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ADNOC GROUP PROJECTS AND ENGINEERING

RECIPROCATING COMPRESSORS (API 618 & ISO 13631) SPECIFICATION

Specification

AGES-SP-05-003

**GROUP PROJECTS & ENGINEERING / PT&CS DIRECTORATE**

CUSTODIAN	Group Projects & Engineering / PT&CS
ADNOC	Specification applicable to ADNOC & ADNOC Group Companies

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This specification will be reviewed and updated in case of any changes affecting the activities described in this document.

INTER-RELATIONSHIPS AND STAKEHOLDERS

- a) The following are inter-relationships for implementation of this Specification:
 - i. ADNOC Upstream and ADNOC Downstream Directorates and
 - ii. 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**” means ‘Reciprocating Compressors (API 618 & ISO 13631) Specification’

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GENERAL

1. PURPOSE

- 1.1 This specification details the minimum technical requirements for Reciprocating Compressors for applications across ADNOC Business Units. Unless otherwise stated in this specification, the supplied equipment shall comply fully with the requirements of API 618 5th Edition, December 2017 (Reaffirmed August 2016) and ISO 13631: 2002, (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. 'Condition Monitoring System Requirements', Appendix 4 (Ref. 5)

2 SCOPE

This specification amends, supplements and deletes various clauses/ paragraphs of API Standard 618 and ISO 13631. 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 Appendix 1 (Ref. 2). Terms/ Abbreviations/ References relating specifically to Reciprocating Compressors are included below.

3.1 List of Abbreviations

The abbreviations listed in [Table 1](#) are those used in this document and related Appendices 1 – 4. Standard abbreviations for SI units of measure and abbreviations that are already defined in API 618 and ISO 13631 are not shown.

Table 1 – List of Abbreviations

Abbreviation	Definition
HVOF	High-Velocity Oxygen Fuel
PEEK	Polyether ether ketone

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. Refer to 'General Technical and Contractual Requirements for Rotating Equipment' (Ref. 2) for generic references applicable to all rotating equipment types.

Table 2 – Normative References

Ref.	Document No.	Title
1.	ANSI/API Standard 618 5th Edition	Reciprocating Compressors for Petroleum, Petrochemical and Natural Gas Industries
	ISO 13631:2002	Petroleum and natural gas industries — Packaged reciprocating gas 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	Condition Monitoring & Machine Protection System Requirements
6.	ASME PTC 9	Displacement Compressors, Vacuum Pumps and Blowers
7.	ASME B16.20:2017	Metallic Gaskets for Pipe Flanges
8.	ASME B16.21:2016	Non-Metallic Flat Gaskets for Pipe Flanges
9.	API RP 688	Pulsation and Vibration Control in Positive Displacement Machinery Systems for Petroleum, Petrochemical, and Natural Gas Industry Services
10.	ISO 1217	Positive Displacement Compressors - Acceptance Tests

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 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 4 (Ref. 5) and shall be taken into account in design of Reciprocating Compressors Condition Monitoring and Protection System.

SECTION B – TECHNICAL REQUIREMENTS

9 TECHNICAL AMENDMENTS / SUPPLEMENTS TO API 618

- 9.1 The technical amendments applicable to API 618 and ISO 13631 for Process Reciprocating Compressors are listed in the tables below (Table 3 to 11 Table inclusive) where referenced to each section of the API 618 and ISO 13631 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 618 5th Edition, 'Reciprocating Compressors for Petroleum, Chemical and Gas Industries, December 2007' and ISO 13631 :2002, 'Petroleum and natural gas industries - Packaged reciprocating gas compressors' (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 618 5th Edition or ISO 13631:2002, as applicable, standards shall apply in full.

Table 3 - API 618 Technical Amendments: Section 1 – Scope

API Clause No.	Description of Change
SECTION 1 – SCOPE	
1. (Add)	This specification provides requirements for the design, materials, fabrication, inspection, testing, documentation and preparation for shipment of reciprocating compressors for Petroleum, chemical and gas industry services
1.1 (New)	Driver shall be in accordance with applicable ADNOC standard as listed in Appendix 1 (Ref. 2).

Table 4 - API 618 Technical Amendments: Section 2 – Normative References

API Clause No.	Description of Change
SECTION 2 – NORMATIVE REFERENCES	
2.1 (Modify)	(Modify first paragraph of clause to read) For updated references, the latest edition of the referenced document (including any amendment) at CONTRACT award shall apply.

Table 5 - API 618 Technical Amendments: Section 3 – Terms and Definitions

API Clause No.	Description of Change
SECTION 3 – DEFINITIONS OF TERMS	
3.64 (New)	Piston average speed Piston average speed is calculated by the following equation: $m/min = (stroke)(rpm)(2)/1\,000$ (SI units)
3.65 (New)	Port unloader Suction valve port without valve elements.
3.66 (New)	Partial valve Suction valve with element and plug unloader

Table 6 - API 618 Technical Amendments: Section 5 – Requirements

API Clause No.	Description of Change
SECTION 5 – REQUIREMENTS	
5.1 (Modify)	(Modify clause to Read) SUPPLIER data, drawings, documents, and nameplates shall be in English and in SI system of units.

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
SECTION 6 – BASIC DESIGN	
6.1 GENERAL	
6.1.1 (Modify)	<p>(Replace) “20 years” with “30 years”. Replace “at least 3 years” with “at least 5 years”.</p> <p>(Add) Compressors shall be sufficiently robust to withstand without damage, the results of occasional abnormal conditions of limited duration. The SUPPLIER shall indicate any limitation on the starting frequency of the equipment or whether the frequency is unrestricted. The reasons for any limitation should be explained e.g. cooling of windings of large electric motors and the permitted frequency given. All components of the machinery train e.g. gears, couplings; etc. shall be included in the assessment.</p>
6.1.2 (Add)	The combined performance of the machine and its driver under all operating conditions shall be the responsibility of the SUPPLIER. The combined unit shall perform substantially as well on its permanent foundations as it did on the Manufacturer’s test stand.
6.1.3 (Add)	<ol style="list-style-type: none"> 1. The CONTRACTOR shall specify the equipment’s normal operating point and all other applicable operating points (e.g., start-up, loading and unloading, and regeneration). 2. The MANUFACTURER/SUPPLIER shall confirm the compressor’s performance and mechanical capabilities at the specified operating points (including valve selections). 3. Negative tolerances on capacity shall not apply to any specified operating points.
6.1.5 (Modify)	<p>(Replace with:)</p> <p>Pressure design code shall be as per ASME pressure vessel codes as applicable and as listed in this specification, or other Project Design code that agreed between SUPPLIER and COMPANY as listed in the Purchaser Order.</p>
6.1.6 (Modify)	<p>(Replace with:)</p> <p>Maximum sound pressure level of the compressor package shall not exceed 85dB(A) measured at 1 meter from the equipment surface for recommended range of operation.</p>
6.1.7 (Modify)	Modify table as:

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change																										
	<table> <tr> <th>Parameter</th><th>Requirement</th></tr> <tr> <td>For Heat Exchanger</td><td>SI Units</td></tr> <tr> <td>Velocity over exchanger surfaces</td><td>1.5 – 2.5 m/sec</td></tr> <tr> <td>Maximum allowable working pressure (MAWP)</td><td>Refer datasheet</td></tr> <tr> <td>Test pressure (>1.5 MAWP)</td><td></td></tr> <tr> <td>Maximum pressure drop</td><td>Refer datasheet</td></tr> <tr> <td>Maximum inlet temperature</td><td>Refer datasheet</td></tr> <tr> <td>Maximum outlet temperature</td><td>Refer datasheet</td></tr> <tr> <td>Maximum temperature rise</td><td>Refer datasheet</td></tr> <tr> <td>Water side fouling factor</td><td>Refer datasheet</td></tr> <tr> <td>Corrosion allowance for carbon steel shells</td><td>Refer datasheet</td></tr> <tr> <td colspan="2">Cylinder Jackets and Packing Cases</td></tr> <tr> <td>Maximum allowable working pressure (MAWP)</td><td>Refer cooling water datasheet Provision shall be made for complete venting and draining of the system.</td></tr> </table>	Parameter	Requirement	For Heat Exchanger	SI Units	Velocity over exchanger surfaces	1.5 – 2.5 m/sec	Maximum allowable working pressure (MAWP)	Refer datasheet	Test pressure (>1.5 MAWP)		Maximum pressure drop	Refer datasheet	Maximum inlet temperature	Refer datasheet	Maximum outlet temperature	Refer datasheet	Maximum temperature rise	Refer datasheet	Water side fouling factor	Refer datasheet	Corrosion allowance for carbon steel shells	Refer datasheet	Cylinder Jackets and Packing Cases		Maximum allowable working pressure (MAWP)	Refer cooling water datasheet Provision shall be made for complete venting and draining of the system.
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6.1.8 (Modify) [PSR]	(Replace with:) All equipment SHALL [PSR] be designed to run simultaneously at the relief valve setting (including accumulation) and trip speed without damage. (see 7.6.5). Accumulation is the static head build-up above the gas relief pressure set by the relief valve.																										
6.1.12 (Modify) [PSR]	(Replace with:) All electrical components and installations SHALL [PSR] be suitable for the area classification, gas grouping and temperature classes as specified in the data or requisition sheets.																										
6.1.14 (Modify)	Modify the last sentence in the clause to the following: <ol style="list-style-type: none"> 1. This may be accomplished by such methods as shouldering or precision cylindrical dowels. 2. Distance piece to cylinder and distance piece to crosshead guide shall be shouldered or registered fits. 																										

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
6.1.15 (Modify)	(Replace with:) The combined performance of the compressor and its driver under all operating conditions shall be the responsibility of the MANUFACTURER/SUPPLIER.
6.1.17 (Delete)	(Delete) "When specified" from the clause
6.1.18 (Add)	Negative tolerance on capacity mentioned in Annex B of API 618 is not be acceptable.
6.1.20 (Add)	For all the compressors, the following minimum requirements shall apply: <ol style="list-style-type: none"> 1. Dust and air-tight enclosure of the crankcase. 2. Dust-tight distance pieces, vented and purged 3. If ambient conditions require winterising, heating facilities should include crankcase, oil lines, lubricators and cooling water conduits, as necessary. 4. Complete drainage facilities of all cooling water spaces and lines.
6.1.25 (Add) [PSR]	<ol style="list-style-type: none"> a. Compressor unit SHALL [PSR] be able to withstand the effects of a fully loaded shutdown against the safety relief valve set pressure, including accumulation. b. The complete unit shall be able to withstand the effects of a 2-phase or 3 phase short circuit in the case of an electrical motor driver
6.1.27 (New) [PSR]	Non-lubricated type compressors SHALL [PSR] be provided in air and oxygen bearing gas service which will support combustion of lubricant (including those normally in hydrocarbon service where a regeneration mode with air is required.
6.2 BOLTING	
6.2.1 (Add)	<ol style="list-style-type: none"> 1. Details of fasteners requiring hardness control of sour service shall be subject to review and approval by the COMPANY. 2. Cap screws shall not be used. 3. Cadmium and Zinc plated studs, bolts, and nuts shall not be used. 4. Bolting shall also conform to NACE material grades. 5. Hardness control shall be insisted for sour service and reduced stresses to avoid SCC.
6.2.2 (Add)	Adequate clearance shall be provided to permit the use of torque wrenches, including multipliers for torque values over 300 Nm. If hydraulically tensioned studs are provided, the extended threaded stud end shall be protected by a steel cover.
6.2.6 (New)	The following bolting shall have rolled threads (to reduce stress concentration): <ol style="list-style-type: none"> a. Valve cover studs. b. Crosshead housing to frame bolting. c. Crosshead to distance piece bolting. d. Distance piece to cylinder bolting.

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change															
	<div>e. Head to cylinder bolting.</div> <div>f. Packing case to head bolting.</div> <div>g. Main bearing studs.</div> <div>h. Connecting rod bolting.</div> <div>i. Crosshead bolting.</div> <div>j. Piston rod bolting.</div> <div>k. Piston through bolts.</div> <div>l. Cylinder support mounting bolting.</div> <div>Bolts with diameters 35 mm (1-1/2 in) or larger shall be designed for hydraulic tensioning.</div>															
6.4 ALLOWABLE SPEEDS																
6.4 (Add)	<div>1. Compressor speeds and corresponding average piston speeds shall be limited to the values in table below:</div> <div>Values of compressor speeds and piston speeds</div> <table><tr><td>Installed power</td><td>Maximum compressor speed</td><td>Maximum average piston speed</td></tr><tr><td>< 26 KW</td><td>600 rpm</td><td>300 m/min</td></tr><tr><td>27-335 KW</td><td>500 rpm</td><td>260 m/min</td></tr><tr><td>336 – 1490 KW</td><td>429 rpm</td><td>250 m/min</td></tr><tr><td>> 1491 KW</td><td>333 rpm</td><td>226 m/min</td></tr></table> <div>2. The average piston speed in compressors handling saturated hydrocarbon gases and in non-lubricated compressor cylinders shall not exceed 210 m/min.</div> <div>3. Average piston speed in compressors that handle dry gases in non-lubricated compressor cylinders shall not exceed 180 m/min.</div> <div>4. The maximum speed of vertical labyrinth piston-type compressors shall be 429 rpm.</div>	Installed power	Maximum compressor speed	Maximum average piston speed	< 26 KW	600 rpm	300 m/min	27-335 KW	500 rpm	260 m/min	336 – 1490 KW	429 rpm	250 m/min	> 1491 KW	333 rpm	226 m/min
Installed power	Maximum compressor speed	Maximum average piston speed														
< 26 KW	600 rpm	300 m/min														
27-335 KW	500 rpm	260 m/min														
336 – 1490 KW	429 rpm	250 m/min														
> 1491 KW	333 rpm	226 m/min														
6.5 ALLOWABLE DISCHARGE TEMPERATURE																
6.5.1 (Modify)	<div>(Replace with:)</div> <div>The maximum calculated discharge temperature shall not exceed 140°C. For non-lubricated service or hydrogen-rich services (molecular weight of 12 or less), the maximum calculated discharge temperature shall not exceed 130°C. These temperature limits do not apply to relief valve setting conditions. These limits apply to all specified operating and load conditions.</div>															
6.5.2 (Add) [PSR]	<div>1. Reciprocating compressors for process air services and oxygen compressors SHALL [PSR] not be (piston/packing) lubricated.</div> <div>2. Reciprocating compressors for air services and services with 21% volume or greater oxygen-bearing gases or where the oxygen partial pressure is 10 barg or higher SHALL [PSR] not be (piston/packing) lubricated.</div>															

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
	3. Each compressor cylinder shall have: <ol style="list-style-type: none"> a dedicated temperature measuring point for alarm; a dedicated temperature measuring point for trip purposes; The cylinder temperature measuring points be located in the nozzle neck between the cylinder discharge flange and the pulsation bottle, but as close as possible to the discharge valves on the cylinder; measuring point with its own thermowell.
6.6 ROD AND GAS LOADS	
6.6.1 (Add) [PSR]	<ol style="list-style-type: none"> Combined rod loading SHALL [PSR] not exceed 80% of MANUFACTURER maximum allowable continuous combined rod loading for compressor running at any specified operating points and relief valve set point plus accumulation. Combined rod loads shall be calculated on the basis of set point pressure of discharge relief valve of each stage and of lowest specified suction pressure corresponding to each load step. Dated material shall be furnished with the proposal to document the authenticity of the frame load rating.
6.6.2 (Add) [PSR]	<ol style="list-style-type: none"> Gas load SHALL [PSR] not exceed 80% of MANUFACTURER maximum allowable continuous gas loading at specified operating load steps. Combined rod loads shall be calculated on the basis of set point pressure of discharge relief valve of each stage and of lowest specified suction pressure corresponding to each load step. Dated material shall be furnished with the proposal to document the authenticity of the frame load rating.
6.6.4 (Modify)	Replace the second sentence with: For all specified operating conditions including 'no load', the duration of this reversal shall be at least 45 degrees of crank angle and the magnitude of the peak combined reverse load shall be at least 20% of the actual peak combined load in the opposite direction. The SUPPLIER shall provide the COMPANY with instructions regarding the restrictions in operational conditions due to above limits. This shall be presented in the form of a graph (per stage), which shows the minimum required discharge pressure as a function of the suction pressure (from 0 to maximum specified suction pressure). If step-less, reverse-flow controls are used for varying load, then the MANUFACTURER/SUPPLIER shall verify that there is adequate rod reversal for bushing lubrication over the entire control range.
6.6.6 (New)	<ol style="list-style-type: none"> Rods in sour gas service shall be suitably de-rated to reflect the strength of the materials used, particularly after hardness control, and the stresses allowable in a sour environment. If de-rating of the rod causes the selected frame size to be increased, the frame sizing shall be subject to review and approval by the COMPANY.

