

**MATERIAL AND EQUIPMENT STANDARD**

**FOR**

**RECIPROCATING COMPRESSORS FOR UTILITY**

**AND**

**INSTRUMENT AIR SERVICES**

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## **0. INTRODUCTION**

This specification gives the amendment and supplement to API Std, 680 first edition, October 1987 "Packaged Reciprocating Plant and Instrument Air Compressors for General Refinery Services".

It shall be used in conjunction with data sheets for reciprocating air compressors .

For ease of reference, the clause (or paragraph) numbering of API Std, 680 has been used throughout this Standard. Clauses in API Std, 680 not mentioned remain unaltered. For the purpose of this specification the following definitions shall hold:

- Sub. : The API Std, clause is deleted and replaced by a new clause.
- Del. : The API Std. clause is deleted without any replacement.
- Add. : A new clause with a new number is added.
- Mod : Part of the API Std, clause is modified and /or a new statement or comment is added to that clause.

## 1. GENERAL

### 1.1 Scope

This specification, contains the minimum requirements for Double-Acting Reciprocating Compressors for plant air and/or instrument air service for use in refinery services, chemical plants, gas plants, petrochemical plants and where applicable in exploration, production and new ventures.

Compliance with the provisions of this specification does not relieve the supplier of the responsibility of furnishing Compressors of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

The main vendor is the Compressor vendor, who shall hold unit responsibility for the Compressor package. (Mod.)

### 1.2 Alternative Designs

Equivalent SI unit systems, dimensions and ratings shall be used, unless otherwise specified. (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 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 Company in writing. The Company will issue confirmation documents if needed for clarification.

Should the Vendor's interpretation suggest a conflict between specifications, data sheets or purchase requisition, the Vendor shall obtain clarification before proceeding with any work. (Sub.)

### 1.5 Reference Publication

1.5.1 The latest editions of the following standards, to the extent specified herein, form part of this standard.

#### IPS (IRANIAN PETROLEUM STANDARDS)

M-PM-240	"General Purpose Steam Turbine".
M-PM-250	"Special Purpose Steam Turbine".
M-EL-132	"Induction Motors".
M-PM-300	"Special Purpose Gear Units for Process Services".
M-PM-320	"Lubrication, Shaft Sealing and Control Oil System for Special Purpose Application".

E-SF-900	"Noise and Vibration Control".
E-EL-110	"Electrical Area Classification and Extent".
M-PM-260	"Industrial Combustion Gas Turbines".
M-PM-270	"Expansion Turbines".
G-ME-220	"Shell and Tube Heat Exchangers".
G-ME-245	"Air Cooled Heat Exchangers".
M-PM-115	"Centrifugal Pumps for General Services".

**2. BASIC DESIGN**

**2.1 General**

**2.1.3** All equipment furnished shall be designed to minimize the generation of noise and shall not exceed the noise limits given in the supplementary clauses below : (Sub.)

**2.1.3.1** All definitions, notations, measuring equipment, measuring procedures, test reporting, calculation methods and calculation procedures shall be in accordance with IPS-E-SF-900.(Add.)

**2.1.3.2** Unless otherwise specified, the following limits shall be met at any measuring location not less than 1m from the equipment surface:

<b>SOUND PRESSURE LIMIT IN dB RE 20 Pa</b>	
COMPRESSOR	87 dB (A)
COMPRESSOR+DRIVER	90 dB (A)

If the equipment produces impulsive and/or narrow band noise the above limits shall be taken 5 dB(A) lower, thus 82 dB(A) for Compressor and 85 dB(A) for the Compressor + driver. Noise levels shall have an upper tolerance of +0dB. The above requirements apply in the absence of reverberation and background noise from other sources, and for all operating conditions between minimum flow and rated flow.

In the event that more stringent limits apply, then these will be indicated on the data sheet which forms part of the requisition. In such cases, the equipment shall not exceed the sound power or sound pressure limit stated on the requisition. (Add.)

**2.1.3.3** Where excessive noise from equipment can not be eliminated by low noise design, corrective measures should, preferably, take the form of acoustic insulation for pipes, gearboxes, etc. where noise hoods are proposed, prior approval of the Purchaser shall be obtained regarding construction, materials and safety requirements.

Noise control measures shall cause no hindrance to operation nor any obstruction to routine maintenance activities. (Add.)

**2.1.5** All equipment shall be designed to run safely to the relief valve setting including accumulation. (Sub.)

**2.1.7** Electrical components and installation shall meet the requirement of IPS-E-EL-110. "Electrical Area classification and extent". (Mod.)

**2.1.22** In case of an electrical motor driver (either fixed or variable speed) the complete unit shall be able to withstand the effects of a 2 phase short circuit. The complete unit shall be capable for a restart with full opposite residual voltage. (Add.)

