

**MATERIAL AND EQUIPMENT STANDARD**

**FOR**

**RECIPROCATING COMPRESSORS FOR PROCESS SERVICES**

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## **0. INTRODUCTION**

This Specification gives amendment and supplement to API Standard 618, Third Edition, February 1986, "Reciprocating Compressors for General Refinery Services".

Problems stemming from the publication of revisions or amendments to the above standard by the American Petroleum Institute in subsequent years shall be referred to the purchaser.

For ease of reference, the clause or section numbering of API Std. 618 has been used throughout this Specification.

Clauses in API Std. 618 not mentioned remain unaltered.

For the purpose of this Specification, the following definitions shall hold:

Sub. (Substitution) : The API Std. clause is deleted and replaced by a new clause.

Del. (Deletion) : The API Std. clause is deleted with no replacement.

Add. (Addition) : A new clause with a new number is added.

Mod. (Modification) : Part of the API Std. clause is modified, and/or a new statement is added to that clause.

## 1. GENERAL

### 1.1 Scope

This Specification, contains the minimum requirements for reciprocating compressors and their drivers for use in refinery services, chemical plants, gas plants, petrochemical plants and where applicable in exploration, production and new ventures.

Compliance with the provision of this Standard does not relieve the Vendor of the responsibility of furnishing compressors of proper design, mechanically suited to meet operating guarantee at the specified service condition.

Unless specific exception accompanied by a description of the proposed substitute is recorded under the heading "Exception" in manufacturer's proposal, it shall be mutually understood that the proposal, is based on equipment, which complies strictly with the requirements of this Standard. (Mod.)

### 1.2 Alternative Design

Unless otherwise specified, equivalent SI Unit System , dimensions and ratings shall be substituted. (Mod.)

### 1.3 Conflicting Requirements

In case of conflict between documents relating to the inquiry or purchase order the following priority of documents, whichever more stringent realized by the company shall apply:

- First priority: purchase order (including attachments) and variations thereon.
- Second priority: data-requisition sheets and drawings.
- Third priority: this specification.

All conflicting requirements shall be referred to the purchaser in writing. The purchaser will issue conforming documentation if needed for clarification .

Mandatory requirements can not be superseded by any of the foregoing. (Sub.)

### 1.4 Definition of Terms

**1.4.19** The international nomenclature "diameter nominal" written as DN 15, 20, 25, 32, 40, etc., has been used for pipe sizes in accordance with ISO-6708-1980 and Appendix I in this Standard Specification. (Add.)

**1.4.20** The international nomenclature "pressure nominal" written as PN 20, 50, 68, 100, 150, etc., has been used for flange ratings in accordance with ANSI-ASME B16.5-1981, ISO 7268-1983, and Appendix J in this Standard Specification. (Add.)

### 1.5 Referenced Publications

**1.5.1** The following standards and specifications shall, to the extent specified herein, form a part of this Standard:

**IPS (IRANIAN PETROLEUM STANDARDS)**

M-PM-115	"Centrifugal Pumps for General Services"
M-PM-140	"Positive Displacement Pumps-Rotary"
M-PM-240	"General Purpose Steam Turbines"
M-PM-250	"Special Purpose Steam Turbines"
M-PM-260	"Industrial Combustion Gas Turbine for Process Services"
M-PM-280	"Internal Combustion Diesel Engines"
M-PM-300	"Special Purpose Gear Units for Process Services"
M-PM-310	"Special Purpose Couplings"
M-PM-320	"Lubrication, Shaft Sealing, and Control Oil System for Special Purpose Applications"
M-ME-220	"Shell and Tube Heat Exchangers"
M-ME-245	"Air Cooled Heat Exchangers"
M-EL-132	"Induction Motors"
E-EL-110	"Electrical Area Classification and Extent"
E-SF-900	"Noise and Vibration Control"

**ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)**

A105	"Forgings, Carbon Steel, for Piping Components"
A285	"Pressure Vessel Plates, Carbon Steel Low and Intermediate-Tensile Strength"
B 111	"Copper and Copper-Alloy Seamless Condenser Tubes and Ferrule Stock"
E 94	"Radiographic Testing"
E 165	"Liquid Penetrant Inspection"

**NACE (NATIONAL ASSOCIATION OF CORROSION ENGINEERS)**

MR-01-75	"Sulfide Stress Cracking Resistant Metallic Material for Oil Field Equipment"
(Mod.)	