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API Clause No.	Description of Change
6.7 CRITICAL SPEEDS	
6.7.3 (Add)	For compressors with a VSDS or other variable speed driver, the SUPPLIER shall perform a response analysis of the rotating system during all possible resonance conditions which may occur during run-up and within the complete operating speed range. All possible excitation frequencies and consequent torques shall be considered.
6.8 COMPRESSOR CYLINDERS	
6.8.1 GENERAL	
6.8.1.1 (Modify)	(Replace with:) <ol style="list-style-type: none"> The maximum allowable working pressure of the cylinder SHALL [PSR] be at least 5% higher than the specified relief valve set pressure plus accumulation. Relief valve set pressure shall be specified, if not provided by COMPANY.
6.8.1.2 (Modify)	(Replace with:) <p>Unless otherwise agreed by COMPANY, horizontal cylinders shall be provided and following requirements shall be taken in to account:</p> <ol style="list-style-type: none"> Delete "Unless otherwise specified" from the first sentence. Replace the second sentence with: Horizontal cylinders shall have top suction and bottom discharge connections. Vertical type labyrinth compressor cylinders should be considered for dry services and Boil off Gas (BOG) service. Vertical cylinders shall be designed so that complete drainage of the cylinder is possible. <p>[Add] The arrangement of valves and ports shall be such as to ensure complete drainage of cylinders.</p>
6.8.1.4 (Modify)	(Replace with) <p>Step pistons and tandem cylinder arrangements are not permitted.</p>
6.8.1.5 (Modify)	(Replace with): <ol style="list-style-type: none"> All cylinders shall be supplied with replaceable liners. Cylinders shall be thick enough to provide for re-boring to a total of 3.0 mm (1/8 in) increase over the original diameter.

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API Clause No.	Description of Change
	3. An increase in piston diameter shall not affect the cylinder MAWP, the maximum allowable continuous gas load, or the maximum allowable continuous combined rod load.
6.8.1.8 (Add)	4. Clearance shall be provided to permit the use of torque wrenches, including multipliers for torque values over 300 Nm. 5. A steel cover shall be fitted to protect the extended threaded stud end when hydraulically tensioned studs are provided.
6.8.1.9 (Add)	Anaerobic adhesives or epoxy shall not be used to set studs.
6.8.1.12 (New)	Cylinder bore diameter shall not exceed 800 mm without the COMPANY's approval.
6.8.1.13 (New)	When compressor cylinders are shipped as an assembled unit, the cylinder alignment shall be verified and recorded by wire-line methods to establish benchmarks for alignment confirmation once the unit has been installed in the field.
6.8.2 CYLINDER APPURTENANCES	
6.8.2.1 (Add)	1. Piston rod run-out shall be measured directly adjacent to the cylinder packing case flange. 2. Supports shall be furnished at the outer (head) end of each cylinder in addition to the cylinder supports inboard of the cylinder. 3. These supports shall be stiff vertically and horizontally in the axis parallel to the crankshaft to reduce cylinder side - sway. 4. Vertical adjustment on all cylinder supports shall be achieved solely by the use of shims. 5. Only stainless steel shims shall be provided for field installation on supports.
6.8.2.2 (Add)	In the first sentence of this clause, delete the words "Unless otherwise specified,"
6.8.2.3 (Modify)	In the first sentence of this clause, delete the words "and cylinders without liners". Add to this clause: 1. Wear ring MANUFACTURERS/SUPPLIERS shall advise the required surface roughness to achieve maximum lifetime of the proposed rings.
6.8.2.4 (Modify)	(Delete) "If specified," from First Sentence
6.8.2.6 (Modify)	[Replace with:] Replace the 3 rd and 4 th sentence of the clause with: "Through bolt designs shall not be furnished."
6.8.2.10 (New)	Each valve cover shall be drilled to accept the installation of spring loaded RTD to

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
	monitor valve temperatures for predictive monitoring.
6.8.3 CYLINDER COOLING	
6.8.3.1 (Add)	(Add): Cooling water jackets of fabricated construction shall not be used and air-cooled cylinders are not acceptable.
6.8.3.2 (Add)	Use of static cylinder cooling shall be subject to approval by COMPANY. Static cooling is very inefficient and is only acceptable when no other options are viable.
6.8.3.3 (Add)	Use of thermosyphon cylinder cooling shall be subject to COMPANY approval.
6.8.3.4.3 (Modify)	Replace the second sentence with: 1. For wet and saturated gas, coolant inlet temperatures shall be maintained at least 10 K above the inlet gas temperature. These inlet temperature limits do not apply to “bone dry” gases.
6.8.3.5.1 (Add)	Cooling water jackets of fabricated (welded) construction shall not be used. Seawater / brackish water shall not be used for jacket cooling. Fresh water or tempered water shall be used for cylinder cooling and the water return lines shall have visible Acrylic sight glasses. Apart from sight glasses with wheels, Temperature Transmitter(TT) at inlet and outlet, FT(Flow Transmitter) shall be provided for each cylinder. Plugs for core holes and / or repairs shall not be used on the gas pressure containing wall sections of cylinder heads or cylinders including the bore under the liner. Cooling water jackets for once-through systems shall have removable covers of ample dimension for cleaning purposes.
6.8.3.5.2 (Modify)	(Replace to read) SUPPLIER shall provide a self-contained, forced circulation, closed loop jacket coolant system. It shall meet the requirements of API para no. (6.8.3.5.1) through (6.8.3.5.3) (refer to figure G-1, Plan D of API STD 618) with additional instrumentation for proper monitoring. The coolant system shall be such that the temperature limits as specified in API para no. (6.8.3.4.3) and (6.8.3.5.4) are met under all specified operating conditions, including start-up, shut down and other transients. Cooling liquid data is available in datasheet.
6.8.3.5.6 (New)	SUPPLIER shall provide two jacket water cooling pumps of 100% capacity each with AC motors suitable for continuous operation. (One AC motor and pump assembly as working and one AC motor and pump assembly as standby shall be used). The pumps shall be centrifugal pumps and supplied with mechanical seal and oil lubricated bearings.

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API Clause No.	Description of Change
6.8.4 CYLINDER CONNECTIONS	
6.8.4.1.2 (Add)	(Add) Studs shall be supplied. Cap screws are not acceptable.
6.8.4.1.5 (Modify)	(Replace to read) Utilities connections shall be flanged irrespective of the size.
6.8.4.1.6 (Modify)	Replace “should” with “shall”.
6.8.4.1.16 (Modify)	Delete The bullet and the words “If specified”. (Add) Each cylinder tap shall be provided with a DN 12 (NPT 1/2) indicator with valve connections.
6.8.4.1.17 (Modify)	Delete “if specified”.
6.8.4.2 FLANGES	
6.8.4.2.1 (Add)	The application of hydraulic fastening tools, or similar, shall be possible for <ol style="list-style-type: none"> Class 1500 flanges of DN 150 (6”) and larger. Class 2500 flanges of DN 100 (4”) and larger. Add to this clause: <ol style="list-style-type: none"> Gasket contact surfaces and, where used, ring joints shall be in accordance with ASME B16.5 or ASME B16.47. Gaskets used between cylinders and pulsation dampeners shall be the spiral wound type with an inner ring. The flange finish on both the cylinder and pulsation bottles shall be 125 AARH - 250 AARH. For hydrogen service the flange finish shall be 125 AARH – 175 AARH.
6.8.4.2.5 (Add)	The use of non-standard (oversized) flanges shall be subject to the approval of the COMPANY.
6.9 VALVES AND UNLOADERS	
6.9 (Add)	<ol style="list-style-type: none"> Valve and unloader drawings shall be subject to approval by COMPANY. Approval of the valve type, material and performance is required. Plug type valves shall be proposed. An alternative design of valve if proposed by SUPPLIER, will be further evaluated and subject to COMPANY approval.
6.9.1 VALVES	

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API Clause No.	Description of Change
6.9.1.1 (Add)	<ol style="list-style-type: none"> 1. Average gas velocities of each head end and crank end shall be shown on the datasheets. 2. The valve MANUFACTURER/SUPPLIER shall indicate the maximum allowable gas velocity for the proposed design.
6.9.1.2 (Add)	<ol style="list-style-type: none"> 1. Non-metallic (e.g., PEEK, engineered polymers) plate, process poppet or ring type valves shall be supplied. 2. Engineered polymers shall not contain any re-grind or re-processed polymer. 3. Unloaders shall be able to operate at the minimum available air pressure value stated on the datasheet.
6.9.1.4 (Add)	Replace with: <ol style="list-style-type: none"> 1. Valve seat to cylinder gaskets shall be of soft iron or steel and of solid rectangular design. 2. Metal-jacketed gaskets shall not be used. 3. The proposed type and material of gaskets shall be subject to the approval of the COMPANY.
6.9.1.6 (Modify)	Replace the first sentence of this clause with the following: <ol style="list-style-type: none"> 1. The SUPPLIER shall provide a device to facilitate the removal and installation of all underslung discharge valve assemblies.
6.9.1.8 (Add)	Designs with centre bolt or jackscrew shall not be provided.
6.9.1.9 (Modify)	[Replace the last sentence with the following]: The MANUFACTURER/SUPPLIER shall submit a written valve dynamic report.
6.9.1.9.1 (New)	Valve selection shall be based on at least a five-year operating life. <ol style="list-style-type: none"> a. Where valve port dimensions prohibit the selection of valves fulfilling the five-years life requirement, the valve MANUFACTURER/SUPPLIER shall indicate this and submit a proposal to overcome it. b. The valve selection proposal may include alternatives such as different valve design, change in swept volume per stroke, number of valves per cylinder end or different valve diameter. c. Detailed valve information, including spring wire diameter, spring constant, disc thickness, disc configuration (single or web type), and recommended valve lift with minimum and maximum serviceable limits shall be provided. d. If case hardened valve seats are furnished, depth of the case and minimum seat thickness shall be stated. e. If the full hardened case is less than 7.6mm deep, instructions for re-hardening shall be provided.
6.9.1.10 (Add)	<ol style="list-style-type: none"> 1. Metal valve discs or plates and damper plates should not be supplied unless approved by COMPANY.

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API Clause No.	Description of Change
	<ol style="list-style-type: none"> 2. If metal valve plates are provided, then they shall be fully milled or laser cut, not punched. 3. Valve plates and rings shall be non-metallic in wet gas, dirty gas and sour gas service where the following applies: <ol style="list-style-type: none"> a. ISO 15156 or NACE MR0175 which apply to oil and gas production facilities and natural gas sweetening plants. b. NACE MR0103 / ISO 17945 which applies to applications other than ISO 15156 or NACE MR0175 (e.g., oil refineries, LNG plants and chemical plants).
6.9.1.11 (New)	Valve lift shall be selected to allow adjustment following commissioning of the equipment.
6.9.2 UNLOADERS	
6.9.2.1 (Modify) [PSR]	<ol style="list-style-type: none"> 1. The unloading hierarchy to manage capacity shall be as follows: <ol style="list-style-type: none"> a. Cooled Bypass/Recycle Piping <ol style="list-style-type: none"> I. Machine shall be capable of starting with operating suction pressure on each stage. II. MANUFACTURER/SUPPLIER shall advise the maximum pressure drop across the recycle start up valves. b. Plug or Port Unloaders. <ol style="list-style-type: none"> I. Unloaders shall be pneumatically operated. Hydraulically actuated actuators are not acceptable. II. When unloaders are required on cylinders that do not require a full complement of suction valves, plug type unloaders shall be installed on the extra suction ports. III. The MANUFACTURER/SUPPLIER shall provide the minimum number of valve unloader steps required to meet the conditions of service specified on the data/requisition sheets. IV. Unloaders shall be designed so indication of the loading state is clearly visible. V. Refer to (6.9.2.1 item 2 and 3) c. The use of Finger type unloaders is subject to COMPANY approval. <ol style="list-style-type: none"> I. Refer to (6.9.2.1 item 2 and 3) 2. The unloader stem packing of any unloader design shall be sealed with nitrogen purged O-rings. 3. The unloader stem packing vent SHALL [PSR] be routed to the flare or disposal system indicated on the data/requisition sheets. 4. The MANUFACTURER/SUPPLIER shall provide COMPANY with a system of properly sequenced unloader operation (7.6.2.1). 5. Settle out pressure starting is not required, unless otherwise specified.

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API Clause No.	Description of Change
6.9.2.2 (Add)	a. Unless specified otherwise, one plug unloader per end shall be supplied. b. Cylinders with four valves per end shall have one full valve and one partial valve with a plug unloader. c. Cylinders with six or more valves per end may have partial valves or port unloaders.
6.9.2.3 (Delete)	Delete clause as these are not acceptable.
6.9.2.4 (Modify)	Replace the first sentence of this clause by: “Unloaders shall be pneumatically actuated air-to-load”. Add to this clause: The unloader actuator shall be sized to operate at the minimum pneumatic pressure as stated on the data/requisition sheet without any valve element fluttering while in operation.
6.9.2.6 (Add)	1. The unloader stem packing shall be provided with a lantern ring and a purge connection for the injection of a buffer gas. 2. All purge and vent connections shall be piped up to a single purge and vent connection. 3. All lines to and from unloaders shall be AISI 316L stainless steel.
6.9.2.8 (New)	Feather type (Flexible plate) valves shall not be used.
6.9.2.9 (New)	Sealing material used in valve unloaders and pockets shall be able to withstand 55°C greater than the maximum allowable unloading step discharge temperature.
6.9.2.10 (New)	For high hydrogen services, special design features incorporated to seal plug to seat shall be identified.
6.9.2.11 (New)	Unloaders shall have vent valves at each unloader.
6.9.2.12 (New)	Unloaders shall have a braided stainless-steel hose from the vent valve to the unloader.
6.10 PISTONS, PISTON RODS AND PISTON RINGS	
6.10.2 CONNECTION OF PISTON ROD TO CROSSHEAD	
6.10.2.1 (Add)	All piston rod to crosshead connections shall be tightened using hydraulic tooling and methods.
6.10.2.3 (New) [PSR]	1. Applications of Multi-jack bolt Design Heavy Hex Nuts to mechanically attach the Piston to Piston Rod connection shall be limited to less than 89 mm (3.5 in).

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API Clause No.	Description of Change
	<ol style="list-style-type: none"> 2. MANUFACTURER/SUPPLIER shall provide a complete detailed assembly / disassembly procedure for installing removing Multi-jackbolt design heavy hex nuts. <ol style="list-style-type: none"> a. This procedure for installing/removing Multi-jackbolt design heavy hex nuts shall indicate the type of lubricant to be used, the surfaces to receive the lubricant, and the torque procedure. 3. Multi-jack bolt (super-bolt) design heavy hex nuts SHALL [PSR] not be used to attach the piston to the piston rod in sour service (due to hardness restrictions in sour gas service). 4. For threaded piston rods, the stress at the crosshead attachment shall not exceed 70 MPa (10,000 psi) fluctuating stress peak (half the stress range) measured at the thread root diameter at maximum continuous rod loading.
6.10.3 PISTONS	
6.10.3.1 (Modify)	<p>Replace the last sentence with :</p> <ol style="list-style-type: none"> 1. Vent holes shall be located at the bottom of the piston. <p>Add:</p> <ol style="list-style-type: none"> 1. Spring-loaded relief plugs shall not be used. 2. Aluminium pistons shall have a wear resistant coating on the piston ring and the rider ring landing. Aluminium piston shall be subject to COMPANY approval.
6.10.3.2 (Modify)	<p>Replace the second sentence with the:</p> <ol style="list-style-type: none"> 1. Pistons shall be segmented because of the material of the selected wear (rider) band. 2. A Finite Element Analysis (FEA) shall be performed for all piston designs where compressor MANUFACTURER/SUPPLIER prior experience with the identical pistons in similar or more severe service cannot be demonstrated. 3. The methodology and results of the FEA analysis shall be subject to COMPANY approval. <p>Replace the fourth and fifth sentences of this clause with the following:</p> <ol style="list-style-type: none"> 4. Non-metallic rings and wear bands (rider bands) shall be provided on all machines. 5. Piston and ring selections made shall be backed up with supportive evidence of successful application in similar duty. 6. Piston ring and wear band material selection, material configuration, arrangement on the piston, and piston contour design shall be based on a five-year continuous operating period. 7. The compressor MANUFACTURER/SUPPLIER shall submit to COMPANY a copy of the written selection report made by the prospective ring SUPPLIERS.

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API Clause No.	Description of Change
	<ol style="list-style-type: none"> 8. The ring selections made shall be backed up with supportive evidence of successful application in similar duty. 9. Rider bands in horizontal cylinders shall have a maximum unit loading of 37.2 kPa for lubricated or non-lubricated cylinders.
6.10.3.3 (New)	Aluminium pistons shall be hard anodized and conform to MIL A A8625t, YIII, Cl. 1, Rev. E, Amend. 1. Aluminium pistons shall be used only for air services and shall be subject to COMPANY approval.
6.10.4 PISTON RODS	
6.10.4.1 (Add)	<ol style="list-style-type: none"> 1. Rods used in non-lubricating service shall not be coated without the approval of COMPANY and the selected packing ring MANUFACTURER/SUPPLIER. 2. Piston rod material for non-lubricated, corrosive services shall be 17-4 PH, 17-6 PH, or equal for corrosion resistance and subject to COMPANY approval. 3. All piston rod materials shall be supplied with mill certificates and have a letter of compliance indicating the material is in compliance by positive material identification. 4. Uncoated rods may be induction hardened or nitrided to achieve the required minimum surface hardness of HRC 50. <ol style="list-style-type: none"> a. The core hardness shall not exceed HRC 22 in sour gas applications where ISO 15156 or NACE MR0103 apply. b. Nitriding shall not be used in sour gas applications. c. Material certificates shall indicate the final hardness after heat treatment. 5. The rod coating shall have a minimum thickness of 80 µm and a maximum thickness of 380 µm.
6.10.4.2 (Modify)	<p>Replace wording in fifth sentence “are not recommended” with “shall not be used”</p> <p>Replace wording in sixth sentence “is not recommended” with “shall not be used”</p> <p>Add to this clause:</p> <ol style="list-style-type: none"> 1. HVOF and D-Gun are accepted coating methods for piston rods. 2. “Cold” metal spray techniques shall not be used. 3. Rod coatings acceptance criteria shall have no chips, flaking, cracks, patches or porosity or discontinuities on finished coating when examined with the unaided eye, reflected light and PT check. 4. Questionable areas, as determined by the rod coating acceptance criteria (6.10.4.2, item 3), shall be examined at 10X magnification.
6.10.4.3 (Add)	<ol style="list-style-type: none"> 1. NACE MR0175/ISO 15156 shall apply to oil and gas production facilities and natural gas sweetening plants. 2. NACE MR0103/ ISO 17945 shall apply to oil Refineries.