## **2.2 Allowable Speeds**

**2.2.1** Piston speed for non-lubricated cylinders are to be limited to 3.8 m/s. The Compressor rotative speed shall be limited to 600 RPM (Mod.)

## **2.3 Discharge Temperature**

**2.3.1** The use of synthetic oils is recommended for additional safety, however, the application of these oils shall not be used as a reason to increase the maximum allowable discharge temperature. (Mod.)

## **2.6 Compressor Cylinders**

**2.6.1.1** Compressor cylinders shall be of the double-acting non-lubricated dry type. The maximum allowable working pressure of the cylinder shall be at least equal to the specified relief valve setting including accumulation. (Mod.)

**2.6.1.7.1** Air Coolers shall be sized for 17% extra surface inclusive of fouling (internal and external) factors. (Mod.)

**2.6.1.12** Pumps in the cooling system shall be centrifugal type 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 screen. (Add.)

## **2.7 Valves**

**2.7.8** Metal valve disks or plates and damper plates shall be fully milled. They shall not be punched. Valves and valve seats shall be made of stainless steel. (Mod.)

**2.7.9** Cylinder unloading shall be accomplished by either valve depressors or plug-type unloaders. The use of the latter needs the approval of the purchaser. Valve lifters shall not be used. When valve depressors are specified, all inlet valves of the cylinder ends involved shall be provided with unloaders.

Where plug-type unloaders are used, the number of unloaders is determined by the area per plug opening, the total of which must be equal to or greater than one half of the total free lift area (or at least flow area) of all suction valves on that end.

Unloaders shall be pneumatically operated, unless specifically stated otherwise on the data sheet. Manual overrides on pneumatically operated unloaders are not permitted.

If actuators are specified, unloaders on valve depressors shall be capable of maintaining the suction valve fully depressed without any plate fluttering, while operating on the minimum specified instrument air pressure.

Pneumatically operated unloaders shall be piped by the manufacturer in such a way that incorrect selection between stages and cylinder ends shall not occur. The vendor shall provide the purchaser with a system of properly sequenced unloader operation see 3.6.2 (Add.)

## **2.8 Piston and Piston Rods**

**2.8.1** The use of cutter pin for positive locking device shall be agreed upon by the Purchaser and the Vendor. (Mod.)

**2.8.3** In case of using segmented wear band, the attaching provision to the piston shall be agreed upon by the Purchaser and the vendor. (Mod.)

**2.8.4** Vendor shall clarify, if any wire-wooling tendency has been experienced for the piston rod area under oil wiper and type of provision which recommended. (Mod.)

## **2.9 Crankshafts, Bearings, and Crossheads**

**2.9.1** When over-sizing of bearings are practicable, Vendor shall advise in his proposal method of shaft under-sizing and/or any other shaft repolishment. (Mod.)

**2.9.4** Antifriction bearings are acceptable for main bearings in Compressors Rated 225 KW or less. (Mod.)

## **2.11 Stuffing Boxes and Packing**

**2.11.2** Gland flanges shall be bolted to the cylinder with at least four stud bolts. Cap bolts are not allowed.

The construction of the stuffing box/distance pieces shall be such that the packing case assembly can be installed as a whole .If this is not possible, the packing case and flange may be separated in sub-assemblies, which shall be provided with separate tiebolts in order to maintain positive alignment during installation in the stuffing box. Packing cases shall be designed to accommodate piston rod movements. (Mod.)

## **2.12 Compressor Frame Lubrication**

**2.12.2** Lubrication systems shall consist of a twin full-flow oil filter.(Mod.)

**2.12.3** The pump shall be a rotary internal screw-or gear-type pump. cast iron or nodular iron construction is not acceptable. (Mod.)

**2.12.4** The Compressor manufacturer shall state in his proposal whether the offered compressor can run down safely without mechanical damage in case of a lube oil pump failure. If not, alternative lubrication proposals are required. (Sub.)

**2.12.5** The relief valve discharge line shall be provided with a sight glass. (Mod.)

**2.12.6** Oil coolers shall comply with IPS-G-ME-220. The vendor shall design the lubrication oil system such that the oil pressure at cooler outlet will be at least 1 bar higher than the maximum water pressure stated in the data sheet, to prevent contamination of the lubricating oil in case of cooler failure. (Mod.)

**2.12.7** Oil filters shall be of disposable type and suitable for the size of particles as specified in data sheet. (Mod.)

**2.12.8** Delete when specified and add the following sentence to the beginning of this clause:

"When the specified minimum ambient temperature is lower than the minimum lube oil temperature required by the manufacturer" (Mod.)

## **2.13 Cylinder and Packing Lubrication**

**2.13.4** Every reciprocating compressor having a Compression cylinder that is designed and intended to function without liquid lubrication shall be provided with a caution notice to that effect. (Add.)

