply for overall train. Individual process compressor section head tolerances shall be $\pm 2\%$ of normal head. A 2% limitation shall be adopted for parallel units.
Part 2 6.3.3.2 (Add)	Replace with.... "Refer to Section 11.7 of this document (Appendix 2) for details of complete unit test (CUT)."
Part 2 6.3.3.3 (Modify)	Replace with.... "Casings arranged for tandem drive shall be tested as per the requirements of clause 6.3.3.2."
Part 2 6.4.1 (Modify)	Delete the bullet and the words "if specified". Add.... "Dry gas seals shall be removed for transportation and a shaft locking device shall be in place to avoid damage to bearings and internals during transportation. Dry gas seal shall be installed at site by SUPPLIER."

Table 14 – API 617 Technical Amendments – Part 3

API 617 Clause No. (Part 3)	Description of Change
Part 3 6.3.1.1.3 (Add)	Oil temperature shall be varied with use of an electrical heater as much as possible on the test bench along with oil cooler bypass controls. Oil temperature during test shall be close to maximum site oil inlet temperatures to bearings.
Part 3 6.3.1.1.6 (New)	After the shutdown/ramp down to zero speed, two hot starts shall be carried out. First hot start shall be immediately after the machine records zero speed to MCS and stay at MCS for 15 minutes and ramp down to zero speed. This stop sequence shall be by pressing ESD. Second hot start shall be 40-45 minutes after completion of first hot start. Increase speed to MCS, stay at MCS for 15 minutes and ramp down. This shall be by normal stop methods.
Part 3 6.3.1.3.1 (Modify)	Delete last two sentences and replace with..... “The measured unfiltered vibration shall not exceed the limits of clause 4.8.8.8 of Chapter 1 as amended by this specification and shall be recorded throughout the operating speed range. Test bed oil sample shall be taken at the time of MRT and its analysis included in the test report.”
Part 3 6.3.1.3.3 (Add)	Copies of sweep plots (frequency vs. displacement) shall be included in the SUPPLIER'S test report. As a minimum, these sweeps shall be made at minimum, normal, rated and maximum continuous speeds. Journal orbits shall be recorded at maximum continuous speed. Vibration phase readings shall be related to the fixed shaft phase references.
Part 3 6.3.1.3.4 (Modify)	Replace with... “The mechanical running test shall verify that the lateral and torsional critical speeds and vibration levels conform to the requirements of Clause 4.8.2 of Chapter-1. When these are not confirmed or the critical speed(s) cannot be clearly identified, the unbalance response test requirements of Clause 4.8.3 of Chapter-1 shall apply. These measurements shall be made at minimum, normal, rated and maximum continuous speed.”
Part 3 6.3.1.3.5 (Modify)	Delete the bullet and the words “If specified”. Add the following... “Frequency spectrum analysis for each channel of vibration shall be made at each stabilized point of test and the hard copy submitted in the SUPPLIER'S test report. As a minimum these sweeps shall be made at minimum, normal, rated and maximum continuous speeds. Immediately before the mechanical run test, the shaft run-out shall be measured at the location of each proximity probe.”
Part 3 6.3.1.3.6 (Modify)	Delete the bullet and the words “If specified”.
Part 3 6.3.1.3.7 (Modify)	Delete the bullet and the words “If specified”.
Part 3 6.3.2.2 (Add)	The leakage test of the compressor shall be carried out with seals installed after successful MRT and Performance test. The test shall be conducted at the settle out pressure.

API 617 Clause No. (Part 3)	Description of Change
Part 3	Delete the bullet and the words "If specified".
6.3.2.3 (Modify)	Add the following... "Test duration shall be for 30 minutes or time taken to complete the verification of leaks whichever is higher."
Part 3 6.3.3.1 (Add)	This test is mandatory. If identical compressors (not operating in parallel) are ordered at the same time, this test is required by COMPANY on only one compressor. ASME PTC10 Type 2 Performance test code shall be followed. Composition of test gas shall be agreed as part of test procedure. Surge flow of the compressor shall be clearly measured during the Type 2 test at speed(s) corresponding to the certified point(s), and at maximum continuous speed and minimum operating speed. The performance test shall demonstrate the compliance of the aerodynamic performance with the requirements. During performance test, coast down time shall be recorded and this shall be verified against indicated value (used for sizing the lube oil system). ASME PTC10 Type 1 Performance test code shall be performed (base quote only even if 200 bar pressure). Test bench instrumentation and set up shall be agreed before the test as part of procedures including measurement of pressure and temperatures at various locations. For the spare rotor, a PTC10 Type 2 test is acceptable. When multi-section compressors are supplied, each section shall be tested and shall meet the performance tolerances described.
Part 3 6.3.3.1.2 (Add)	At the guaranteed (or certified) points(s) for each compressor / section: • Speed: $\pm 2\%$ allowable adjustment but not to exceed 100% (rated) speed. • Absorbed power: expected +4% (combined power of all stages) • Polytropic head: expected $\pm 0\%$ • Inlet volume flow: expected $\pm 0\%$ In addition, the following tolerances shall be also verified: • Inlet volume flow at surge: expected +0% on predicted surge point flow • Polytropic head at surge: expected $\pm 2\%$ on predicted head rise • Inlet volume flow at stone wall: expected -0% • Polytropic head at stone wall: expected -3% • Side stream capability: Flow $\pm 0\%$ Complete compressor shaft line: • Inlet guide vane angle shall be determined so as to reach the overall polytropic head value with zero tolerance, Inlet mass flow: expected $\pm 0\%$, Compressor shaft end power: expected +4% • The driver shall be capable to deliver the power required.
Part 3 6.3.3.1.3 (Modify)	Replace second and third sentences with... "The horsepower at the specified capacity and actual head shall not exceed 104% of the guaranteed value. For constant speed machines, a tolerance of +3% is acceptable on polytropic head."

API 617 Clause No. (Part 3)	Description of Change
	Replace last sentence with... "If the power required at this point exceeds 104%, excess head may be removed by trimming impellers."
Part 3 6.3.3.1.4 (Add)	Spare rotor shall be ordered by CONTRACTOR along with the main order. MRT and performance test shall be done on the spare rotor.
Part 3 6.3.3.1.6 (New)	The contract seals shall be used during the performance test. On applications with gas seals, the following flows shall be measured during the performance test: • Dynamic seal leakage during the test • Static leakage before and after the test • Seal gas and buffer gas flows • Separation gas flows The dynamic seal leakage measurement shall be performed at a speed and sealing pressure as close as possible to the conditions of the seal MANUFACTURER's shop test. The measured leakage rates may be adjusted for differences in conditions (e.g. pressure, temperature and speed) between the performance test and seal SUPPLIERS' shop test after agreement between the seal MANUFACTURER, SUPPLIER and COMPANY prior to the test. The seal shall be acceptable if the adjusted leakage rates are within 125 % of the accepted seal SUPPLIER shop test results and the seal gas and buffer gas flows are within the guaranteed values. No further increase in leakage rates acceptable at site conditions (beyond guaranteed leak rates).
Part 3 6.3.3.1.7 (New)	During performance testing, original internal clearances and tolerances shall be maintained.
Part 3 6.3.3.1.8 (New)	In the performance test procedure, the SUPPLIER shall quantify all flows and correction factors for inter-stage losses and other such losses to be considered. The performance procedure including these calculations shall be subject to COMPANY approval.
Part 3 6.3.3.2 (Add)	This test is always required for electric motor driven compressors with variable speed drive system (VSDS) control. For such trains, provisions shall be made for torsional vibration measurements during testing to check for torsional resonances and to verify the SUPPLIER'S torsional analysis; this may be for example with strain gauges on the coupling. Complete unit test at full load of 1 (one) compressor package (full package, full speed) is required from SUPPLIER. For CO2 compressor, CO2 shall be utilised as circulation gas during the test. Complete unit test shall include following as a minimum: - Compressor and complete drive train equipment (such as gearbox, drive motor and their important auxiliaries) - LO System (using flexible hose connections between LO unit). Shop coolers are permitted. - Complete seal system, seal conditioning units (where applicable) and seal panel. - All instrumentation within SUPPLIER scope. - ASC / Performance monitoring system and other panels when supplied.

API 617 Clause No. (Part 3)	Description of Change
	f. Complete driver controls (such as steam turbine controller, VFD system, in case of VFD motors). g. Shop control systems shall be used for gathering performance data. Complete unit test is required for one unit in a set of similar compressors. If due to logistics and schedule requirements, any of the components cannot be shipped, assembled for complete unit tests, deletion of those items require COMPANY approval.

Table 15 – API 617 Technical Amendments – Part 4

API 617 Clause No. (Part 4)	Description of Change
Part 4 6.3.3.1 (Add)	The mechanical run test shall apply to the complete expander compressor package unit, incorporating a complete unit test. All accessories/auxiliaries shall be assembled in the SUPPLIER works for such a test. Temporary cables may be installed to the control system.
Part 4 6.3.3.1.3 (Add)	During the shop test the specified oil shall be used and the maximum oil inlet temperature related to maximum site ambient temperature used. Test bed oil shall be taken at the time of MRT and its analysis included in the test report.
Part 4 6.3.3.2 (Modify)	Replace with.... "Complete unit test shall be performed.".
Part 4 6.3.3.2.2 (Modify)	Replace with.... "The speed shall be reduced to the maximum continuous speed and the equipment shall be run for 2 hours."
Part 4 6.3.3.3.2 (Add)	The vibration amplitude versus frequency sweep shall be performed at minimum and normal operating speed and the frequency range shall cover the same factors as those quoted for the maximum continuous speed. If discrete frequencies exceed the allowable amplitude based on maximum continuous speed, they shall be initially compared with the frequency spectrum at slow roll conditions, i.e. 500 - 1000 rpm, taking into account the speed dependent frequency generation, and then the effect and significance of these frequencies assessed between CONTRACTOR and SUPPLIER. Copies of sweep plots (Frequency vs. Displacement) shall be included in the SUPPLIER's test report. As a minimum these sweeps shall be made minimum, normal, rated and maximum continuous speeds. Journal orbits shall be recorded at maximum continuous speed. Vibration phase readings shall be related to the fixed shaft phase references.
Part 4 6.3.3.3.5 (Modify)	Delete the bullet and the words "If specified,"
Part 4 6.3.3.4.2 (Modify)	Delete the bullet and the words "If specified,"
Part 4 6.3.3.5 (Add)	Before and immediately after the mechanical run test, the shaft run-out shall be measured at the location of each proximity probe.
Part 4 6.3.5.1 (Add)	The optional tests shall be conducted if specified in the requisition datasheet or when required by the following clauses.
Part 4 6.3.5.1 (Add)	This test is mandatory test. If identical turbo expander compressors packages (not operating in parallel) are ordered at the same time, this test is required by COMPANY on only one turbo expander compressor with the provision that should problems be encountered, other units shall be performance tested.

API 617 Clause No. (Part 4)	Description of Change
	A suitable large-scale curve of predicted isentropic efficiency against U/C and expander exit volumetric flow rate will be provided with submission of compressor and expander test procedures not later than 12 weeks after order committal. The following shall particularly be demonstrated: • Expander: • The swallowing capacity at the design inlet guide vane setting and also the range of swallowing capacity. • The expander isentropic efficiency at the rated condition specified in the datasheets and variation of this efficiency over the operation U/C range. • Compressor: • Inlet flow, polytropic head and efficiency at the rated condition specified in the datasheets and their variation over the range of operation from surge to 130% rated capacity. • Horsepower shall be guaranteed for both the expander and the compressor. Horsepower for the entire turbo expander/compressor unit may vary by $\pm 4\%$.
Part 4 6.3.5.1.1 (Add)	The expander end of the unit shall be performance tested on air or agreed gas composition (to be decided during technical evaluation and agreed by COMPANY) and a plot of isentropic efficiency against the ratio of tip speed over ideal spouting velocity developed. A dummy wheel may be used instead of compressor impeller during this test. The isentropic head drop shall be confirmed at the guarantee point flowrate. The efficiency at the stated, rated U/C value shall be as guaranteed, the only correction factor to be applied will be to correct for the expander exit volumetric flow rate by a method to be agreed between CONTRACTOR and SUPPLIER prior to order. Test shall be performed over U/C range flow that equivalent to 60% AM3/H to 130% AM3/H at guarantee point flow rate. To achieve required range to U/C expander suction may be throttled or substitute impeller fitted for this test only. 'Swallowing capacity' of expander shall also be demonstrated over this range of U/C by inlet air flow measurements to PTC 10 code requirements. The 'intent' of PTC 10 will be applied to other pressure and temperature measurements with respect to number of probes and 'spread' of readings. Five equally spaced tests points as a minimum are required with adequate indication of temperature stabilisation shown at each test point. A minimum of 5 test points shall also be taken at maximum continuous speed and against minimum operating speed.
Part 4 6.3.5.1.2 (Add)	The compressor end of the unit shall be performance tested on air in open loop with throttled suction and discharge to atmosphere or agreed gas composition (to be decided during technical evaluation and agreed by COMPANY) to ASME Power Test Code 10, Class III, requirements (or SUPPLIER approved equivalent). This test shall confirm polytropic head and efficiency at the guarantee point flow rate. Five equally spaced test points as a minimum on compressor head/quantity curve from near surge to 130% of normal flow are required conducted to code requirements at 100% equivalent speed, plus one point to establish 'surge flow'. A minimum of 5 test points shall also be taken at maximum continuous speed and again at minimum operating speed. No Reynolds number correction for efficiency shall be applied. The temperature rise method for determination of power shall be employed.

API 617 Clause No. (Part 4)	Description of Change
Part 4 6.3.5.1.4 (Modify)	[Replace with] Spare rotor & center section shall be ordered by CONTRACTOR along with the main order. Performance test shall also be done on the spare rotor & center section
Part 4 6.3.5.1.5 (Add)	The Contract seals shall be used during the performance test.
Part 4 6.3.5.1.6 (Add)	On applications with self-acting gas seals, the following flow rates shall be measured during the performance test: • Dynamic seal leakage during the test • Static leakage after the test • Seal gas and buffer gas flows The dynamic and static leakage rates shall be measured with seal gas shut off. The dynamic seal leakage measurement shall be performed at a speed and sealing pressure as close as possible to the conditions of the seal MANUFACTURER's shop test (see Annex F). The measured leakage rates may be adjusted for differences in conditions (pressure, temperature and speed, etc.) between the performance test and seal MANUFACTURER's shop test by means agreed between the SUPPLIER and CONTRACTOR, COMPANY or its authorized representative prior to the test. The seal shall be acceptable when the adjusted leakage rates are within 110% of the seal MANUFACTURER's shop test results and the seal gas and buffer gas flows are within the allowable range.
Part 4 6.3.5.1.7 (Add)	During performance testing original internal clearances and tolerances shall be maintained; no increased balance drum clearance with subsequent correction is allowed.
Part 4 6.3.5.1.8 (Add)	In the performance test procedure, the MANUFACTURER shall quantify all flows and correction factors for inter-stage losses, balance losses and other such losses to be considered. The performance procedure including these calculations shall be subject COMPANY approval.
Part 4 6.3.5.2 (New)	When FL-FP-FS test is carried out, the magnetic bearing exciter test as outlined in I.4 of Annex-I of API 617 shall also be carried out.
Part 4 6.3.5.3 (New)	A post-test inspection is required. The rotating assembly, expander inlet guide vane assembly, bearings and seals shall be stripped and examined. This test shall be performed after successfully completing spare rotor mechanical and performance tests. The level of disassembly will be mutually agreed between the COMPANY, CONTRACTOR and the SUPPLIER.

THE CONTENTS OF THIS DOCUMENT ARE PROPRIETARY.



INFORMATION REQUIREMENTS FOR CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION Appendix 3 - AGES-SP-05-002



Information Requirements for
Nonintegrally / Integrally Geared
Centrifugal and Axial Compressors
and Expander-Compressors

Insert Project Logo Here

CLIENT : Insert Client_name

PROJECT TITLE : Insert Project Title

PROJECT LOCATION : Insert Project_location

JOB/PROJECT NUMBER : Insert Job/Project number here

TAG No. : Insert Tag_No

SERVICE : Insert Service Description

DOCUMENT NUMBER : Insert Project Document Number

REVISION : Insert Project Document Revision

Issue	Date	Issue Description	By	Checked	Approved	
ADNOC Document No. xxxxxxxx Version 1.0						Sheet 1 of 1

Information requirements for
Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-
Compressors

Manufacturer's Record Book (MRB) SUBMITTAL REQUIREMENTS

1 GENERAL

1.1 DELIVERABLES

The SUPPLIER document requirements are defined within the DELIVERABLES section of this APPENDIX. These listed documentation shall be considered to be the minimum required. Additional requirements shall be discussed and agreed where specifically required by individual projects. All drawings and documents shall be written in the ENGLISH Language.

1.2 MANUFACTURING RECORD BOOK

The Manufacturing Record Book (MRB) for each equipment item shall be compiled in accordance with the following requirements and the applicable codes:-

- a) Documents shall be written in English.
- b) Documents shall be in a legible, reproducible form.
- c) The number of MRB's to be supplied shall be specified in the request for quotation (RFQ) and the Purchase Order (PO) documents.
- d) Drawings and other data shall be based on the A4 series sizes, and all drawings larger than A4 size shall be folded to A4 size so that title box and status decal are visible from the front and inserted into pre-punched plastic sleeves.
- e) The contents of the MRB shall be collated into a logical sequence in accordance with the Purchase Order/Contract requirements and in accordance with DGS 0000 003 "Minimum Shop Inspection and Certification Requirements". Tabbed dividers shall be provided to separate the sections of data.
- f) MANUFACTURER/ SUPPLIER shall submit a detailed MRB index/contents list for CONTRACTOR approval within 8 weeks of order placement unless stated otherwise in the Purchase Order.
- g) The reports shall be provided in loose leaf form with numbered pages in 2.5 inch hard cover A4 size binders (MANUFACTURER / SUPPLIER can use narrower binders if appropriate subject to COMPANY/ CONTRACTOR approval). Binder mechanism shall be four pillar interlock type. The color and finish of the binder will be advised by CONTRACTOR / COMPANY during a pre-production meeting.
- h) Multiple binders must be clearly referenced i.e. "1 of xx", and each contains an index detailing how many volumes and the contents of each volume.

2 DOCUMENTS

2.1 SUPPLIER'S RESPONSIBILITIES

As manufacturing of the equipment progresses, the MANUFACTURER / SUPPLIER shall compile the MRB with all the design, manufacturing, inspection, tests, and certification information on a per tag item number basis. Documents that are common to more than one item shall be duplicated in each report.

2.1 SUPPLIER'S RESPONSIBILITIES (Continued)

The MANUFACTURER / SUPPLIER shall present MRB's to the nominated inspector at each inspection visit. It is also their responsibility to ensure that Inspection & Test Plans are signed and dated by the nominated inspector on the day of any Inspection / Test. The spine and cover of each binder shall indicate the following as a minimum:-

- a) Manufacturing Data Report
 - b) Project Name
 - c) MANUFACTURER / SUPPLIER Name
 - d) Purchase Order No.
 - e) Equipment No.
 - f) Equipment Description
 - g) MANUFACTURER / SUPPLIER Order Ref. No.
 - h) MANUFACTURER / SUPPLIER Doc. No.
 - i) Date of Issue and Revision
- j) Alterations, deletions, or additions to certification are not normally permitted, and a new document must be prepared. However where this is not possible the alteration must be approved, signed and dated. Additions and revisions shall be added to the documentation, not as a replacement but as an addition to the existing records
- k) The Manufacturing Data Report shall, after being accepted by clear endorsement of each page by stamp, date and signature of the nominated inspector, be submitted to the CONTRACTOR.
- l) MDR documents that are already approved by CONTRACTOR with a signed and dated endorsement do not require additional endorsement by the nominated inspector at the MANUFACTURER / SUPPLIER works. The nominated inspector shall endorse the index as correct with reference to documents embodied within the MRB. For multi-page documents the first page (used for approval) shall clearly state the document total number of pages and each page shall be numbered. CONTRACTOR can use dated stamps, subject to COMPANY approval (without requirement for signature endorsement) providing stamp is uniquely identifiable to individual inspectors.
- m) The original and the required number of copies shall be forwarded promptly after the completion of the equipment in accordance with the terms and conditions of the purchase order. If the order is subject to inspection by COMPANY / CONTRACTOR, the release note for the acceptance of the equipment shall only be issued when the manufacturing report, including the required number of copies, is presented.
- n) The use of colored markers to highlight certificates shall not be permitted.
- o) The use of correction fluids is not permitted.
- p) When test / material certification is called for, these certificates are to be countersigned by COMPANY / CONTRACTOR.