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API Clause No.	Description of Change
6.10.4.4 (Modify)	<p>Replace the second sentence of this clause with the following:</p> <ol style="list-style-type: none"> 1. The rod finish in the packing area for induction hardened rods shall be 0.2 $\mu\text{m Ra}$ – 0.3 $\mu\text{m Ra}$ (8 $\mu\text{in Ra}$ – 12 $\mu\text{in Ra}$). 2. For D-Gun or HVOF coated rods the surface finish shall be 0.1 $\mu\text{m Ra}$ – 0.2 $\mu\text{m Ra}$ (4 $\mu\text{in Ra}$ – 8 $\mu\text{in Ra}$). 3. Hard chrome and nitrided rods shall be finished to 0.15 $\mu\text{m Ra}$ – 0.25 $\mu\text{m Ra}$ (6 $\mu\text{in Ra}$ – 10 $\mu\text{in Ra}$). 4. The ring MANUFACTURER/SUPPLIER shall confirm the required optimum finish.
6.10.4.5 (Add)	<ol style="list-style-type: none"> 1. The entire piston rod shall be polished, including areas to be threaded. 2. After the piston rod threads are rolled, the thread crests shall be polished to a smooth finish.
6.10.4.6 (Modify)	<p>Replace with:</p> <p>Tail rod constructions shall not be used.</p>
6.10.4.7 (New)	<ol style="list-style-type: none"> 1. Piston rods shall be designed to accommodate a guide sleeve or bullet for installation through packing assemblies. 2. Subsequent to all manufacturing processes, the piston rod thread area, except for thread piston side on labyrinth compressors, shall be inspected by the wet magnetic particle method. 3. The piston rod collar to rod diameter transition shall have a radius that avoids stress concentrations while still allows for the piston to seat correctly. <ol style="list-style-type: none"> a. The piston rod collar to rod diameter transition radius shall be 13mm minimum for rods of 100mm in diameter or less. b. Rods larger than 100mm in diameter shall have a 25mm minimum radius. 4. Ultrasonic Testing (UT) of rods in both the radial and longitudinal directions shall be done by a person qualified as SNT Level II inspector. <ol style="list-style-type: none"> a. The use of any alternative technique that may be required due to the geometry of the rod shall be subject to review and approval of COMPANY. 5. The rod shall be Ultrasonic Tested (UT) both in rough condition, after rough machining and after heat treatment (but prior to age hardening, drilling holes, cutting keyways, tapers, grooves or machining sections to contour). 6. The final UT of rods shall occur immediately prior to rolling of threads.
6.11.1 CRANKSHAFTS	
6.11.1 (Add)	<ol style="list-style-type: none"> 1. Crankshafts shall have integral coupling hubs, except for machines with pressurized and sealed crankcases. 2. A written UT Flaw Detection report shall be provided in the final documentation to the COMPANY.
6.11.2 BEARINGS	

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API Clause No.	Description of Change
6.11.2.1 (Modify)	[Replace this clause with:] <ol style="list-style-type: none"> 1. Replaceable precision-bored shell (sleeve) crankpin bearings and main bearings shall be used. 2. Anti-friction bearings shall not be used for compressor. 3. Aluminium bearings with less than 7% Tin shall not be applied. 4. Only bearing materials that meet the criteria of proven equipment (1.3.2) shall be used. 5. All Babbitt lined bearings shall be inspected for proper bond and side separation using UT Flaw Detection Methods on the bond and PT (Dye Penetrant) Inspection for side separation. 6. The acceptable Babbitt bond is 99% with zero defects or separation allowed between the Babbitt and parent material located anywhere on the bearing.
6.11.2.2 (Delete)	Delete this clause.
6.11.2.3 (Delete)	Delete this clause.
6.11.2.4 (Delete)	Delete this clause.
6.11.3 CONNECTING RODS	
6.11.3 (Add)	Crank-end rod bolts shall be furnished with rolled threads and should be provided with hydraulically tightened nuts. Bolts larger than M30 (1-3/16 in) shall be furnished with hydraulically tightened nuts.
6.11.4 CROSSHEADS	
6.11.4 (Add)	<ol style="list-style-type: none"> 1. Aluminium or aluminium alloys in crosshead shoes with less than 7% tin shall not be used. 2. If ductile iron crossheads are provided, model data and finite element stress analysis to show acceptable stress levels shall be provided. 3. Designs in which the crosshead pin is clamped in the connecting rod and designs using forked connecting rods are not acceptable. Cross head housings bolted to the crankcase shall be dowelled in position after the alignment and piston rod run out have been verified.
6.11.4.1 (New)	<ol style="list-style-type: none"> a. Crosshead housings shall have gasketed solid aluminium covers with handles for removal. b. Covers shall have inspection ports to verify eutectic dump valve position, while compressor is in operation. This can be achieved with either a separate port cover or polycarbonate type cover.
6.11.5 CRANKCASES	
6.11.5 (Modify)	Delete "If specified" Add to this clause: <ol style="list-style-type: none"> 1. Crosshead housings bolted to the crank case shall be doweled in place after the alignment and piston rod run out have been verified.

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
	<ol style="list-style-type: none"> 2. Straight dowels shall be used to dowel the bolted crosshead housing to the crank case. 3. Crankcase explosion relief valves shall have a minimum throat area of 70mm² for each dm³ of the gross crankcase contents free volume. <ol style="list-style-type: none"> a. The crankcase explosion relief valves shall be operable in all mounting positions. b. Integral flame arrestors shall be applied in the crankcase explosion relief valves. 4. The crankcase shall be designed to mount slow speed velometers or accelerometers on a non-gasketed surface of the crankcases 5. The crankcase mounting surface for the velometers or accelerometers shall be a "FLAT" boss cast or fabricated into the main part of the case. <ol style="list-style-type: none"> a. The boss shall be drilled and tapped to accept the device specified on the data/requisition sheets. <p>slow speed 4-20mA vibration transmitter may be specified in place of the velometers or accelerometers.</p> 6. The crankcase shall have at least one top mounted vent connection and be provided with a provision for a nitrogen sweep of the crankcase. <ol style="list-style-type: none"> a. A crankcase that has more than four throws shall have at least two top mounted vent connections and be provided with provisions for nitrogen sweep of the crankcase.
6.12 DISTANCE PIECES	
6.12.1 DISTANCE PIECES TYPES	
6.12.1 (Add)	<p>Unless otherwise stated in the data/requisition sheet, the following type of distance piece is required.</p> <ol style="list-style-type: none"> a. For air or pure nitrogen : type A or B b. For all process gas service : type C or D
6.12.1.1 (Add)	<ol style="list-style-type: none"> a. For Exploration and Production applications, compressors in flammable or toxic service shall have type D compartment distance pieces. For Refining applications, compressors in flammable or toxic service shall have type C compartment distance pieces. b. The frame side distance piece, wiper packing, and intermediate packing shall be purged with nitrogen and vented to a safe area.
6.12.1.6 (New)	<p>The packing flare connection line between connection and the liquid collection pot in "type B" and "type C" arrangements shall be provided with a pressure and a temperature indicator, which shall be located as close as practical to the distance piece connection.</p>
6.12.2 DISTANCE PIECE REQUIREMENTS	

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
6.12.2.1 (Modify)	Replace clause with the following: <ol style="list-style-type: none"> 1. Access holes of adequate size shall be provided in each distance piece compartment to permit removal of the assembled packing case. 2. Access through internal partitions shall not be provided. 3. Distance piece covers weighing more than 15kg shall have handles.
6.12.2.2 (Add)	Distance pieces shall be designed so that the assembled packing cartridge can be replaced via the access opening.
6.12.2.3 (Modify)	Replace this clause with the following: <ol style="list-style-type: none"> 1. The outer compartment of the distance piece adjacent to the cylinder, partitions, covers, bolting and intermediate seal packing shall be designed for a minimum compartment pressure of 3.5bar(g). 2. For all vent and drain arrangements, where the inboard compartment can become plugged while it is buffered with nitrogen, shall be designed/certified as a pressure compartment.
6.12.2.4 (Add)	<ol style="list-style-type: none"> 1. Inboard and cylinder side compartments shall be separately vented to a safe area. 2. All ports on distance piece shall be permanently labelled in accordance with API 618 Figure G-3. 3. Distance piece relief protection shall be provided by MANUFACTURER / SUPPLIER.
6.12.2.7 (Add)	Stainless steel hoses may be substituted with Alloy 825 for the tubing, subject to approval by COMPANY. This same statement also relates to 6.13.2.6.
6.12.2.9 (Add)	a. Distance pieces shall have gasketed solid aluminium covers with handles for removal.
6.12.2.10 (New)	No gasket shall be used between the frame and distance pieces, between distance pieces or between distance pieces and cylinders.
6.13 PACKING CASES AND PRESSURE PACKING	
6.13.1 GENERAL	
6.13.1.1 (Modify)	Delete "If specified," from second sentence. Pressure and wiper packing shall be filled PTFE or PEEK segmented rings.
6.13.1.2 (Modify)	Replace the first two sentences of this clause with the following: <ol style="list-style-type: none"> 3. The packing case and end flange shall be stainless steel and be bolted to the cylinder with at least four stud bolts (cap bolts are not allowed).

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API Clause No.	Description of Change
	<p>In the last sentence of this clause, delete the words “cup-to-cup pilot fits and/or”.</p> <p>Add to this clause:</p> <ol style="list-style-type: none"> 1. Packing cases shall be designed to accommodate piston rod radial movements without metal-to-metal contact between rod and case in the event of loss of the total rider ring height. 2. Packing cases shall be provided with a captured case to cylinder gasket. 3. Unless otherwise specified, the packing case to cylinder gasket shall be a stainless steel, spiral-wound gasket.
6.13.1.3 (Modify)	<ol style="list-style-type: none"> 1. Packing case vent and drain piping and fittings shall be of AISI 316 L stainless steel if compatible with the process medium or Alloy 825. 2. Connections shall be minimum 25 mm (1 in) NPT.
6.13.1.6 (Modify) [PSR]	<p>Delete “If specified”</p> <p>Add to this clause:</p> <ol style="list-style-type: none"> 1. MANUFACTURER/SUPPLIER’s standard designs of the purge system and support instrumentation shall be provided in the proposal per arrangements shown in Annex I, Figures I-2 and I-3. 2. Each cylinder packing case vent connection (G) SHALL [PSR] be separately connected to the flare or the header to the flare disposal system. 3. The cylinder packing case and the frame inboard distance piece of type C and D arrangements shall be purged with nitrogen. <ol style="list-style-type: none"> a. The MANUFACTURER/SUPPLIER shall provide a suitable pressure relieving device to prevent the nitrogen pressure in the compartment from exceeding the maximum allowable compartment working pressure. 4. Subject to the saturation point of the leak-off gas, heat tracing may be required. 5. The inboard distance piece compartment vent shall be plugged and the outboard compartment be vented to the location defined in the data/requisition sheets (connection A). 6. The scope of supply for the cylinder pressure packing shall be as indicated on by the data/requisition sheets. 7. If no nitrogen buffer gas is available, then the cylinder packing case purge connection shall be plugged. <ol style="list-style-type: none"> a. The inboard compartment shall be vented to atmosphere via a breather. b. The outboard compartment shall be provided with a vacuum system as defined in the data/requisition sheets. c. When an ejector is applied, the outlet of the ejector shall be vented to a disposal system as indicated on the data/requisition sheets. d. The driving medium for the ejector shall be as indicated on the data/requisition sheet. 8. The type B distance piece applied in air or nitrogen service shall be vented to atmosphere if the cylinder packing case is vented into the distance piece.

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API Clause No.	Description of Change
6.13.1.7 (Modify)	Delete “Unless otherwise specified” Add to the clause: Entering sleeves shall have the same outside diameter as the rod.
6.13.1.8 (New)	A packing cross sectional drawing that identifies the following shall be subject to approval by COMPANY. An evaluation will verify design, materials, and details are correct for the application. <ol style="list-style-type: none"> Packing arrangement. Venting, cooling, purge, and lubrication arrangement. Thickness, mm (in), of each packing ring. Maximum and minimum axial clearance between the rings and cup. Minimum wall thickness for each cup. Gland bolt torque values. Maintenance instructions.
6.13.2 PRESSURE PACKING CASE COOLING SYSTEMS	
6.13.2.1 (Modify)	“Add to clause and delete bullet”
6.13.2.3 (Add)	(Add at the beginning of the clause) <ol style="list-style-type: none"> The packing MANUFACTURER/SUPPLIER shall indicate whether cooling is required. The cooling proposal shall be supported by references to similar or more severe applications and submitted to the COMPANY for review.
6.13.2.4 (Add)	Documentation of the assessment of the compatibility of O-rings with the fluid services to which they will be exposed shall be submitted to the COMPANY for approval.
6.13.2.7 (Add)	Add to this clause: <ol style="list-style-type: none"> Direct cooling of the packing assembly by water shall not be used. <ol style="list-style-type: none"> A self-contained closed-circuit cooling system for the packing assembly shall be installed using oil or glycol as the cooling medium. The packing assembly may be included in self-contained cylinder jacket cooling systems that use glycol as a cooling medium. <ol style="list-style-type: none"> For all sour or any very toxic gas services, the packing assembly system shall be separate from the cylinder jacket cooling system.
6.14 LUBRICATION	
6.14.2 COMPRESSOR FRAME LUBRICATION	
6.14.2.1.1 (Modify)	Replace this clause with the following: <ol style="list-style-type: none"> The frame lubrication system shall be a pressurized system. The crankcase oil sump temperature shall not exceed 70 °C (160 °F).

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API Clause No.	Description of Change
	3. Cooling coils shall not be used in crankcases or oil reservoirs.
6.14.2.1.3 (Modify)	<p>Delete "If specified"</p> <p>(Add) Each forced lubrication system shall consist of one crankshaft driven main oil pump and electric motor driven auxiliary oil pump with flanged inlet and outlet connection. Each forced lubrication system shall have a supply and return system, a twin full flow oil filter (one working + one standby) and oil cooler installed upstream of the oil filter and instruments and other necessary appurtenances. A valve and flanged oil sampling connection shall be provided between oil filter and oil cooler.</p>
6.14.2.1.4b (Modify)	<ol style="list-style-type: none"> 1. The crankshaft driven main lube oil pump shall be subject to COMPANY approval. 2. The auxiliary pump shall start automatically upon the system pressure falling to a pre-determined pressure level. 3. The pump shall have an external pressure relief valve with a sight glass in the relief valve discharge line. 4. Suction strainers of main and standby pumps shall be interchangeable while the compressor is in operation.
6.14.2.1.4c (Modify)	<p>Delete "when required"</p> <ol style="list-style-type: none"> 1. The auxiliary oil pump shall be equipped with a spring loaded "manual-off-automatic" switch that is locked to stay in the "off" position. 2. Motor space heaters, arranged to come on when motor is not running, shall be provided for standby oil pump motor drivers. 3. Once started, the auxiliary pump shall remain running until manually stopped. 4. A control board alarm shall indicate when the auxiliary pump is running. 5. The compressor MANUFACTURER/SUPPLIER shall state in the proposal whether the offered compressor can run down safely without mechanical damage in the event of a lube oil pump failure. 6. If the compressor cannot run down safely as stated in item 5, then alternative lubrication shall be provided.
6.14.2.1.4d (Modify)	d [Replace with] Dual oil coolers with continuous flow transfer valves shall be provided.
6.14.2.1.4e (Add)	<ol style="list-style-type: none"> 1. Dual filter housings shall include a six port continuous-flow transfer valve (manually operated). 2. Each filter element housing shall be equipped with a vent valve and a drain valve. 3. The oil fill/equalization line between the filter element housings shall have a restriction orifice with a block valve on both sides of the restriction orifice.

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API Clause No.	Description of Change
	4. A thermal relief valve for each filter element housing shall only be applied if required by the MANUFACTURER/SUPPLIER.
6.14.2.1.4k (Add)	All piping fittings shall be butt welded type. Socket welded fittings are specifically prohibited. Oil piping shall be Schedule 40 minimum.
6.14.2.1.4m (New)	A drain valve shall be located at the lube console elevation to drain oil from piping between the console and compressor during maintenance.
6.14.2.1.5 (Modify)	Delete “have cast iron or” from the industry clause.
6.14.2.1.9 (Modify)	<ol style="list-style-type: none"> 1. The crankcase, serving as an oil reservoir, shall have sufficient retention time for the oil to release entrained air and prevent foaming of the oil. 2. The crankcase top and cover plates shall be designed to prevent rain or hose water from entering. 3. The crankcase shall have provisions for a nitrogen purge or blanket.
6.14.2.1.10 (Modify)	Delete “If specified”
6.14.2.1.11 (New)	Crankshaft oil seals shall be replaceable without the coupling or flywheel having to be removed.
6.14.2.2 AUXILIARY PUMP	
6.14.2.2 (Modify)	Add to the clause: <ol style="list-style-type: none"> 1. The auxiliary oil pump shall be a rotary internal screw or gear type driven by an electric motor. 2. Both main and auxiliary pumps shall be sized for 20% greater flow than the total required oil demand. 3. Each pump shall be provided with flanged connections for oil inlet and outlet and a non-integral pressure relief valve individually piped back to the crankcase reservoir. 4. The auxiliary pump shall be equipped with a ready to run indication.
6.14.2.3 COOLER	
6.14.2.3c (Modify)	[Replace this clause with the following:] Tubes shall have an outside diameter of not less than 16mm (5/8 in) and a wall thickness of not less than 1.65mm (0.065 in - 16 BWG).