**2. BASIC DESIGN**

**2.1 General**

**2.1.2** Compressors shall be designed to minimize the generation of noise conforming to the requirements of IPS-E-SF-900.

Unless otherwise specified the following limits shall be met at any measuring location, 1 m from the equipment surface:  
 Compressor = 87 dB and compressor + Driver = 90 dB.

Where acoustic insulation and/or noise hoods are proposed, prior approval of the purchaser shall be obtained. Noise control measures shall cause no hindrance to operations nor any obstruction to routine maintenance activities.

Vendor shall include in the proposal completed noise data sheet indicating guaranteed sound levels for the compressor, driver and lube System, as a single noise source. (Sub.)

**2.1.7** All electrical components and installations shall meet the requirements of IPS-E-EL-110. (Mod.)

**2.1.12** The capacity at the performance point certified by the manufacturer is to have no negative tolerance. The compressor vendor shall submit the design tolerance between the compressor’s rated capacity and the required capacity. This tolerance should not be more than 3%. (Sub.)

**2.1.15** All equipment shall be designed for outdoor installation. Unless otherwise specified. (Mod.)

**2.1.19** Compressor and drive train shall also be designed for continuous operation in any condition of loading or unloading that can be achieved with the capacity control system provided when operating at rated suction conditions . (Add.)

**2.1.20** In strength calculations the manufacturer shall amongst other things, give due consideration to the combined effect of static, alternating bending and torsional stresses as well as the effect of stress raisers, such as stress concentration factors and notch sensitivities. The manufacturer shall indicate the most highly stressed locations in the system and the safety factor applying at these locations. Safety factors shall be clearly defined. (Add.)

**2.2 Allowable Speed**

Unless otherwise specified by Company, compressor speeds and corresponding average piston speeds shall be limited to the following maximum:

<b>INSTALLED POWER</b>	<b>MAXIMUM COMPRESS. SPEED</b>	<b>MAXIMUM AVERAGE PISTON SPEED</b>
25 kW and below	500 rpm	6 m/s
25-150 kW	400 rpm	5 m/s
150 kW and above	375 rpm	4 m/s

For special high pressure services these maximum speeds could be considerably lower, based on the manufacturer’s experience.

The average piston speed in compressors handling saturated hydrocarbon gases and in non-lubricated compressor cylinders shall not exceed 3.5 m/s. (Mod.)

**2.3 Allowable Discharge Temperature**

**2.3.2** The high discharge temperature trip signal, which will shut down the unit, shall be set at 20°C above the maximum operating discharge temperature. Each cylinder shall have its own dedicated temperature measuring point for this purpose, which shall be located as close as possible to the cylinder discharge valve. (Mod.)

## 2.4 Rod Loading

**2.4.1** Change the "manufacturer's maximum" at first sentence to "85% of the manufacturer's maximum". (Mod.)

**2.4.3** Actual combined rod loading for specified normal and worst case condition (i.e., at relief valve set pressure of part load) shall be submitted at the time of proposal. (Add.)

## 2.5 Critical Speeds

**2.5.1** Vendor shall perform an analysis of torsional critical speeds with resulting stresses and submit a report of the results to the purchaser. The Vendor's proposal shall state whether the report is for steady state or transient condition or both. (Mod.)

**2.5.2** For compressors with variable speed driver the vendor shall perform a response analysis of the rotating system during all possible resonance condition which may occur during run-up and within complete operating speed range. All possible excitation frequencies and consequent torques shall be considered. (Mod.)

## 2.6 Compressor Cylinders

### 2.6.1 General

**2.6.1.2** Unless otherwise specified in data sheet, horizontal cylinders shall be provided, which shall have top suction and bottom discharge. (Sub.)

**2.6.1.5** Stud holes shall be counterbored (chamfered). (Mod.)

### 2.6.2 Cylinder appurtenances

**2.6.2.2** Liners shall extend the full length of the cylinder, and shall be pinned or doweled from outside to prevent possible rotation. (Mod.)