3 MANUFACTURER/ SUPPLIER QC DOCUMENTATION AND CERTIFICATION

Supplier document and deliverables shall be as per the attached schedule of DELIVERABLES, which shall be updated with required document submission times according to the project schedule requirements.

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors

Deliverables

Column	Heading - Details and requirements												
A	Code - a unique identifier for the Information Deliverable, referencing the Parent Standard, IOGP Supplement or Industry Standard where the Information is requested. e.g. API617#01.												
B	Requirement - a short description of the Information Deliverable that would typically provide the Information required, based on the description in the Parent Standard, IOGP Supplement or an Industry Standard Title.												
C	Condition Invoking Requirement - describes special condition(s) under which the Information Deliverable is required; e.g.. service offshore and weight greater than 1 tonne means information is required. NB: if blank, always required.												
D	Typical Deliverable - Purchaser to confirm or add a short description of the Information Deliverable that would typically include this Information Requirement.												
E	Submit With Proposal - Yes or No, where 'Yes' means the Information Deliverable is required to be submitted with Suppliers Proposal or 'No' is not required												
F, G & H	First Issue Post Purchase Order - deliverable shall be issued 'For Information' or 'For Acceptance' at the agreed time defined as weeks after order placement (WAO), Weeks prior to delivery (WPTD), Weeks prior to test (WPTT) or weeks after test (WAT).												
I	Required As Built - Yes or No, where 'Yes' means the Information Deliverable is required to be 'As Built' on completion or delivery of equipment or 'No' is not required 'As Built'												
J	Fulfilled by Information Deliverable Number(s) – identifies which deliverable(s) to be provided by the Supplier include the Purchaser's information requirements described within the Definitions tab. NB; it should be noted that one single Deliverable may include more than one defined information line item.												
K	Manufacturer's Record Book - Yes or Yes ®, where 'Yes' means that the Supplier shall provide details within the Manufacturer's Record Book and 'Yes ®' means that the MRB shall be reviewed by the inspector during inspection. This requirement does not preclude formal / duplicate submission of documents for project purposes												
L	Installation, Operating and Maintenance Manual - ✓, where ✓ means that the Supplier shall provide details within the Installation, Operating and Maintenance Manual(s)												
M	Translation Required -Yes or No, where 'Yes' means the Deliverable should be translated into one or more other languages (where specified in the purchase order) other than English and 'No' means to be provided in English												
N	Remarks - may include additional requirements, conditions & decisions as may be appropriate to the content of the deliverable.												
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
Contract Management Information Deliverables													
MD#01	Supplier Master Information Schedule		Information Deliverables List	No	For Acceptance	4	WAO	Yes		Yes	✓		List of Supplier's Documents and Drawings
MD#02	Delivery schedule		Delivery/Production Schedule	Yes	For Information		WAO	No					
MD#03	Progress report		Progress Report	No	For Information		WAO (Monthly)	No					Bi-weekly progress reports are to be submitted by the SUPPLIER indicating lookahead and manufacturing status.
MD#04	Quality plan		Quality Plan	No	For Acceptance		WAT	No		Yes			
MD#05	Design and Development Plan		Design and Development Plan	No	For Acceptance		WAO	No					
MD#06	List of Sub-Suppliers		List of Sub-Suppliers	Yes	For Acceptance		WAO	No			✓		To be updated monthly to show Sub-Supplier details, including component description, sub-order number, order placement and delivery dates
MD#07	Inspection and test plan		Inspection and Test Plan (ITP)	Yes	For Acceptance		WAO	No		Yes ®			Prior to the start of manufacture, an ITP shall be submitted for approval by SUPPLIER for review at the Pre-inspection meeting.
MD#08	'Packing, shipping, storage and preservation procedure		Handling, shipping and storage procedure	No	For Acceptance		WPTD	No			✓		Preparation of equipment for transportation shall conform to the packing, marking, and shipping instructions or other documents identified in the Purchase Order. In Addition SUPPLIER shall comply with the Handling - Package - Preservation and Storage requirements given in "Common Requirements" Appendix of this Specification.
MD#09	Non-conformance records		Nonconformance History	No	For Acceptance		WAO	Yes		Yes ®			
MD#10	Concession requests		Concession request	Yes	For Acceptance		WAO	Yes		Yes			
MD#11	Preservation and Maintenance Instructions for Insurance/Capital Spares		Preservation and Maintenance Instructions for Insurance/Capital Spares	No	For Acceptance		WPTD	No			✓		This shall be submitted prior to the packing, shipping storage and preservation procedure, MD#08
Technical Information Deliverables													
API 617#01	General Arrangement Drawing		General Arrangement Drawing	Yes	For Acceptance		WAO	Yes			✓		
API 617#02	Compressor Performance Curves		Compressor Performance Curves	Yes	For Acceptance		WAO	Yes			✓		
API 617#03	Data Sheet of Compressor / Expander Package		Data Sheet of Compressor Package *Note: all individual sub components of package shall have respective data sheets.	Yes	For Acceptance		WAO	Yes			✓		
API 617#04	Noise Data Sheets		Noise Data Sheets	Yes	For Acceptance		WAO	Yes			✓		
API 617#05	Utility Requirements Schedule		Tabulation of Utility Requirements (Process and Electrical)	Yes	For Acceptance		WAO	Yes			✓		
API 617#06	Process Control Description		Process Control Description	Yes	For Acceptance		WAO	Yes			✓		
API 617#07	Cross Sectional Drawings and Bill of Materials		Cross Sectional Drawings and Bill of Materials	Yes	For Acceptance		WAO	No			✓		
API 617#08	General Arrangement Drawing of Main Driver		General Arrangement Drawing of Main Driver	Yes	For Acceptance		WAO	Yes			✓		
API 617#09	P&I Diagram of Process and ASV System		'P&I Diagram of Process and ASV System	Yes	For Acceptance		WAO	Yes			✓		
API 617#10	P&I Diagram of Lube Oil System		P&I Diagram of Lube Oil System	Yes	For Acceptance		WAO	Yes			✓		
API 617#11	P&I Diagram of Sealing System		P&I Diagram of Air System	Yes	For Acceptance		WAO	Yes			✓		

Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
API 617#12	P&I Diagram for Condition Monitoring Instruments		P&I Diagram for Condition Monitoring Instruments	Yes	For Acceptance		WAO	Yes			✓		
API 617#13	Recommended Spare Parts		List of recommended spare parts for complete package including commissioning spares, two year spares and insurance spares.	Yes	For Information		WPTD	Yes			✓		
API 617#14	Life Cycle Cost Analysis		Life Cycle Cost Analysis	Yes	For Acceptance		WAO	No			✓		
API 617#15	Reliability & Availability Study		Reliability & Availability Study	Yes	For Acceptance		WAO	No			✓		
API 617#16	Site Acceptance Test Procedure (SAT)		Site Acceptance Test Procedures	Yes	For Acceptance		WAO	No			✓		Preliminary version to be submitted with proposal. FINAL version to be developed and submitted after purchase order award.
API 617#17	Detailed Drawings		Detailed Drawings	No	For Acceptance		WAO	Yes			✓		
API 617#18	Stair, ladders and platform drawing		Stair, ladders and platform drawing	No	For Acceptance		WAO	Yes			✓		
API 617#19	Nameplate Drawing		Nameplate Drawing	No	For Information		WAO	Yes			✓		
API 617#20	Drive Coupling Assembly Drawing		Main Driver Coupling Assembly Drawing with	No	For Information		WAO	Yes			✓		
API 617#21	Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic		Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic	No	For Acceptance		WAO	No			✓		
API 617#22	Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details		Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details	No	For Acceptance		WAO	Yes			✓		
API 617#23	Foundation Loading Diagram		Foundation Loading Diagram	No	For Acceptance		WAO	Yes			✓		
API 617#24	Cause & Effect chart		Cause & Effect chart	No	For Acceptance		WAO	Yes			✓		
API 617#25	Coupling Data Sheets		Coupling Data Sheets	No	For Acceptance		WAO	Yes			✓		
API 617#26	Electric Motor Data Sheets		Electric Motor Data Sheets	No	For Acceptance		WAO	Yes			✓		Separate data sheet required for each size/type of electric motor supplied for auxiliary equipment drives.
API 617#27	ISA Data Sheets for Instruments		ISA Data Sheets for Instruments	No	For Acceptance		WAO	Yes			✓		
API 617#28	Material Safety Data Sheets		Material Safety Data Sheets	No	For Acceptance		WAO	Yes			✓		
API 617#29	Insulation specification		Insulation specification	No	For Acceptance		WAO	No			✓		
API 617#30	Weight Data Sheet (For OFFSHORE application)		Weight Data Sheet (For OFFSHORE application)	No	For Acceptance		WAO	Yes			✓		
API 617#31	Vibration Data Sheet		Vibration Data Sheet	No	For Acceptance		WAO	Yes			✓		
API 617#32	Lubrication Schedule		Lubrication Schedule	No	For Acceptance		WAO	No			✓		
API 617#33	Relief Valve Sizing Calculation		Relief Valve Sizing Calculation	No	For Acceptance		WAO	Yes			✓		
API 617#34	Structural Calculations		Structural Calculations	No	For Acceptance		WAO	Yes			✓		
API 617#35	CFD and FEM Calculation notes		CFD and FEM Calculation notes	No	For Acceptance		WAO	Yes			✓		
API 617#36	Anti surge calculation sheet (with anti surge valve sizing)		Anti surge calculation sheet (with anti surge valve sizing)	No	For Acceptance		WAO	Yes			✓		
API 617#37	Auxiliaries data sheets		Auxiliaries data sheets	No	For Acceptance		WAO	Yes			✓		
API 617#38	Drawings of auxiliaries and itemized equipment supplied loose		Drawings of auxiliaries and itemized equipment supplied loose	No	For Acceptance		WAO	Yes			✓		
API 617#39	Thermal rating for air cooler / heat exchangers		Thermal rating for air cooler / heat exchangers	No	For Acceptance		WAO	Yes			✓		
API 617#40	Pressure vessel / cooler fabrication drawings		Pressure vessel / cooler fabrication drawings	No	For Acceptance		WAO	Yes			✓		
API 617#41	Dry gas seal drawings (with material list)		Dry gas seal drawings (with material list)	No	For Acceptance		WAO	Yes			✓		
API 617#42	Blades Campbell Diagrams		Blades Campbell Diagrams	No	For Acceptance		WAO	Yes			✓		
API 617#43	Driver Performance & Data and Curves		Motor Performance & Electrical Data and Curves	No	For Acceptance		WAO	Yes			✓		
API 617#44	Hydrostatic Test Procedure and Certificates		Hydrostatic Test Procedure and Certificates	No	For Acceptance		WPTT	Yes		Yes ®			
API 617#45	Impeller overspeed test procedure		Impeller overspeed test procedure								✓		
API 617#46	Full-load/Full-pressure/Full-speed test procedure										✓		
API 617#47	Complete Package Performance/Mechanical Run Test Procedure		Complete Package Performance/Mechanical Run Test Procedure	No	For Acceptance		WPTT	No			✓		
API 617#48	Lateral Critical Speed Analysis		Lateral Critical Speed Analysis	No	For Acceptance		WAO	Yes			✓		
API 617#49	Material Certificates		Material Certificates	No	For Information		WAT	No		Yes ®			The document is not required to be submitted as a separate document part of project review cycle. It can be included part of the MDR
API 617#50	Preservation, Packaging and Shipping Procedures		Preservation, Packaging and Shipping Procedures	No	For Acceptance		WPTD	Yes			✓		
API 617#51	Torsional Critical Speed Analysis		Torsional Critical Speed Analysis	No	For Acceptance		WAO	No			✓		
API 617#52	Welding Procedure Specification, including Procedure Qualification Record / Certificates		Welding Procedure Specification, including Procedure Qualification Record	No	For Information		WPTF	No		Yes ®			
API 617#53	Welding Repair Procedure		Welding Repair Procedure Major and minor weld repairs list	No	For Information		WPTF	No		Yes ®			
API 617#54	Complete Unit Test Report		Complete Unit Test Report	No	For Information		WAT	No			✓		
API 617#55	Surface Preparation and Coating Procedure Specification		Surface Preparation and Coating Procedure Specification	No	For Information		WAO	No			✓		

Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
API 617#56	Factory Acceptance Tests procedure (FAT)		Factory Acceptance Tests procedure (FAT)	No	For Acceptance		WAO	No			✓		
API 617#57	Compressor / Expander Performance Tests procedure		Compressor / Expander Performance Tests procedure	No	For Acceptance		WAO	No			✓		
API 617#58	Performance/ Routine Test Procedure- Driver		Performance/ Routine Test Procedure- Electric Motor	No	For Information		WPTT	No			✓		
API 617#59	Non-Destructive Examination (NDE) Report		Non-Destructive Examination (NDE) Report	No	For Information		WAT	No		Yes ®			
API 617#60	Instrument Calculation Sheets		Instrument Calculation Sheets	No	For Information		WPTD	No		Yes			
API 617#61	Instrument Hook-Up Drawings		Instrument Hook-Up Drawings	No	For Information		WPTD	No			✓		
API 617#62	SIL / ATEX Certificates		SIL / atex Certificates	No	For Information		WAO	No		Yes ®			
API 617#63	Instrument List/Index		Instrument List/Index	No	For Acceptance		WAO	No			✓		
API 617#64	Preliminary Packing List		Preliminary Packing List	No	For Information		WPTD	No			✓		
API 617#65	Installation, Operation and Maintenance Manual index		Installation, Operation and Maintenance Manual Index	No	For Information		WAO	No			✓		
API 617#66	Installation, Operation & Maintenance Manual		Installation, Operation & Maintenance Manual								✓		
API 617#67	List of special tools for maintenance		List of special tools for maintenance								✓		
API 617#68	Manufacturing record book index		Manufacturer Record Book Index	No	For Acceptance		WAO	No		Yes ®			
API 617#69	Manufacturing record book		Manufacturer Record Book	No	For Acceptance		WPTD	Yes		Yes			
API 617#70	Non-Destructive Examination (NDE) Procedure		Non-Destructive Examination (NDE) Procedure	No	For Information		WPTF	No		Yes			
API 617#71	Declaration of conformity		Declaration of Conformity	No	For Acceptance		WPTD	No		Yes ®			The document is not required to be submitted as a separate document part of project review cycle. It can be included part of the MDR.
API 617#72	Hazardous Area Certification		Hazardous Area Certification	No	For Information		WPTD	No		Yes ®			
API 617#73	Supplier's Piping Specification	For conformity to ASME B31.1 or B31.3 (as appropriate)	Written Specification	No	For Acceptance		WAO	No			✓		
API 617#74	List of Weld Repairs		List of Weld Repairs	No	For Information		WPTT	Yes		Yes ®			To include list of major and minor weld repairs