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API Clause No.	Description of Change
6.14.2.3g (New)	The Manufacturer/Supplier shall design the lubrication oil system so that the oil pressure at the cooler outlet is at least 1 barg (15 psig) higher than the maximum water pressure stated in the data/requisition sheet in order to prevent oil contamination in the event of cooler failure.
6.14.2.3h (New)	The oil cooler shall be sized for the total cooling load taking into account the fouling factor and 10% tubes plugged at any given time for the conditions specified in the data/requisition sheet.
6.14.2.3i (New)	The material selections for the shell-and-tube lube oil cooler shall be subject to review and approval by COMPANY.
6.14.2.3j (New)	If specified, a lube oil wear particle detector shall be required to alarm of an impending crankshaft bearing failure.
6.14.2.3k (New)	<p>The system design hierarchy to manage cooling of the compressor shall be as follows:</p> <ol style="list-style-type: none"> 1. Water-cooled exchanger is acceptable if where there is a cooling water network in the plant. shell & tube coolers shall conform to TEMA C and Project Specifications. 2. Air-cooled cooler shall comply with the following requirements: <ol style="list-style-type: none"> i. 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. ii. 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.). iii. U-stamp or PED certificate is required. iv. Margins to be applied: Max. flow * 10% (define flow per API 614, cl 4.4.11b), heat load * 10% or on heat exchange surface area * 10%. 3. Sea water cooling system is acceptable subject to COMPANY approval.
6.14.2.4 FILTERS	
6.14.2.4 (Add)	Dual filters shall be provided with differential pressure indication and a high differential pressure alarm.
6.14.2.4d (New)	d) A continuous flow transfer valve shall be provided.
6.14.2.4e (New)	e) Filters shall be designed to ASME VIII and U-Code stamped.
6.14.2.5 HEATER	

Table 7 - API 618 Technical Amendments: Section 6 – Basic Design

API Clause No.	Description of Change
6.14.2.5 (Modify)	<p>[Delete] “When specified”</p> <p>[Add] An electric immersion heater shall be provided if the minimum ambient temperature specified is lower than the minimum lube oil temperature required.</p>
6.14.2.6 PRESSURE RELIEF VALVE	
6.14.2.6 (Modify)	<p>[Delete] : The bullet.</p> <p>Replace second and third sentences with:</p> <ol style="list-style-type: none"> 1. All safety/relief valves shall have flanged inlet and outlet connections. 2. The minimum inlet flange rating shall be ASME Class 300 RF unless the service requires a higher rating or different type of flange facing. 3. The relief valve for the crankcase-driven pump shall be mounted outside the crankcase. 4. The relief valves for the crankcase-driven pump shall have a steel body and be non-chattering with corrosion resistant internals. 5. Relief valve materials shall be as required in (7.6.5).
6.14.3 CYLINDER AND PACKING LUBRICATION	
6.14.3.1.1 (Modify)	<p>Replace with:</p> <p>Unless otherwise specified by COMPANY, the MANUFACTURER/SUPPLIER shall supply a single plunger per point mechanical lubricator system for the compressor cylinder and packing lubrication. Divider-block mechanical lubricator can be offered as an alternative for COMPANY approval.</p>
6.14.3.1.2 (Add)	<p>Replace this clause with the following:</p> <ol style="list-style-type: none"> 1. Cylinder lubricators shall be driven by two 100% redundant electric motors. Compressor shaft driven is subject to COMPANY approval. 2. Unless otherwise specified by the COMPANY, the electric motors driving cylinder lubricators shall comply with ADNOC electric motors Standards as listed in Appendix 1 (Ref. 2). 3. Each compressor cylinder packing box shall have at least two lubricating points, in addition to the cylinder lubrication requirements. 4. Subject to MANUFACTURER/SUPPLIER experience and subject to approval by the COMPANY, lubricating points within the packing box shall be located on the upper side of the piston rod and at each end of the packing assembly. 5. Lubricators shall be suitable for outdoor installation.
6.14.3.1.3 (Add)	<p>Provision to check oil flow (drops/min) and adjust as required shall be provided on each injection point.</p>
6.14.3.1.4 (Modify)	<p>Replace this clause with:</p> <p>When specified in the datasheets, or minimum ambient temperature dictates, an external heating device with thermostatic control for cylinder lubrication reservoir oil shall be provided.</p>

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API Clause No.	Description of Change
	a. The heat density of the external heating device shall be limited to 15 kW/m ² . b. The external heaters shall be approved for electrical area classification defined on the data/requisition sheets.
6.14.3.1.5 (Modify)	[Delete] “Unless otherwise specified”
6.14.3.1.6 (Add)	Lubricator reservoirs shall be equipped with a low-level alarm.
6.14.3.1.7 (Modify)	<p>¶ Replace with:]</p> <p>Each compressor cylinder shall have a minimum of two lubricating points. Piston rod packing of cylinders with a rated discharge pressure above 245 bar(g) shall have a minimum of three lubricating points. Lubricating points shall be made on the upper side of the piston rod.</p> <p>All lubrication points shall be agreed during bid evaluation with COMPANY. Necessary measurement and monitoring shall be considered in SUPPLIER scope of work.</p>
6.14.3.1.10 (Add)	Lubricator reservoir shall have the following: <ol style="list-style-type: none"> A float type level control that allows automatic oil replacement from gravity feed or pressure feed supply. Float assembly shall be designed for 4.8 bar(g) and above. A manual fill connection. Be removable. Openings to allow full cleaning.
6.14.3.1.11 (New)	<ol style="list-style-type: none"> The lubricator system shall be designed to be freestanding and remotely mounted from the machine. The interconnecting tubing shall be provided by the CONTRACTOR to frame mounted bulkhead, one tubing connection per cylinder. Remotely mounting of the lubricator system shall be done to isolate the system from shaking forces that lower lubricator system's reliability.
6.14.3.1.12 (New)	<ol style="list-style-type: none"> The lubricator system oil storage tank shall be a bulk oil storage tank system provided by the MANUFACTURER/SUPPLIER and mounted at grade near the lubricator system. For multiple compressor installations, one bulk oil storage tank shall feed all compressors. Each compressor shall have a dedicated drum pump mounted in the bulk oil storage tank. Bulk oil storage system instrumentation shall include low level alarm and low pressure alarm located at the lubricator. Low pressure transmitter shall be provided by the compressor MANUFACTURER/SUPPLIER.
6.14.3.1.13 (New)	Suction port lubricators shall not be supplied.

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API Clause No.	Description of Change
6.14.3.1.14 (New)	Frame lubricator tubing shall be installed at the factory and used during the mechanical running test.
6.14.3.2 PUMP-TO POINT LUBRICATION	
6.14.3.2.2 (Add)	Pre-lubrication duration shall be programmed in the start-up logic of the compressor.
6.15 MATERIALS	
6.15.1 GENERAL	
6.15.1.1 (Modify)	<p>[Replace with:]</p> <p>The materials of construction shall be as specified in Annex H or as specified on the data/requisition sheets. The MANUFACTURER may propose alternative materials if, based on his experience and the experience of the SUPPLIER of pistons and packing rings, these would be a better solution.</p> <p>Delete from Table H-1 the following:</p> <ul style="list-style-type: none"> • Cylinders gray cast iron • Compressor cylinder heads gray cast iron • Valve seats and guards cast iron • Packing cases cast iron
6.15.1.1 (Add)	The components shall be positively identified and traceable. Refer to Appendix 2 (Ref. 3).
6.15.1.3 (Add)	Delete the third sentence of this clause.
6.15.1.6 (Add)	Materials of construction shall be suitable for the process conditions, service, duty and ambient conditions specified.
6.15.1.9 (Add)	<ol style="list-style-type: none"> Weld overlays or hard facings with austenitic stainless steels shall have at least two layers of overlay and thickness 3 mm. The selection of materials shall be approved by the COMPANY responsible engineer if there are chlorides in the process gas. Use of austenitic stainless steels in recycle gas service for catalytic reforming units shall be subject to approval by COMPANY.
6.15.1.11 (Add)	<ol style="list-style-type: none"> NACE MR0103/ ISO 17945 shall apply to applications other than NACE MR0175/ISO 15156 in refinery application. During design, the MANUFACTURER/SUPPLIER shall make allowances for the reduced strength of certain materials, as a result of compliance with the heat treatment and hardness restrictions of the applicable NACE standard.

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API Clause No.	Description of Change
6.15.1.17 (New)	<p>If hydrogen rich, corrosive services or sour service are specified on the datasheets, bolting grades B7M and 2HM shall be supplied for areas in which contact with the process gas is possible, including the following:</p> <ol style="list-style-type: none"> Valve cover studs. Cylinder suction flange bolting. Cylinder discharge flange bolting. Indicator tap flange bolting. Jacket water flange bolting. Crosshead to distance piece bolting. Distance piece to cylinder bolting. Head to cylinder bolting. Packing case to cylinder/head bolting. Piston through bolts.
6.16 NAMEPLATES AND ROTATION ARROWS	
6.16.1 (Add)	<ol style="list-style-type: none"> Frame and bed sections shall have engraved nameplates that list clearances, torque values, and tension values that are required for compressor assembly. Tag data and location of tags shall be subject to approval by COMPANY. Locate tags in visible locations.
6.16.4g (New)	“g. year of manufacture”
6.16.7 (Add)	Unless otherwise specified, the text on the nameplates shall be in the English language. The units of measurement shall be as stated in SI units.

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change				
7 ACCESSORIES					
7.1 DRIVERS					
7.1.1.1 (Modify)	(Delete) the bullet and the words “Unless otherwise specified”. (Add) The type of driver will be indicated on the datasheets.				
7.1.1.2 (Modify)	Replace the first sentence of this clause with the following: <ol style="list-style-type: none"> The type of driver and drive system shall be as specified in the data/requisition sheet. Add to this clause: 1. The full flow relief condition at the discharge (see 7.6.5) and normal conditions at the suction shall be taken into account when sizing the driver. 				
7.1.1.4 (Add)	SUPPLIER shall clearly state in his proposal whether it is required to depressurize the stages below the normal suction pressure(s) prior to start-up.				
7.1.1.5 (Add)	The driver shall be sized for all process conditions as stated on the datasheet (plus 10% margin) and be capable of operating at the relief conditions.				
7.1.1.6 (Add)	<ol style="list-style-type: none"> The unit shall be suitable for starting with the compressor at the maximum specified suction pressure with a bypass line (from the discharge to the suction line) open, or with the compressor unloaded. The driver shall be suitable for torque fluctuation at any degree of unloading. The agreement between the MANUFACTURER/SUPPLIER and the Contractor of the bypass line pressure drop shall be documented and submitted to COMPANY prior to purchase of the driver. 				
7.1.1.7 (Modify)	<p>The speed oscillations of the rotating system as a percentage of the rated speed shall be limited to the following:</p> <table border="1"> <tr> <td>Compressor with Belt Drives</td><td>1.25 %</td></tr> <tr> <td>All other Drives</td><td>1.00 %</td></tr> </table> <p>If a variable speed driver drives the compressor, the speed irregularity shall be less than 1.00% of operating speed throughout the speed range.</p>	Compressor with Belt Drives	1.25 %	All other Drives	1.00 %
Compressor with Belt Drives	1.25 %				
All other Drives	1.00 %				
7.1.2 MOTOR DRIVES					
7.1.2.1(Add)	Type of motor shall be as specified on the datasheets.				
7.1.2.1 (Modify)	[Delete the bullet]				
7.1.2.1q (Modify)	(Delete) API 541 or 546, or IEEE 841 (Modify) Applicability will be specified on motor datasheet.				
7.1.2.3 (Modify)	Single Bearing Motors shall not be supplied.				

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change
7.1.2.4 (Add)	1. The compressor MANUFACTURER/SUPPLIER shall be responsible for the performance of the driver/compressor unit.
7.1.2.7 (Modify)	(Replace the first sentence by) Electric motor shall be in the scope of compressor's SUPPLIER and the compressor SUPPLIER shall furnish the CONTRACTOR with the following:
7.1.2.8 (Add)	1. Flywheels shall be clamped between the hubs or mounted on the compressor crankshaft. 2. Taper fits shall not be used.
7.1.2.15 (Modify)	Antifriction bearings shall not be used.
7.1.2.16 (Modify)	[Replace with:] Electric motors for main drivers as well as auxiliary drivers shall be as per Project Specification for motors and respective business unit specification listed in Appendix -1 (Ref. 2).
7.1.2.17 (New)	Motor bearing temperature device shall be externally accessible and replaceable without disassembly of the bearing.
7.1.3 TURBINE DRIVERS	
7.1.3.1 (Modify)	Replace the first sentence of this clause with: Steam turbine drivers shall be in accordance with the specifications identified in the applicable data/requisition sheets. In the third sentence of this clause, delete 'normal'.
7.1.3.2 (Modify)	Delete "If specified" [Replace with:] Lubrication design requirements have been specified in ADNOC standard AGES-SP-05-005, Gas Turbine Specification.
7.1.4 (NEW) INTERNAL COMBUSTION - SPARK IGNITED ENGINE DRIVERS	
7.1.4.1 (New)	1. The type of engine drive (integral or separate) and the composition of the fuel to be used shall be as specified in the data/requisition sheet. 2. The engine shall be sized to continuously deliver the rated compressor power plus any transmission losses. 3. The MANUFACTURER/SUPPLIER shall state the de-rating factors used in the proposal. a. Engine ratings shall be based upon specified site ambient conditions and the fuel composition.
7.1.4.2 (New)	Refer to Appendix 1 for the requirements for internal combustion spark-ignited engine drivers.

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change
7.2 COUPLING AND GUARDS	
7.2.1 COUPLINGS	
7.2.1.1 (Modify)	When a flexible coupling is required between motor and the driven equipment, it shall be supplied by the compressor SUPPLIER. Couplings shall be suitable for continuously transmitting the maximum torque and the maximum torque fluctuations without undue wear.
7.2.1.3 (Add)	Coupling and coupling mountings shall conform to API Standard 671 for driver ratings more than 500kW or when specified in the equipment datasheets or enquiry documents.
7.2.1.6 (Add)	Coupling hubs shall be integral with the shaft for driver power ratings of 500 kW and higher, but not for compressors with a pressurized and sealed crankcase.
7.2.1.7 (Modify)	[Replace with:] General purpose couplings for auxiliary drives shall be in accordance with ISO 14691 or API 677.
7.2.2 GUARDS	
7.2.2.3 (Modify)	Guards shall be easily removable and shall be sufficiently rigid to withstand deflection and to prevent rubbing as a result of bodily contact of 100 kg.
7.2.2.4 (Add)	Guards shall be made of one of the following spark resisting materials: <ol style="list-style-type: none"> Aluminium alloys with a maximum content of 2% magnesium or 0.2% copper Copper or copper based alloys (e.g. brass or bronze)
7.2.3 FLYWHEELS	
7.2.3 (New)	Flywheels shall be either clamped between the hubs or mounted on the compressor crankshaft. Flywheels shall be mounted in such a way that they cannot become loose e.g. due to fretting. Taper fits are not acceptable.
7.2.4 BARRING DEVICES	
7.2.4 (New)	The compressor shall be fitted with barring gear that is either manual, electrical or pneumatic. Manual barring may be achieved by turning the flywheel, provided that the arrangement is such that the barring tool cannot be retained. The barring device shall be designed so that gas forces acting on the pistons cannot cause the compressor either to accelerate or to rotate in the reverse direction. With the barring device engaged, it shall not be possible to start the compressor.
7.3 REDUCTION GEARS	
7.3.1 (Modify)	[Replace with:] Gear units shall be separated, and all process applications shall comply with the ADNOC Std for Auxiliary Items and API 613 as amended / supplemented by the Project Specification.
7.4 BELT DRIVES	

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API Clause No.	Description of Change
7.4.1 (Add)	<ol style="list-style-type: none"> 1. Belt drives shall be limited to compressor applications with nominal requirements of 75 kW or less and shall be banded multi-V-belts. 2. If V-belts and tooth belts are provided, they shall be oil resistant and shall conform to BS 903-part A16 and shall be antistatic in accordance with either BS 3790, ISO 1813.
7.4.2 (Add)	Belts shall be adjustable without need to remove guard.
7.4.5 (New)	Provisions shall be made to bar over the compressor using a ratcheting manual barring device.
7.5 MOUNTING PLATES	
7.5.1 GENERAL	
7.5.1.1 (Add)	Unless otherwise specified, the equipment shall be mounted on soleplates.
7.5.1.3 (Add)	g. Surfaces in direct contact with grout shall be painted with a compatible epoxy-prime.
7.5.3 LEVELLING, ALIGNMENT AND LIFTING	
7.5.3.1 (Modify)	c [Replace with:] “450 kg” with “150 kg”
7.5.3.3 (Add)	No more than three shims shall be used at any location.
7.5.3.5 (Modify)	(Delete) the bullet and “if specified”
7.5.3.6 (Modify)	(Replace with) Anchor bolts will be furnished by SUPPLIER. The method of installation in the foundations will be furnished by the SUPPLIER to the CONTRACTOR.
7.5.3.9 (Modify)	(Delete) the bullet and “if specified” (Add) Levelling plates shall be supplied by SUPPLIER.
7.5.4 BASEPLATES AND SKIDS	
7.5.4.1 (Modify)	(Modify the clause to read) A skid base shall be supplied to support the compressor and motor package. The skid shall comply with Structural Steel Works, AGES-SP-01-002 and Structural Design Basis, AGES-SP-01-003. Add following requirements: <ol style="list-style-type: none"> 1. If the compressor driver can be re-aligned after initial installation, removable vertical and horizontal driver alignment jackscrews shall be provided. <ol style="list-style-type: none"> a. Lugs holding the driver alignment jackscrews do not interfere with the installation or removal of the drive equipment and shims. 2. Jackscrews shall be plated for rust-resistance (cadmium or other), and be placed in locations that do not interfere with removal of alignment shims. 3. Motor shims shall be full bearing.