**2.6.2.5.4** Also adequate clearance shall be provided to permit the use of torque wrenches, including multipliers for torque values over 300 Nm. (Mod.)

### 2.6.3 Cylinder cooling

**2.6.3.5.4** Pumps in the cooling system shall be centrifugal type pumps and shall be of the vertical close coupled type, unless other types are approved in the data sheet. Pumps shall comply with IPS-M-PM-115, "Centrifugal Pumps for General Services".

Pumps shall have nodular cast iron or steel casings. The type of drivers shall be as indicated in the data sheet. Each pump shall have a suction strainer, which shall be provided with a 40 mesh SWG 32 stainless steel screen. (Add.)

**2.6.3.5.5** Water jackets shall be hydrostatically tested at 1.5 times the design pressure not less than 530 kPag (5.3 barg).

Drains shall be provided at the lowest points. (Add.)

## 2.7 Valves and Unloaders

**2.7.3** The design of valves shall aim for maximum valve life. If valves are required to operate by different gas compositions, the manufacturer shall clearly state in his proposal which of the gas compositions the valve design has been optimized and which restrictions are to be applied during operation on other gases. (Mod.)

**2.7.4** The proposed type and material of gaskets shall be subject to the purchaser's approval. (Mod.)

**2.7.5** All valves located at the bottom side of a cylinder shall be provided with an arrangement to retain the complete valve assembly, including cage, in position while the cover plate is removed or installed. (Mod.)

**2.7.6** Unless otherwise specified valve springs shall be made of corrosion resistant material. (Mod.)

**2.7.9** Replace "when specified" by "unless otherwise specified". (Mod.)

**2.7.11** All purge and vent connections shall be piped up to a single purge and vent connection. Unless otherwise specified all lines to and from unloaders shall be AISI 316 L stainless steel. (Mod.)

## 2.8 Pistons, Piston Rods, and Piston Rings

**2.8.1** Hydraulic tightening methods are strongly preferred for all piston rod diameters and if applied, shall be positively locked. (Mod.)

**2.8.6** Tail rods, if used, shall have forged steel enclosures which will contain the rod in the event of rod failure. (Mod.)

**2.8.7** Piston diameters larger than 500 mm shall only be furnished with the explicit approval of the purchaser. (Add.)

## 2.9 Crankshafts, Connecting Rods, Bearing and Crossheads

**2.9.7** When the distance piece compartment adjacent to the crankcase is gas tight, the crankcase shall be provided with relief device to protect against rapid pressure rises.

Crankcase explosion relief valves shall have a minimum throat area of  $70 \text{ mm}^2$  for each  $\text{dm}^3$  of the gross crankcase contents. (Mod.)

**2.9.8** Vendor shall provide a crank case purge connection for injection of a dry, inert gas by the purchaser. This connection shall be in an accessible location at the maximum practical distance away from the crankcase breather. (Add.)

## 2.10 Distance Pieces

**2.10.1** Unless stated otherwise in the data sheet, the following type of distance piece is required:

- a) For air or pure nitrogen. Type B
- b) For all other gases. Type C (Mod.)

**2.10.3** Solid metal distance piece covers shall be provided. The outer compartment of the distance piece adjacent to the cylinder, the partitions, the covers, the bolting, and the intermediate seal packing shall be designed for a minimum compartment pressure of 100 kPag (1 barg). (Sub.)

**2.10.4** Each distance piece compartment shall be provided with a valved (plugged, bottom drain connection and a top vent connection for hooking-up to purchaser's vent system.

Packing vent piping inside of distance piece shall be designed for the maximum working pressure of cylinder. (Mod.)

## **2.11 Packing Cases and Pressure Packing**

**2.11.2** Packing case flanges shall be of steel and shall be bolted to the cylinder or cylinder head with at least four stud bolts. Cap bolts are not allowed. (Mod.)

**2.11.3** Connections on packing case shall be minimum DN20 (3/4"). (Mod.)

**2.11.4.2** Cooling passages and their respective sealing between the cups shall be designed such that any entrainment of process gas into the coolant system is positively prevented. (Mod.)