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors

شركة بترول أبوظبي الوطنية
Abu Dhabi National Oil Company

Definitions

Column	Heading - Details and requirements				
A	Code - a unique identifier for the Information Deliverable, referencing the Parent Standard, IOGP Supplement or Industry Standard where the Information is requested. e.g. API672#01, S-612#01				
B	Requirement - a short description of the Information Deliverable that would typically provide the Information required, based on the description in the Parent Standard, IOGP Supplement or an Industry Standard Title.				
C	Description - an excerpt from the Parent Standard, IOGP Supplement or Industry Standard.				
D	Reference - reference to the Parent Standard, IOGP Supplement or Industry Standard that the Information Deliverable is identified in.				
E	Format - defines the required format of the relevant Information Deliverable to be submitted by Supplier for Purchaser/Contractor for information and acceptance as shown in Table 9.1 of Instructions Tab and selected from pick list.				
F	CFIHOS Discipline Document Type Code - the CFIHOS discipline document type that could be used to classify the document having this IRS content.				
Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
Contract Management Information Deliverables					
MD#01	Supplier Master Information Schedule	Schedule of specific information deliverables developed by the [SUPPLIER] and accepted by the [COMPANY] to meet the information requirements defined in the agreed Information Requirements Specification (IRS). The schedule typically defines; a) information deliverable type, title/description b) unique identification (code/number) in the [supplier's] format unless agreed otherwise in the contract. c) planned submission arrangements including; purpose, formats, timing, frequency Arrangements for managing submissions, tracking progress and updating the schedule during the execution of the contract scope will be in accordance with contractual agreements.	Contract Requirement, API 617, Part 1, 7.3	Native	
MD#02	Delivery schedule	Schedule depicting, as applicable to the service or product scope, design, supply, manufacture, inspection, testing and delivery activities to be executed by [supplier/sub-suppliers] Schedule details typically** include;. a) Contractual milestones b) Activity early/late start/completion dates, durations, dependencies (Calendar Dates) c) Critical path and float d) Outsourced services and equipment (cross referenced to purchase order and supplier) e) Information deliverable submission dates identifying any execution activity dependencies Once agreed , changes to planned dates are subject to agreement by [customer]. Progress against planned dates is measured and the schedule updated and reported to the [customer] in accordance with contract reporting agreements. ** Schedule development tools, formats and submission protocols follow the [supplier's] standard practice unless otherwise agreed in the contract.	Contract Requirement, API 617, Part 1, 7.3	PDF	
MD#03	Progress report	Report detailing activities completed in the period, percent complete against planned, activities planned for the next period, risks/areas of concern, cause of any delays and proposed recovery plans, concessions, internal and outsourced inspection and audit activities.. Note: may also include actionable items such as Health, Safety, Security & Environment (HSSE) incidents & status if required under the Contract.	Contract Requirement, API 617, 9.2.3.1 r	PDF	
MD#04	Quality plan	Plan specifying the actions, responsibilities and associated resources to be applied by the [supplier], and when applicable [sub-suppliers] or [manufacturers], to deliver the services or procured item(s) in conformance with the agreed requirements. ISO9001 Clause 8.1 and ISO10005 may be used to inform the development of quality plans for specific applications, processes or products. [API Spec Q2 may be used to inform the development of Service Quality Plans]	Appendix 2- ADNOC Std	PDF	
MD#05	Design and Development Plan	Definition of the stages and controls for design and development; encompassing, design and development inputs, methods and associated controls (review, verification, validation), outputs and design change management. refer ISO9001, API Spec Q1 or equivalent requirements.		PDF	
MD#06	List of Sub-Suppliers	List to include component or material description, SUB-SUPPLIER name and contact details, sub-order reference number, manufacturing location, PO placement date (planned and actual) and contractual delivery dates for products or services that will be externally provided, including specifications and controls to be applied by the [Supplier] to ensure conformance with agreed requirements. The schedule includes evidence of the basis of capability assessment , quality management system certification (or equivalent), process or product qualification for proposed suppliers of outsourced products and services when nominated in the Contract or Quality Requirements Specification (QRS) . Note: ISO 9001, API Specs Q1/Q2 define requirements for assessing risks and establishing controls for outsourced products and services.	Contract Requirement	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
MD#07	Inspection and Test Plan	Tabular presentation of a quality plan typically used for process or product applications to define the specific sequence of inspection and testing activities, references to work instructions, acceptance criteria records and associated [Supplier], [purchaser] and independent conformity assessment activities. Inspection and test activities shall be listed in chronological sequence and shall include activities at sub-supplier(s) and shall identify them as such. The ITP shall include pre-determined intervention points advised by Contractor to Supplier in data sheets and/or within Appendix 2. ISO 9001, API Specification Q1 or equivalent quality management system standard (as agreed with purchaser) may be used to inform the development of inspection and test plans for specific processes and products. The ITP shall include inspection and testing activities to be performed for the complete package, including those at sub-suppliers' works and shall make reference to all testing procedures, control documents, and resulting records and reports.	Contract Requirement	PDF	
MD#08	Packing, shipping, storage and preservation procedure	Definition of practices to be followed during the; storage, transport, lifting and preservation of the equipment and materials included in the scope of supply to maintain their functionality and guarantees. Procedures typically define: a) Packaging requirements; contents, identification, size, weight and number of packages/container (s), b) special packing/unpacking/handling requirements c) storage location and requirements, d) preservation requirements detailing inspection periods and required maintenance, materials required etc., both prior to installation and post installation, but prior to commissioning.	Contract Requirement	PDF	
MD#09	Non-conformance records	Details of non-conformances raised by or to the [supplier/sub suppliers] against technical requirements prior to or during the delivery of the products or services. Non-conformance is managed by the [supplier] in accordance with ISO9001 Clause 8.7 and associated records typically include; description of non-conformance, analysis and disposition, correction implemented and details of any retesting or inspection taken to demonstrate subsequent conformance. Note: Instances where the proposed disposition is to accept a non-conforming condition are subject to agreement by the [Customer] in accordance with the concession management protocols defined in the Contract.	Contract Requirement	PDF	
MD#10	Concession requests	Formal submission seeking [customer] agreement to accept deviations from the contracted scope or technical requirements. Requests may be raised as a result of, as examples, material or service availability, obsolescence, innovation, non-conformance. Requests are typically raised as required during execution with a summary report detailing concessions raised, [customer] directions, agreed action status provided with progress reports and at contract closeout	Contract Requirement	PDF	
MD#11	Preservation and Maintenance Instructions for Insurance/Capital Spares	Detailed instructions for preservation, storage and maintenance of insurance/capital spares (i.e. spare pump rotors, etc) which require specific controls to be applied. This shall be submitted prior to the packing, shipping storage and preservation procedure, MD#08.	Contract Requirement	PDF	
Technical Information Deliverables					
API 617 #01	General Arrangement Drawings	Dimensional outline drawings and list of connections, including the following: a. Size, type, rating, location, and identification of all purchaser connections b. The weight of the package and approximate overall erection and maintenance handling weights of equipment and subassemblies 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 & auxiliary drives 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. i. Customer connection tie-in for electrical & control interface j. Lifting Arrangement	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #02	Compressor / Expander performance curves	Performance curves showing discharge pressure and brake horsepower plotted against delivered inlet volume flow rate at rated conditions and other specified operating conditions. Performance curves are also to incorporate surge line and surge control line showing the separation margin between the surge capacity and rated capacity. Performance curves are to be provided to reflect various control modes such as base load control, load/unload control and showing operating envelope with surge control line & with effect of Inlet Guide Vane setting angle.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #03	Data Sheet of Compressor / Expander Package	Supplier is also to complete in full a data sheet for all items of Equipment to be provided	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #04	Noise Data Sheets	The vendor is also to provide maximum expected overall sound pressure level @ 1.0 meter from the skid, and sound power level for the skid. Supplier is also to provide per octave band data for sound pressure level and sound power level for the equipment.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #05	Tabulation of Utility Requirements (Process and Electrical)	Tabulation of utility requirements (may be on as built purchaser data sheets).	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #06	Process Control Description				
API 617 #07	Cross Sectional Drawings and Bill of Materials	Cross-sectional drawings and bill of materials, including a listing of all parts. To be submitted with Operation and Maintenance Manual	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #08	General Arrangement Drawing of Main Driver	Details as showing details of Driver drawing are to include terminal box details, purchaser connections & wiring instructions, direction of rotation viewed from driven end	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #09	P&I Diagram of Process and ASV System	Main process schematic including the following: a. Piping and valve sizes. b. Instrumentation, safety devices c. Purchaser's connections d. Minimum straght length at suction and discharge sides	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #10	P&I Diagram of Lube Oil System	Lube oil schematic including the following: a. Piping and valve sizes. b. Instrumentation, safety devices c. Purchaser's connections	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #11	P&I Diagram of Sealing System	Sealing system schematics , including the following: a. Seal flow schematics showing necessary instrumentation and controls b. Seal Air System schematic including distribution of seal gas from compressor discharge or from seal booster (if applicable) c. Pipe and valve sizes d. Instrumentation and safety devices e. purchaser connections (if any). f. Seal Gas flows and control-valve (regulator) settings (if applicable) Is also include seal gas/ nitrogen system, if applicable.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #12	P&I Diagram for Condition Monitoring Instruments	Schematic showing number, arrangement, details of proximity probes, axial position probes, key-phasers, accelerometers, bearing temperature monitoring, winding temperature monitoring for compressor, gear and driver motor.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #13	Recommended spare parts	Recommended list of spares covering all equipment furnished by Supplier. - List is to indicate all spare parts recommended by Supplier/Sub Supplier for commissioning, start-up, 2 years of operation and capital or insurance spares. - For each part listed, the original manufacturer's name and part number is to be shown. - For antifriction bearings, full bearing designation numbers with appropriate suffixes that clearly indicate bearing type, size, cage type, and the selected internal clearance or pre-load is to be shown. 'Spare parts list with stocking level recommendations in accordance with 9.3.4. The proposal is to include an itemized list of the recommended spares referenced to a typical cross-sectional drawing. Spares are to be individually identified and priced. As a minimum the following spares are to be offered: a. Pinion shaft rotors b. Impellers for individual stages c. All bearing assemblies d. Spare bearing liners or pads as applicable e. All oil or air seals f. Diffusers g. Lube Oil Pumps h. Compressor service kit	API 617, Part 1,2,3,4 Annex B	Native	
API 617 #14	Life Cycle Cost Analysis	A cost analysis to include operating costs, maintenance costs, repair and refurbishment costs for an equipment life of 30 years shall be performed. Parameters to be used for lifecycle costing such as utlity costs, escalation factors, discount factors, etc shall be agreed with COMPANY.		PDF	
API 617 #15	Reliability, Availability & Maintainability Study	Study to include details of equipment reliabilty, availability and maintainability based on mathematical modelling using typical equipment MTTF, MTTR and MTBF data supported by actual field reliabilty and maintenance data where available.		PDF	
API 617 #16	Site Acceptance Test Procedure	A preliminary version of the proposed SAT procedure shall be issued by the SUPPLIER with the Proposal. FINAL version to be developed and submitted after purchase order award. A fully detailed test procedure identifying the required site acceptance tests including test durations, test operating conditions, site utilities, test equipment and acceptable tolerances/limits. Refer to minimum test requirements detailed within Appendix 2 'QA Inspection and test Requirements'	Contract Requirement	PDF	
API 617 #17	Detailed Drawings	Dimensional drawings for all major auxiliary equipment or components or component (such as electric motor, lube oil reservoir, coolers) with bill of materials	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #18	Stair, ladders and platform drawing	Dimensional drawings for all associated stairs, ladders and platforms to be supplied seprately from main equipment skid package.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #19	Nameplate Drawing	As a minimum, the following data is to be clearly stamped or engraved on the nameplate for compressor and auxiliary equipment: 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 is to be consistent with those used on the data sheets.	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #20	Drive Coupling Assembly Drawing	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. Parallel & angular mis-alignment tolerance	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #21	Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic	Electrical, instrumentation and control schematics	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #22	Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details	Diagrams are to display, in block form, the items of electrical and instrument equipment and all cables interconnecting them. They are to show each terminal block with the terminals numbered and the cores of the connecting cables identified and landed on terminal points. The core identifiers given are to be those ferruled onto the conductors and are required to follow the agreed numbering systems. Note: Reference on these diagrams is to be made to the internal wiring diagrams for each of the electrical and instrument equipment involved. In simple cases, the internal wiring for this equipment may be shown directly on the diagram for simplicity. Symbols are to be in accordance with IEC 60617 or BS EN 60617-12:1999.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #23	Foundation Loading Diagram	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 (for bolted down skid) b. Dimensions, number, material and location of deck plates including weld thickness (for skid welded to the deck e.g. for off-shore installation) c. Weights and centers of gravity for major components. d. Foundation loads at each support location for various load cases e.g. dead load, live load, dynamic load, seismic, wind, transportation load etc. This drawing can also be made part of the General Arrangement Drawing (2.1) e. for OFFSHORE application, shaft distortion calculation shall be submitted for review.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #24	Cause & Effect chart	Cause & Effects (C&E's) are to include schedule of Control, Alarm, Trip and Start-Permissive Functions including recommended setpoints and associated actions and any narratives thereof. For offshore installations this ought to also take into consideration safety analysis checklist requirements for a compressor as defined in American Petroleum Institute (API) RP14C.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #25	Coupling Data Sheets	Supplier is also to complete in full a data sheet for all items of Equipment to be provided	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #26	Electric Motor Data Sheets	Supplier is also to complete in full a data sheet for electric motor (in sub-vendor data sheet format)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #27	ISA Data Sheets for Instruments	ISA data sheets for all instruments.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #28	Material Safety Data Sheets	Material Safety data sheets	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #29	Insulation specification	Supplier is also to provide insulation specification to be reviewed and approved. (If applicable)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #30	Weight Data Sheet (For OFFSHORE application)	Main and auxiliary equipment / parts' weight are to be confirmed with regard to total weight guaranteed in proposal phase.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #31	Vibration Data Sheet (For OFFSHORE application)	Vibration level / range of frequencies are to be provided by Supplier.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #32	Lubrication Schedule	Schedule to indicate type and grade of lubricants and other consumables required for all equipment supplied. For each schedule entry the following is also to be included as a minimum: Tag number, tag description / component (e.g. bearings, engine, gearbox, etc), lubricant manufacturer, lubricant type and grade (product code), first fill capacities, rate of consumption (litres / day) and frequency of change.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #33	Relief Valve Sizing Calculation	Sizing calculations for external relief valves	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #34	Structural Calculations	Structural Calculations for Baseplate and Lifting Beam taking into consideration various lifting configurations during lifting, transportation and installation. Baseplate calculations are also to take into consideration dead and live load and also load arising from environmental conditions such as wind, seismic etc.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #35	CFD and FEM Calculation notes	Computational Fluid Dynamic, Finite Element analysis, Skid Vibration calculation note, Skid strength & rigidity calculation note, 3D FEA)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #36	Anti surge calculation sheet (with anti surge valve sizing)	Specification and calculation of antisurge control valve with Anti-surge Valve Sizing including	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #37	Auxiliaries data sheets	Supplier is also to provide auxiliaries data sheets to be reviewed and approved. Mechanical Data Sheets for lube oil cooler, LO pumps and couplings)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #38	Drawings of auxiliaries and itemized equipment supplied loose	Coupling Drawing(s) & Bills of Materials; Cold and Hot alignment Data, 'Witches Hat' strainer and other Auxiliary Equipment Drawings & Bill of Materials	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #39	Thermal rating for air cooler / heat exchangers	Heat transfer details calculation is to be submitted by Supplier	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #40	Pressure vessel / cooler fabrication drawings	All fabrication / shop drawing are to be submitted.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #41	Dry Gas seal drawings (with material list)	Dry gas seal cross-section / general arrangement to be submitted.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #42	Blades Campbell Diagrams				

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #43	Main Driver Performance Data and Curves	Curves for Electrical driven are to indicate torque and current against speed for 80% and 100% voltage conditions and at rated frequency, superimposed on driven equipment torque curve to confirm that there is adequate net torque for acceleration. The following performance curves are required for both 80% and 100% voltage: - motor speed 'v' torque - motor speed 'v' Power factor - motor speed 'v' current - driver equipment torque 'v' speed for all start up conditions	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #44	Hydrostatic Test Procedure and Certificates	Procedures for compliance with Purchaser specifications/ International Standards including duration of test, quality of test medium, confirmation of no leakage. Certificates of hydrostatic, leak and / or pneumatic tests carried out - Note! Specific Purchaser approval is required for all Pneumatic testing.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #45	Impeller overspeed test procedure			PDF	
API 617 #46	Full-load/Full-pressure/Full-speed test procedure			PDF	
API 617 #47	Complete Package Performance/Mechanical Run Test Procedure	Procedure to determine that equipment operates according to Purchaser requirements is to include- a. Performance test procedure as per ASME PTC 10, with test points, tolerances etc. b. Mechanical run test procedure c. Noise test procedure d. Control panel functional test procedure e. Lube oil flushing / cleanliness test procedure	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #48	Lateral Critical Speed Analysis	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 (speed vs phase & response amplitude showing Amplification Factor at x/y vibration probe location for each damped unbalance critical speed- Bode plot). c. Graphic display of bearing and support stiffness and its effect on critical speeds(Undamped critical speed-support stiffness map for bull gear rotor & both high speed pinion rotors). d. Graphic display of rotor response to unbalance (including damping) (deflected rotor shape showing the major-axis amplitude at key locations - radial bearing, shaft seal, oil seal to demonstrate amplitude well within diametral running clearance). e. Journal static loads. f. Stiffness and damping coefficients for min and max clearance (max and min pre-loads). g. Tilting-pad bearing geometry and configuration	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #49	Material Certificates	Type 3.1 and Type 2.2 material inspection certificates as per EN 10204 for various components for compressor and accessories.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #50	Preservation, Packaging and Shipping Procedures	Contains the following: - The instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up, as described in API 686, Chapter 3. - Packaging procedure. - Shipping procedure.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #51	Torsional Critical Speed Analysis	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 model. c. Tabulation identifying the mass moment and torsional stiffness of each component identified in the mass elastic system. d. Graphic display of exciting frequencies versus speed and natural torsional frequency (Campbell Diagram). e. Graphic display of torsional critical speeds and deflection angle for torsional vibration (mode-shape plot). f. Effects of alternative coupling on analysis.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #52	Welding Procedure Specification, including Procedure Qualification Record	Define all shop welding techniques and repair welding procedures in accordance with Code and Purchaser's requirements. WPQR – To define parameters, techniques and test results of all Sellers proposed welding procedures in compliance with Purchaser's requirements.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #53	Welding Repair Procedure	When specified, documentation of major defects is to be submitted to the purchaser prior to any repairs being conducted at the manufacturer's shop and to 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 is to be indicated on a sketch or drawing of the affected component. f. Repair welding procedures in accordance with Code	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #54	Complete Unit Test Report	Test report from combined mechanical/ performance test of compressor package with tabulation of string test data. To also include noise test report, functional test report of local control panel, lube oil flushing test report & calibration certificates for test instruments/ apparatus. Report to include performance test results, 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. c. compressor performance data d. impeller over-speed test record alongwith the NDE record	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #55	Surface Preparation and Coating Procedure Specification	This specification is to be supplied for all equipment and is to include as a minimum: surface cleaning and preparation, environmental controls for both shop and field painting, lining (where applicable) and repairs to damaged coatings.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #56	Factory Acceptance Tests (FAT) procedure			PDF	
API 617 #57	Compressor / Expander Performance Tests Procedure			PDF	
API 617 #58	Performance/ Routine Test Procedure- Driver	Routine Test procedure for Medium Voltage Motor as per relevant standard *e.g. IEC 60034/ NEMA MG-1 etc. specifying the tests conducted, test method and acceptance criteria	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #59	Non-Destructive Examination (NDE) Report	Compilation of all non-destructive test reports & logs such as radiography, magnetic particle, dye-penetrant, ultrasonic test and PMI. To be submitted part of the manufacturing data book.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #60	Instrument Calculation Sheets		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #61	Instrument Hook-Up Drawings		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #62	SIL / atex Certificates		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #63	Instrument List/Index	Information to be provided as data entered within a Spreadsheet pro forma supplied and content defined by the Purchaser. Typical items for which information required are: Field instruments, Control instruments, Condition monitoring instruments, Panel mounted instruments, In-line instruments, Control valves, Actuated valves and Safety valves	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #64	Preliminary Packing List		API 617, Part 1,2,3,4 Annex B		
API 617 #65	Installation, Operation and Maintenance Manual index	Instruction manuals describing installation, operation and maintenance procedures; each manual is to include the following sections: 1) Section 1 - Installation 2) Section 2 - Operation 3) Section 3 - Disassembly and assembly 4) Section 4 - Performance curves 5) Section 5 - Vibration data 6) Section 6 - As-built data 7) Section 7 - Drawing and data requirements 8) Operating procedures for special tools, if any 9) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment 10) Motor Installation, Operation and Maintenance Manuals 11) Detailed information covering the design & operation of the instrumentation & control system including but not limited to: - Wiring diagrams & logic diagrams - Self diagnostic capability of the controller - Design clearance tolerance sheets - Full balancing procedures for rotor assemblies	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #66	Installation, Operation & Maintenance Manual	Provides sufficient information to install, operate and maintain the equipment, as well as sufficient information for troubleshooting. Description of methods of installing a piece of equipment. Installation refers to the mounting, setting, erection, etc. Description of methods of maintaining a specific piece of equipment. Typically originates from the equipment or package Supplier. Description of methods of operating a piece of equipment or process unit, including but not limited to instructions, procedures, drawings, tables, etc. for the operation -stop, start, and emergency shutdown. Including operational limits, function testing, possible interruptions, corrective actions, hazards and corrective measures to be taken. NOTE: Unless otherwise agreed, can be delivered in manufacturer's standard manual or as one or several documents clearly marked which part they cover (I, O, M)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #67	List of special tools for maintenance	List of special tools and fixtures which are required to disassemble, assemble, or maintain the supplied equipment.		PDF	
API 617 #68	Manufacturing record book index	Each manufacturing record book (MRB) is to include all of the manufacturing records and certification referenced in the Purchaser accepted Inspection and Test Plans and all documentation required to demonstrate full compliance with, and/or as specified in the Purchase Order and its attachments. As a minimum, the MRB shall contain the below listed documentation. All ITP verifying documents All as-built data Some examples of these are: material certificates, NDE certificates, welding detail, manufacturing and test personnel qualifications, balance certificates, as-built dimensions, as-built clearances, declarations of conformity.		PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #69	Manufacturers Record Book	The Manufacturer's Record Book (MRB) is to contain all of the manufacturing records and certification referenced in the Purchaser approved Manufacturing & Test Quality Plans (MTQPs) and/or those required to demonstrate full compliance with, and/or as specified in the Purchase Order & its attachments, including but not limited to material certificates, pressure test certificates, personnel qualifications/competence, inspection & test reports, NDT reports, calibration reports, manufacturing & fabrication records etc. The MRB is to be compiled in strict accordance with the Purchaser's approved Index for Manufacturer's Record Book	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #70	Non-Destructive Examination (NDE) Procedure	Procedure describing how to perform non-destructive test (NDT) (i.e. Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), Radiographic Testing (RT), Ultrasonic Testing (UT) and Visual Testing (VT)) for a given object, including acceptance criteria and reporting. The procedure shall also include positive material identification (PMI) for corrosion resistant alloys, if applicable for any of the package component.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #71	Declaration of conformity	The manufacture's or other party's confirmation that the product is designed, manufactured and tested as specified. To be delivered according to applicable authorities requirements.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #72	Hazardous Area Certification	Certification attesting to the suitability of mechanical and electrical equipment to operate within classified locations according to IEC 60079. Certificates shall be issued by a recognised independant certification body for each equipment type located in the specifed location.		PDF	
API 617 #73	Supplier's Piping Specification	Packaged equipment piping shall comply with either ASME B31.1 for Power Piping or ASME B31.3 for Process Piping. As part of Supplier's proposal, Supplier shall confirm compliance and provide a copy of their piping specification.	Contract Requirement	PDF	
API 617 #74	List of Weld Repairs	A complete list of major and minor weld repairs listing component location, weld procedure and NDT procedure used	Contract Requirement	PDF	

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander- Compressors Instructions & Guidance

This workbook contains a hidden sheet ('Pick Lists') which is used for drop down menu selection within the main part of this workbook.

1 Front & Preliminaries Tab

The 'Front & Preliminaries' tab includes an IOGP Front sheet for the IRS followed by Acknowledgements, a Disclaimer, Copyright Notice, Foreword and Introduction.

2 IRS Cover Tab

The 'IRS Cover' tab has been included for COMPANY and/or CONTRACTOR to update and include as a Cover Sheet for the issue of the IRS to SUPPLIERS, but Users may replace this sheet with an alternative User or Project format.

3 'Deliverables' Tab

The 'Deliverables' tab includes columns A to L, including Column A for the relevant requirement code and Column B for the requirement for the different Information Deliverables (Data, Documents and/or Models) to be provided by SUPPLIERS, based on the parent standard, IOGP Supplement or the specified parent industry Standard.

Condition Invoking Revoking Requirement Column C is included to allow any specific conditions to be identified that may require a additional deliverable(s).

Typical Deliverable Column D is provided for PURCHASER to identify the deliverable type that the information would typically appear within; this also allows the PURCHASER's Requisitioning Engineers to group the various Information Requirements by Deliverable Type.

Column E includes Submission Requirements (Yes or No) at Proposal, while columns F, G & H identify Issue Purpose (For Information or For Acceptance) and Durations (Period or Weeks/Months) for First Issue of the particular deliverable Post Purchase Order.

[Note for PURCHASER - default values in the downloadable IRS are set to the equivalent of CAS level D, as defined in the QRS. Buyer is to adjust the values in these columns to match the actual CAS level for the specific application].

Required As Built, Fulfilled by Document Number(s), Translation Required and Remarks columns I, J, K & L are also included.