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API Clause No.	Description of Change
	4. Each alignment support point shall include a minimum of a ground 3 mm (1/8 in) solid stainless-steel spacer and 1.5 mm (1/16 in) total various thickness stainless steel shim stock.
7.5.4.7 (Modify)	(Modify the clause to read) The skid shall be suitable for single lift of the package for transportation and installation with certified lifting frames, slings and shackles. Baseplates for other process package equipment shall also be supplied and single lift.
7.5.4.16 (New)	The Skid and the anti-vibration mounting design shall be optimized to achieve acceptable piping loads and deflection of the skid during start up. SUPPLIER shall submit details of maximum deflection of the compressor nozzles during start up.
7.5.4.17 (New)	All loose supplied piping, components, cables, instruments shall be properly tagged, identified by SUPPLIER for installation at site. SUPPLIER shall submit the installation drawings for all loose supplied items identifying all the components.
7.5.5 SOLEPLATES AND RAILS	
7.5.5.3 (Add)	Soleplates shall not deflect during levelling while the weight of the compressor is supported by the levelling screws.
7.6 CONTROL AND INSTRUMENTATION	
7.6.1 GENERAL	
7.6.1.1 (Modify) [PSR]	[Replace with:] <ol style="list-style-type: none"> 1. Controls and instrumentation shall be as specified on the data/requisition sheets. 2. All instrumented protective functions SHALL [PSR] be subject to Instrumented Protective Function (IPF) classification including exercise results in implementation and test requirements. 3. If specified on the data/requisition sheet, the MANUFACTURER/SUPPLIER shall provide a compressor control system. <p>The controls and instrumentation shall be adequate for controlling the compressor safely and efficiently at the operating conditions specified conform relevant business unit requirements for "Instrumentation Furnished with Package Equipment".</p>
7.6.1.2 (Modify)	(Delete) the bullet
7.6.1.3 (Add)	<ol style="list-style-type: none"> a. Unless specified otherwise, a separately mounted local instrument panel shall be provided. b. Panel shall contain indication of alarms, trips, and important instruments and controls for compressor, transmission, and driver to facilitate safe control and rapid fault finding.
7.6.1.5 (Add)	<ol style="list-style-type: none"> a. Tubing runs and multitube bundles shall be tagged at each end. b. Tubing that passes through a wall, bulkhead, or equipment that obscures one end from the other shall be tagged at each end.

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API Clause No.	Description of Change
7.6.1.6 (New)	<p>Gauges shall be in either SI or US customary units as specified in the datasheets. Dual units shall not be used.</p> <p>Control and instrumentation shall be in accordance with the relevant ADNOC business unit requirements.</p>
7.6.2 CONTROL SYSTEMS	
7.6.2.3 (Add)	<p>The control system shall be dual redundant PLC based, designed by the SUPPLIER for Local and remote start-up and shutdown. All package instruments and control shall be supplied and tested along with the compressor package.</p> <p>The Package Control system shall be provided to incorporate all interlocking functions, manual and automatic start-up and emergency shutdown sequences as well as the normal running mode functions for the package.</p> <p>The control system shall be designed to start, stop and control the equipment remotely from the Central Control Room (CCR).</p>
7.6.2.5 (Modify)	<p>[Replace with:]</p> <p>Capacity control for constant-speed units will normally be achieved by suction valve unloading, clearance pockets, or bypass (internal-plug type or external) or a combination of these methods. Step-less capacity control can be adopted case to case basis and with COMPANY approval.</p> <p>Control operation shall be either automatic or manual as specified on the datasheet. The number of steps (5 or 3 or 2) for capacity control shall be as specified on the datasheet. Five-step unloading shall provide nominal capacities of 100%, 75%, 50%, 25% and 0%; three-step unloading shall provide nominal capacities of 100%, 50% and 0%, and two-step unloading shall provide capacities of 100% and 0%.</p>
7.6.2.6 (Modify)	<p>[Replace with:]</p> <p>Capacity control on variable-speed units is usually accomplished by speed control, but this can be supplemented by one or more of the control methods specified in 7.6.2.5 and as specified on the datasheet.</p>
7.6.2.10 (Modify)	<p>(Modify the clause to read)</p> <p>Variable type clearance pockets are not allowed for capacity control.</p>
7.6.3 INSTRUMENT AND CONTROL PANELS	
7.6.3 (Add)	<p>The requirements for the instrument and control panels shall be specified in the data/requisition sheets.</p>
7.6.4 INSTRUMENTATIONS	
7.6.4 (Add)	<p>a. Instrumentation design shall conform with ADNOC business units requirements for Packaged Units.</p> <p>b. Where a local panel is specified, annunciation at the local panel and in the control room shall be provided. Common trouble and common trip annunciation in the control room shall not be allowed.</p>

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API Clause No.	Description of Change						
	c. Junction boxes, bulkhead plates, cable transits, and blind enclosures shall have individual, fixed identification tags.						
7.6.4.1 (Add)	<p>a. Transmitters shall be required.</p> <p>b. Use of switches for control, alarm, and shutdown devices are not recommended and shall be used only subject to approval by COMPANY.</p> <p>c. Switches, if used, shall be hermetically sealed, double pole, double throw, with 5 A, minimum, at 120 VAC and 1/2 A, minimum, at 120 VDC.</p> <p>The control system shall consist of local gauge boards, local stop/start facilities and a remote full function control panel. Each auxiliary system (e.g. lubrication system, jacket water system etc.) shall have a separate local gauge board containing pressure and temperature gauges pertaining to the system. Local start/stop panel shall comprise essential indications, capacity step indication, group alarm status, trip status and start /stop facilities.</p>						
7.6.4.3.2 (Modify)	(Delete) the clause						
7.6.4.3.3 (Modify)	(Modify first Sentence to Read) Packing or piston rod temperature indication shall be provided for all cylinders.						
7.6.4.3.4 (Modify)	<p>(Delete) "If specified," from 1st Sentence</p> <p>(Add) System shall be installed and tested in SUPPLIER shop during mechanical run test.</p>						
7.6.4.3.5 (New)	Process gas inlet and discharge temperature transmitters shall be supplied with local indicator for each cylinder and be indicated locally and on the gauge.						
7.6.5 ALARMS AND SHUTDOWNS							
7.6.5 (Modify)	<p>MAWP shall be 5% above Relief Valve Accumulation pressure.</p> <p>The following requirements shall be considered in relief valve design:</p> <p>a. Relief valves on process gas duties will be supplied by the CONTRACTOR.</p> <p>b. Brass or cast iron safety/relief valves and fittings are not allowed. All safety/relief valves shall have inlet and outlet connections flanged. The minimum flange rating shall be ASME Class 300 RF unless the service requires a higher rating or different type of flange facing. Safety/relief valves shall also comply with any other national and/or local regulations.</p> <p>c. Double lock nuts shall be used to prevent flange bolts from loosening due to chattering relief valves. Alternatively, pilot operated relief valves may be used instead.</p> <p>[Replace Table 4 with:]</p> <table border="1"> <tr> <td>Max Operating Pressure (MOP) (barg) plus peak pulsation pressure</td><td>Safety/relief valve setting (barg)</td></tr> <tr> <td>0 to 10</td><td>MOP + 1 but not less than 3.5</td></tr> <tr> <td>> 10</td><td>110% MOP</td></tr> </table>	Max Operating Pressure (MOP) (barg) plus peak pulsation pressure	Safety/relief valve setting (barg)	0 to 10	MOP + 1 but not less than 3.5	> 10	110% MOP
Max Operating Pressure (MOP) (barg) plus peak pulsation pressure	Safety/relief valve setting (barg)						
0 to 10	MOP + 1 but not less than 3.5						
> 10	110% MOP						

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API Clause No.	Description of Change
7.6.6 ALARMS AND SHUTDOWNS	
7.6.6.1 (Add)	<ol style="list-style-type: none"> Discrete, direct mounted field switches for alarm and instrumented protective functions (IPFs) shall not be used. All alarm and trip functions shall be initiated by transmitters. The minimum alarm and shutdown requirements, as listed in Table 5, shall be considered only as the initial requirements. The SIL classification exercise (7.6.1.1) shall set the final requirements. <p>Refer to Appendix 4 (Ref. 5), condition monitoring system requirements for more details.</p>
7.6.6.6 (Modify)	<p>[Replace with:]</p> <p>The shutdown circuits shall be designed to de-energize to initiate shutdowns.</p>
7.6.6.7 (Modify)	Delete "if specified"
7.6.6.8 (New)	Power supply for alarm, shutdown and control systems shall be as per Project Specifications. Safeguarding systems shall be designed and constructed entirely independent of control systems.
7.6.7 VIBRATION AND POSITION DETECTORS	
7.6.7.1 (Add) [PSR]	<ol style="list-style-type: none"> A vibration protection system SHALL [PSR] be supplied. The vibration protection system shall be located in the field, if hazardous area classification allows to do so. The MANUFACTURER/SUPPLIER shall advise set-points for alarm and/or trip. Accelerometer / velocity transducers reading in g's / mm/s, complete with transmitters, shall be provided for crosshead/distance piece vibration and frame vibration detection. Frame vibration shall be measured at each end of the machine. Redundant transducers may be required depending on the availability requirements determined during the SIL assessment.
7.6.7.2 (Add)	<ol style="list-style-type: none"> Each piston rod of a horizontal compressor shall be provided with a non-contacting probe for rod run-out measurement. The non-contacting probe shall be located in the outer distance piece on the packing case flange and be wired to an outside junction box. <ol style="list-style-type: none"> If permanent signal read-out from the non-contacting probe is not required in the vibration monitoring or equipment control system, then the junction box shall have plug type connections for portable read-out equipment. Mounting probes using reverse mount probes in stinger style probe holders through the distance piece shall not be used. Probes should be mounted directly to the face of the packing flange. Mounting probes other than directly to the face of the packing flange shall be subject to the approval of the COMPANY. Indication of the dynamic signal (dynamic rod runout) shall be provided in addition to rod position.

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API Clause No.	Description of Change
	7. Rod drop device may have a 4 mA - 20mA output for trending purposes – if the alarm and/or shutdown are de-activated when the machine is shutdown.
7.6.7.3 (Modify)	<p>A one-event-per-revolution machined mark on the crankshaft shall be provided to permit synchronization on top dead center with a cylinder performance analyzer and/or rod drop detector. A corresponding phase-reference transducer(s) shall be provided. The transducer(s) shall be supplied, installed and calibrated in accordance with API 670.</p> <p>A second once-per-revolution trigger shall be supplied as a redundant probe for compressor protection systems or for portable monitoring systems.</p>
7.6.7.4 (Modify)	When specified in the datasheet, provision shall be made for connection to a central monitoring system supplied by COMPANY. This will include both vibration and thermodynamic inputs. Condition monitoring signals for re-transmission shall be hard wired, to terminals in the unit control panel.
7.6.8 TEMPERATURE MONITORING SYSTEMS	
7.6.8 (Modify)	(Delete) the bullet and “If specified”
7.6.8.1 (New)	Each crosshead pin shall be furnished with a temperature measurement device that is mutually agreed upon by the MANUFACTURER/SUPPLIER and the COMPANY.
7.6.8.2 (New)	Main bearing temperature measuring devices shall be supplied and mutually agreed upon by the MANUFACTURER/SUPPLIER and the COMPANY.
7.6.8.3 (New)	Packing box temperature measuring devices shall be supplied and mutually agreed upon by the MANUFACTURER/SUPPLIER and the COMPANY.
7.6.8.4 (New)	Valve cover temperature measuring devices shall be supplied and mutually agreed upon by the MANUFACTURER/SUPPLIER and the COMPANY.
7.6.9 (NEW) PRESSURE MEASUREMENT	
7.6.9.1 (New)	<p>The following pressure transmitters shall be supplied with a local indicator:</p> <ol style="list-style-type: none"> Lube oil pressure at frame headers(s). Process gas inlet and discharge for each cylinder.
7.6.9.2 (New)	[Replace] Electrical installation and wiring, instrumentation installation and wiring shall comply with Design General Specification DGS 1630-013.
7.7 PIPING AND APPURTENANCES	
7.7.1 GENERAL	
7.7.1.1 (Add)	<ol style="list-style-type: none"> Table 1A of API-614 Chapter 1: Delete “except DN 20 (NPS 1) and smaller may be socket welded or threaded” from Note # 1. Table 1B of API-614 Chapter 1: Replace Note # 1 with “Piping to be socket welded or butt welded”. Table 1C of API-614 Chapter 1. Table 1B of API-614 Ch1. Replace Note # 1 with “Piping to be socket welded or butt welded”. Table 1D of API-614 Chapter 1. Delete “except DN 20 (NPS 1) and smaller may be socket welded or threaded” from Note # 1.

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API Clause No.	Description of Change
7.7.1.2 (Add)	Unless otherwise stated, process gas piping will be by the CONTRACTOR. The SUPPLIER's scope will be from the intake flange on suction pulsation suppressors and up to discharge flange on the discharge pulsation suppressors. The SUPPLIER shall locate the frame oil console in relation to the compressor. Interconnecting piping for "ship loose" items will be by CONTRACTOR (e.g. oil & cooling water consoles).
7.7.1.3 (Add)	a. If flange-through bolting cannot be used, studs shall be furnished. b. Machine bolts and studs shall be high tensile steel, if supplied for steel cylinders shall conform to 6.8.4. c. For hydrogen and sour services, B.7.M shall be supplied.
7.7.1.4 (Modify)	(Delete) "If specified" from first sentence.
7.7.1.5 (Add)	The application of hydraulic fastening tools, or similar, shall be possible for 1" (25mm) bolt and larger.
7.7.1.6 (Modify)	(Delete) the bullet and the words "If specified".
7.7.1.8 (Modify)	a. Process piping connections less than or equal to DN 50 (NPS 2), including connections on dampening, intercooling, and aftercooling equipment, shall be reinforced with at least two gusset plates placed $\pi/2$ radians (90 degrees) apart. If either material is cast iron, alternative support arrangements shall be supplied and be subject to approval by the COMPANY. b. Connections shall be made with weld neck flanges. Piping shall be schedule 160.
7.7.1.10 (Add)	Threaded connections shall only be used for non-sour services if threaded connections are the MANUFACTURER/SUPPLIER's standard: <ol style="list-style-type: none"> connections to the distance piece compartments for purging and venting purposes; cylinder and packing lubrication connections; cylinder indicator ports. Threaded connections in sour services is not acceptable.
7.7.1.16 (New)	Cast iron and malleable iron pipe, fittings, valves strainers and/or other components shall not be used.
7.7.2 FRAME LUBRICATION OIL PIPING	
7.7.2.3 (Add)	1. 316L stainless steel piping shall be fabricated with stainless steel weld neck flanges. 2. Slip-on flanges shall not be used. 3. Socket-weld joints shall not be used.
7.7.2.6 (New)	The piping system shall have low point drains and breakout spools to facilitate oil flushing.
7.7.2.7 (New)	All oil piping gaskets shall be PTFE-filled spiral wound gaskets with stainless steel inner and outer rings.