**2.11.8** For services containing H<sub>2</sub>S the API arrangement is mandatory. (Mod.)

## **2.12 Compressor Frame Lubrication**

**2.12.3** Twin full-flow filter shall be furnished. (Mod.)

**2.12.3.2** The pump shall be rotary internal screw type and shall be driven by an electric motor. The electric motor driver shall be suitable for the area classification specified and shall comply with IPS-M-EL-132. (Mod.)

**2.12.4** Coolers shall be furnished with removable bundles and the minimum tube wall thickness shall be 1.65 mm (16 BWG).

The Vendor shall design the lubrication oil system such that the oil pressure at cooler outlet be at least 100 kPa (1 bar) higher than the maximum water pressure stated in the data sheet in order to prevent oil contamination in case of cooler failure. (Mod.)

**2.12.5** Delete last two sentences of this Clause and substitute, "All filter systems shall be designed to permit cartridge replacement and re-pressuring during compressor operation. For unspared, continuous service compressors dual filters shall be supplied complete with separate or integral continuous flow transfer valve that provides tight shut off of the idle filter." (Mod.)

**2.12.6** Delete "when specified" from this clause and replace it by "If the specified minimum ambient temperature is lower than the minimum lube oil temperature required by the manufacturer for starting ....." (Mod.)

**2.12.8** When an auxiliary pump is furnished or when coolers or filters are too large to be located within the confines of the compressor base, the pump, coolers, filters, interconnecting piping, and instruments shall be mounted together on a skid. (Add.)

**2.12.9** Required quantity and specification for the cylinder and/or frame lubricating oil shall be specified in the proposal. (Add.)

## **2.13 Cylinder and Packing Lubrication**

**2.13.1** Lubricator reservoirs shall be equipped with a low level alarm.

Each compressor cylinder shall have a minimum of two lubricating points. Piston rod packing of cylinders with a rated discharge pressure of 10000 kPa g (100 barg) or more shall have a minimum of two lubricating points unless otherwise specified.

Piston Rod packing of cylinders with a rated discharge pressure above 25000 kPa g (250 barg) shall have a minimum of three lubricating points unless otherwise specified. Lubricating points shall be made on the upper side of the piston rod. (Mod.)

**2.13.3** Refer to Para. 2.12.6 above for providing lubricator reservoir heater criteria. (Mod.)

## **2.14 Materials**

### **2.14.1 General**

**2.14.1.2** When vendor's quoted material specification is DIN, JIS, or other Foreign Standard, the proposal shall indicate the nearest above named American Specification equivalent along with exact and specific deviation, (chemical properties, physical properties, testing, etc.) for purchaser's evaluation of equivalence for service intended. (Mod.)

**2.14.1.11** Gray cast iron shall not be used for compressor cylinders, above 7000 kPa g cylinder relief valve pressure. Nodular cast iron (also known as ductile iron) shall not be used. (Mod.)

**2.14.1.13** The anti-seize compound shall be suitable for the operating temperature. (Mod.)

### **2.14.4 Material inspection**

**2.14.4.2** Full non-destructive inspection shall be carried out on all critical areas of cylinder castings, such as abrupt changes in section, weld ends, at the junction of risers, gates or feeders to the castings and areas of high stress. prior to inspection, the purchaser and manufacturer shall agree the critical areas and the type of non-destructive testing which shall be applied. Radiographic inspection shall be applied, whenever possible. (Mod.)

**2.14.4.4** Magnetic particle inspection shall be carried out on all surfaces after final machining. Dye-penetrant inspection shall be used only when magnetic particle inspection is not feasible. (Add.)

## **2.15 Nameplates and Rotation Arrows**

**2.15.3** Unless otherwise specified the text on the nameplates shall be in English language and all data in SI units. (Mod.)

## **3. ACCESSORIES**

### **3.1 Drivers**

#### **3.1.1 General**

**3.1.1.1** The full flow relief condition at the discharge and normal conditions at the suction shall be taken into account when sizing the driver.

If a diesel engine is specified as the main driver, it shall be per IPS-M-PM-280. (Mod.)