Definitions for each column are contained in the rows above the columns:

Abbreviations used for various submission requirements in Column H are shown in table 3.1 below:

Abbreviation	Description
WAD	Weeks After Delivery
WAI	Weeks After Inspection
WAO	Weeks After Order
WAO(Monthly)	Weeks After Order Monthly
WAT	Weeks After Test
WPTD	Weeks Prior To Delivery
WPTF	Weeks Prior to Fabrication
WPTT	Weeks Prior To Test

Table 3.1 - Information Submission Abbreviations

4 'Definitions' Tab

The 'Definitions' tab includes several columns A to F, including Column A for the relevant Code & Column B for the Requirement for the different Information (Data, Documents and/or Models) Deliverables to be provided by SUPPLIER's, all copied from the 'Deliverables' tab.

Column C includes a full description of the Information Deliverable based on the Parent Standard or relevant Industry Standard.

Column D gives a reference to the Purchase Order or Industry Standard that the Information is identified within.

Column E identifies the Deliverable format as listed in Table 9.1 below.

Column F relates the CFIHOS discipline document type that could be used to classify the document having this IRS content.

Definitions for each column are contained in the rows above the columns.

5 'Instructions' Tab

This 'Instructions' tab is provided to instruction & guidance to COMPANY, CONTRACTOR, PURCHASER and/or SUPPLIERS in the use of this IRS.

6 Abbreviations and Definitions

The following abbreviations, terms and definitions have been used in the various tabs of this workbook:

PURCHASER: Organisation placing a Contract or Purchase Order with Supplier for equipment or services on project; may be alternatively referred to as 'User' or 'Purchaser'

CFIHOS: Capital Facilities Information Hand Over Specification

COMPANY: Project Owner and/or Operator or other body acting on their behalf

CONTRACTOR: Nominated Contractor responsible for engineering, procurement of materials, building/installation and commissioning of the plant.

Information: Data Sheets, Documents, Drawings and/or PDMS Models

IRS: Information Requirements Specification

PO: Purchase Order

QRS: Quality Requirements Specification (QA Inspection and Testing Requirements - Appendix 2)

SMIS: Supplier Master Information Schedule

SUPPLIER: Organisation supplying equipment or services to Company and/or Contractor on project; may alternatively be referred to as "Supplier", "Seller" or "Manufacturer".

7 CFIHOS

The Information Requirements and Deliverables described in this IRS are based on the CFIHOS (Capital Facilities Information Hand Over Specification) Industry Standard. The objective of CFIHOS is to create a common information standard across the Oil and Gas industry to facilitate efficient information exchange on projects. Further information on CFIHOS can be found at <http://uspi-global.org/index.php/projects/frameworks-methodologies/136-cfihos>

8 Document Metadata

Typical Metadata for Information Deliverables to be provided by Suppliers is shown in Table 8.1 below

Property_Name	Definition
document number	The unique identifier for the Document according to the Owner/Operator Document numbering scheme.
revision code	A code used to identify the content of a document at a certain point in time according to the Owner/Operator Document Revision Coding scheme. It is used to track the evolution of a document during its lifecycle and is applied at time of release from Originator to reflect the document is frozen.
document title	Describes in a short and concise manner the content of the document. Remark: The title of the document usually appears on the front page of the document or in title block.
revision date	The date of the document revision.
originator company	Identifies the name of the Company who has generated the Document.
author	Author(s) of the current revision of the document. This should be an individual name, not a role, i.e. Initials and last name, not just initials
accepted by	Name or UserID of the person who has accepted the current revision of the document as per the document management acceptance workflow. This should be an individual name, not a role, i.e. Initials and last name, not just initials.
file name	The unique name of the electronic file (including the file extension).
originator document number	The unique identifier for the Document according to originator which doesn't necessarily conform to the Owner/Operator's document numbering scheme. Remark: One potential use is to allow Owner/Operator to identify duplicate documents provided by multiple subcontractors but from the same OEM.
originator document revision code	A code used to identify the content of a document at a certain point in time according to the originator which doesn't necessarily conform to the Owner/Operator's document revision coding scheme. Remark: One potential use is to allow Owner/Operator to identify duplicate documents provided by multiple subcontractors but from the same OEM.
document status code	A code used to indicate the life cycle status of the document. A code which identifies the state of the document within the publication lifecycle process. A document is classified by a single state, which changes as the document advances through this lifecycle.
language	Indicates the language that the document is written in.
discipline document type short code	Classifies the Document with a Discipline_Document_Type.
project code	A unique code used to identify the Project.
document comment	Indicates any additional Comment / Explanation for a Document Revision.
plant code	Identifies the Plant that the document is related to. This is a smaller subdivision than 'Site' but larger than 'Unit' or 'Area.'
export control classification	Indicate the Export Control Rule applicable for the Document (e.g., ECCN, EAR).
transmittal number	A unique transmittal identifier generated by the document control system of the company sending the transmittal.
security classification	Indicates internal Owner-Operator access restriction applicable for the Document.

Table 8.1 - Supplier Deliverable Metadata

9 Deliverable Formats

The format of the relevant Information Deliverable to be submitted by Supplier for Buyer/Contractor is to be as described in table 9.1 below. Where required to be 'As Built' deliverables are to be updated and handed over in the native format.

1. All engineering documents shall be electronically transmitted in a searchable ADOBE pdf format, with text documents being supplied in A4 size, portrait orientation, and engineering drawings being supplied in A3 size, landscape format.
2. Engineering drawings shall be supplied in both the native CAD format and pdf copies
3. All text shall be typed and in Arial font size 10 as a minimum.

Format	Description
Hard Copy	Should be electronically developed, but in particular and exceptional circumstances, say for legal reasons, may need to be handed over in printed paper format
Native	To be electronically developed and must be retained in the original application software format, with no embedded or linked files.
Portable Document Format (PDF)	To be electronically developed and must be in Optical Character Recognition (OCR) format which is text searchable & indexed. Embedded graphics in Joint Photographic Experts Groups(JPEG), Graphics Interchange Format (GIF) (suitably compressed) or Tagged Image File Format (TIFF) formats may be allowed but by exception only and with Purchaser's written approval.
Intelligent Vector (CAD)	Intelligent vector drawing Like CAD
Multi media (Film)	Multi media Like Film, Micro fiche, Video, Sound
Raster Image (Bitmap)	Raster Image like a bitmap
Structured Data (MS Apps)	Structured Data Like CSV file, MS-access, MS-Excel, Application Database
Technical Publication (Text)	Technical publication or Text

Table 9.1 – Deliverable Formats

Row	Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors		Issue
2	Tag No. :	Insert Tag_No	
3	Service :	Insert Service Description	
4	USER SUPPLEMENTARY REQUIREMENTS		
5	API Clause Ref.	Description of Amendment	
6	4.4	Part 1 - General Requirements - Basic Design	
7	4.4.8 (New)	The SUPPLIER shall indicate in his proposal the equations of state and the method used to predict the aerodynamic performance of compressors with the specified gas from characteristics of each single stage comprising of impeller, diffuser, return channel etc.	
8		[Process conditions and gas analyses are shown on the specification/data sheets.	
9		The determination of the thermodynamic properties of the gases and their effect on the design performance of the unit are the SUPPLIER'S responsibility. The SUPPLIER shall indicate in his proposal the equations of state and the method used to predict the aerodynamic performance of expander, compressors with the specified gas from characteristics of each single stage comprising of impeller, diffuser, return channel etc.	
10			
11			
12			
13	4.4.10.2 (New)	The average Mach numbers (at any location within compressor) shall be within the normal 0.85 limit. On a case by case basis, subject to the COMPANY's approval, higher numbers may be acceptable if Computational Fluid Dynamics (CFD) results can indicate that localized stalling at the impeller eye rim is minimal and will not be affected by the specified temperature and pressure variations in the impeller inlet. Transonic conditions shall never be accepted. The gas velocity at flange main connections shall be limited to 28 m/s at any specified operating point.	
14			
15			
	4.4.10.3 (New)	SUPPLIER shall verify their design by Finite Element Analysis for all critical components of the compressor. These components shall include casings, impellers, shafts, locations where sudden change in thickness, inlet and outlet flanges, and diaphragms as a minimum and implement any recommendations observed in such analysis. This information shall be shared with CONTRACTOR and COMPANY. FEA done on similar / identical machine may be provided if the offered model is within the range.	
	4.10.1.10 (Modify)	The materials for component parts shall be suitable for the service and shall be submitted within six weeks of order receipt for CONTRACTOR's and COMPANY's review.	
	4.10.4.11 (New)	If the compressor or the driver needs to be rotated at low speed for the purpose of warming up or cooling down (barring), the Vendor shall confirm that the dry gas seals will not be damaged by such operation and/or shall warn the COMPANY of any special precautions that must be taken.	
19	4.5	Part 1 - General Requirements - Accessories	
20	5.3.2 (Add)	The intention is to use the same type of oil for the machine train unless agreed otherwise by COMPANY. SUPPLIER shall indicate at least three alternate makes of suggested lube oil with their trade names / ISO Grades for use in case of non-availability of specified one in the market. ADNOC lube oils shall be used as first preference.	
21			
	5.4.1.2.13 (Modify)	The type of grout, thickness and grout manufacturer details shall be indicated on the foundation drawings. ☐ [Replace] Vendor shall recommend special grout material if any, considering low temperature service. Grout shall be epoxy non-shrink type complying with the requirements of DGS 1783 004.	
23	5.7.1 (Add)	SUPPLIER to clarify if he will use the contract special tools during factory assembly work to ensure proper assembly.	
24		Part 2 - Section 4 - General	
25	4.6.7.10 (Add)	SUPPLIER shall indicate in the datasheets the maximum allowable differential pressure for diaphragms between main intermediate nozzles.	
26		The SUPPLIER shall, as part of his supply, carry out studies to assess pressure excursions due to start-up, shutdown, trip-out, and blocked in settle-out pressure/ temperature conditions, surging (one or more stages) and any other worst combination of pressures and temperatures. The SUPPLIER shall report to the PURCHASER the outcome of his study and upon exhausting his (SUPPLIER'S) design solutions, shall propose any required modifications to the PURCHASER's system (including piping, valving, static equipment sizing, location and sizing of orifices etc) to ensure that the SUPPLIER's scope of supply safely operates within the overall system of the PURCHASER.	
27		SUPPLIER shall furnish, in his proposal, the maximum allowable differential pressure across each diaphragm, including the center wall. When two process stages are provided in a single casing, the suction nozzles shall be located at either end and discharge nozzles close to the stage separation wall to avoid high thermal gradients across the inter-stage separation wall.	
28	4.7.8 (Add)	Compressor SUPPLIER and driver SUPPLIER shall establish maximum transient torques that will occur in shaft system under start-up, running, and fault conditions.	
29			
30			
34		Part 3 - Section 4 - General	
37	4.9.3 (Add)	The SUPPLIER's primary offering shall be direct lubricated low oil consumption bearings. As an alternative, the SUPPLIER may offer his standard flooded bearing design. In the proposal, the SUPPLIER shall state the power demand difference between the two thrust bearing designs, if applicable.	
38			
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42	4.9.5 (Add)	Details of thrust bearing design shall be submitted within six weeks of order receipt for CONTRACTOR's and COMPANY's review.	
43			

Appendix 3: Information Requirements

Appendix 3: Information Requirements

Row	Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors		Issue
2	Tag No. :	Insert Tag_No	
3	Service :	Insert Service Description	
4	USER SUPPLEMENTARY REQUIREMENTS		
5	API Clause Ref.	Description of Amendment	
6	7	SUPPLIER's Data	
7	7.1.1 (Add)	Technical data, registers, documents, and drawings that together define the scope of the Purchase Order shall conform to the requirements for SUPPLIER information identified in the Purchase Order. The SUPPLIER shall comply with the following minimum requirements concerning submission of drawings and documentation:- - EM 30.99.95.0006 - ADCO Guidelines for Submission of Electronic Documentation - EP 30.99.90.0024 - Preparation of Supplier's/Supplier's Engineering Drawings and Documents	
8			
9			
10			
11			
12			
13	7.1.3 (Modify)	(Modification)	
14		The first sentence shall be modified to read "A SUPPLIER coordination meeting shall be held, preferably at the SUPPLIER's works, within four to six weeks after order commitment with the PURCHASER's Engineer in attendance."	
15			
16	7.2.1	Proposals / General	
17	7.2.1.1 (Add)	The SUPPLIER's proposal shall clearly state whether or not the offered equipment is in full compliance with the listed specifications. Where applicable, the SUPPLIER shall include a list in the proposal that details and explains each deviation.	
18			
19	7.2.1.2 (Add)	The proposal shall conform to this Specification. As an option, a basic proposal may be supplemented with alternative proposals, if the following conditions are conformed to: 1. Alternative proposal has process, lifecycle costing, or delivery date advantage and is a superior product at a justifiably higher price or a product of equal quality at a lower lifecycle cost. 2. Delivery date advantage alone shall not be used as justification for purchase of an alternative proposal. 3. Alternative proposal shall have equal or greater operating reliability based on proven experience.	
20	7.2.1.3 (New)	Driver, if offered, shall be included in the proposal with a separate price.	
21	7.2.3	Technical Data	
22	7.2.3 (Add)	Add to sub-clause a)... "Motor data sheets for each selected electric motor driver offered by the SUPPLIER shall also be included, which shall identify the electrical supply requirements and other special motor requirements."	
23			
24			
25	7.2.3 (Add)	Add to sub-clause f)... "Spare parts for commissioning and two years operation are required in accordance with Appendix 1. Capital spares are required for spare parts shall be available for purchase and all manufacturing drawings retained throughout the service life specified in (4.4.1.2) of ADNOC Standard. Unless otherwise specified, below insurance / capital spares shall be included in scope by SUPPLIER / EPC Contractor for Non-integrally / Integrally Geared Centrifugal and Axial Compressors."	
26			
28	7.3.2.1.6 (Modify)	Delete the words "If specified".	
29		Add.... "SUPPLIER shall furnish calculations (not merely calculation results) for the thrust load for various scenarios including surge and impeller blockage, clearly identifying the worst case scenario. Thrust load calculations shall take into account actual pressure profiles on the impeller surfaces. a. Radial and thrust bearings shall withstand reverse rotation without damage for duration of shutdown, both controlled and emergency. b. SUPPLIER shall provide loads and corresponding time limits."	
30			
31			
32			
33			
34			
35			
36	7.2.4 (Add)	Curves	
37		The compressor performance curves shall reflect the following additional requirements: SUPPLIER shall provide in his proposal, curves of suction, discharge and differential pressure versus unit loading of the thrust bearing. The curve(s) shall show, as a minimum, all operating conditions including surge and stonewall.	
38			
39		The Expander performance curve shall be submitted with the following requirements: o The swallowing capacity at the design inlet guide vane setting and also the range of swallowing capacity. o The expander isentropic efficiency at the rated condition specified in the datasheets and variation of this efficiency over the operation U/C range.	
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Appendix 3: Information Requirements

Appendix 3: Information Requirements

THE CONTENTS OF THIS DOCUMENT ARE PROPRIETARY.



INFORMATION REQUIREMENTS FOR CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION Appendix 3 - AGES-SP-05-002



Information Requirements for
Nonintegrally / Integrally Geared
Centrifugal and Axial Compressors
and Expander-Compressors

Insert Project Logo Here

CLIENT : Insert Client_name

PROJECT TITLE : Insert Project Title

PROJECT LOCATION : Insert Project_location

JOB/PROJECT NUMBER : Insert Job/Project number here

TAG No. : Insert Tag_No

SERVICE : Insert Service Description

DOCUMENT NUMBER : Insert Project Document Number

REVISION : Insert Project Document Revision

Issue	Date	Issue Description	By	Checked	Approved	
ADNOC Document No. xxxxxxxx Version 1.0						Sheet 1 of 1

Information requirements for
Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-
Compressors

Manufacturer's Record Book (MRB) SUBMITTAL REQUIREMENTS

1 GENERAL

1.1 DELIVERABLES

The SUPPLIER document requirements are defined within the DELIVERABLES section of this APPENDIX. These listed documentation shall be considered to be the minimum required. Additional requirements shall be discussed and agreed where specifically required by individual projects. All drawings and documents shall be written in the ENGLISH Language.

1.2 MANUFACTURING RECORD BOOK

The Manufacturing Record Book (MRB) for each equipment item shall be compiled in accordance with the following requirements and the applicable codes:-

- a) Documents shall be written in English.
- b) Documents shall be in a legible, reproducible form.
- c) The number of MRB's to be supplied shall be specified in the request for quotation (RFQ) and the Purchase Order (PO) documents.
- d) Drawings and other data shall be based on the A4 series sizes, and all drawings larger than A4 size shall be folded to A4 size so that title box and status decal are visible from the front and inserted into pre-punched plastic sleeves.
- e) The contents of the MRB shall be collated into a logical sequence in accordance with the Purchase Order/Contract requirements and in accordance with DGS 0000 003 "Minimum Shop Inspection and Certification Requirements". Tabbed dividers shall be provided to separate the sections of data.
- f) MANUFACTURER/ SUPPLIER shall submit a detailed MRB index/contents list for CONTRACTOR approval within 8 weeks of order placement unless stated otherwise in the Purchase Order.
- g) The reports shall be provided in loose leaf form with numbered pages in 2.5 inch hard cover A4 size binders (MANUFACTURER / SUPPLIER can use narrower binders if appropriate subject to COMPANY/ CONTRACTOR approval). Binder mechanism shall be four pillar interlock type. The color and finish of the binder will be advised by CONTRACTOR / COMPANY during a pre-production meeting.
- h) Multiple binders must be clearly referenced i.e. "1 of xx", and each contains an index detailing how many volumes and the contents of each volume.

2 DOCUMENTS

2.1 SUPPLIER'S RESPONSIBILITIES

As manufacturing of the equipment progresses, the MANUFACTURER / SUPPLIER shall compile the MRB with all the design, manufacturing, inspection, tests, and certification information on a per tag item number basis. Documents that are common to more than one item shall be duplicated in each report.

2.1 SUPPLIER'S RESPONSIBILITIES (Continued)

The MANUFACTURER / SUPPLIER shall present MRB's to the nominated inspector at each inspection visit. It is also their responsibility to ensure that Inspection & Test Plans are signed and dated by the nominated inspector on the day of any Inspection / Test. The spine and cover of each binder shall indicate the following as a minimum:-

- a) Manufacturing Data Report
 - b) Project Name
 - c) MANUFACTURER / SUPPLIER Name
 - d) Purchase Order No.
 - e) Equipment No.
 - f) Equipment Description
 - g) MANUFACTURER / SUPPLIER Order Ref. No.
 - h) MANUFACTURER / SUPPLIER Doc. No.
 - i) Date of Issue and Revision
- j) Alterations, deletions, or additions to certification are not normally permitted, and a new document must be prepared. However where this is not possible the alteration must be approved, signed and dated. Additions and revisions shall be added to the documentation, not as a replacement but as an addition to the existing records
- k) The Manufacturing Data Report shall, after being accepted by clear endorsement of each page by stamp, date and signature of the nominated inspector, be submitted to the CONTRACTOR.
- l) MDR documents that are already approved by CONTRACTOR with a signed and dated endorsement do not require additional endorsement by the nominated inspector at the MANUFACTURER / SUPPLIER works. The nominated inspector shall endorse the index as correct with reference to documents embodied within the MRB. For multi-page documents the first page (used for approval) shall clearly state the document total number of pages and each page shall be numbered. CONTRACTOR can use dated stamps, subject to COMPANY approval (without requirement for signature endorsement) providing stamp is uniquely identifiable to individual inspectors.
- m) The original and the required number of copies shall be forwarded promptly after the completion of the equipment in accordance with the terms and conditions of the purchase order. If the order is subject to inspection by COMPANY / CONTRACTOR, the release note for the acceptance of the equipment shall only be issued when the manufacturing report, including the required number of copies, is presented.
- n) The use of colored markers to highlight certificates shall not be permitted.
- o) The use of correction fluids is not permitted.
- p) When test / material certification is called for, these certificates are to be countersigned by COMPANY / CONTRACTOR.

3 MANUFACTURER/ SUPPLIER QC DOCUMENTATION AND CERTIFICATION

Supplier document and deliverables shall be as per the attached schedule of DELIVERABLES, which shall be updated with required document submission times according to the project schedule requirements.