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API Clause No.	Description of Change
7.7.3 FORCED-FEED LUBRICATOR TUBING	
7.7.3.3 (New)	Routing of lubricator tubing shall be arranged such that it does not obstruct: <ul style="list-style-type: none"> • Removal of valves or distance piece covers. • Maintenance openings.
7.7.4 COOLANT PIPING	
7.7.4.1 (Modify)	The jacket water system shall conform to Annex G, Figure G-1, Plan D.
7.7.4.3 (Add)	1. Coolant piping shall be provided and be arranged such that it does not obstruct: <ul style="list-style-type: none"> a. Removal of valves, cylinder heads, or distance piece covers. b. Maintenance openings. 2. If obstruction cannot be prevented then breakout spools shall be furnished.
7.7.4.4 (Modify)	Delete the last sentence of this clause.
7.7.4.5 (New)	Self-contained rod packing cooling systems shall be 316L stainless steel and all connections shall be flanged or welded.
7.7.4.6 (New)	Unless specified otherwise, Piping shall be Schedule 160.
7.7.4.7 (New)	Threaded connections shall not be used.
7.7.4.8 (New)	Piping systems shall be welded and flanged. Unions shall not be used.
7.7.6 PROCESS PIPING	
7.7.6.1 (Modify)	SUPPLIER shall include in his scope of supply process gas piping as required within the confines of the compressor package battery limit. The process piping shall conform to the requirements of the Project Specifications.
7.7.6.2 (Add)	Suction and discharge flanges shall be designed to withstand the maximum allowable working pressure of the cylinder.
7.7.6.3 (Add)	Temporary suction screens shall be supplied by the SUPPLIER scope.
7.7.7 DISTANCE PIECE VENT AND DRAIN PIPING	
7.7.7.2 (Add)	Tubing shall not be used external to the distance piece.
7.7.8.1 (New)	Packing vent and drain piping and fittings shall be of AISI 316L, stainless steel. Connections shall be minimum 1" NPT.
7.8 INTERCOOLERS, AFTERCOOLERS AND SEPARATORS	
7.8.1 INTERCOOLERS AND AFTERCOOLERS	
7.8.1.1 (Add)	Unless otherwise specified, air-cooled intercoolers, aftercoolers and separators shall be supplied by the SUPPLIER. Inter and after-coolers shall follow the requirements of ADNOC documents AGES-SP-06-002 and AGES-SP-06-003. Coolers shall be ASME code 'U'-stamped. Water-cooled systems are acceptable where plant close loop systems are available.

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API Clause No.	Description of Change
7.8.1.4 (Add)	a. Tubes in hydrogen service shall be seal welded. b. Tubes of ferrous materials shall conform to Material Specification.
7.8.1.5 (New)	Coolers shall not be installed on top of the compressor. If the shell side has a lower design pressure than the tube side, an appropriate relief device is required.
7.8.1.6 (New)	Coolers shall be installed separately and shall not be machine mounted.
7.8.1.7 (New)	If air cooler is supplied, SUPPLIER shall submit datasheet, characteristic curves for percentage air flow to louver blade angle for the specific exchanger selection, fan performance curves, general arrangement drawings and other data asked for elsewhere in this specification for review / approval of the COMPANY.
7.8.2 SEPARATORS	
7.8.2.6 (Add)	Drains shall be at least DN 40 (NPS 1 1/2).
7.9 PULSATION AND VIBRATION CONTROL	
7.9.1 GENERAL	
7.9.1.2 (Add)	1. The MANUFACTURER/SUPPLIER shall provide pulsation suppression devices at the suction and discharge side of each cylinder. <ol style="list-style-type: none"> Cylinders operating in parallel may be connected to a common suction and a common discharge pulsation suppression device. 2. The application of pulsation filters and attenuators with internal pulsation control devices such as choke tubes, baffles, and orifices shall be subject to an acoustic simulation and analysis and a stress evaluation to assure that components are designed to withstand acoustic forces. <ol style="list-style-type: none"> The analysis for (7.9.1.2, item 2) shall be performed by the compressor MANUFACTURER/SUPPLIER or a third-party consultant. Intercoolers and/or aftercoolers shall not be used as a pulsation suppression device.
7.9.3 MULTIPLE UNIT ADDITIVE EFFECTS	
7.9.3.1 (Add) [PSR]	1. The MANUFACTURER/SUPPLIER SHALL [PSR] perform the acoustical model study for each of the following cases to attenuate pulsation levels in the piping system: <ol style="list-style-type: none"> single operation of main compressor; single operation of the spare compressor; parallel operation of both machines during change over. parallel operation with selected part load operation 2. Pulsation suppression devices shall be sized and installed to operate the units independently or in parallel operation.
7.9.4 DESIGN AND DOCUMENTATION	
7.9.4.1 DESIGN APPROACH SELECTION	
7.9.4.1.1 (Modify)	Replace "Design Approach 2" with "Design Approach 3" in Table 6 of this clause.

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API Clause No.	Description of Change
7.9.4.1.2 (Add)	Acoustical simulation or mechanical analysis may be performed and furnished by the compressor MANUFACTURER/SUPPLIER.
7.9.4.2 DESIGN APPROACHES	
7.9.4.2.1 GENERAL	
7.9.4.2.1 (Add)	Unless specifically stated otherwise, only Design Approach 1 or 3 are to be used in the proposal.
7.9.4.2.5.2.2.3 (Add)	<ol style="list-style-type: none"> 1. If the results of an acoustic simulation and/or the results of a mechanical response analysis are such that modifications to the piping and/or pulsation suppression devices are necessary, the following shall be used by the MANUFACTURER/SUPPLIER in making proposals for modifications, in descending order of preference: <ol style="list-style-type: none"> a. The application of orifices. The restriction orifice plates shall be tagged as instrument flow orifice plates; b. Modification in piping supports c. Increase of bottle volume (if feasible) d. Increase of pipe volume (if feasible) e. The application of other types of pulsation suppression devices. 2. Each modification to the piping and/or pulsation suppression devices shall be subject to COMPANY's approval.
7.9.4.2.5.2.5.2 (Modify)	Replace "if specified" with "for Design Approach 3".
7.9.4.2.7 (New)	<p>In case of compressor system malfunctioning once installed at site, which is attributed directly to errors and / or omissions in the Design Approach studies defined in API 618, the SUPPLIER shall retain responsibility to work with the CONTRACTOR to expeditiously identify the root cause of these problems. The SUPPLIER shall recommend any modifications that are required (i.e. with regard to vibration suppression device design, acoustic simulation recommendations or piping restraint design). The SUPPLIER and CONTRACTOR shall mutually agree and implement the agreed modifications.</p> <p>If the root cause of the problem is found to be an error or omission in the compressor package design scope, or with the SUPPLIER's agreed scope of review of the CONTRACTORS piping isometrics drawings and pipe support design, then the SUPPLIER shall be responsible for the cost of identifying and implementing the required solution.</p>
7.9.5 PULSATION SUPPRESSION DEVICES	
7.9.5.1 GENERAL	
7.9.5.1.1 (Modify)	Delete ' If specified '
7.9.5.1.2 (Add)	The design pressure of suction pulsation suppressors of any cylinder shall be equal to that of the discharge pulsation suppressor of the cylinder.

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API Clause No.	Description of Change
7.9.5.1.4 (Modify)	(Delete) the bullet and “If specified”.
7.9.5.1.6 (Modify)	Replace this clause with the following: <ol style="list-style-type: none"> 1. Suction pulsation suppression devices shall be designed to prevent liquid being trapped. 2. All suction piping shall be sloped back toward the KO Drum to prevent liquid accumulation in the machine suction bottles.
7.9.5.1.9 (Add)	The suction and discharge piping connections of cylindrical volume bottles shall be located at the longitudinal centre or at the end of the volume bottle in such a way that optimal symmetry is obtained to eliminate free gas forces.
7.9.5.1.10 (Modify)	<ol style="list-style-type: none"> 1. Inlet and outlet nozzles of suction pulsation suppressing equipment shall be flush with the inner wall and arranged such that no liquid can accumulate inside the vessel, thus preventing liquid slugs entering the compressor. 2. Volume bottles shall not be provided with instrument connections.
7.9.5.1.11 (Modify)	Delete “if specified” in the second sentence. Add to this clause: <ol style="list-style-type: none"> 1. The natural vibration frequencies of the thermowells shall not fall within 20% of any compressor running speed whole number multiple. 2. The natural frequency shall be at least five times the induced vortex frequency - at a maximum process fluid velocity (accounting for the pulsed nature of the gas flow).
7.9.5.1.12 (Add)	For connections 50 mm (2 in) and smaller, welding neck flanges shall be used with the flanges supported and braced in four directions.
7.9.5.1.13 (Add)	All connections to a pulsation suppresser shall be butt welded flanged connections.
7.9.5.1.15 (Modify)	[Replace with:] All connections to a pulsation suppresser shall be butt welded flanged connections.
7.9.5.1.16 (Modify)	[Replace with:] Flanges shall be in accordance with ANSI B16.5, except that lap-joint and slip-on flanges shall not be used. Flange facings shall be in accordance with 6.8.4.1.11 of this standard .
7.9.5.1.17 (Modify)	Delete “if specified” in the 1 st sentence and add: <ol style="list-style-type: none"> 1. Unless otherwise specified on the datasheets, suction dampeners and suction piping provided by the compressor MANUFACTURER/SUPPLIER shall have attachment features to install insulation and heat tracing to maintain the metal temperature 10 degrees above the rated suction temperature. 2. Dampeners shall be designed to accept insulation up to 2” thick.
7.9.5.1.20 (Modify)	Internal coating of pulsation suppression devices shall be subject to approval by COMPANY
7.9.5.1.22 (Modify)	Delete “if specified”.

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change
7.9.5.1.23 (Add)	Pulsation suppression device fabrication shall not commence until sizes have been verified by the pulsation analysis.
7.9.5.1.24 (New)	The use of suction and discharge pulsation suppressors common to multiple cylinders shall be subject to approval of the COMPANY.
7.9.5.1.25 (New)	<ol style="list-style-type: none"> 1. Discharge bottles shall be self-draining. 2. The final moisture separation shall be done in KO drums
7.9.6 SUPPORTS FOR PULSATION SUPPRESSION DEVICES	
7.9.6 (Modify)	<p>Delete "If specified"</p> <ol style="list-style-type: none"> 1. Supports shall be supplied by the SUPPLIER. Inlet vessels supports shall be goal post type. 2. 300 Series stainless steel shims shall be provided for levelling the compressor cylinder on the hot and cold support locations. <ol style="list-style-type: none"> a. Shims shall be pre-cut and supplied by the MANUFACTURER / SUPPLIER. 3. The pulsation limits are subject to field verification. <ol style="list-style-type: none"> a. The MANUFACTURER/SUPPLIER is responsible for making corrections to meet the pulsation limits. 4. Piping and piping component vibration shall be the least of the following: <ol style="list-style-type: none"> a. 0.25 mm (0.010 in) peak-to-peak displacement; b. 25 mm/s (1 in/s) peak velocity; c. 2 g's peak acceleration.
7.10 AIR INTAKE FILTERS	
7.10.1 (Add)	Intake filters shall be designed to suppress noise and have sufficient stiffness to prevent filter and filter housing damage due to pulsation-induced vibration.
7.10.2 (Add)	<ol style="list-style-type: none"> f. Electrical area classification. g. Noise suppression. h. Drain facilities.
7.11 SPECIAL TOOLS	
7.11.2 (Modify)	<p>item b:</p> <p>Replace "valve assemblies" with: "valve assemblies, heads, packing boxes, distance piece covers, crankcase covers or other compressor components requiring frequent lifting for maintenance".</p> <p>Item e: delete "if specified"</p>
7.11.4 (Add) [PSR]	<ol style="list-style-type: none"> 1. The compressor shall be fitted with barring gear that is either manual, electrical or pneumatic. <ol style="list-style-type: none"> a. Manual barring may be achieved by turning the flywheel, provided that the arrangement is such that the barring tool cannot be retained.

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change
	<ul style="list-style-type: none"> b. The barring device shall be designed so that gas forces acting on the pistons cannot cause the compressor either to accelerate or to rotate in the reverse direction. c. With the barring device engaged it SHALL [PSR] not be possible to start the compressor. <ul style="list-style-type: none"> 2. Manual barring devices shall have a locking feature. 3. Compressors rated 750 kW and above shall be provided with a pneumatic barring device. <ul style="list-style-type: none"> a. Pneumatic barring devices shall incorporate safety switches/measures for interlocking with the main driver. b. Pneumatic motor shall be equipped with air supply inlet filter/oiler and 4-way control valve for operation in forward or reverse direction.
7.11.5 (Modify)	(Delete) the bullet and "If specified" (Replace note with) The CONTRACTOR shall interlock this limit switch with the driver.
7.12 VESSELS (NEW CLAUSE)	
7.12 (New)	Knock-out drum shall be included in compressor scope of work.
7.12.1 (New)	The knock-out drum shall be designed to separate the entrained moisture from the process gas stream, in accordance with the requirements specified in the attached Datasheets.
7.12.2 (New)	The vessels shall be designed, fabricated and tested in accordance with ASME, SECTION VIII, Pressure Vessel ADNOC Standard, AGES-SP-06-002 and Shell & Tube Heat Exchanger Specification, AGES-SP-06-003. In case of sour gas applications, all the requirements of NACE shall be complied.
7.12.3 (New)	ASME U-Stamp is required on the knock-out drum. The knock-out drum shall be 100% radiographed and the heat treatment of the drum shall be as per the relevant code.
7.12.4 (New)	The vessel shall be designed such that they are suitable for all the process conditions specified in the attachments.
7.12.5 (New)	Corrosion allowance on thickness shall be as per the datasheet.
7.12.6 (New)	SUPPLIER shall provide adequate liquid retention capacity between high-level and low-level limits such that if corrective actions lead to closure of liquid outlet valve it shall avoid nuisance shutdown of compressor.
7.12.7 (New)	The vessel shall be adequately supported and provided with lifting lugs, as necessary. Access ladders and maintenance platforms, as necessary for maintenance and operation shall be provided. The vessel shall be supplied complete with all internals and demisters as applicable.

Table 8 - API 618 Technical Amendments: Section 7 – Accessories

API Clause No.	Description of Change
9 SUPPLIER'S DATA	
9.2 PROPOSALS	
9.2.3 (Modify)	<p>The SUPPLIER shall recommend and supply spare parts for commissioning and start up as part of SUPPLIER's scope of supply. This list shall be provided with the final documentation.</p> <p>The SUPPLIER shall recommend and submit his priced spare parts list for two years of operation strictly in accordance with COMPANY Spare Parts Procedure including standard form for 'Spare Parts' referred in the Purchase Requisition. Spare parts shall be identified to its original manufacturer identification number.</p> <p>(Add)</p> <p>w. Expected normal values for each monitored and/or controlled variable, with recommended minimum and maximum values, if applicable, with recommended action associated with each.</p> <p>x. The Manufacturer shall state in the proposal which components need to be replaced after the first five years or 40 000 hours of operation.</p> <p>y.</p> <p>a. Price list and approximate delivery time for the following components:</p> <ol style="list-style-type: none"> i. a set of wear parts for each stage (to include as a minimum valve springs and plates/rings/poppets, packing, O-rings, valve gaskets, head gaskets, valve cover gaskets, distance piece cover gaskets) piston rings and rider bands for each stage; ii. a set of packing for each stage; iii. a spare set of valves for each stage; iv. an unloader assembly for each different size used; v. a piston and rod assembly for each stage; vi. packing box for each size used; vii. a cylinder liner for each stage; viii. a set of crankcase bearings; ix. auxiliary lube pump wear parts including gaskets, heat exchanger gaskets, and compressor case access door gaskets; x. a crosshead; xi. a connecting rod.

Table 9 - API 618 Technical Amendments: Section 9 – SUPPLIER's Data

API Clause No.	Description of Change
9.3 CONTRACT DATA	
9.3.3 PERFORMANCE DATA	
9.3.3.1 (Delete)	Delete the words "If specified,"
9.3.3.3 (Delete)	Delete the words "If specified,"
9.3.3.4 (Delete)	Delete the words "If specified,"
9.3.4 TECHNICAL DATA	
9.3.4 (Add)	Calculation of natural frequencies of all thermo-wells shall be provided.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
1 – SCOPE	
	<p>[Add] to 1st Clause</p> <p>This standard defines the minimum requirements for design, materials, fabrication, inspection, testing, and documentation of high-speed reciprocating gas compressors with a maximum power rating of 1860 kW.</p> <p>[Add] to 3rd Clause</p> <p>Air compressors and compressors for hydrogen rich gases (gases with a molecular weight less than 12) are excluded.</p> <p>Overall system responsibility for adequate sizing and interaction of components shall be with the SUPPLIER.</p>
1.1 (New)	<p>Datasheets</p> <ol style="list-style-type: none"> Compressor package, operating conditions, and compressor material requirements will be specified by COMPANY on the compressor datasheet. Datasheets from other applicable specifications will be used by COMPANY to specify driver, cooler, exchanger and control panel. Complete listing of specific exemptions (if any) to COMPANY specifications shall be supplied by SUPPLIER on the datasheet or other suitable document. Datasheet changes are not sufficient to be considered an exception.
5 – GENERAL PACKAGE REQUIREMENTS	
5.1 (Add)	<ol style="list-style-type: none"> Performance curves shall present values of dependent variables (compressor capacity, compressor shaft power, stage discharge temperatures, and combined rod loads and gas loads) on ordinate and shall show line plots for each of several constant compressor discharge pressures (barg) as parameters. Values of inlet pressure (barg) that are common to all curves shall be shown on abscissa. Separate curves to the same scale for various discharge pressures are acceptable. Cover the full range of pressure and flow conditions over the life of the machine for new condition as well as 5 years operation (increased clearances corresponding to worn out piston rings, rider rings, valve seats etc.). Include variable volume clearance pocket position or the range thereof (when variable clearance pockets indicated); Indicate the minimum volumetric efficiency, rod load, and horsepower limitations.
5.5 (Modify)	Applicable Project Specifications/ADNOC Standards need to be complied by compressor SUPPLIER.
5.6 (Modify)	<p>[Replace with]</p> <p>Site conditions will be specified in the compressor datasheet or applicable Environmental & Utilities Specification will be referred.</p>