**3.1.1.3** Any limitation on starting or special provision to be furnished by the purchaser shall be stated in the Vendor's Proposal. (Mod.)

**3.1.1.6** V-belt drives are not permitted. (Mod.)

**3.1.1.7** The Vendor shall make provisions for jacking in two horizontal directions (axial and transverse) for foot mounted drivers and gearboxes mounted on vendor furnished baseplates. (Add.)

### **3.1.2 Motor drivers**

**3.1.2.2** Electric motors for main drives as well as auxiliary drives shall be as specified in data sheet and shall also comply with IPS-M-EL-132. (Sub.)

**3.1.2.4** Delete this Clause. (Del.)

**3.1.2.11** Anti-friction bearings are not acceptable. (Mod.)

### **3.1.3 Turbine drivers**

**3.1.3.1** Steam turbine drivers shall conform to API Std. 611, as supplemented by IPS-M-PM-240 or to API Std. 612, as supplemented by IPS-M-PM-250 and related data sheet whichever is applicable.

Gas turbine drivers shall comply with API Std. 616. as supplemented by IPS-M-PM-260 and related data sheet. (Mod.)

**3.1.3.2** When specified, a separate lube oil system in accordance with API Std. 614 as supplemented by IPS-M-PM-320 shall be furnished for a turbine drive train. (Sub.)

## **3.2 Couplings and Guards**

### **3.2.1 Couplings**

**3.2.1.2** Couplings and coupling mountings shall comply with API Std. 671 as amended/supplemented by IPS-M-PM-310. (Mod.)

**3.2.1.3** Use of quill shaft shall be highlighted in the Vendor's Proposal. (Mod.)

### **3.2.2 Guards**

**3.2.2.1** Guards shall be made of spark-resisting materials. (Mod.)

## **3.4 Belt Drives**

Delete this section. (Del.)

## **3.5 Soleplates, Rails, and Baseplates**

**3.5.2** Delete "when specified" from last sentence of this Clause (Mod.)

**3.5.8** Unless otherwise specified anchor bolts will be furnished by the Vendor.

The design and method of installation in the foundation will be subject to the vendor's review and approval. (Mod.)

## **3.6 Controls and Instrumentation**

### **3.6.1 General**

**3.6.1.1** The control and instrumentation shall be adequate for controlling the compressor safely and efficiently at the operating conditions specified in data sheet. (Mod.)

**3.6.1.9** Each piston rod of a horizontal compressor shall be provided with a non-contacting probe for rod run-out measurement.

The probe shall be located in the outer distance piece on the packing case flange and shall be wired to an outside junction box, where the proximator is located. The junction box shall provide plug type connections for portable read-out equipment. (Add.)

### **3.6.2 Control system**

**3.6.2.3** Vendor shall select controls to avoid any loaded or unloaded condition which could damage the compressor. Vendor shall state in the proposal the extent of unloading required for start-up (if not specified by the purchaser). (Mod.)

**3.6.2.6** If clearance pockets are recommended by the Vendor, they shall be preferably of the 2-position type (open and closed) and shall be pneumatically actuated. (Mod.)

### **3.6.3 Instrument and control panels**

**3.6.3.4** Wiring termination for different voltages if any, shall be housed in separate enclosures. (Mod.)

### **3.6.4 Instrumentation**

#### **3.6.4.4 Relief valves**

**3.6.4.4.1** Delete "when specified" from first sentence. Brass or Cast iron safety/relief valves and fittings are not allowed. All safety relief valves shall have flanged inlet and outlet connections. (Mod.)

### **3.6.5 Alarms and shutdowns**

**3.6.5.1** Vendor shall recommend protective devices, in addition to those specified, which are deemed necessary to prevent damage to equipment. Direct switches in alarm and shutdowns are not allowed.

A combinations of signal transmitter with switch and/or trip amplifier shall always be used. (Mod.)

**3.6.5.8** Alarm and shutdown devices shall be energized at normal operating conditions of the system and be installed such that device failure, power supply failure, wire breakage etc. will cause alarm and/or shutdown. (Sub.)

**3.6.5.9** Minimum instrumentation shall include the following switches:

- a) Excessive discharge gas temperature (each compressor cylinder) alarm.