**2.13.5** Instruction manuals for nonlubricated reciprocating compressors shall clearly explain all special maintenance procedures. Particular attention shall be given to avoiding metal-to-metal sliding contact (Add.)

## **2.14 Material**

### **2.14.2 Castings**

**2.14.2.7** Delete if specified, (Mod.)

### **2.14.4 Welding**

**2.14.4.2** Casting repair and procedures shall be subjected to approval by the purchaser. (Mod.)

### **2.14.6 Material inspection**

**2.14.6.1** 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 casting and areas of high stress. Prior to inspection, the purchaser and manufacturer shall agree the critical areas and the type of nondestructive testing which shall be applied. Radiographic inspection shall be applied wherever possible. Ultrasonic inspection shall be used where radiography is not possible. (Mod.)

**2.14.6.4** All casting and forging surfaces shall be examined visually by the manufacturer.

Dye-penetrant inspection shall be used only when magnetic particle inspection is not feasible. (Add.)

## **2.15 Nameplates and Rotation Arrows**

**2.15.3** The text on the nameplates shall be in English language. The information on the nameplates shall include the year of manufacture. Unless otherwise specified, all data on nameplates shall be in SI units. (Mod.)

## **3. ACCESSORIES**

### **3.1 Drivers**

**3.1.5** Electric motors for main drivers as well as auxiliary drivers shall be as specified in the data sheet and shall also comply with IPS-M-EL-132 and IPS-E-EL-110. (Sub.)

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

**3.1.8** Steam turbine drivers shall conform to IPS-M-PM-240 or IPS-M-PM-250 whichever is applicable. Gas turbine driver shall comply with IPS-M-PM-260. (Mod.)

**3.1.13** Internal combustion spark-ignited gas engine drivers shall comply with the requirements of IPS-M-PM-290 and diesel engines shall be per IPS-M-PM-280. (Add.)

## **3.2 Couplings and Guards**

**3.2.1.8** Delete, when specified by the purchaser from this clause. (Mod.)

## **3.3 Reduction Gears**

The gear unit design shall conform to IPS-M-PM-300.(Mod.)

## **3.4 Belt Drivers**

**3.4.1** Belt drives may be used for Compressors 112 kw or less whenever approved by the Purchaser.(Mod.)

## **3.5 Base Plates**

**3.5.5** Delete " when specified " from this clause. (Mod.)

**3.5.11** Unless otherwise specified, anchor bolts shall be provided by Vendor. (Sub.)

**3.5.12** For compressor below 112 kilowatts, skid shall be furnished to accommodate all equipment of each compressor package being furnished and to allow shipment and setting in place as a unit.

Skid will be grouted under main support members only. (Add.)

**3.5.13** Ends of main longitudinal members shall be rounded to permit pulling on to rollers and shall be fitted with a transverse piece of pipe to provide purchaser for pulling. (Add.)

## **3.6 Controls and Instrumentation**

### **3.6.1 General**

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

### **3.6.3 Control station**

**3.6.1.3** A local free standing control cabinet shall be supplied for each compressor unit. (Mod.)

**3.6.3.3** Change item a. as per following:

a. Pressure gages.

- 1) Bearing oil header pressure (down stream of filter )
- 2) Compressor interstage, and discharge pressure. (Mod.)

**3.6.4 Instrumentation**

**3.6.4.1** Add the following items to this clause:

- e) Frame oil level sight gage.
- f) Coolant surge tank level sight gage.
- g) Coolant flow sight indicator.
- h) Thermowell (test connection) intercooler and aftercooler inlets and outlets. (Mod.)

**3.6.4.7 Relief valves**

Brass or cast iron safety relief valves and fittings are not allowed. All safety relief valves shall have inlet and outlet connections flanged. (Mod.)

**3.6.5 Alarms and shutdowns**

**3.6.5.1 General**

Direct switches in alarm and shutdown are not allowed. A combination of signal transmitter with switch and/or trip amplifier shall always be used. (Mod.)

**3.6.5.2 Alarm and trip switches**

**3.6.5.2.2** 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 ect, will cause alarm and/or shutdown (Sub.)

**3.6.5.2.6** As a minimum alarm and trip shall be as per following table: (Mod.)

ITEM	HIGH LEVEL		LOW LEVEL	
	ALARM	TRIP	ALARM	TRIP
FINAL STAGE INLET AIR TEMP.	×	×	—	—
MAIN OIL PUMP PRESS.	×	—	—	—
OIL TEMP.	×	×	×	×
BEARING OIL PRESS.	×	—	×	×
STAGE VIBRATION LEVEL	×	×	—	—
POWER SUPPLY VOLTAGES	×	—	×	—
OIL TANK LEVEL	—	—	×	—
INLET AIR FILTER DELTA P	×	—	—	—
OIL FILTER DELTA P	×	×	—	—
VIBRATION PROBES	×	×	—	—
COOLING WATER FLOW	—	—	×	×
LUBRICATOR RESERVOIR	—	—	×	—

### 3.7 Piping and Appurtenances

**3.7.1.5** Threaded connections are not allowed, except in the following cases :

- Cooling water piping ( not cooling oil for packing cooling).
- Connections to the distance piece compartments for cooling, lubrication and venting purposes.
- Cylinder and packing lubrication connections .