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
5.7 (Add)	<p>Torsional natural frequencies of the driver-compressor system (including couplings and any gear unit) shall be avoided:</p> <ol style="list-style-type: none"> within 10% of any operating shaft speed; within 5% of any other multiple of operating shaft speed in the rotating system up to, and including, the tenth multiple. for motor-driven compressors, torsional natural frequencies shall be separated from the first and second multiples of the electrical power frequency by the same separation margins.
6.COMPRESSOR	
6.2 ALLOWABLE SPEEDS	
6.2 (Modify)	<p>[Replace with]</p> <p>Maximum allowable compressor RPM and maximum compressor power that may be used at a given RPM is shown in the following tables:</p> <p><u>Lubricated Cylinders:</u></p> <p>Compressor Stroke Length - mm RPM Per compressor throw - kW Max per frame - kW</p> <p>76 1 800 37 150</p> <p>89 1 400 56 225</p> <p>102 to 114 1 200 150 600</p> <p>127 to 140 1 000 225 900</p> <p>152 900 466 1 860</p> <p>178 775 466 1 860</p> <p>203 675 466 1 860</p> <p>Note:</p> <p>Maximum average compressor piston speed for lubricated compressor cylinders shall be 4,8 compressor piston m/s.</p> <p><u>Non-lubricated cylinders:</u></p> <p>Max. RPM Maximum average compressor piston speed (m/s) kW</p> <p>850 3,6 225 maximum</p> <p>750 3,0 Greater than 225 (300)</p> <p>Note:</p> <p>If stage differential pressure exceeds 1380 kPa for non-lubricated cylinders, lower limits to achieve adequate ring life may be specified or proposed by the SUPPLIER, based on application.</p>

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
6.4 ROD LOADS	
6.4.1.1 (Modify) [PSR]	a. Combined rod loading shall not [PSR] exceed 80% of the MANUFACTURER maximum allowable continuous combined rod loading for compressor running at any specified operating points and RV set point plus accumulation. b. Combined rod loads shall be calculated on the basis of set point pressure of discharge relief valve of each stage and of the lowest specified suction pressure corresponding to each load step.
6.4.1.2 (Modify) [PSR]	a. Gas load shall not [PSR] exceed 80% of the MANUFACTURER maximum allowable continuous gas loading at specified operating load steps. b. Combined rod loads shall be calculated on the basis of set point pressure of the discharge relief valve of each stage and of the lowest specified suction pressure corresponding to each load step.
6.4.1.3 (New)	Gas and rod loading in sour gas service shall be suitably de-rated to: <ol style="list-style-type: none"> reflect the strength of the materials used, particularly after hardness control, the stresses allowed in a sour environment.
6.5 COMPRESSOR CYLINDERS	
6.5.2.1 (Add)	Piston rod run-out shall be measured directly adjacent to the cylinder packing case flange. The cylinder support shall be designed to avoid misalignment or excessive rod run-out at maximum allowable temperature. A cylinder end support shall not be used in place of the distance piece support. Head-end cylinder supports are not required unless indicated by the pulsation study.
6.5.2.2 (Add)	Cylinder gas temperatures shall be held above the inlet temperature of the gas to prevent condensation or liquid formation.
6.5.2.3.1 (Add)	Distance piece to cylinder stud fasteners shall have rolled threads.
6.5.2.4 (New)	<ol style="list-style-type: none"> Water cooled cylinders shall have dry liner cylinder construction. Liners shall be minimum of 13 mm thickness. Liners shall: <ol style="list-style-type: none"> Have interference fit to cylinders. Be retained in place by positive mechanical means. Inside liner bore finish shall not exceed RMS roughness values listed in the table below: <ul style="list-style-type: none"> Cylinder bore ring materials and service conditions Diameter mm RMS finish μm Metallic rings and rider bands ≤ 500 0,8 Metallic rings and rider bands > 500 1,6 Nonmetallic rings and rider bands < 250 2,0 Nonmetallic rings and rider bands 250 to 500 0,4 Nonmetallic rings and rider bands > 500 0,8 Unless required by compressor manufacturer, non-water-cooled compressor cylinders (air or gas cooled cylinders) 250 mm or less in diameter shall not require cylinder liners.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
6.5.3.2 (Modify)	Compressor cylinders shall have flanged connection.
6.6 VALVES	
6.6.1 (Add)	Average gas velocity shall not exceed 41 m/s.
6.6.2.5 (New)	Thermoplastic valve sealing elements shall be supplied (such as PEEK / Equivalent). SUPPLIERS shall provide expected life of valves.
6.7 PISTONS, PISTON RODS AND PISTON RINGS	
6.7 (Add)	Aluminium pistons shall not be provided unless approved by COMPANY.
6.7.1 (Add)	Multi-through-bolt designs are not an acceptable method of attaching the piston to the piston rod. Hydraulically tensioned piston-to-piston rod connections should be used in lieu of a standard jam nut connection if the tensioned option is offered as a SUPPLIER standard practice.
6.7.3 (Modify)	[Replace with:] Non-metallic wear bands (PEEK / Equivalent) shall be provided. Non-metallic wear bands shall not over-run the valve port or counter bore by more than one-half of the axial width of the wear band.
6.7.4 (Add)	Surface roughness at rod packing area shall not exceed: a. 0,4 µm (16 micron) RMS for lubricated service. b. 0,2 µm (8 micron) RMS for non-lubricated service.
6.7.4 (New)	Add to this clause: 1. Rods used in non-lubricating service shall not be coated without the approval of COMPANY and the selected packing ring MANUFACTURER/SUPPLIER. 2. Piston rod material for non-lubricated, corrosive services shall be 17-4 PH, 17-6 PH, or equal for corrosion resistance and subject to COMPANY approval. 3. All piston rod materials shall be supplied with mill certificates and have a letter of compliance indicating the material is in compliance by positive material identification. 4. Uncoated rods may be induction hardened or nitrided to achieve the required minimum surface hardness of HRC 50. a. The core hardness shall not exceed HRC 22 in sour gas applications where ISO 15156 or NACE MR0103 apply. b. Nitriding shall not be used in sour gas applications. c. Material certificates shall indicate the final hardness after heat treatment. 5. The rod coating shall have a minimum thickness of 80 µm and a maximum thickness of 380 µm.
6.8 CRANKCASES, CRANKSHAFTS, CONNECTING RODS, BEARINGS AND CROSSHEADS	
6.8.2 (Modify)	For crank bearings, irrespective of rating, sleeve bearing shall be provided. Antifriction bearing is NOT acceptable.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
6.8.5 (Modify)	<p>[Replace with]:</p> <p>The crankcase shall be provided with relief devices to protect against rapid pressure rises. These devices shall incorporate downward-directed apertures (away from the operator's face), a flame-arresting mechanism and a rapid-closure device to minimise reverse flow.</p> <p>When a distance piece vacuum system is supplied, the compressor crankcase shall be vented to a safe location with a desiccant breather and flame arrestor.</p> <p>The total throat area of these devices should be not less than 70 mm² for each cubic decimetre of crankcase free volume.</p>
6.9 DISTANCE PIECES	
6.9.1 DESIGN	
6.9.1.1 (Add)	<p>Add the following to this clause:</p> <ol style="list-style-type: none"> 1. Close-coupled single compartment (Type 1) distance pieces shall be used for non-flammable or non-hazardous service. 2. Single compartment (Type 2) distance pieces shall be furnished for remote, unmanned production compressors and pipeline booster compressors involved in compressing sweet natural gas. Eductor systems discharging to combustors or flares, driven by sweet gas, can be used to maintain a slight vacuum in the distance piece. 3. For all services containing flammable, hazardous, or toxic gases, a double compartment distance piece design (Type 3) shall be furnished with the following: <ol style="list-style-type: none"> a. A nitrogen purge on the partition packing; b. Vents to flare and atmosphere where the sizing of vents meet the following: <ol style="list-style-type: none"> i. capacity for a full packing failure; ii. accommodate all normal operating scenarios.
6.9.1.2 (Modify)	Delete: "If specified"
6.10 PACKING CASES AND PRESSURE PACKINGS	
6.10.3 (Add)	Project drain and vent standard shall be complied.
6.11 COMPRESSOR CRANKCASE LUBRICATION SYSTEM	
6.11.3.1 (Add)	An external relief device shall be provided downstream of the lube-oil pump.
6.11.4 (Add)	<ol style="list-style-type: none"> 1. Compressors shall be equipped with: <ol style="list-style-type: none"> a. dual filters with a differential pressure transmitter; b. full flow transfer valve; c. valved vent and drain connections. 2. A valve oil sampling connection shall be provided between oil filter and oil cooler.
6.11.5 (Add)	1. Pumps (CS with SS rotors), filters, valves and oil coolers shall be of SS316L as minimum

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	2. Piping of complete package should be 316 SSL minimum. 3. Copper/copper alloy components are not allowed in any part of the system.
6.11.6 (Add)	External reservoirs shall be supplied with a level gauge local indicator and transmitter.
6.11.7 (Add)	a. Heater shall be sized to the heat system in two hours from minimum ambient temperature to minimum circulation temperature. b. Heater shall have independent control, alarm, trip function temperature sensors, transmitters. c. On/Off type heater acceptable.
6.11.8 (New)	Pressurised frame lubrication system shall be supplied in accordance with API 614 requirements.
6.12 COMPRESSOR CYLINDER LUBRICATION	
6.12.1 (Add)	A divider block-distribution system for compressor cylinder bore and piston rod packing shall be provided with the following features and design elements: <ol style="list-style-type: none"> suited for variable flow (manual or automatic based on datasheets); weatherproof construction; includes provisions for compressor pre-lube prior to compressor start-up; System shall be supplied with: <ol style="list-style-type: none"> a reservoir with external level transmitters and heater no flow alarm and trip; lube rate measurement via proximity transmitters; double check valves installed as close to the injection point; a resettable, spring loaded indicator pin to indicate plugged lines on each primary divider block; overpressure protection by a device between the pump and the injection point; pressure transmitters on each injection point; balancing valves when system differential pressures exceed 68 barg.
6.13 MATERIALS	
6.13.1.1 (Add)	<ol style="list-style-type: none"> For both non-lubricated and lubricated service, cylinder liners, if provided, shall be ASTM A48 grade 40 with a Brinell hardness exceeding 200 HBW. For applications which require extreme corrosion resistance, the recommended liner material is one of the following: <ol style="list-style-type: none"> Ni-resist ASTM A436 grade 2B; ASTM A439 grade D3A; ASTM A439 grade D4 with a minimum Brinell hardness of 180 HBW. To prevent dimensional changes, the Ni-resist castings shall be stress relief heat treated prior to final machining.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
6.13.1.3 (Add) [PSR]	Grey cast iron SHALL [PSR] not be used for compressor cylinders or any other pressure components (except for packing cases), nor for valve seats or valve guards. Acceptable "cast" cylinder metallurgy shall be A 395 (Nodular), A 439 grades D4 and D3A & A 436 grade 2B (Ni Resist), A 216 grades WCA or WCC / A352 (Carbon steel).
6.13.1.4 (Add)	Materials selection for pressure containing parts shall be subject to the approval of the COMPANY.
6.13.1.5 (New)	The MANUFACTURER/SUPPLIER shall provide O-rings and sealing groove designs that are proven resistant to explosive decompression.
6.13.2.1 (Add)	<ol style="list-style-type: none"> 1. Critical sections of cylinder castings shall be fully radiographed in accordance with ASME/BPVC SEC VIII-1, Appendix 7 when specified by COMPANY in the data/requisition sheets. <ol style="list-style-type: none"> a. If such sections cannot be radiographed, ultrasonic examination (also in accordance with ASME/BPVC SEC VIII-1, Appendix 7) shall be substituted. b. The MANUFACTURER/SUPPLIER shall submit, for approval by COMPANY, details of the critical sections proposed to be radiographed or ultrasonically examined. 2. All casting surfaces shall be examined and shall meet the visual acceptance standards of MSS SP 55. 3. After final machining, all surfaces shall be examined by the wet magnetic particle method in accordance with ASME/BPVC SEC VIII-1, Appendix 7. <ol style="list-style-type: none"> a. Liquid penetrant examination shall be performed in accordance with ASME/BPVC SEC VIII-1, Appendix 7 if magnetic particle examination is not possible.
6.14 POWER TRANSMISSION	
6.14.2 (Modify)	[Replace second sentence with:] Couplings shall have 2,0 safety factor based on nameplate power rating of prime mover.
6.14.3 (Modify)	Unless approved by COMPANY, belt drives shall not be used.
6.14.5 (Modify)	Guards shall be made of one of the following spark resisting materials: <ol style="list-style-type: none"> a. Aluminium alloys with a maximum content of 2% magnesium or 0.2% copper b. Copper or copper-based alloys (e.g. brass or bronze)
6.14.6 (New)	<ol style="list-style-type: none"> 1. The compressor shall be fitted with barring gear that is either manual, electrical or pneumatic. <ol style="list-style-type: none"> a. Manual barring may be achieved by turning the flywheel, provided that the arrangement is such that the barring tool cannot be retained. b. The barring device shall be designed so that gas forces acting on the pistons cannot cause the compressor either to accelerate or to rotate in the reverse direction.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	c. With the barring device engaged it SHALL [PSR] not be possible to start the compressor. 2. Manual barring devices shall have a locking feature. 3. Compressors rated 750 kW (1,000 hp) and above shall be provided with a pneumatic barring device. a. Pneumatic barring devices shall incorporate safety switches/measures for interlocking with the main driver. b. Pneumatic motor shall be equipped with air supply inlet filter/oiler and four-way control valve for operation in forward or reverse direction.
7 CAPACITY CONTROL	
7.4. CLEARANCE VARIATION	
7.4.2 (Add)	Manual variable valve clearance pockets shall be provided on the head end of all cylinders.
7.5 BYPASS SYSTEMS	
7.5.2 (Modify)	Manual or automatic hot gas bypass systems shall not be provided.
7.5.3 (Add)	A cold gas, automatic capacity control bypass shall be included on each package and shall be capable of full flow of the compressor at maximum suction pressure and this will be used for start-up and capacity control.
7.6 VALVE REMOVAL OR UNLOADING	
7.6.1 (Add)	Suction valve removal shall not be at crank end side.
7.6.4 (Modify)	[Replace with:] a. Pneumatically operated unloaders shall be suitable for operation with any gas specified on datasheet. b. If air operated, unloaders shall be designed such that air used for unloading cannot be mixed with gas being compressed in event of failure of diaphragm or another part.
8 PRIME MOVER	
8.2 SPARK-IGNITED GAS ENGINES	
8.2.1 (Add)	Engine output power at max. ambient of 58°C (including internal engine losses, final power available for driven equipment) shall be higher than compressor absorbed power at relief valve set pressure. At engine rated temp. of 54°C, standard losses, power shall be 10% above driven equipment power (at rated discharge pressure). Checks shall be done for the margin at the safety valve set pressure.
8.2.4.1 (Modify)	[Replace with:] "Unless otherwise specified, air shall not be taken from inside enclosed buildings."
8.2.4.6 (Modify)	[Replace with:] Differential pressure transmitter with gauge indicator shall be provided.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
8.2.5.5 (Modify)	[Replace second sentence with:] Other types of exhaust muffler/silencers, if specified, shall comply with the following minimum requirements as specified: <ol style="list-style-type: none"> Sound attenuation. Personnel protection. Spark arresting capability.
8.2.11 (Add)	Necessary fuel treatment system shall be supplied by Packager to keep unit responsibility and this system shall be subject to COMPANY approval.
8.3 ELECTRIC MOTORS	
8.3.1 (Modify)	[Replace with:] Refer electrical motor specifications / datasheet for more details.
8.3.2 (Modify)	[Replace with:] The driver shall be sized for all process conditions as stated on the datasheet (plus 10% margin) and be capable of operating at the relief conditions.
9 COOLING SYSTEM	
9.1 GENERAL	
9.1 (Delete)	This clause is to be deleted.
9.3 COMPRESSOR	
9.3.3 (Modify)	Unless specified otherwise on datasheet, pressure packing case cooling criteria shall be as follows: <ol style="list-style-type: none"> Compressor manufacturer standard design may be used for packing pressures up to 170 bara on piston rods 65 mm in diameter or less. Cooled packing cases are required for packing pressures above 170 bara. Internal tubing of SS316L and forged fittings shall be provided by manufacturer. External lines shall be piped and made of SS316L if compatible with coolant liquid. If packing cooling is required, compressor manufacturer shall advise compressor packager of minimum requirements, such as: <ol style="list-style-type: none"> Flow and pressure. Pressure drop. Temperature. Filtration. Corrosion protection. Type of coolant.
9.3.4 (Add)	Compressor oil cooling system shall be provided.
9.3.5	Unless otherwise specified, air cooled intercoolers, aftercoolers and separators shall be supplied by the SUPPLIER. Inter and after-coolers shall follow requirements of ADNOC documents DGS-0710-001, AGES-SP-06-002 and AGES-SP-06-003.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	Coolers shall be ASME code U-stamped. Water cooled systems are acceptable where plant close loop systems are available.
9.4 TYPES OF COOLERS	
9.4.1 (Add)	<p>The system design hierarchy to manage the cooling of the compressor shall be as follows:</p> <ol style="list-style-type: none"> 1. Water-cooled exchanger is acceptable if where there is a cooling water network in plant. Shell & tube Coolers shall conform to TEMA C and the relevant Project Specifications. 2. Air-cooled cooler if comply following requirements: <ol style="list-style-type: none"> i. 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. ii. 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.). iii. U-stamp or PED certificate is required. iv. Margins to be applied: Max. flow * 10% (define flow per API 614, cl 4.4.11b), heat load * 10% or on heat exchange surface area * 10%. <p>Sea water cooling system is acceptable subject to COMPANY approval.</p>
10 PRESSURE VESSELS	
10.3 PULSATION SUPPRESSION DEVICES	
10.3.1 (Modify) [PSR]	<p>[Replace with:]</p> <ol style="list-style-type: none"> 1. A pulsation study of each compressor package SHALL [PSR] be performed. 2. The pulsation study shall be performed by MANUFACTURER/SUPPLIER who is experienced in performing such analyses and who is approved by COMPANY. Boundary limits for pulsation study shall be approved by COMPANY. 3. Coordination between the piping and vessel design and the pulsation study is the responsibility of the CONTRACTOR. 4. The study shall be done to Design Approach 3 as specified in API 618 5th edition. 5. The study shall include a finite element analysis of the skid structure, supporting structure (specified by COMPANY), compressor, and all vessels, coolers and piping in the MANUFACTURER/SUPPLIER's scope of supply. 6. Piping and piping support design and layout from the package to and from any off-skid coolers (outside of SUPPLIER scope) shall be provided by COMPANY/ CONTRACTOR and included in the study. 7. The study report shall recommend suitable locations for connections to perform future on-line vibration/ pulsation analysis during normal operation of the compressor.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	<p>8. Mechanical natural frequencies and acoustic (organ-pipe) frequencies shall not be coincident with pulsation frequencies generated by the compressor.</p> <p>9. The mechanical natural frequencies of vessels, structures, piping and attachments, on skid or within the compressor building, shall be above 2.4 times crankshaft speed or 30 Hz, whichever is higher.</p> <p>10. Pipe supports shall be located at each heavy mass concentration (e.g., large valves) and piping discontinuity (e.g., hanging elbows, reducers).</p> <p>11. The limits for pressure drop shall be according to API Std 618, paragraph 7.9.4.2.5.3.1.</p> <p>12. The pulsation limits shall not exceed 25 mm/s (1 in/s) peak velocity, if measured by velocity pick-up method of measurement and same shall be demonstrated in field during SAT.</p> <p>13. If the results of an acoustical simulation and/or a mechanical response analysis are such that modifications to the piping and/or pulsation suppression devices are necessary, the following shall be used by the MANUFACTURER/SUPPLIER in making proposals for modifications, in descending order of preference:</p> <ul style="list-style-type: none"> a. application of restriction orifices plates; <ul style="list-style-type: none"> i. restriction orifice plates shall be tagged as instrument flow orifice plates; ii. restriction orifice plates shall be installed at all compressor connections and in the discharge bottle exit nozzles during package manufacturing; iii. the restriction orifices may be cut to pipe ID on the bore in order to have them in place for future. <i>The intent of the clause is to have the component in place, even as a line size element, in the event a true RO for pulsation control is needed.</i> b. increase of volume bottle and/or pipe volume (if still feasible at the time when results become available); c. application of other types of pulsation suppression devices. <p>14. Each modification shall be subject to COMPANY approval.</p> <p>15. Any modifications necessary due to the results of the pulsation study shall be made by MANUFACTURER/SUPPLIER without any cost / schedule impact to COMPANY.</p>
10.3.2 (Modify)	<p>Pulsation bottles shall be designed using a digital pulsation analysis tool with a maximum peak to peak pulsation as follows:</p> <p>Less than 75 KW - 5%</p> <p>75 to 750 KW - 4%</p> <p>Greater than 750 KW - 3%</p> <p>Volume bottles shall be provided on the suction and discharge of each cylinder.</p>
10.3.3 (Modify)	<p>[Replace with:]</p> <p>1. Suction pulsation bottles shall have no baffles and shall be completely self-draining. No separate, dedicated drain connections shall be applied in suction pulsation bottles.</p>