- b) Excessive vibration alarm.
- c) Excessive engine jacket water temperature (each cylinder) pre-alarm and shutdown with alarm.
- d) Low oil level or drive failure on forced feed lubrication-alarm.
- e) Low pressure for frame lubricating system. Pre-alarmed and shutdown with alarm. (Add.)

**3.6.5.10** All instruments and controls including alarm and shutdown sensing devices, shall be installed with sufficient valving for isolation to permit testing and removal while the system is in operation. (Add.)

### **3.7 Piping and Appurtenances**

**3.7.1.4** Vendor shall clearly identify, on schematic drawing, all piping requiring insulation or heat tracing. (Mod.)

**3.7.1.5** Delete "when specified" from the first sentence. (Mod.)

**3.7.1.9** Unless approved by the purchaser otherwise, threaded connections are allowed only on instruments. (Mod.)

**3.7.1.11** Delete this Clause. (Del.)

**3.7.1.16** The application of hydraulic fastening tools, or similar, shall be possible for:

- a) Class 1500 flanges of DN 150 and larger.
- b) Class 2500 flanges of DN 100 and larger. (Mod.)

#### **3.7.2 Frame lubricating oil piping requirements**

**3.7.2.2** All lubricating oil lines shall be made of AISI 316L stainless steel and shall have flanged connections. (Mod.)

### **3.8 Inter Coolers and After Coolers**

**3.8.1** Water-cooled shell-and-tube intercoolers and after coolers shall be designed and constructed in accordance with TEMA R, as amended/supplemented by IPS-M-ME-220, (unless otherwise specified). Finned tubes and U tubes are not acceptable. (Sub.)

**3.8.7** When air coolers are specified, they shall conform to IPS-M-ME-245. (Sub.)

### **3.9 Pulsation and Vibration Control Requirements**

#### **3.9.1 General**

- a) The manufacturer shall provide pulsation suppression devices at the suction and discharge side of each cylinder. Cylinders operating in parallel may be connected to a common suction and a common discharge pulsation suppression device.
- b) Volume bottles (defined as vessels without any internals, with a diameter of at least twice the line connection diameter, and having an internal volume of at least 12 times the piston displacement per revolution of all connected cylinders) shall be used as pulsation suppression devices.

The use of inter coolers and/or after coolers as pulsation suppression devices are not permitted.

c) Vendor shall supply a moisture separator for each interstage, either separate from or integral with the suction pulsation damper. All separators shall be designed, constructed and inspected in accordance with ASME Code, Sect. VIII, Div. 1, (latest revision) and be code stamped. Each separator operating below 6800 kPag (68 barg) shall have one hour minimum liquid holding capacity and be equipped with an automatic drain trap with inlet and outlet block valves, check valve, bypass with globe valve, and an equalizing line with block valve.

Each separator operating above 6800 kPag (68 barg) shall have four hour minimum liquid holding capacity and shall have two manual globe type drain valves in series. Liquid volumes shall be based on the condensation that occurs when using minimum cooling water temperatures as during winter months. Each separator shall be equipped with a level gage and high level pre-alarm switch. All piping between the separators and drain traps shall be supplied by the Vendor and shall be (type 304 stainless steel). (Mod.)

### **3.9.2 Design approaches**

**3.9.2.1** Unless specifically stated otherwise only Approach 1 or 3 are to be used. (Mod.)

**3.9.2.4** Unless otherwise specified, the guidelines specified in 3.9.2.4.1 and 3.9.2.4.2 are to be followed for application of the appropriate design approach. (Sub.)

**3.9.2.6** If the result of an acoustical 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 descending order of priority shall be used by the manufacturer in making proposals for modifications:

- 1) Increase of volume bottle and/or pipe volume.
- 2) The application of orifices. The restriction orificeplates shall be tagged as instrument flow orifice plates.
- 3) The application of other types of pulsation suppression devices.

Each modification is subject to the purchasers approval. (Mod.)

**3.9.2.8** Replace "should normally be specified" in the first sentence by "shall be performed". (Mod.)

### **3.9.3 Pulsation suppression devices**

**3.9.3.4** All butt welds for pulsation suppression devices are to be 100 percent radiographed. (Sub.)

**3.9.3.9** Vendor shall state in his proposal the volume bottle nozzle location and orientation options that are available. (Sub.)