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors

Deliverables

Column	Heading - Details and requirements												
A	Code - a unique identifier for the Information Deliverable, referencing the Parent Standard, IOGP Supplement or Industry Standard where the Information is requested. e.g. API617#01.												
B	Requirement - a short description of the Information Deliverable that would typically provide the Information required, based on the description in the Parent Standard, IOGP Supplement or an Industry Standard Title.												
C	Condition Invoking Requirement - describes special condition(s) under which the Information Deliverable is required; e.g.. service offshore and weight greater than 1 tonne means information is required. NB: if blank, always required.												
D	Typical Deliverable - Purchaser to confirm or add a short description of the Information Deliverable that would typically include this Information Requirement.												
E	Submit With Proposal - Yes or No, where 'Yes' means the Information Deliverable is required to be submitted with Suppliers Proposal or 'No' is not required												
F, G & H	First Issue Post Purchase Order - deliverable shall be issued 'For Information' or 'For Acceptance' at the agreed time defined as weeks after order placement (WAO), Weeks prior to delivery (WPTD), Weeks prior to test (WPTT) or weeks after test (WAT).												
I	Required As Built - Yes or No, where 'Yes' means the Information Deliverable is required to be 'As Built' on completion or delivery of equipment or 'No' is not required 'As Built'												
J	Fulfilled by Information Deliverable Number(s) – identifies which deliverable(s) to be provided by the Supplier include the Purchaser's information requirements described within the Definitions tab. NB; it should be noted that one single Deliverable may include more than one defined information line item.												
K	Manufacturer's Record Book - Yes or Yes ®, where 'Yes' means that the Supplier shall provide details within the Manufacturer's Record Book and 'Yes ®' means that the MRB shall be reviewed by the inspector during inspection. This requirement does not preclude formal / duplicate submission of documents for project purposes												
L	Installation, Operating and Maintenance Manual - ✓, where ✓ means that the Supplier shall provide details within the Installation, Operating and Maintenance Manual(s)												
M	Translation Required -Yes or No, where 'Yes' means the Deliverable should be translated into one or more other languages (where specified in the purchase order) other than English and 'No' means to be provided in English												
N	Remarks - may include additional requirements, conditions & decisions as may be appropriate to the content of the deliverable.												
Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
Contract Management Information Deliverables													
MD#01	Supplier Master Information Schedule		Information Deliverables List	No	For Acceptance	4	WAO	Yes		Yes	✓		List of Supplier's Documents and Drawings
MD#02	Delivery schedule		Delivery/Production Schedule	Yes	For Information		WAO	No					
MD#03	Progress report		Progress Report	No	For Information		WAO (Monthly)	No					Bi-weekly progress reports are to be submitted by the SUPPLIER indicating lookahead and manufacturing status.
MD#04	Quality plan		Quality Plan	No	For Acceptance		WAT	No		Yes			
MD#05	Design and Development Plan		Design and Development Plan	No	For Acceptance		WAO	No					
MD#06	List of Sub-Suppliers		List of Sub-Suppliers	Yes	For Acceptance		WAO	No			✓		To be updated monthly to show Sub-Supplier details, including component description, sub-order number, order placement and delivery dates
MD#07	Inspection and test plan		Inspection and Test Plan (ITP)	Yes	For Acceptance		WAO	No		Yes ®			Prior to the start of manufacture, an ITP shall be submitted for approval by SUPPLIER for review at the Pre-inspection meeting.
MD#08	'Packing, shipping, storage and preservation procedure		Handling, shipping and storage procedure	No	For Acceptance		WPTD	No			✓		Preparation of equipment for transportation shall conform to the packing, marking, and shipping instructions or other documents identified in the Purchase Order. In Addition SUPPLIER shall comply with the Handling - Package - Preservation and Storage requirements given in "Common Requirements" Appendix of this Specification.
MD#09	Non-conformance records		Nonconformance History	No	For Acceptance		WAO	Yes		Yes ®			
MD#10	Concession requests		Concession request	Yes	For Acceptance		WAO	Yes		Yes			
MD#11	Preservation and Maintenance Instructions for Insurance/Capital Spares		Preservation and Maintenance Instructions for Insurance/Capital Spares	No	For Acceptance		WPTD	No			✓		This shall be submitted prior to the packing, shipping storage and preservation procedure, MD#08
Technical Information Deliverables													
API 617#01	General Arrangement Drawing		General Arrangement Drawing	Yes	For Acceptance		WAO	Yes			✓		
API 617#02	Compressor Performance Curves		Compressor Performance Curves	Yes	For Acceptance		WAO	Yes			✓		
API 617#03	Data Sheet of Compressor / Expander Package		Data Sheet of Compressor Package *Note: all individual sub components of package shall have respective data sheets.	Yes	For Acceptance		WAO	Yes			✓		
API 617#04	Noise Data Sheets		Noise Data Sheets	Yes	For Acceptance		WAO	Yes			✓		
API 617#05	Utility Requirements Schedule		Tabulation of Utility Requirements (Process and Electrical)	Yes	For Acceptance		WAO	Yes			✓		
API 617#06	Process Control Description		Process Control Description	Yes	For Acceptance		WAO	Yes			✓		
API 617#07	Cross Sectional Drawings and Bill of Materials		Cross Sectional Drawings and Bill of Materials	Yes	For Acceptance		WAO	No			✓		
API 617#08	General Arrangement Drawing of Main Driver		General Arrangement Drawing of Main Driver	Yes	For Acceptance		WAO	Yes			✓		
API 617#09	P&I Diagram of Process and ASV System		'P&I Diagram of Process and ASV System	Yes	For Acceptance		WAO	Yes			✓		
API 617#10	P&I Diagram of Lube Oil System		P&I Diagram of Lube Oil System	Yes	For Acceptance		WAO	Yes			✓		
API 617#11	P&I Diagram of Sealing System		P&I Diagram of Air System	Yes	For Acceptance		WAO	Yes			✓		

Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
API 617#12	P&I Diagram for Condition Monitoring Instruments		P&I Diagram for Condition Monitoring Instruments	Yes	For Acceptance		WAO	Yes			✓		
API 617#13	Recommended Spare Parts		List of recommended spare parts for complete package including commissioning spares, two year spares and insurance spares.	Yes	For Information		WPTD	Yes			✓		
API 617#14	Life Cycle Cost Analysis		Life Cycle Cost Analysis	Yes	For Acceptance		WAO	No			✓		
API 617#15	Reliability & Availability Study		Reliability & Availability Study	Yes	For Acceptance		WAO	No			✓		
API 617#16	Site Acceptance Test Procedure (SAT)		Site Acceptance Test Procedures	Yes	For Acceptance		WAO	No			✓		Preliminary version to be submitted with proposal. FINAL version to be developed and submitted after purchase order award.
API 617#17	Detailed Drawings		Detailed Drawings	No	For Acceptance		WAO	Yes			✓		
API 617#18	Stair, ladders and platform drawing		Stair, ladders and platform drawing	No	For Acceptance		WAO	Yes			✓		
API 617#19	Nameplate Drawing		Nameplate Drawing	No	For Information		WAO	Yes			✓		
API 617#20	Drive Coupling Assembly Drawing		Main Driver Coupling Assembly Drawing with	No	For Information		WAO	Yes			✓		
API 617#21	Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic		Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic	No	For Acceptance		WAO	No			✓		
API 617#22	Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details		Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details	No	For Acceptance		WAO	Yes			✓		
API 617#23	Foundation Loading Diagram		Foundation Loading Diagram	No	For Acceptance		WAO	Yes			✓		
API 617#24	Cause & Effect chart		Cause & Effect chart	No	For Acceptance		WAO	Yes			✓		
API 617#25	Coupling Data Sheets		Coupling Data Sheets	No	For Acceptance		WAO	Yes			✓		
API 617#26	Electric Motor Data Sheets		Electric Motor Data Sheets	No	For Acceptance		WAO	Yes			✓		Separate data sheet required for each size/type of electric motor supplied for auxiliary equipment drives.
API 617#27	ISA Data Sheets for Instruments		ISA Data Sheets for Instruments	No	For Acceptance		WAO	Yes			✓		
API 617#28	Material Safety Data Sheets		Material Safety Data Sheets	No	For Acceptance		WAO	Yes			✓		
API 617#29	Insulation specification		Insulation specification	No	For Acceptance		WAO	No			✓		
API 617#30	Weight Data Sheet (For OFFSHORE application)		Weight Data Sheet (For OFFSHORE application)	No	For Acceptance		WAO	Yes			✓		
API 617#31	Vibration Data Sheet		Vibration Data Sheet	No	For Acceptance		WAO	Yes			✓		
API 617#32	Lubrication Schedule		Lubrication Schedule	No	For Acceptance		WAO	No			✓		
API 617#33	Relief Valve Sizing Calculation		Relief Valve Sizing Calculation	No	For Acceptance		WAO	Yes			✓		
API 617#34	Structural Calculations		Structural Calculations	No	For Acceptance		WAO	Yes			✓		
API 617#35	CFD and FEM Calculation notes		CFD and FEM Calculation notes	No	For Acceptance		WAO	Yes			✓		
API 617#36	Anti surge calculation sheet (with anti surge valve sizing)		Anti surge calculation sheet (with anti surge valve sizing)	No	For Acceptance		WAO	Yes			✓		
API 617#37	Auxiliaries data sheets		Auxiliaries data sheets	No	For Acceptance		WAO	Yes			✓		
API 617#38	Drawings of auxiliaries and itemized equipment supplied loose		Drawings of auxiliaries and itemized equipment supplied loose	No	For Acceptance		WAO	Yes			✓		
API 617#39	Thermal rating for air cooler / heat exchangers		Thermal rating for air cooler / heat exchangers	No	For Acceptance		WAO	Yes			✓		
API 617#40	Pressure vessel / cooler fabrication drawings		Pressure vessel / cooler fabrication drawings	No	For Acceptance		WAO	Yes			✓		
API 617#41	Dry gas seal drawings (with material list)		Dry gas seal drawings (with material list)	No	For Acceptance		WAO	Yes			✓		
API 617#42	Blades Campbell Diagrams		Blades Campbell Diagrams	No	For Acceptance		WAO	Yes			✓		
API 617#43	Driver Performance & Data and Curves		Motor Performance & Electrical Data and Curves	No	For Acceptance		WAO	Yes			✓		
API 617#44	Hydrostatic Test Procedure and Certificates		Hydrostatic Test Procedure and Certificates	No	For Acceptance		WPTT	Yes		Yes ®			
API 617#45	Impeller overspeed test procedure		Impeller overspeed test procedure								✓		
API 617#46	Full-load/Full-pressure/Full-speed test procedure										✓		
API 617#47	Complete Package Performance/Mechanical Run Test Procedure		Complete Package Performance/Mechanical Run Test Procedure	No	For Acceptance		WPTT	No			✓		
API 617#48	Lateral Critical Speed Analysis		Lateral Critical Speed Analysis	No	For Acceptance		WAO	Yes			✓		
API 617#49	Material Certificates		Material Certificates	No	For Information		WAT	No		Yes ®			The document is not required to be submitted as a separate document part of project review cycle. It can be included part of the MDR
API 617#50	Preservation, Packaging and Shipping Procedures		Preservation, Packaging and Shipping Procedures	No	For Acceptance		WPTD	Yes			✓		
API 617#51	Torsional Critical Speed Analysis		Torsional Critical Speed Analysis	No	For Acceptance		WAO	No			✓		
API 617#52	Welding Procedure Specification, including Procedure Qualification Record / Certificates		Welding Procedure Specification, including Procedure Qualification Record	No	For Information		WPTF	No		Yes ®			
API 617#53	Welding Repair Procedure		Welding Repair Procedure Major and minor weld repairs list	No	For Information		WPTF	No		Yes ®			
API 617#54	Complete Unit Test Report		Complete Unit Test Report	No	For Information		WAT	No			✓		
API 617#55	Surface Preparation and Coating Procedure Specification		Surface Preparation and Coating Procedure Specification	No	For Information		WAO	No			✓		

Col A	Col B	Col C	Col D	Col E	Col F	Col G	Col H	Col I	Col J	Col K	Col L	Col M	Col N
Code	Requirement	Condition Invoking Requirement	Typical Deliverable	Submit At Proposal	First Issue Post Purchase Order			Required As Built	Fulfilled by Document Number(s)	MRB	IOM Manual	Translation Required	Remarks
				(Yes/No)	Purpose	(Weeks)	(Period)	(Yes/No)		(Yes / Yes ®)	(✓)	(Yes/No)	
API 617#56	Factory Acceptance Tests procedure (FAT)		Factory Acceptance Tests procedure (FAT)	No	For Acceptance		WAO	No			✓		
API 617#57	Compressor / Expander Performance Tests procedure		Compressor / Expander Performance Tests procedure	No	For Acceptance		WAO	No			✓		
API 617#58	Performance/ Routine Test Procedure- Driver		Performance/ Routine Test Procedure- Electric Motor	No	For Information		WPTT	No			✓		
API 617#59	Non-Destructive Examination (NDE) Report		Non-Destructive Examination (NDE) Report	No	For Information		WAT	No		Yes ®			
API 617#60	Instrument Calculation Sheets		Instrument Calculation Sheets	No	For Information		WPTD	No		Yes			
API 617#61	Instrument Hook-Up Drawings		Instrument Hook-Up Drawings	No	For Information		WPTD	No			✓		
API 617#62	SIL / ATEX Certificates		SIL / atex Certificates	No	For Information		WAO	No		Yes ®			
API 617#63	Instrument List/Index		Instrument List/Index	No	For Acceptance		WAO	No			✓		
API 617#64	Preliminary Packing List		Preliminary Packing List	No	For Information		WPTD	No			✓		
API 617#65	Installation, Operation and Maintenance Manual index		Installation, Operation and Maintenance Manual Index	No	For Information		WAO	No			✓		
API 617#66	Installation, Operation & Maintenance Manual		Installation, Operation & Maintenance Manual								✓		
API 617#67	List of special tools for maintenance		List of special tools for maintenance								✓		
API 617#68	Manufacturing record book index		Manufacturer Record Book Index	No	For Acceptance		WAO	No		Yes ®			
API 617#69	Manufacturing record book		Manufacturer Record Book	No	For Acceptance		WPTD	Yes		Yes			
API 617#70	Non-Destructive Examination (NDE) Procedure		Non-Destructive Examination (NDE) Procedure	No	For Information		WPTF	No		Yes			
API 617#71	Declaration of conformity		Declaration of Conformity	No	For Acceptance		WPTD	No		Yes ®			The document is not required to be submitted as a separate document part of project review cycle. It can be included part of the MDR.
API 617#72	Hazardous Area Certification		Hazardous Area Certification	No	For Information		WPTD	No		Yes ®			
API 617#73	Supplier's Piping Specification	For conformity to ASME B31.1 or B31.3 (as appropriate)	Written Specification	No	For Acceptance		WAO	No			✓		
API 617#74	List of Weld Repairs		List of Weld Repairs	No	For Information		WPTT	Yes		Yes ®			To include list of major and minor weld repairs