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	2. Discharge bottles require a drain connection located at the bottom of the bottle. 3. Drain connection in discharge bottles may be either of the following: <ol style="list-style-type: none"> a 50 mm (2 in) reinforced LWNF; a reinforced studded outlet;
10.3.6 (Add)	No inspection nozzles on the pulsation bottles are required when code requirements may be satisfied by removing the piping spools and inspecting through nozzle connections.
11 PIPING AND APPURTENANCES	
11.1 GENERAL	
11.1.4 (Add)	a. Piping connections DN 50 (NPS 2) and larger shall be welded using weld neck flanges. b. Process gas piping shall be welded using butt weld fittings and weld neck flanges only. c. of AISI 316L stainless steel or Alloy 825 tubing may be used in gas applications, such as distance piece vents and drains (only close to the equipment) and other section shall be piped. d. Slip-on flanges are prohibited for gas service piping.
11.2 DESIGN	
11.2 (modify)	[Replace 10 th sentence with:] a) U bolts for pipe clamps shall be limited to piping DN 25 (NPS 1) and smaller. b) Wide plate pipe clamps shall be used on piping larger than DN 25 (NPS 1) and all gas piping subject to pulsation.
11.9 TUBING MATERIAL AND SIZES	
11.9 (Add)	All tubes shall be alloy 825 and 316L stainless steel fitting.
11.14 LUBRICATING OIL PIPING REQUIREMENTS	
11.14.2 (Modify)	[Replace with:] All tubes shall be alloy 825 and 316L stainless steel fitting.
11.15 COOLANT PIPING REQUIREMENTS	
11.15.2 (Add)	Coolant piping on liquid cooled cylinders shall have an isolation valve on the inlet and outlet coolant piping of each cylinder to allow draining of coolant from single compressor cylinder.
11.18 RELIEF VALVES	
11.18.1 (Add)	Relief valves shall be located on piping supported on the skid deck. Installation at the top of pressure vessels is not permitted.
11.18.2 (Modify)	Pilot operated relief valves are preferred over spring type relief valves.

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
11.18.6 (Add)	Venting of relief valves inside a building is not permitted under any circumstances. Compressors designed for installation within a building shall have the relief valve vent piping routed outside.
12 ELECTRICAL SYSTEMS	
12.1 (Add) [PSR]	All electrical components and installations SHALL [PSR] be suitable for the area classification, gas grouping and temperature classes specified by the COMPANY in the data/requisition sheets.
13 INSTRUMENTS AND CONTROLS	
13.1 (Add)	Unless specified otherwise, all instrumentation and control equipment required to monitor and sequence compressor through pressurization, start-up, operation, shutdown, and depressurisation shall be in-line with plant control philosophy. Logic shall be provided by SUPPLIER. Unless otherwise specified, driver controls shall be integrated into the same panel as the compressor controls. Compressor control, shutdown and monitoring systems shall be compatible with the plant facility control system including DCS, ESD and VMS.
13.3 (Add)	The instrument package shall conform with ADNOC respective business unit requirement relating Instrumentation Furnished with Packages.
13.3.8 (Modify)	Vibration transducers shall be fitted to compressors above 100 kW and shall be selected to accommodate the full range of temperature, frequency, and amplitude expected for the design.
15 SKIDS	
15.2 DESIGN	
15.2.8 (Modify)	[Replace with:] Compressor skids must have an environmental drip lip which is seal-welded around the skid to capture all liquids. The drip lip shall have connection so that trapped liquids can be piped to a drain system for collection.
16 PAINT AND PAINTING	
16.1 (Add)	Project painting and coating specification needs to be referred and followed.
20 CORROSIVE GASES	
20.2 HYDROGEN SULPHIDE	
20.2 (Modify)	Replace the fifth paragraph of this clause with: Copper and copper alloys shall not be used for parts of compressors or auxiliaries in contact with the process gas. b) Replace this clause with the following: Piston rods shall be coated with a tungsten carbide HVOF coating.
21 OFFSHORE AND MARINE ENVIRONMENTS	
21.1.5	Electrical installations

Table 10 – ISO 13631 Technical Amendments

ISO Clause No.	Description of Change
	Project/COMPANY electrical specification needs to be referred and complied with compressor SUPPLIER.
21.5 (delete)	Delete the clause.
21.7 (delete)	Delete the clause.
21.8 (delete)	Delete the clause.
BIBLIOGRAPHY	
[22] (New)	Recommended Practice for Control of Torsional Vibrations for High Speed Separable Reciprocating Compressors, Southwest Research Institute, May 2002.

10 ANNEX D - REPAIRS TO GREY AND NODULAR IRON CASTINGS

ANNEX D (informative)

Repairs to Gray or Nodular Iron Castings **Amendment to API 618 5th Edition, 2007**

Use of this Annex does not constitute blanket authorization. All repairs and/or repair methods are subject to the explicit approval of the COMPANY.

Grey cast iron **SHALL [PSR]** not be used for compressor cylinders or any other pressure containing components.

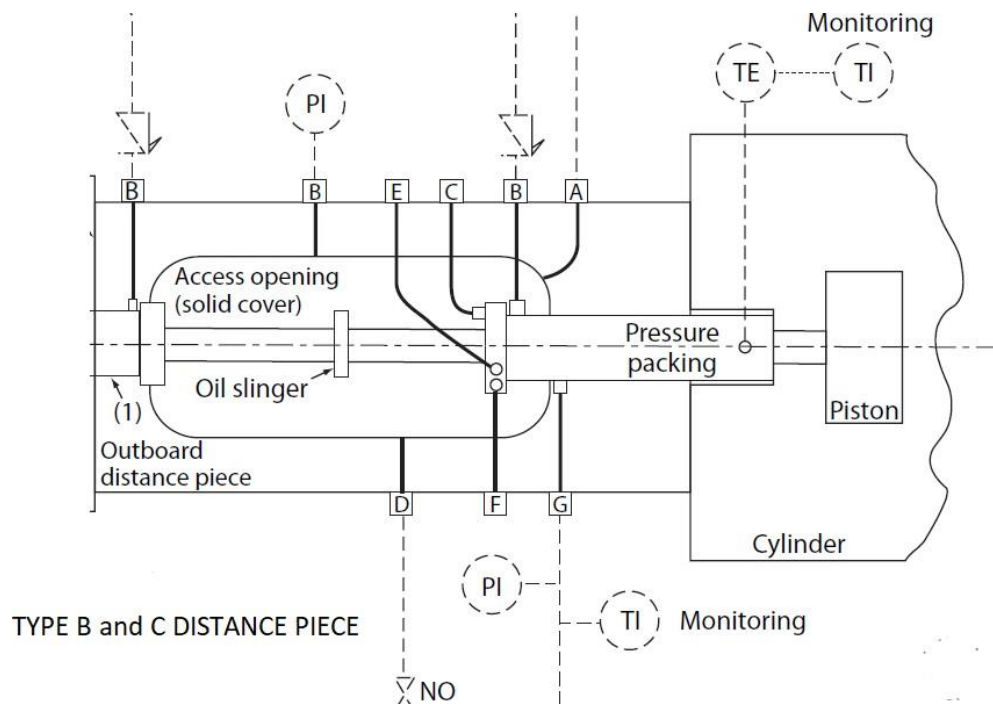
11 ANNEX G – FIGURES AND SCHEMATICS

ANNEX G (normative)

Figures and Schematics Amendment to API 618 5th Edition, 2007

Add to Figures G-3:

Notes : 5) The packing flare connection line between connection “G” and the liquid collection pot in “type B” and “type C” arrangements shall be provided with a pressure and a temperature indicator, located as close as practical to the distance piece connection.



12 ANNEX H – MATERIAL SPECIFICATIONS FOR MAJOR COMPONENT PARTS

ANNEX H (Informative)

Materials for Major Component Parts **Amendment to API 618 5th Edition, 2007**

Delete the following from Table H-1:

- Cylinders gray iron
- Compressor cylinder heads gray iron
- Valve seats and guards cast iron
- Packing cases cast iron

(Add to the Annex:)

1. Where the terms in (Table H-2) are used, the ASTM designations shall apply.
2. The Manufacturer/Supplier may propose material specifications other than those in (Table H-2) for the approval of the COMPANY.

Table H-2 Material and ASTM designations

Material	ASTM
Nodular iron, cast	A 395
Ni-resist, cast	A 439 grades D4 and D3A A 436 grade 2B
Steel, cast	A 216 grades WCA or WCC

13 ANNEX I – DISTANCE PIECE VENT, DRAIN AND BUFFER SYSTEMS TO MINIMIZE PROCESS GAS LEAKAGE

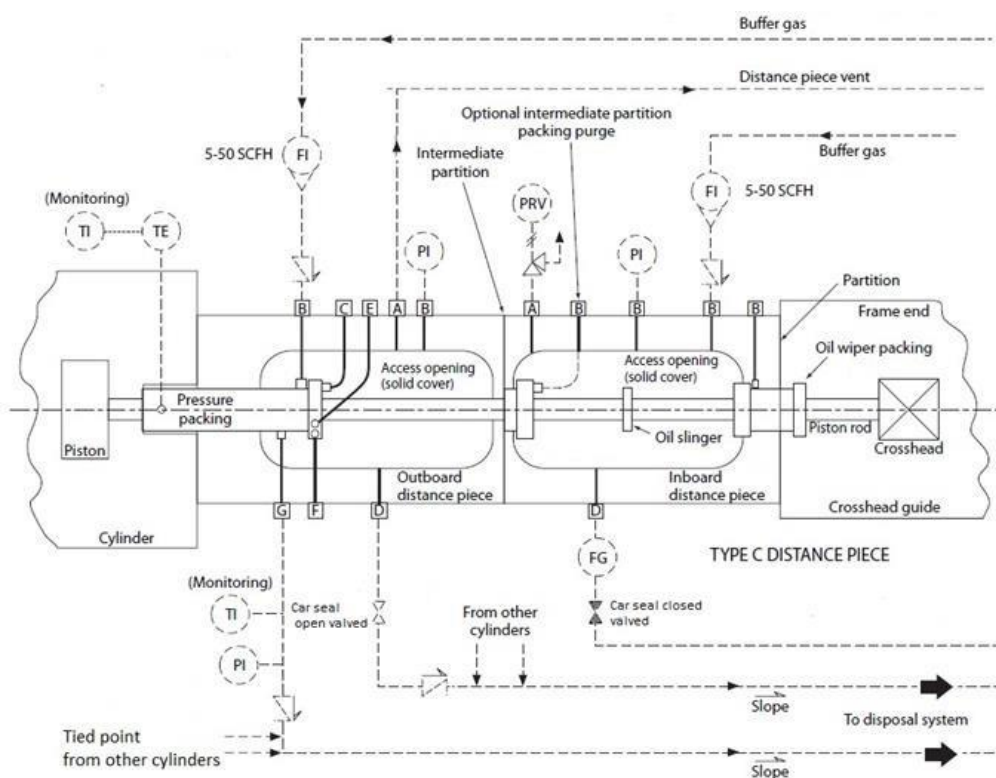
ANNEX I (Informative)

Distance Piece Vent, Drain and Buffer Systems to Minimize Process Gas Leakage

Amendment to API 618 5th Edition, 2007

Modify the Figure I-2 as follows:

1. A pressure indicator should be added as close as practical to the distance piece connection G.
2. A check valve downstream of distance piece connection G shall be added, just before the tie in with other leak-off points.
3. The “optional” inboard distance piece purge shall be provided and be purged dead-ended and direct, not via the oil wiper packing.
4. Broken line ----- shall be provided by SUPPLIER.



SECTION C – ADDITIONAL REQUIREMENTS

14 SCOPE OF SUPPLY

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

15 QUALITY CONTROL AND ASSURANCE

Equipment shall only be purchased from SUPPLIERS and SUB-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.

16 MATERIAL & CERTIFICATIONS

16.1 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).

17 INSPECTION & TESTING REQUIREMENTS

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

18 SUB-CONTRACTORS / SUB- SUPPLIERS

18.1 Refer to QA Inspection and Testing Requirements - Appendix 2 (Ref. 3) for details regarding SUB-SUPPLIERS.

19 SPARE PARTS

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

19.2 The SUPPLIER shall include in his scope of supply the required quantities of CAPITAL spares as listed in Table 11 below.

Table 11 – Capital spares part list

ITEM DESCRIPTION	QUANTITY
Complete Crank Shafts, connecting rods, Pistons, Piston rods, cross head assemblies. 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
Cylinder liners for each stage, in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set for each installed compressor

ITEM DESCRIPTION	QUANTITY
Crank shaft bearings, connecting rod big & small end bearings, cross head bearings, piston rings, rider rings, cross head pins etc., in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set for each installed compressor
Complete suction and discharge valve assemblies (regardless of duplication) for each stage, in SUPPLIER standard packaging suitable for long term storage inside warehouse	2 Sets for each installed compressor
Complete packing assembly for each cylinder (at crank end and cylinder end), in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set for each installed compressor
Complete valve unloader assembly for each cylinder, in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set Common for multiple identical compressors
Complete cylinder lubricator pumps and assemblies, 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
Vee belts set (as applicable), in SUPPLIER standard packaging suitable for long term storage inside warehouse	1 Set for each installed compressor

20 PAINTING, PRESERVATION & SHIPMENT

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

21 INSULATION

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

22 COMMISSIONING

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

23 TRAINING

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

24 DOCUMENTATION/MANUFACTURER DATA RECORDS

24.1 Refer to General Technical and Contractual Requirements for Rotating Equipment – Appendix 1 (Ref. 2) and the Information Requirements – Appendix 3 (Ref. 4).

25 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

26 DATASHEETS TEMPLATES

Refer to **Annex A** of API618 5th Edition, equipment Data Sheets.

27 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: SUPPLEMENTARY REQUIREMENTS

APPENDIX 5: CONDITION MONITORING REQUIREMENTS