**3.9.3.19** Volume bottles shall be designed for full vacuum service. Minimum design pressure for suction volume bottles shall be two-third (2/3) of the rating of the discharge bottle or as specified by the purchaser on the data sheets. (Add.)

### **3.9.4 Supports for pulsation suppression devices**

**3.9.4.1** Proper supports shall be provided for all pulsation suppression devices. The supports shall:

- a) Support the weight of the pulsation suppression device and any external piping load at normal operating conditions.

- b) Permit thermal expansion of the compressor frame along the axis of the cylinder.
- c) Permit thermal expansion between the cylinder centerline and the support centerline along the axis of the cylinder nozzle.
- d) Prevent movement of the pulsation suppression device along its major axis. (Mod.)

## 4. INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

### 4.1 General

**4.1.5** All certificates shall contain the following information as a minimum:

- Name of purchaser.
- Purchase order number and date.
- Manufacturer's order number.
- Identification number of certificate and its date of issue.
- Material specification(s).
- Dimensions in SI Units, unless otherwise specified or approved.
- Material charge number, or batch number.
- Mechanical properties recorded from test results.
- Chemical composition recorded from results of chemical analysis.
- NDT methods and results, when and where applicable.
- Heat treatment procedures, furnace charge number and heat treatment records, where applicable.
- Any supplementary or additional information as may be required. (Add.)

**4.1.6** If specified on data sheet, third party witnessed, material test certificates are required for pressure-containing parts in hydrocarbon services and for crank shafts, connecting rods, crossheads, piston rods, cylinder liners, and main bolts and nuts. (Add.)

### 4.2 Inspection

**4.2.6** Delete "when specified". (Mod.)

**4.2.7** The oil system shall be circulated in the manufacturer shop. The oil system shall meet the test screen cleanliness requirements specified in API 614 as amended and supplemented by IPS-M-PM-320. (Sub.)

### 4.3 Testing

#### 4.3.1 Hydrostatic and pressure tests

**4.3.1.2** All cast pressure containing parts for toxic or flammable services greater than 12 molecular weight shall have a gas pressure test as described above. Nitrogen may be used for services greater than 12 molecular weight. (Mod.)

#### 4.3.2 Mechanical running test

**4.3.2.2** Delete "when specified" from this Clause. (Mod.)

**4.3.2.4** Auxiliary equipment not integral with compressor such as auxiliary oil pumps, oil coolers, filters, etc. shall be subjected to a functional test and cleanliness verification as a subassembly in the vendor's shop if not used during a compressor running test. (Sub.)

**4.3.2.5** The compressor shall be dismantled for inspection which shall be carried out as follows:

- Internal surface of cylinder liners to be checked for roundness, required surface finish and material imperfections.
- Piston rings and rider rings to be checked for gap clearance, groove clearance and bearing surface.
- Piston rod to be checked on packing area surface and run-out, which shall be in accordance with the limits of (2.6.2.1).
- All valve assemblies to be checked for correct lifting height of valve plates and leakage (leakage test of valves to be done either with air or with low viscosity solvent, water is not allowed).
- Main bearings, crank bearings and cross head to be checked for correct bonding of babbitt material to the base metal and for correct bearing surface.
- Crankshaft journal, crank pin and cross head pin to be checked for the bearing contact area.
- Crankcase to be internally inspected to check:
  - Locking device of all bearing bolt nuts.
  - Correct fitting of lubricating oil piping to main bearing.
  - Correct securing of lubricating oil piping in the crankcase.

#### 4.3.3 Other tests

**4.3.3.2** Replace "when specified" by "unless otherwise specified". (Mod.)

#### 4.3.3.3 Packaged unit test

When specified, such components as gears, the driver, the control panel, and all auxiliaries that make up the complete compressor unit shall be tested together with the compressor during the mechanical running test.

This will include, but not necessarily be limited to, coolers, vessels, piping, all instrumentation and all electrical equipment in the scope of supply of the Vendor. Compressor control system and all associated instrumentation shall be demonstrated to be fully and correctly operational.