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors

شركة بترول أبوظبي الوطنية
Abu Dhabi National Oil Company

Definitions

Column	Heading - Details and requirements				
A	Code - a unique identifier for the Information Deliverable, referencing the Parent Standard, IOGP Supplement or Industry Standard where the Information is requested. e.g. API672#01, S-612#01				
B	Requirement - a short description of the Information Deliverable that would typically provide the Information required, based on the description in the Parent Standard, IOGP Supplement or an Industry Standard Title.				
C	Description - an excerpt from the Parent Standard, IOGP Supplement or Industry Standard.				
D	Reference - reference to the Parent Standard, IOGP Supplement or Industry Standard that the Information Deliverable is identified in.				
E	Format - defines the required format of the relevant Information Deliverable to be submitted by Supplier for Purchaser/Contractor for information and acceptance as shown in Table 9.1 of Instructions Tab and selected from pick list.				
F	CFIHOS Discipline Document Type Code - the CFIHOS discipline document type that could be used to classify the document having this IRS content.				
Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
Contract Management Information Deliverables					
MD#01	Supplier Master Information Schedule	Schedule of specific information deliverables developed by the [SUPPLIER] and accepted by the [COMPANY] to meet the information requirements defined in the agreed Information Requirements Specification (IRS). The schedule typically defines; a) information deliverable type, title/description b) unique identification (code/number) in the [supplier's] format unless agreed otherwise in the contract. c) planned submission arrangements including; purpose, formats, timing, frequency Arrangements for managing submissions, tracking progress and updating the schedule during the execution of the contract scope will be in accordance with contractual agreements.	Contract Requirement, API 617, Part 1, 7.3	Native	
MD#02	Delivery schedule	Schedule depicting, as applicable to the service or product scope, design, supply, manufacture, inspection, testing and delivery activities to be executed by [supplier/sub-suppliers] Schedule details typically** include;. a) Contractual milestones b) Activity early/late start/completion dates, durations, dependencies (Calendar Dates) c) Critical path and float d) Outsourced services and equipment (cross referenced to purchase order and supplier) e) Information deliverable submission dates identifying any execution activity dependencies Once agreed , changes to planned dates are subject to agreement by [customer]. Progress against planned dates is measured and the schedule updated and reported to the [customer] in accordance with contract reporting agreements. ** Schedule development tools, formats and submission protocols follow the [supplier's] standard practice unless otherwise agreed in the contract.	Contract Requirement, API 617, Part 1, 7.3	PDF	
MD#03	Progress report	Report detailing activities completed in the period, percent complete against planned, activities planned for the next period, risks/areas of concern, cause of any delays and proposed recovery plans, concessions, internal and outsourced inspection and audit activities.. Note: may also include actionable items such as Health, Safety, Security & Environment (HSSE) incidents & status if required under the Contract.	Contract Requirement, API 617, 9.2.3.1 r	PDF	
MD#04	Quality plan	Plan specifying the actions, responsibilities and associated resources to be applied by the [supplier], and when applicable [sub-suppliers] or [manufacturers], to deliver the services or procured item(s) in conformance with the agreed requirements. ISO9001 Clause 8.1 and ISO10005 may be used to inform the development of quality plans for specific applications, processes or products. [API Spec Q2 may be used to inform the development of Service Quality Plans]	Appendix 2- ADNOC Std	PDF	
MD#05	Design and Development Plan	Definition of the stages and controls for design and development; encompassing, design and development inputs, methods and associated controls (review, verification, validation), outputs and design change management. refer ISO9001, API Spec Q1 or equivalent requirements.		PDF	
MD#06	List of Sub-Suppliers	List to include component or material description, SUB-SUPPLIER name and contact details, sub-order reference number, manufacturing location, PO placement date (planned and actual) and contractual delivery dates for products or services that will be externally provided, including specifications and controls to be applied by the [Supplier] to ensure conformance with agreed requirements. The schedule includes evidence of the basis of capability assessment , quality management system certification (or equivalent), process or product qualification for proposed suppliers of outsourced products and services when nominated in the Contract or Quality Requirements Specification (QRS) . Note: ISO 9001, API Specs Q1/Q2 define requirements for assessing risks and establishing controls for outsourced products and services.	Contract Requirement	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
MD#07	Inspection and Test Plan	Tabular presentation of a quality plan typically used for process or product applications to define the specific sequence of inspection and testing activities, references to work instructions, acceptance criteria records and associated [Supplier], [purchaser] and independent conformity assessment activities. Inspection and test activities shall be listed in chronological sequence and shall include activities at sub-supplier(s) and shall identify them as such. The ITP shall include pre-determined intervention points advised by Contractor to Supplier in data sheets and/or within Appendix 2. ISO 9001, API Specification Q1 or equivalent quality management system standard (as agreed with purchaser) may be used to inform the development of inspection and test plans for specific processes and products. The ITP shall include inspection and testing activities to be performed for the complete package, including those at sub-suppliers' works and shall make reference to all testing procedures, control documents, and resulting records and reports.	Contract Requirement	PDF	
MD#08	Packing, shipping, storage and preservation procedure	Definition of practices to be followed during the; storage, transport, lifting and preservation of the equipment and materials included in the scope of supply to maintain their functionality and guarantees. Procedures typically define: a) Packaging requirements; contents, identification, size, weight and number of packages/container (s), b) special packing/unpacking/handling requirements c) storage location and requirements, d) preservation requirements detailing inspection periods and required maintenance, materials required etc., both prior to installation and post installation, but prior to commissioning.	Contract Requirement	PDF	
MD#09	Non-conformance records	Details of non-conformances raised by or to the [supplier/sub suppliers] against technical requirements prior to or during the delivery of the products or services. Non-conformance is managed by the [supplier] in accordance with ISO9001 Clause 8.7 and associated records typically include; description of non-conformance, analysis and disposition, correction implemented and details of any retesting or inspection taken to demonstrate subsequent conformance. Note: Instances where the proposed disposition is to accept a non-conforming condition are subject to agreement by the [Customer] in accordance with the concession management protocols defined in the Contract.	Contract Requirement	PDF	
MD#10	Concession requests	Formal submission seeking [customer] agreement to accept deviations from the contracted scope or technical requirements. Requests may be raised as a result of, as examples, material or service availability, obsolescence, innovation, non-conformance. Requests are typically raised as required during execution with a summary report detailing concessions raised, [customer] directions, agreed action status provided with progress reports and at contract closeout	Contract Requirement	PDF	
MD#11	Preservation and Maintenance Instructions for Insurance/Capital Spares	Detailed instructions for preservation, storage and maintenance of insurance/capital spares (i.e. spare pump rotors, etc) which require specific controls to be applied. This shall be submitted prior to the packing, shipping storage and preservation procedure, MD#08.	Contract Requirement	PDF	
Technical Information Deliverables					
API 617 #01	General Arrangement Drawings	Dimensional outline drawings and list of connections, including the following: a. Size, type, rating, location, and identification of all purchaser connections b. The weight of the package and approximate overall erection and maintenance handling weights of equipment and subassemblies 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 & auxiliary drives 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. i. Customer connection tie-in for electrical & control interface j. Lifting Arrangement	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #02	Compressor / Expander performance curves	Performance curves showing discharge pressure and brake horsepower plotted against delivered inlet volume flow rate at rated conditions and other specified operating conditions. Performance curves are also to incorporate surge line and surge control line showing the separation margin between the surge capacity and rated capacity. Performance curves are to be provided to reflect various control modes such as base load control, load/unload control and showing operating envelope with surge control line & with effect of Inlet Guide Vane setting angle.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #03	Data Sheet of Compressor / Expander Package	Supplier is also to complete in full a data sheet for all items of Equipment to be provided	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #04	Noise Data Sheets	The vendor is also to provide maximum expected overall sound pressure level @ 1.0 meter from the skid, and sound power level for the skid. Supplier is also to provide per octave band data for sound pressure level and sound power level for the equipment.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #05	Tabulation of Utility Requirements (Process and Electrical)	Tabulation of utility requirements (may be on as built purchaser data sheets).	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #06	Process Control Description				
API 617 #07	Cross Sectional Drawings and Bill of Materials	Cross-sectional drawings and bill of materials, including a listing of all parts. To be submitted with Operation and Maintenance Manual	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #08	General Arrangement Drawing of Main Driver	Details as showing details of Driver drawing are to include terminal box details, purchaser connections & wiring instructions, direction of rotation viewed from driven end	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #09	P&I Diagram of Process and ASV System	Main process schematic including the following: a. Piping and valve sizes. b. Instrumentation, safety devices c. Purchaser's connections d. Minimum straght length at suction and discharge sides	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #10	P&I Diagram of Lube Oil System	Lube oil schematic including the following: a. Piping and valve sizes. b. Instrumentation, safety devices c. Purchaser's connections	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #11	P&I Diagram of Sealing System	Sealing system schematics , including the following: a. Seal flow schematics showing necessary instrumentation and controls b. Seal Air System schematic including distribution of seal gas from compressor discharge or from seal booster (if applicable) c. Pipe and valve sizes d. Instrumentation and safety devices e. purchaser connections (if any). f. Seal Gas flows and control-valve (regulator) settings (if applicable) Is also include seal gas/ nitrogen system, if applicable.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #12	P&I Diagram for Condition Monitoring Instruments	Schematic showing number, arrangement, details of proximity probes, axial position probes, key-phasers, accelerometers, bearing temperature monitoring, winding temperature monitoring for compressor, gear and driver motor.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #13	Recommended spare parts	Recommended list of spares covering all equipment furnished by Supplier. - List is to indicate all spare parts recommended by Supplier/Sub Supplier for commissioning, start-up, 2 years of operation and capital or insurance spares. - For each part listed, the original manufacturer's name and part number is to be shown. - For antifriction bearings, full bearing designation numbers with appropriate suffixes that clearly indicate bearing type, size, cage type, and the selected internal clearance or pre-load is to be shown. 'Spare parts list with stocking level recommendations in accordance with 9.3.4. The proposal is to include an itemized list of the recommended spares referenced to a typical cross-sectional drawing. Spares are to be individually identified and priced. As a minimum the following spares are to be offered: a. Pinion shaft rotors b. Impellers for individual stages c. All bearing assemblies d. Spare bearing liners or pads as applicable e. All oil or air seals f. Diffusers g. Lube Oil Pumps h. Compressor service kit	API 617, Part 1,2,3,4 Annex B	Native	
API 617 #14	Life Cycle Cost Analysis	A cost analysis to include operating costs, maintenance costs, repair and refurbishment costs for an equipment life of 30 years shall be performed. Parameters to be used for lifecycle costing such as utlity costs, escalation factors, discount factors, etc shall be agreed with COMPANY.		PDF	
API 617 #15	Reliability, Availability & Maintainability Study	Study to include details of equipment reliabilty, availability and maintainability based on mathematical modelling using typical equipment MTTF, MTTR and MTBF data supported by actual field reliabilty and maintenance data where available.		PDF	
API 617 #16	Site Acceptance Test Procedure	A preliminary version of the proposed SAT procedure shall be issued by the SUPPLIER with the Proposal. FINAL version to be developed and submitted after purchase order award. A fully detailed test procedure identifying the required site acceptance tests including test durations, test operating conditions, site utilities, test equipment and acceptable tolerances/limits. Refer to minimum test requirements detailed within Appendix 2 'QA Inspection and test Requirements'	Contract Requirement	PDF	
API 617 #17	Detailed Drawings	Dimensional drawings for all major auxiliary equipment or components or component (such as electric motor, lube oil reservoir, coolers) with bill of materials	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #18	Stair, ladders and platform drawing	Dimensional drawings for all associated stairs, ladders and platforms to be supplied seprately from main equipment skid package.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #19	Nameplate Drawing	As a minimum, the following data is to be clearly stamped or engraved on the nameplate for compressor and auxiliary equipment: 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 is to be consistent with those used on the data sheets.	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #20	Drive Coupling Assembly Drawing	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. Parallel & angular mis-alignment tolerance	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #21	Electrical and Instrument Interconnecting Cable Block diagram or interface wiring schematic	Electrical, instrumentation and control schematics	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #22	Electrical and Instrument Connection & Wiring Diagrams with Bill of Material and termination details	Diagrams are to display, in block form, the items of electrical and instrument equipment and all cables interconnecting them. They are to show each terminal block with the terminals numbered and the cores of the connecting cables identified and landed on terminal points. The core identifiers given are to be those ferruled onto the conductors and are required to follow the agreed numbering systems. Note: Reference on these diagrams is to be made to the internal wiring diagrams for each of the electrical and instrument equipment involved. In simple cases, the internal wiring for this equipment may be shown directly on the diagram for simplicity. Symbols are to be in accordance with IEC 60617 or BS EN 60617-12:1999.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #23	Foundation Loading Diagram	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 (for bolted down skid) b. Dimensions, number, material and location of deck plates including weld thickness (for skid welded to the deck e.g. for off-shore installation) c. Weights and centers of gravity for major components. d. Foundation loads at each support location for various load cases e.g. dead load, live load, dynamic load, seismic, wind, transportation load etc. This drawing can also be made part of the General Arrangement Drawing (2.1) e. for OFFSHORE application, shaft distortion calculation shall be submitted for review.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #24	Cause & Effect chart	Cause & Effects (C&E's) are to include schedule of Control, Alarm, Trip and Start-Permissive Functions including recommended setpoints and associated actions and any narratives thereof. For offshore installations this ought to also take into consideration safety analysis checklist requirements for a compressor as defined in American Petroleum Institute (API) RP14C.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #25	Coupling Data Sheets	Supplier is also to complete in full a data sheet for all items of Equipment to be provided	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #26	Electric Motor Data Sheets	Supplier is also to complete in full a data sheet for electric motor (in sub-vendor data sheet format)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #27	ISA Data Sheets for Instruments	ISA data sheets for all instruments.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #28	Material Safety Data Sheets	Material Safety data sheets	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #29	Insulation specification	Supplier is also to provide insulation specification to be reviewed and approved. (If applicable)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #30	Weight Data Sheet (For OFFSHORE application)	Main and auxiliary equipment / parts' weight are to be confirmed with regard to total weight guaranteed in proposal phase.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #31	Vibration Data Sheet (For OFFSHORE application)	Vibration level / range of frequencies are to be provided by Supplier.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #32	Lubrication Schedule	Schedule to indicate type and grade of lubricants and other consumables required for all equipment supplied. For each schedule entry the following is also to be included as a minimum: Tag number, tag description / component (e.g. bearings, engine, gearbox, etc), lubricant manufacturer, lubricant type and grade (product code), first fill capacities, rate of consumption (litres / day) and frequency of change.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #33	Relief Valve Sizing Calculation	Sizing calculations for external relief valves	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #34	Structural Calculations	Structural Calculations for Baseplate and Lifting Beam taking into consideration various lifting configurations during lifting, transportation and installation. Baseplate calculations are also to take into consideration dead and live load and also load arising from environmental conditions such as wind, seismic etc.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #35	CFD and FEM Calculation notes	Computational Fluid Dynamic, Finite Element analysis, Skid Vibration calculation note, Skid strength & rigidity calculation note, 3D FEA)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #36	Anti surge calculation sheet (with anti surge valve sizing)	Specification and calculation of antisurge control valve with Anti-surge Valve Sizing including	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #37	Auxiliaries data sheets	Supplier is also to provide auxiliaries data sheets to be reviewed and approved. Mechanical Data Sheets for lube oil cooler, LO pumps and couplings)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #38	Drawings of auxiliaries and itemized equipment supplied loose	Coupling Drawing(s) & Bills of Materials; Cold and Hot alignment Data, 'Witches Hat' strainer and other Auxiliary Equipment Drawings & Bill of Materials	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #39	Thermal rating for air cooler / heat exchangers	Heat transfer details calculation is to be submitted by Supplier	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #40	Pressure vessel / cooler fabrication drawings	All fabrication / shop drawing are to be submitted.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #41	Dry Gas seal drawings (with material list)	Dry gas seal cross-section / general arrangement to be submitted.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #42	Blades Campbell Diagrams				

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #43	Main Driver Performance Data and Curves	Curves for Electrical driven are to indicate torque and current against speed for 80% and 100% voltage conditions and at rated frequency, superimposed on driven equipment torque curve to confirm that there is adequate net torque for acceleration. The following performance curves are required for both 80% and 100% voltage: - motor speed 'v' torque - motor speed 'v' Power factor - motor speed 'v' current - driver equipment torque 'v' speed for all start up conditions	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #44	Hydrostatic Test Procedure and Certificates	Procedures for compliance with Purchaser specifications/ International Standards including duration of test, quality of test medium, confirmation of no leakage. Certificates of hydrostatic, leak and / or pneumatic tests carried out - Note! Specific Purchaser approval is required for all Pneumatic testing.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #45	Impeller overspeed test procedure			PDF	
API 617 #46	Full-load/Full-pressure/Full-speed test procedure			PDF	
API 617 #47	Complete Package Performance/Mechanical Run Test Procedure	Procedure to determine that equipment operates according to Purchaser requirements is to include- a. Performance test procedure as per ASME PTC 10, with test points, tolerances etc. b. Mechanical run test procedure c. Noise test procedure d. Control panel functional test procedure e. Lube oil flushing / cleanliness test procedure	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #48	Lateral Critical Speed Analysis	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 (speed vs phase & response amplitude showing Amplification Factor at x/y vibration probe location for each damped unbalance critical speed- Bode plot). c. Graphic display of bearing and support stiffness and its effect on critical speeds(Undamped critical speed-support stiffness map for bull gear rotor & both high speed pinion rotors). d. Graphic display of rotor response to unbalance (including damping) (deflected rotor shape showing the major-axis amplitude at key locations - radial bearing, shaft seal, oil seal to demonstrate amplitude well within diametral running clearance). e. Journal static loads. f. Stiffness and damping coefficients for min and max clearance (max and min pre-loads). g. Tilting-pad bearing geometry and configuration	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #49	Material Certificates	Type 3.1 and Type 2.2 material inspection certificates as per EN 10204 for various components for compressor and accessories.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #50	Preservation, Packaging and Shipping Procedures	Contains the following: - The instructions necessary to preserve the integrity of the storage preparation after the equipment arrives at the job site and before start-up, as described in API 686, Chapter 3. - Packaging procedure. - Shipping procedure.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #51	Torsional Critical Speed Analysis	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 model. c. Tabulation identifying the mass moment and torsional stiffness of each component identified in the mass elastic system. d. Graphic display of exciting frequencies versus speed and natural torsional frequency (Campbell Diagram). e. Graphic display of torsional critical speeds and deflection angle for torsional vibration (mode-shape plot). f. Effects of alternative coupling on analysis.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #52	Welding Procedure Specification, including Procedure Qualification Record	Define all shop welding techniques and repair welding procedures in accordance with Code and Purchaser's requirements. WPQR – To define parameters, techniques and test results of all Sellers proposed welding procedures in compliance with Purchaser's requirements.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #53	Welding Repair Procedure	When specified, documentation of major defects is to be submitted to the purchaser prior to any repairs being conducted at the manufacturer's shop and to 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 is to be indicated on a sketch or drawing of the affected component. f. Repair welding procedures in accordance with Code	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #54	Complete Unit Test Report	Test report from combined mechanical/ performance test of compressor package with tabulation of string test data. To also include noise test report, functional test report of local control panel, lube oil flushing test report & calibration certificates for test instruments/ apparatus. Report to include performance test results, 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. c. compressor performance data d. impeller over-speed test record alongwith the NDE record	API 617, Part 1,2,3,4 Annex B	PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #55	Surface Preparation and Coating Procedure Specification	This specification is to be supplied for all equipment and is to include as a minimum: surface cleaning and preparation, environmental controls for both shop and field painting, lining (where applicable) and repairs to damaged coatings.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #56	Factory Acceptance Tests (FAT) procedure			PDF	
API 617 #57	Compressor / Expander Performance Tests Procedure			PDF	
API 617 #58	Performance/ Routine Test Procedure- Driver	Routine Test procedure for Medium Voltage Motor as per relevant standard *e.g. IEC 60034/ NEMA MG-1 etc. specifying the tests conducted, test method and acceptance criteria	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #59	Non-Destructive Examination (NDE) Report	Compilation of all non-destructive test reports & logs such as radiography, magnetic particle, dye-penetrant, ultrasonic test and PMI. To be submitted part of the manufacturing data book.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #60	Instrument Calculation Sheets		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #61	Instrument Hook-Up Drawings		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #62	SIL / atex Certificates		API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #63	Instrument List/Index	Information to be provided as data entered within a Spreadsheet pro forma supplied and content defined by the Purchaser. Typical items for which information required are: Field instruments, Control instruments, Condition monitoring instruments, Panel mounted instruments, In-line instruments, Control valves, Actuated valves and Safety valves	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #64	Preliminary Packing List		API 617, Part 1,2,3,4 Annex B		
API 617 #65	Installation, Operation and Maintenance Manual index	Instruction manuals describing installation, operation and maintenance procedures; each manual is to include the following sections: 1) Section 1 - Installation 2) Section 2 - Operation 3) Section 3 - Disassembly and assembly 4) Section 4 - Performance curves 5) Section 5 - Vibration data 6) Section 6 - As-built data 7) Section 7 - Drawing and data requirements 8) Operating procedures for special tools, if any 9) Any start-up, shutdown or operating restrictions required to protect the integrity of the equipment 10) Motor Installation, Operation and Maintenance Manuals 11) Detailed information covering the design & operation of the instrumentation & control system including but not limited to: - Wiring diagrams & logic diagrams - Self diagnostic capability of the controller - Design clearance tolerance sheets - Full balancing procedures for rotor assemblies	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #66	Installation, Operation & Maintenance Manual	Provides sufficient information to install, operate and maintain the equipment, as well as sufficient information for troubleshooting. Description of methods of installing a piece of equipment. Installation refers to the mounting, setting, erection, etc. Description of methods of maintaining a specific piece of equipment. Typically originates from the equipment or package Supplier. Description of methods of operating a piece of equipment or process unit, including but not limited to instructions, procedures, drawings, tables, etc. for the operation -stop, start, and emergency shutdown. Including operational limits, function testing, possible interruptions, corrective actions, hazards and corrective measures to be taken. NOTE: Unless otherwise agreed, can be delivered in manufacturer's standard manual or as one or several documents clearly marked which part they cover (I, O, M)	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #67	List of special tools for maintenance	List of special tools and fixtures which are required to disassemble, assemble, or maintain the supplied equipment.		PDF	
API 617 #68	Manufacturing record book index	Each manufacturing record book (MRB) is to include all of the manufacturing records and certification referenced in the Purchaser accepted Inspection and Test Plans and all documentation required to demonstrate full compliance with, and/or as specified in the Purchase Order and its attachments. As a minimum, the MRB shall contain the below listed documentation. All ITP verifying documents All as-built data Some examples of these are: material certificates, NDE certificates, welding detail, manufacturing and test personnel qualifications, balance certificates, as-built dimensions, as-built clearances, declarations of conformity.		PDF	

Col A	Col B	Col C	Col D	Col E	Col F
Code	Requirement	Description	Reference	Format	CFIHOS Discipline Document Type Code
API 617 #69	Manufacturers Record Book	The Manufacturer's Record Book (MRB) is to contain all of the manufacturing records and certification referenced in the Purchaser approved Manufacturing & Test Quality Plans (MTQPs) and/or those required to demonstrate full compliance with, and/or as specified in the Purchase Order & its attachments, including but not limited to material certificates, pressure test certificates, personnel qualifications/competence, inspection & test reports, NDT reports, calibration reports, manufacturing & fabrication records etc. The MRB is to be compiled in strict accordance with the Purchaser's approved Index for Manufacturer's Record Book	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #70	Non-Destructive Examination (NDE) Procedure	Procedure describing how to perform non-destructive test (NDT) (i.e. Magnetic Particle Testing (MT), Liquid Penetrant Testing (PT), Radiographic Testing (RT), Ultrasonic Testing (UT) and Visual Testing (VT)) for a given object, including acceptance criteria and reporting. The procedure shall also include positive material identification (PMI) for corrosion resistant alloys, if applicable for any of the package component.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #71	Declaration of conformity	The manufacture's or other party's confirmation that the product is designed, manufactured and tested as specified. To be delivered according to applicable authorities requirements.	API 617, Part 1,2,3,4 Annex B	PDF	
API 617 #72	Hazardous Area Certification	Certification attesting to the suitability of mechanical and electrical equipment to operate within classified locations according to IEC 60079. Certificates shall be issued by a recognised independant certification body for each equipment type located in the specifed location.		PDF	
API 617 #73	Supplier's Piping Specification	Packaged equipment piping shall comply with either ASME B31.1 for Power Piping or ASME B31.3 for Process Piping. As part of Supplier's proposal, Supplier shall confirm compliance and provide a copy of their piping specification.	Contract Requirement	PDF	
API 617 #74	List of Weld Repairs	A complete list of major and minor weld repairs listing component location, weld procedure and NDT procedure used	Contract Requirement	PDF	

Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander- Compressors Instructions & Guidance

This workbook contains a hidden sheet ('Pick Lists') which is used for drop down menu selection within the main part of this workbook.

1 Front & Preliminaries Tab

The 'Front & Preliminaries' tab includes an IOGP Front sheet for the IRS followed by Acknowledgements, a Disclaimer, Copyright Notice, Foreword and Introduction.

2 IRS Cover Tab

The 'IRS Cover' tab has been included for COMPANY and/or CONTRACTOR to update and include as a Cover Sheet for the issue of the IRS to SUPPLIERS, but Users may replace this sheet with an alternative User or Project format.

3 'Deliverables' Tab

The 'Deliverables' tab includes columns A to L, including Column A for the relevant requirement code and Column B for the requirement for the different Information Deliverables (Data, Documents and/or Models) to be provided by SUPPLIERS, based on the parent standard, IOGP Supplement or the specified parent industry Standard.

Condition Invoking Revoking Requirement Column C is included to allow any specific conditions to be identified that may require a additional deliverable(s).

Typical Deliverable Column D is provided for PURCHASER to identify the deliverable type that the information would typically appear within; this also allows the PURCHASER's Requisitioning Engineers to group the various Information Requirements by Deliverable Type.

Column E includes Submission Requirements (Yes or No) at Proposal, while columns F, G & H identify Issue Purpose (For Information or For Acceptance) and Durations (Period or Weeks/Months) for First Issue of the particular deliverable Post Purchase Order.

[Note for PURCHASER - default values in the downloadable IRS are set to the equivalent of CAS level D, as defined in the QRS. Buyer is to adjust the values in these columns to match the actual CAS level for the specific application].