Seal welding of threaded connections is not allowed . If welded connections are required, only full penetration butt welded connection are permitted. (Mod.)

**3.7.1.13** The piping design shall provide access for chemical or mechanical cleaning and inspection. Piping close to the compressor shall be arranged to allow maintenance access to both sides of all cylinders. (Sub.)

### 3.8 Intercoolers and Aftercooler

**3.8.1** The shell and tube heat exchangers shall be designed in accordance with IPS-G-ME-220.(Mod.)

**3.8.7** When air coolers are specified, they shall be in accordance with IPS-G-ME-245.(Sub.)

### 3.10 Pulsation Controls

**3.10.2** The compressor vendor shall furnish the discharge pulsation suppression device and any other stage dampers when required. Pulsation suppression devices are not required at the suction of an air compressor with an atmospheric intake line, or at the interstage of an internal interstage cooler unless calculations indicate pulsations are likely to occur.

The use of intercoolers and/or aftercooler as pulsation suppression device is not permitted.

For multiple adjacent cylinders operating at different pressure levels, the individual pulsation suppression device may be combined, when possible, in a single vessel with internal partitions. (Mod.)

**3.10.3** The suppression device volume shall be at least six times the total piston displacement of all the cylinders connected to the suppression device, and the suppression device diameter shall be at least twice the diameter of the largest connected nozzle . Orifices shall not be utilized for pulsation suppression unless approved by the purchaser.

Internals, such as baffles, tubes, or any construction other than the partitions of combined pulsation suppression device, shall not be used. (Mod.)

**3.10.4** Each internal compartment shall be accessible for inspection. Additional openings shall be provided if full view of internal welds is not afforded by nozzles or other required openings. (Add.)

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

### 4.1 General

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

- Name of purchaser.
- Purchase order number and date.
- Manufacture'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.)

## **4.2 Inspection**

**4.2.2** Major components shall be examined by means of radiographic, Magnetic particle, Dye penetrant, or ultrasonic methods for surface and subsurface defects. The list of such components will be specified by Purchaser at enquiry stage. (Mod.)

## **4.3 Testing**

**4.3.1.2** Delete and substitute 15 working days.

### **4.3.2 Hydrostatic test**

**4.3.2.3** Test shall be maintained for a minimum of 4 hours (Mod.)

### **4.3.3 Mechanical running tests**

**4.3.3.6** Post-test inspection shall include the following as a minimum:

- 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 (2.6.1.4.).
- 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 crosshead to be checked for correct bonding of babbitt material to the base metal and for correct bearing surface.
- Crankshaft journal, crank pin and crosshead 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 bearings.
  - . Correct securing of lubricating oil piping in the crank- case. (Mod.)

#### **4.3.4.2 Complete-unit tests**

Details of the extent and the procedure of test shall be included in the proposal. The final version of the test procedure shall be subject to the Purchaser's approval. (Mod.)

### **4.4 Preparation for Shipment**

**4.4.1** Delete 6 months and substitute 12 months.

**4.4.3.8** Separate Shipment is not Permitted unless approved otherwise by the Company. (Mod.)

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

### **5.1 Proposals**

A list of spare parts for two years of continuous operation, including price list shall be submitted.

Vendor proposal for spare parts shall include proposed method of protection from corrosion during shipment and subsequent storage. (Mod.)

### **5.2 Contract Data**

#### **5.2.4 Data**

**5.2.4.3** Add "Illustrated " before parts list. (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 equipment shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheets. (Add.)

**APPENDICES****APPENDIX A**

SI data sheets shall be used unless otherwise specified. (Mod.)

**APPENDIX D**

Repairs to gray and nodular iron castings.

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

**APPENDIX G  
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 Systems.

**TABLE G - 1**

NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE		NOMINAL SIZE	
DN (1)	NPS (2)	DN	NPS	DN	NPS	DN	NPS
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 H  
PIPE FLANGES PRESSURE TEMPERATURE RATING**

The purpose of this appendix is to establish an equivalent identity for the pipe flange nominal pressure temperature ratings in imperial system and SI system.

**TABLE H - 1**

<b>PN (1)</b>	<b>ANSI RATING, CLASS</b>
20	150
50	300
68	400
100	600
150	900
250	1500
420	2500

1) Pressure nominal, bar.

(Add.)