Details of the extent and the procedure of the test shall be included in the proposal. The final version of the test procedure shall be subjected to purchaser's approval. (Add.)

#### **4.4 Preparation for Shipment**

**4.4.1** Preparation for shipment shall be in accordance with the requirements of the inquiry and/or the purchase order(s) and the supplements appertaining thereto. The preparation shall make the equipment suitable for 12 months of outdoor storage from the time of shipment. (Mod.)

**4.4.5.9** All materials shall be shipped together and separate shipment is not acceptable. (Mod.)

### **5. VENDOR'S DATA**

#### **5.1 Proposal**

m. Delete this Paragraph and substitute following:

The Vendor's Proposal shall also contain an installation list containing the following:

- 1) Compressor manufactured at the proposed point of manufacture having comparable speed, power, rating, cylinder size, and discharge pressure of a gas of comparable analysis and characteristics.
- 2) Date of installation and beginning of continuous process service. (Mod.)

#### **5.2 Contract Data**

##### **5.2.2 Curves**

**5.2.2.1** Delete "when specified". (Mod.)

**5.2.2.2** In any case the Vendor is responsible for satisfactory load reversal for all specified operating conditions. (Mod.)

### **6. GUARANTEE AND WARRANTY (Add.)**

#### **6.1 Mechanical**

Unless exception is recorded by the Vendor in his proposal, it shall be understood that the Vendor agrees to the following guarantees and warranties:

During a period of 12 months after the date of commissioning, the Vendor shall, with all possible speed and without cost to the purchaser, replace or repair the goods or any part thereof found to be defective due to faulty material, workmanship or to any act or omission of the Vendor. In particular the Vendor shall reimburse any transportation and other charges incurred by the purchaser in effecting such replacement or repair at the point of use. (Add.)

## **6.2 Performance**

The compressor shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheet. Performance tolerance should be as detailed in Par. 2.1.1.2. (Add.)

**APPENDICES****APPENDIX A  
RECIPROCATING COMPRESSORS DATA SHEETS**

Unless otherwise specified, SI Units data sheets shall be used. (Mod.)

**APPENDIX D  
REPAIRS TO GRAY AND NODULAR IRON CASTINGS**

Any repair and/or repair method is subject to the explicit approval of the purchaser. (Sub.)

**APPENDIX G  
FIGURES AND SCHEMATICS**

Add to note 6 of Figure G.4:

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 temperature indicator, which shall be located as close as practical to the distance piece connections G. (Mod.)

**APPENDIX H  
MATERIAL SPECIFICATION FOR MAJOR COMPONENT PARTS**

Delete from table H-1 the following:

- |                            |                  |
|----------------------------|------------------|
| - cylinders                | gray iron        |
| - compressor cylinder head | gray iron        |
| - valve seats and guards   | cast iron        |
| - packing cases            | cast iron (Mod.) |

**APPENDIX I  
PIPE COMPONENTS NOMINAL SIZE**

The purpose of this Appendix is to present the equivalent identities for the piping component nominal size in imperial and SI System.

Nominal Size		Nominal Size		Nominal Size		Nominal Size	
DN (1)	NPS (2)						
15	½	100	4	500	20	1000	40
20	¾	125	5	600	24	1050	42
25	1	150	6	650	26	1100	44
32	1¼	200	8	700	28	1150	46
40	1½	250	10	750	30	1200	48
50	2	300	12	800	32	1300	52
65	2½	350	14	850	34	1400	56
80	3	400	16	900	36	1500	60
90	3½	450	18	950	38	1800	72

1) Diameter Nominal, mm.

2) Nominal Pipe Size, inch.

(ADD.)

**APPENDIX J  
PIPE FLANGE PRESSURE TEMPERATURE RATING**

The purpose of this Appendix is to present the equivalent identities for the pipe flange nominal pressure temperature ratings in imperial and SI System.

PN RATING - BAR (1)	ANSI RATINGS - 1b
20	150
50	300
65	400
100	600
150	900
250	1500
420	2500

1) The indicated PN ratings are introduced by ISO Standard No. 7268.

(Add.)