Required As Built, Fulfilled by Document Number(s), Translation Required and Remarks columns I, J, K & L are also included.

Definitions for each column are contained in the rows above the columns:

Abbreviations used for various submission requirements in Column H are shown in table 3.1 below:

Abbreviation	Description
WAD	Weeks After Delivery
WAI	Weeks After Inspection
WAO	Weeks After Order
WAO(Monthly)	Weeks After Order Monthly
WAT	Weeks After Test
WPTD	Weeks Prior To Delivery
WPTF	Weeks Prior to Fabrication
WPTT	Weeks Prior To Test

Table 3.1 - Information Submission Abbreviations

4 'Definitions' Tab

The 'Definitions' tab includes several columns A to F, including Column A for the relevant Code & Column B for the Requirement for the different Information (Data, Documents and/or Models) Deliverables to be provided by SUPPLIER's, all copied from the 'Deliverables' tab.

Column C includes a full description of the Information Deliverable based on the Parent Standard or relevant Industry Standard.

Column D gives a reference to the Purchase Order or Industry Standard that the Information is identified within.

Column E identifies the Deliverable format as listed in Table 9.1 below.

Column F relates the CFIHOS discipline document type that could be used to classify the document having this IRS content.

Definitions for each column are contained in the rows above the columns.

5 'Instructions' Tab

This 'Instructions' tab is provided to instruction & guidance to COMPANY, CONTRACTOR, PURCHASER and/or SUPPLIERS in the use of this IRS.

6 Abbreviations and Definitions

The following abbreviations, terms and definitions have been used in the various tabs of this workbook:

PURCHASER: Organisation placing a Contract or Purchase Order with Supplier for equipment or services on project; may be alternatively referred to as 'User' or 'Purchaser'

CFIHOS: Capital Facilities Information Hand Over Specification

COMPANY: Project Owner and/or Operator or other body acting on their behalf

CONTRACTOR: Nominated Contractor responsible for engineering, procurement of materials, building/installation and commissioning of the plant.

Information: Data Sheets, Documents, Drawings and/or PDMS Models

IRS: Information Requirements Specification

PO: Purchase Order

QRS: Quality Requirements Specification (QA Inspection and Testing Requirements - Appendix 2)

SMIS: Supplier Master Information Schedule

SUPPLIER: Organisation supplying equipment or services to Company and/or Contractor on project; may alternatively be referred to as "Supplier", "Seller" or "Manufacturer".

7 CFIHOS

The Information Requirements and Deliverables described in this IRS are based on the CFIHOS (Capital Facilities Information Hand Over Specification) Industry Standard. The objective of CFIHOS is to create a common information standard across the Oil and Gas industry to facilitate efficient information exchange on projects. Further information on CFIHOS can be found at <http://uspi-global.org/index.php/projects/frameworks-methodologies/136-cfihos>

8 Document Metadata

Typical Metadata for Information Deliverables to be provided by Suppliers is shown in Table 8.1 below

Property_Name	Definition
document number	The unique identifier for the Document according to the Owner/Operator Document numbering scheme.
revision code	A code used to identify the content of a document at a certain point in time according to the Owner/Operator Document Revision Coding scheme. It is used to track the evolution of a document during its lifecycle and is applied at time of release from Originator to reflect the document is frozen.
document title	Describes in a short and concise manner the content of the document. Remark: The title of the document usually appears on the front page of the document or in title block.
revision date	The date of the document revision.
originator company	Identifies the name of the Company who has generated the Document.
author	Author(s) of the current revision of the document. This should be an individual name, not a role, i.e. Initials and last name, not just initials
accepted by	Name or UserID of the person who has accepted the current revision of the document as per the document management acceptance workflow. This should be an individual name, not a role, i.e. Initials and last name, not just initials.
file name	The unique name of the electronic file (including the file extension).
originator document number	The unique identifier for the Document according to originator which doesn't necessarily conform to the Owner/Operator's document numbering scheme. Remark: One potential use is to allow Owner/Operator to identify duplicate documents provided by multiple subcontractors but from the same OEM.
originator document revision code	A code used to identify the content of a document at a certain point in time according to the originator which doesn't necessarily conform to the Owner/Operator's document revision coding scheme. Remark: One potential use is to allow Owner/Operator to identify duplicate documents provided by multiple subcontractors but from the same OEM.
document status code	A code used to indicate the life cycle status of the document. A code which identifies the state of the document within the publication lifecycle process. A document is classified by a single state, which changes as the document advances through this lifecycle.
language	Indicates the language that the document is written in.
discipline document type short code	Classifies the Document with a Discipline_Document_Type.
project code	A unique code used to identify the Project.
document comment	Indicates any additional Comment / Explanation for a Document Revision.
plant code	Identifies the Plant that the document is related to. This is a smaller subdivision than 'Site' but larger than 'Unit' or 'Area.'
export control classification	Indicate the Export Control Rule applicable for the Document (e.g., ECCN, EAR).
transmittal number	A unique transmittal identifier generated by the document control system of the company sending the transmittal.
security classification	Indicates internal Owner-Operator access restriction applicable for the Document.

Table 8.1 - Supplier Deliverable Metadata

9 Deliverable Formats

The format of the relevant Information Deliverable to be submitted by Supplier for Buyer/Contractor is to be as described in table 9.1 below. Where required to be 'As Built' deliverables are to be updated and handed over in the native format.

1. All engineering documents shall be electronically transmitted in a searchable ADOBE pdf format, with text documents being supplied in A4 size, portrait orientation, and engineering drawings being supplied in A3 size, landscape format.
2. Engineering drawings shall be supplied in both the native CAD format and pdf copies
3. All text shall be typed and in Arial font size 10 as a minimum.

Format	Description
Hard Copy	Should be electronically developed, but in particular and exceptional circumstances, say for legal reasons, may need to be handed over in printed paper format
Native	To be electronically developed and must be retained in the original application software format, with no embedded or linked files.
Portable Document Format (PDF)	To be electronically developed and must be in Optical Character Recognition (OCR) format which is text searchable & indexed. Embedded graphics in Joint Photographic Experts Groups(JPEG), Graphics Interchange Format (GIF) (suitably compressed) or Tagged Image File Format (TIFF) formats may be allowed but by exception only and with Purchaser's written approval.
Intelligent Vector (CAD)	Intelligent vector drawing Like CAD
Multi media (Film)	Multi media Like Film, Micro fiche, Video, Sound
Raster Image (Bitmap)	Raster Image like a bitmap
Structured Data (MS Apps)	Structured Data Like CSV file, MS-access, MS-Excel, Application Database
Technical Publication (Text)	Technical publication or Text

Table 9.1 – Deliverable Formats

Row	Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors		شركة بترول أبوظبي الوطنية Abu Dhabi National Oil Company
2	Tag No. :	Insert Tag_No	
3	Service :	Insert Service Description	
4	USER SUPPLEMENTARY REQUIREMENTS		
5	API Clause Ref.	Description of Amendment	
6	4.4	Part 1 - General Requirements - Basic Design	
7	4.4.8 (New)	The SUPPLIER shall indicate in his proposal the equations of state and the method used to predict the aerodynamic performance of compressors with the specified gas from characteristics of each single stage comprising of impeller, diffuser, return channel etc.	
8		[Process conditions and gas analyses are shown on the specification/data sheets.	
10		The determination of the thermodynamic properties of the gases and their effect on the design performance of the unit are the SUPPLIER'S responsibility. The SUPPLIER shall indicate in his proposal the equations of state and the method used to predict the aerodynamic performance of expander, compressors with the specified gas from characteristics of each single stage comprising of impeller, diffuser, return channel etc.	
13	4.4.10.2 (New)	The average Mach numbers (at any location within compressor) shall be within the normal 0.85 limit. On a case by case basis, subject to the COMPANY's approval, higher numbers may be acceptable if Computational Fluid Dynamics (CFD) results can indicate that localized stalling at the impeller eye rim is minimal and will not be affected by the specified temperature and pressure variations in the impeller inlet. Transonic conditions shall never be accepted. The gas velocity at flange main connections shall be limited to 28 m/s at any specified operating point.	
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	4.4.10.3 (New)	SUPPLIER shall verify their design by Finite Element Analysis for all critical components of the compressor. These components shall include casings, impellers, shafts, locations where sudden change in thickness, inlet and outlet flanges, and diaphragms as a minimum and implement any recommendations observed in such analysis. This information shall be shared with CONTRACTOR and COMPANY. FEA done on similar / identical machine may be provided if the offered model is within the range.	
	4.10.1.10 (Modify)	The materials for component parts shall be suitable for the service and shall be submitted within six weeks of order receipt for CONTRACTOR's and COMPANY's review.	
	4.10.4.11 (New)	If the compressor or the driver needs to be rotated at low speed for the purpose of warming up or cooling down (barring), the Vendor shall confirm that the dry gas seals will not be damaged by such operation and/or shall warn the COMPANY of any special precautions that must be taken.	
19	4.5	Part 1 - General Requirements - Accessories	
20	5.3.2 (Add)	The intention is to use the same type of oil for the machine train unless agreed otherwise by COMPANY. SUPPLIER shall indicate at least three alternate makes of suggested lube oil with their trade names / ISO Grades for use in case of non-availability of specified one in the market. ADNOC lube oils shall be used as first preference.	
21			
	5.4.1.2.13 (Modify)	The type of grout, thickness and grout manufacturer details shall be indicated on the foundation drawings. ☐ [Replace] Vendor shall recommend special grout material if any, considering low temperature service. Grout shall be epoxy non-shrink type complying with the requirements of DGS 1783 004.	
23	5.7.1 (Add)	SUPPLIER to clarify if he will use the contract special tools during factory assembly work to ensure proper assembly.	
24		Part 2 - Section 4 - General	
25	4.6.7.10 (Add)	SUPPLIER shall indicate in the datasheets the maximum allowable differential pressure for diaphragms between main intermediate nozzles.	
26		The SUPPLIER shall, as part of his supply, carry out studies to assess pressure excursions due to start-up, shutdown, trip-out, and blocked in settle-out pressure/ temperature conditions, surging (one or more stages) and any other worst combination of pressures and temperatures. The SUPPLIER shall report to the PURCHASER the outcome of his study and upon exhausting his (SUPPLIER'S) design solutions, shall propose any required modifications to the PURCHASER's system (including piping, valving, static equipment sizing, location and sizing of orifices etc) to ensure that the SUPPLIER's scope of supply safely operates within the overall system of the PURCHASER.	
27		SUPPLIER shall furnish, in his proposal, the maximum allowable differential pressure across each diaphragm, including the center wall. When two process stages are provided in a single casing, the suction nozzles shall be located at either end and discharge nozzles close to the stage separation wall to avoid high thermal gradients across the inter-stage separation wall.	
28	4.7.8 (Add)	Compressor SUPPLIER and driver SUPPLIER shall establish maximum transient torques that will occur in shaft system under start-up, running, and fault conditions.	
29			
30			
34		Part 3 - Section 4 - General	
37	4.9.3 (Add)	The SUPPLIER's primary offering shall be direct lubricated low oil consumption bearings. As an alternative, the SUPPLIER may offer his standard flooded bearing design. In the proposal, the SUPPLIER shall state the power demand difference between the two thrust bearing designs, if applicable.	
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42	4.9.5 (Add)	Details of thrust bearing design shall be submitted within six weeks of order receipt for CONTRACTOR's and COMPANY's review.	
43			

Appendix 3: Information Requirements

Appendix 3: Information Requirements

Row	Information requirements for Nonintegrally / Integrally Geared Centrifugal and Axial Compressors and Expander-Compressors		Issue
2	Tag No. :	Insert Tag_No	
3	Service :	Insert Service Description	
4	USER SUPPLEMENTARY REQUIREMENTS		
5	API Clause Ref.	Description of Amendment	
6	7	SUPPLIER's Data	
7	7.1.1 (Add)	Technical data, registers, documents, and drawings that together define the scope of the Purchase Order shall conform to the requirements for SUPPLIER information identified in the Purchase Order. The SUPPLIER shall comply with the following minimum requirements concerning submission of drawings and documentation:- - EM 30.99.95.0006 - ADCO Guidelines for Submission of Electronic Documentation - EP 30.99.90.0024 - Preparation of Supplier's/Supplier's Engineering Drawings and Documents	
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9			
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11			
12			
13	7.1.3 (Modify)	(Modification)	
14		The first sentence shall be modified to read "A SUPPLIER coordination meeting shall be held, preferably at the SUPPLIER's works, within four to six weeks after order commitment with the PURCHASER's Engineer in attendance."	
15			
16	7.2.1	Proposals / General	
17	7.2.1.1 (Add)	The SUPPLIER's proposal shall clearly state whether or not the offered equipment is in full compliance with the listed specifications. Where applicable, the SUPPLIER shall include a list in the proposal that details and explains each deviation.	
18			
19	7.2.1.2 (Add)	The proposal shall conform to this Specification. As an option, a basic proposal may be supplemented with alternative proposals, if the following conditions are conformed to: 1. Alternative proposal has process, lifecycle costing, or delivery date advantage and is a superior product at a justifiably higher price or a product of equal quality at a lower lifecycle cost. 2. Delivery date advantage alone shall not be used as justification for purchase of an alternative proposal. 3. Alternative proposal shall have equal or greater operating reliability based on proven experience.	
20	7.2.1.3 (New)	Driver, if offered, shall be included in the proposal with a separate price.	
21	7.2.3	Technical Data	
22	7.2.3 (Add)	Add to sub-clause a)... "Motor data sheets for each selected electric motor driver offered by the SUPPLIER shall also be included, which shall identify the electrical supply requirements and other special motor requirements."	
23			
24			
25	7.2.3 (Add)	Add to sub-clause f)... "Spare parts for commissioning and two years operation are required in accordance with Appendix 1. Capital spares are required for spare parts shall be available for purchase and all manufacturing drawings retained throughout the service life specified in (4.4.1.2) of ADNOC Standard. Unless otherwise specified, below insurance / capital spares shall be included in scope by SUPPLIER / EPC Contractor for Non-integrally / Integrally Geared Centrifugal and Axial Compressors."	
26			
28	7.3.2.1.6 (Modify)	Delete the words "If specified".	
29		Add.... "SUPPLIER shall furnish calculations (not merely calculation results) for the thrust load for various scenarios including surge and impeller blockage, clearly identifying the worst case scenario. Thrust load calculations shall take into account actual pressure profiles on the impeller surfaces. a. Radial and thrust bearings shall withstand reverse rotation without damage for duration of shutdown, both controlled and emergency. b. SUPPLIER shall provide loads and corresponding time limits."	
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36	7.2.4 (Add)	Curves	
37		The compressor performance curves shall reflect the following additional requirements: SUPPLIER shall provide in his proposal, curves of suction, discharge and differential pressure versus unit loading of the thrust bearing. The curve(s) shall show, as a minimum, all operating conditions including surge and stonewall.	
38			
39		The Expander performance curve shall be submitted with the following requirements: o The swallowing capacity at the design inlet guide vane setting and also the range of swallowing capacity. o The expander isentropic efficiency at the rated condition specified in the datasheets and variation of this efficiency over the operation U/C range.	
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Appendix 3: Information Requirements

Appendix 3: Information Requirements

BUSINESS UNIT SPECIFIC REQUIREMENTS

FOR

CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION

Appendix 4 – AGES-SP-05-002

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1. SCOPE

The following sections specify additional requirements which relate ONLY to ADNOC Business Unit specific requirements for the supply of Centrifugal Compressors.

The requirements of Sections 3 through 7 contained herein shall apply individually for each specified business unit in addition to the requirements specified within API Standard 617 Axial and centrifugal compressors and Expander-Compressors 8th Edition, September 2014; AGES-SP-05-002, Centrifugal Compressors (API 617) Specification.

2. NORMATIVE REFERENCES

References used throughout this Appendix are listed within AGES-SP-05-002, Centrifugal Compressors (API 617) Specification, Appendix 1, 'General Technical and Contractual Requirements for Rotating Equipment.'

In addition, referenced documents which relate to ADNOC business unit specific requirements are listed within Table 1 and Table 2 below.

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Table 1 – Normative References Specific to ADNOC Gas Processing

Reference Document Number	Reference Document Name
DGS 1000 006	Amendments, Supplements to API-682 (Shaft sealing systems for Centrifugal and rotary pumps)
DGS 1000 007	Dry Gas seals

Table 2 – Normative References Specific to ADNOC Refinery

Reference Document Number	Reference Document Name
DGS-MU-019	Dry Gas Seal Systems for Process Gas Compressors

3. OFFSHORE APPLICATIONS ONLY

Table 3 – Offshore Specific Requirements

API Clause No.	Description of Change
PART 1	
SECTION 4 – GENERAL	
SECTION 4.5 – MATERIALS	
4.5	Also, refer/apply the following ADNOC Offshore standards for the materials, a. STD-100 b. SP-1000

SECTION 5 – ACCESSORIES	
SECTION 5.3 – LUBRICATION AND SEALING SYSTEMS	
5.3.4 [Add]	a. Integrated LO Skid (embedded tank inside main base plate) with main equipment base plate is preferred. If the skid length increases significantly and is not acceptable due to space constraints, separate LO skid may be acceptable. The requirement of an integrated LO skid or independent skid shall be based on overall layouts and platform dimensions and other constraints, which will be defined during FEED stage of the project. b. The LO Coolers can be supplied with removable heavy duty turbulators to reduce size of LO Coolers. c. The LO tank shall be drop in type SS-316L tank. CS tank with internal painting is not acceptable. Vertical LO pumps are acceptable in these cases.
SECTION 5.4 – MOUNTING PLATES	
5.4.2.1 [Add]	Baseplate for OFFSHORE applications shall comply with the following minimum requirements: a. The complete compressor unit including gear (if required) and driver shall be mounted on a single 3-point baseplate of structural steel with Anti-Vibration Mountings (AVM). The skid and the anti-vibration mounting shall be designed considering external forces and moments and the deflection shall be within the allowable limits. b. The SUPPLIER shall provide sufficient space within the skid to allow for access, for withdrawal and maintenance of all maintainable items within the skid. c. The skid shall be suitable for single lift of the complete package during transportation, offloading and erection. The certified lifting frames, slings and shackles shall be provided by SUPPLIER. d. The complete unit shall be shipped, mounted on its baseplate. e. The baseplate deflection and its effect on shaft distortion shall be taken into account in skid design. Compressor's seal clearance shall be designed for maximum shaft distortion. SUPPLIER to submit detail calculations proving the compressor may be run without damaging the internal labyrinth seals.

4. ONSHORE APPLICATIONS ONLY

Table 4 – Onshore Specific Requirements

API Clause No.	Description of Change
PART 1	
SECTION 5 – ACCESSORIES	
SECTION 5.3 – LUBRICATION AND SEALING SYSTEMS	
5.3.4 [Add]	The LO skid shall be integrated with the compressor skid, where there are plot space limitations and subject to COMPANY approval. In such cases, LO tank shall be drop-in type SS-316L tank. CS tank with internal painting is not acceptable. Vertical LO pumps are acceptable in this case.

SECTION 5.4 – MOUNTING PLATES	
5.4.2.1 [Add]	The baseplate for ONSHORE applications shall comply with the following minimum requirements: a. Baseplate shall be extended (length and width) for the compressor and all accessories without overhang, except that motor conduit boxes and removable oil drain header piping may extend beyond the baseplate. b. When the driver is a motor, the drive motor, compressor and any gear shall be mounted on the baseplate. c. When the driver is a turbine, baseplate may be a separate single fabricated unit.

5. LNG APPLICATIONS ONLY

Table 5 – LNG Specific Requirements

API Clause No.	Description of Change
PART 2	
SECTION 4 – GENERAL	
SECTION 6 – CASINGS	
4.6.7.1 [Add]	VIGVs, if utilised, shall be demonstrated to be of proven design with a minimum of 25 000 hours between maintenance inspections, subject to COMPANY approval.
SECTION 7 – ROTATING ELEMENTS	
4.7.3.5 [Add]	Compressor designs not requiring a balance drum shall be subject to approval by the COMPANY.
4.7.10[Add]	The following requirements shall be considered in the design of the LNG UNIT: a. Mach number at the impeller eye shall be provided at the time of the proposal for the maximum molecular weight gas specified. b. Design shall be supported with proven field experience or analytical analysis verification by testing. c. Impeller eye inlet Mach number exceeding 0.80 shall only be used on stage combinations that have been directly tested in a dimensionally exact configuration. d. Stage qualification for impeller eye inlet Mach number exceeding 0.80 by interpolation. Extrapolation or scaling shall not be used.

DRY GAS SEAL REQUIREMENTS FOR CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION

Appendix 5 – AGES-SP-05-002

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1. SCOPE

The following sections specify requirements shall be followed with design of dry gas seal for the supply of centrifugal compressors.

The requirements which have been specified part 1 through part 4, are in-line with “API Standard 617 Axial and centrifugal compressors and Expander-Compressors 8th Edition, September 2014” and shall be considered in conjunction with section B, part 9 of AGES-SP-05-002, Centrifugal Compressors (API 617) Specification.

2. TECHNICAL AMENDMENTS / SUPPLEMENTS TO API 617

- 2.1 The technical amendments applicable to API 617 Process Centrifugal Compressors are listed in the tables below (Table 1 to 4 inclusive) where referenced to each section of the API 617 standard. The clause numbers listed within each table and each related amendment correspond to the same clause number within the API standard, where these are already included in the existing publication. These amendments shall take precedence over the relevant sections of API Standard 617 8th Edition, ‘Axial and Centrifugal Compressor and Expander-Compressors for Petroleum, Petrochemical and Natural Gas Industries, September 2014’.

Table 1 - API 617 Technical Amendments: Part 1

PART 1	
SECTION 4 – GENERAL	
SECTION 4.10 – SHAFT END SEALS	
Part 1 4.10.4.1 [Add]	A tandem Dry Gas Seal with intermediate labyrinths (Fig. B-9) shall be used unless the sealing pressure requires a double Dry Gas Seal arrangement (Fig. B-7). All other Dry Gas Seal arrangements require the approval of the COMPANY. Both primary and secondary seal failures shall result in compressor trip. Primary, secondary and separation seal monitoring (for guaranteed leakage rates) and safeguarding shall be included in design. Both primary and secondary seal failures shall result in compressor trip. In the event of a total seal failure (complete cartridge), the gas leakage rate to the flare and into atmosphere shall be limited to a maximum possible level, which shall be indicated in the SUPPLIER proposal.
Part 1 4.10.4.2 [Add]	Based on the size of filters used in the dry gas seal system/panel, SUPPLIER shall ensure that the filters are preferably mounted inside the dry gas seal panels. Separate seal gas conditioning skid also acceptable. Seal gas supply connections from skid / panel to seals shall be connected by piping. Piping root valves for instrumentation shall be double block and bleed type valves (ball – ball – needle and all side flanged), based on the flange rating as required by process. Tube lengths shall be minimized. The dry gas seal support system shall preferably be sourced from approved manufacturers of dry gas seals. In case compressor SUPPLIER supplies their own seal support systems, compressor SUPPLIER shall obtain endorsement on design (P&ID, layout, equipment, valves and line sizing) and specific requirements for performance of seal, sizing of filters, piping, heaters etc. from seal SUPPLIERS. The complete system shall be in SS316L construction as a minimum. Where specified, Inconel 825 piping and components may be provided based on process conditions.

	The seal's SUPPLIER shall be present in the design review, HAZOP and SIL to have ownership on design. Seal gas conditioning skid when required shall consist of cyclone separator, demister, filter coalescer assemblies. Level alarms shall be provided for operator action. If liquid quantities are significant based on analysis, automatic draining arrangement based on level control shall be incorporated in system design. Seal gas heaters shall have flange temperature sensor & skin temperature sensor for trip and process temperature sensors for control. Electrical tracing, when required, shall be provided with a separate panel. Tracing requirements shall be connected to EDG power source by CONTRACTOR. Tracing system shall have separate temperature sensors for control and safeguarding. Pressure control valves shall be used to control nitrogen supply pressure for secondary and separation (barrier) seals. Flow-based control system for nitrogen requires COMPANY approval. Pressure and flow transmitters shall be provided on each of the secondary and separation seals circuits for secondary seal monitoring in addition to instruments specified in API 614 Chapters 1 and 4. The system shall be designed such that a minimum velocity of 5 m/s is achieved at process & intermediate labyrinths, separation seal areas with two times maximum design clearances (to replicate worn out labyrinths). Accordingly, consumption data for seal gas and nitrogen shall be established.
Part 1 4.10.4.3.1[New]	A separation gas seal shall be included in the dry gas seal cartridge. If possible, the cartridge shall be designed so that such separation gas seals can be replaced in-situ without removing the complete cartridge. A segmented carbon ring lift off type or Coaxial lift off type separation (barrier) gas seal shall be included in the dry gas seal cartridge. Selection of separation seal type requires COMPANY approval. The separation gas seal shall be designed to prevent lubricating oil from entering the Dry Gas Seal and also to minimize nitrogen losses.
Part 1 4.10.4.3.2 [New]	Seal gas, secondary seal gas, seal buffer gas, and separation gas piping shall be designed to prevent accumulation of liquids in the seal assembly. Drain valves in the piping shall be provided at the lowest locations.
Part 1 4.10.4.3.3 [New]	The seal/cartridge design shall be such that secondary sealing devices such as O-rings will not be damaged or dislodged by inadvertent reverse pressure.
Part 1 4.10.4.3.4 [New]	[Tandem Dry Gas Seal with intermediate labyrinth arrangement]
Part 1 4.10.4.3.4.1 [New]	[Add]: The primary leakage (from the inner Dry Gas Seal) shall be routed to a flare. The system shall be designed to impose a minimal backpressure on the primary Dry Gas Seal whilst maintaining a sufficient pressure across the secondary Dry Gas Seal to prevent "hang-up". The system shall be designed / controlled so that all specified pressure fluctuations from the flare can be accommodated without pressure reversal. The secondary leakage shall be routed to a separate independent atmospheric vent through flame arrestors. Independent PDCV shall be provided on seal gas supply to DE and NDE side seals for precise control. PDCV reference lines shall be taken from the flare header, balance line for precise control. Flow based control is not acceptable. Under all operating conditions, minimum required velocities shall be maintained under labyrinths when clearances are twice the original. SUPPLIER shall indicate the maximum allowable back pressure in the vent line of primary seal to flare and in the vent line of secondary seal to atmosphere.
Part 1 4.10.4.3.4.2 [New]	The secondary Dry Gas Seal shall be designed for the maximum pressure that may occur under all foreseeable fault conditions. This will generally be with a disintegrated

	primary Dry Gas Seal with the primary leakage flow limited only by labyrinths and other restrictions and with the maximum pressure in the flare / vent system resulting from other equipment discharging into it. As a minimum the secondary Dry Gas Seal and its housing shall have the same pressure rating as the primary Dry Gas Seal.
Part 1 4.10.4.3.4.3 [New]	In the event of a total seal failure, the gas leakage rate to the flare and into atmosphere shall be limited to as minimum as possible level, which shall be indicated in the SUPPLIER's proposal. An appropriate design of the combination of the restrictive labyrinth between dual or triple tandem seals, the labyrinth between the seals and the bearing compartment, and the venting facilities to flare and safe location shall provide maximum confidence that this leakage rate will not be exceeded and that controlled and safe shut-down is ensured. The venting lines to flare and safe location shall be adequately sized to avoid over-pressurizing of the seal/bearing housing in case of a major seal failure. The MANUFACTURE shall ensure that dual gasketing (e.g., two 'O'-rings) is installed under the shaft sleeve. Primary vent lines up to flare header (battery limits) including safety valve outlet piping shall be same pipe class as inlet piping (based on compressor MAWP). Secondary seal vent lines to atmosphere shall be provided with heat dispersion type flow transmitter which has negligible pr. drop and flame arrestor.
Part 1 4.10.4.3.4.4 [New]	The compressor MANUFACTURER and/or the Dry Gas Seal SUPPLIER shall advise whether it is necessary to increase the quantity of buffer gas for cooling purposes.
Part 1 4.10.4.3.5 [New]	Double Dry Gas Seal Arrangement
Part 1 4.10.4.3.5.1 [New]	A double Dry Gas Seal arrangement operating continuously at a pressure level above 1.2 bar (g) requires the approval of the COMPANY.
Part 1 4.10.4.3.5.2 [New]	In the case of a pressurized double seal configuration, the compressor shall be tripped immediately on pressure loss of the seal gas supply between the seals. The seal MANUFACTURER shall guarantee the safe run-down of the compressor without failure of the inner seal.
Part 1 4.10.4.3.6 [New]	Triple Dry Gas Seal Arrangement
Part 1 4.10.4.3.6.1 [New]	The triple Dry Gas Seal arrangement shall only be considered if the tandem seal arrangement does not give sufficient sealing capabilities (e.g. very toxic gases, for which the leakage rate shall be zero under all circumstances) or the seal operating pressure is above the experience level of the Dry Gas Seal SUPPLIER.
Part 1 4.10.4.3.6.2 [New]	Triple Dry Gas Seal arrangements shall have intermediate labyrinths between the two inner and outer seals.
Part 1 4.10.4.3.6.3 [New]	The configuration of the two outer seals can be a double or tandem arrangement; the final configuration shall be mutually agreed between the compressor MANUFACTURER, Dry Gas Seal SUPPLIER and the COMPANY.
Part 1 4.10.4.3.6.4 [New]	The triple Dry Gas Seal support system shall follow the same philosophy as described in API 614 for tandem Dry Gas Seal arrangement. The final support system design shall be mutually agreed between the compressor MANUFACTURER and the COMPANY.
Part 1 4.10.4.3.7 [New]	Dry Gas Seal Testing Unless otherwise agreed, Dry Gas Seal cartridges shall be tested at the Dry Gas Seal SUPPLIER'S works prior to shipment and before assembly into the compressor.

	The testing shall be in accordance with Annex F (API 617 Part 1) and Appendix F of this Standard. Mechanical seals shall be dismantled and inspected by the seal SUPPLIER after any Mechanical Running Test at compressor SUPPLIER works. Further, it shall be dismantled and inspected after Performance Test if there is any sign of unacceptable leakage. Affected or damaged seal shall never be installed in a compressor for shipment unless it has been refurbished, positively tested, and approved by the seal SUPPLIER. Where SUPPLIER practice is to send dry gas seals separately to site (not assembled in compressor), same shall be informed to COMPANY and necessary activities to assemble the seals at site shall be included by SUPPLIER.
Part 1 4.10.4.3.8 [New]	Bidirectional or unidirectional design
Part 1 4.10.4.3.8.1 [New]	Unless otherwise specified, SUPPLIER shall provide bi-directional seals for compressors. Use of unidirectional seal requires COMPANY approval and due to technical reasons bidirectional seals cannot be employed. Unidirectional not acceptable except for pressures beyond 450barg. The Manufacturer of Dry Gas Seals is subject to COMPANY approval. The Dry Gas Seal SUPPLIER shall clearly indicate on the data / requisition sheet whether the offered Dry Gas Seal design is bi-directional or unidirectional and why such selection is required in case of selecting unidirectional seal.
Part 1 4.10.4.3.8.2 [New]	For unidirectional designs: The direction of rotation shall be permanently marked on the outside of each cartridge. The compressor MANUFACTURER and the Dry Gas Seal SUPPLIER shall ensure that inadvertent fitting of a cartridge at the wrong end of a compressor casing is physically impossible.
Part 1 4.10.4.3.9 [New]	Machines requiring barring If the compressor or the driver needs to be rotated at low speed for the purpose of warming up or cooling down (barring), or when equipment are in prolonged standby modes (either under process gas or under nitrogen), SUPPLIER shall confirm that the dry gas seals will not be damaged by such operation and / or shall warn COMPANY of any special precautions that must be taken. When barring motors are installed on gear, same shall be cut-off automatically after certain duration and logic shall be built accordingly. Barring speed shall be higher than seal lift off speed as confirmed by seal SUPPLIER. SUPPLIER may provide seal faces which don't damage with manual rotation of the shaft. Any such design shall be confirmed by SUPPLIER in consultation with the seal MANUFACTURER. If design philosophy is to operate compressors continuously, barring devices are not required, and it shall be substituted by a seal design with hard faces and manual rotation of shaft.
Part 1 4.10.4.3.10 [New]	CONTRACTOR must ensure / demonstrate that process piping and its components are arranged in such a manner that the seals / equipment will not be subjected to the adverse effects of reverse rotation in consultation with SUPPLIER.
Part 1 4.10.4.3.11 [New]	When self-acting gas seals are provided, details of the seal MANUFACTURER'S shop test per Appendix F shall be included.

Part 1 4.10.4.3.12 [New]	When seal gas boosting is required when supplied from external source (under settle out starting conditions), rotary, motor driven seal less type seal gas boosters shall be employed. Booster motors shall be connected to emergency EDG power supply source. Air / Nitrogen driven Reciprocating type equipment (such as cylinder boosters) require COMPANY approval. Seal gas booster shall be provided with temperature transmitter for tripping. Seals and sealing systems shall be in accordance with the following minimum technical requirements. - There shall be no leakage of process gas to atmosphere local to the machine, or into the bearing housing in normal service nor when the primary seal has failed. - The seal gas shall be filtered to be free from liquids and any contamination that form residues. The seal gas may be taken from the compressor discharge or inter stage point. An alternate seal-gas source may be used and may be required during start-up or shutdown. - Dual parallel filters for the seal gas which are interchangeable during running shall be supplied. Filters shall be sized for 3 times normal flow rate and all particles larger than 1 microns (rating of 0.3 micron absolute) shall be filtered out. The filters shall be rated for compressor casing maximum allowable discharge pressure. Differential pressure transmitter shall be provided for alarm and trip functions. The line to seal gas shall be equipped with a flow meter to provide flow indication in the control system. - The availability of external supplies such a N2, Air or other gas for purging purposes shall be established and provided by CONTRACTOR for each application. - The cavity between the outer seal and inner seal shall be vented to safe area through an orifice parallel. Safety valves shall be used in vent lines and use of rupture discs not permitted. The vents (both primary and secondary) shall have redundant pressure transmitters to provide alarm and minimum 2 out of 3 trip function.
Part 1 4.10.4.11 [New]	The secondary seal gas and separation seal gas shall: - be nitrogen with proper dew point. Minimum nitrogen purity shall be 99% with alarm at 98% (for changeover of standby N2 generators). - conform to the seal and compressor SUPPLIER specification, including supply pressure, temperature, filtration level and dew-point temperature. - be designed such that in case of catastrophic failures or uneven pressure profiles in cartridge, N2 will be ingress into flare header line.
Part 1 4.10.4.12 [New]	Single Dry Gas Seal Arrangement
Part 1 4.10.4.12.1 [New]	If approved by the COMPANY, a single DGS arrangement may be considered for moderate pressure, non-very-toxic, non-flammable services.
Part 1 4.10.4.12.2 [New]	A single DGS arrangement shall be provided with a secondary/separation seal assembly comprising a pair of segmented carbon ring seals (or other approved close-clearance seals), mounted in a face-to-face configuration with inert buffer gas injected between them. The DGS/compressor SUPPLIER shall provide evidence of the proven reliability of the proposed secondary seals in similar applications.
Part 1 4.10.4.14 [New]	A seal freezing evaluation shall be made to demonstrate that ice or hydrate formation will not occur at the seal faces during initial or settle out pressure start up with gas at

	minimum site ambient temperature assuming isenthalpic expansion across the seal face.
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Table 2 - API 617 Technical Amendments: Part 2

PART 2	
SECTION 4 – GENERAL	
SECTION 4.10 – SHAFT END SEALS	
Part 2 4.10.2 [Add]	Dry gas seals shall be provided for shaft end seals as first preference to all process gas compressors unless otherwise approved by COMPANY.
Part 2 4.10.3 [Add]	Seals shall be capable of removal on site without moving the driving or driven equipment, including gear boxes.

Table 3 - API 617 Technical Amendments: Part 3

PART 3	
SECTION 4 – GENERAL	
SECTION 4.10 – SHAFT END SEALS	
Part 2 4.10.2 [Add]	Dry gas seals shall be provided for shaft end seals as first preference for all process gas compressors unless otherwise approved by COMPANY. Dry gas seals, seal system design, application requires COMPANY approval. Seal and compressor SUPPLIER shall agree on seal type and submit reference lists as evidence for successful operation.

Table 4 - API 617 Technical Amendments: Part 4

PART 4	
SECTION 4 – GENERAL	
SECTION 4.10 – SHAFT END SEALS	
Part 2 4.10.1 [Add]	Expander compressor internal seals design to centre section requires COMPANY approval. If dry gas seals are employed due to high H ₂ S content or any other process reasons, design, application, system design shall require COMPANY approval.

LUBRICATION SYSTEM DESIGN REQUIREMENTS FOR CENTRIFUGAL COMPRESSORS (API 617) SPECIFICATION

Appendix 6 – AGES-SP-05-002

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1. SCOPE

This Appendix contains lubrication design requirements shall be taken into account in the design of centrifugal compressors which are designed according to API 617 8th edition in conjunction with as per COMPANY business unit specific standards.

The requirements stated within Section 3 as noted below shall take precedence over API Standard 617 8th Edition, Axial and Centrifugal Compressors and Expander-Compressors; AGES-SP-05-002 Centrifugal Compressors (API 617) Specification and Appendix 1, 'General Technical and Contractual Requirements for Rotating Equipment.

2. NORMATIVE REFERENCES

References used throughout this appendix are listed within AGES-SP-05-002, Centrifugal Compressors (API 617) Specification and Appendix 1, 'General Technical and Contractual Requirements for Rotating Equipment'. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

3. LUBRICATION SYSTEM DESIGN REQUIREMENTS – API 617

Unless otherwise specified in the Purchase Order, the following requirements shall be applied for the design of the Lube Oil systems for Centrifugal Compressors designed to API 617, 8th Edition:-

1. Oil pumps shall be of positive displacement type “triple screw” or “gear type” according to API 676 with separate PSV (not integral with the pump). Horizontal lube oil pumps shall be installed on LO skid, although vertical pumps may be installed where space constraints exist.
2. For sizing of air coolers, use a design ambient temperature of 54°C for onshore and island applications and 48°C for offshore applications; based on single fan operation and peak ambient temperature of 58°C (with no design margin). At peak ambient temperature of 58°C, both fans shall operate to meet the cooling duty requirements.
3. Lube Oil coolers shall preferably be “air cooled” type and include two (2) x 100% cooling fans, induced draft type. Forced draft fans may be used ONLY if the fan diameter is less than 750mm. Use of OEM standard cooler instead of API 661 coolers for lube oil coolers is acceptable subject to COMPANY approval.
4. Lube Oil Coolers may be supplied with removable turbulators in stainless steel 316L. Marine grade aluminium extruded fins (394 fins/m) shall be provided on coolers. The complete lube oil cooler shall be constructed in Stainless Steel 316L (including tubes, headers, plugs etc.).
5. Water-cooled exchangers are acceptable if cooling water is available from site utility supply network. For water cooled systems, 2 x 100% shell and tube lube oil cooler/exchangers shall be used designed according to TEMA C. A removable-bundle design is required for shell-and tube coolers with more than 0.46 m² of tube surface area.
6. Each oil cooler shall maintain the lube oil supply temperature at or below 48 °C for water cooled systems and 68 °C for air cooled systems.
7. ASME U stamp or PED certified equipment is required for all heat exchangers (Lube Oil Coolers).
8. The following design margins shall be applied: The cooler shall be designed to accommodate 110% of the maximum required oil flow defined as per API 614, cl 4.4.11b. In addition, the cooler shall be sized for the following design cases:-

- a. 110% of the required heat transfer load and
 - b. 110% of the calculated heat exchange surface area
9. Oil filters shall have a continuous flow switch-over valve including a pressure equalization line. Duplex filters shall be provided with suitable range differential pressure gauges
10. All vent lines shall be equipped with an isolation valve.
11. The lube oil tank shall be sized for a minimum of 5 minutes circulation volume at the lube oil pump duty flowrate. If required, a rundown tank shall be provided and is preferred instead of a DC emergency pump. A startup interlock shall be provided to ensure minimum required lube oil temperature prior to start-up. Two (2 x 100%) duty/standby motor driven horizontal lube oil pumps shall be provided and an accumulator shall also be provided to ensure smooth pump changeover. For onshore applications only, a shaft driven main lube oil pump and motor driven auxiliary lube oil pump may be provided, subject to COMPANY approval and valid references being provided.
12. The complete lubricating oil system including, lube oil reservoir, oil coolers, filters and piping (except for lube oil pump) shall be supplied in Stainless Steel 316/316L construction as a minimum. Lube oil pump shall have CS casing with SS rotor. However, when using seawater as the cooling medium, oil coolers shall be constructed from Titanium or other suitable material to mitigate corrosive attack by seawater. All components of the lube oil system shall be externally painted in accordance with the relevant COMPANY business unit standard.