

MATERIAL AND EQUIPMENT STANDARD

FOR

CENTRIFUGAL COMPRESSORS

FOR

PROCESS SERVICES

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0. INTRODUCTION

This Specification gives amendment and supplement to API Standard 617, fifth edition April 1988: "Centrifugal Compressors for General Refinery Services"

It shall be used in conjunction with data/requisition sheets for centrifugal compressors.

For ease of reference, the clause or section numbering of API Std 617 has been used throughout this specification.

Clauses in API Std. 617 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 without any 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 description and/or statement is added to that clause.

1. GENERAL

1.1 Scope

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

Machines classed as fans or blowers and packaged-integrally. Geared-centrifugal air Compressors are not covered by this Specification. Selected equipment shall be in all respect, well within the range of manufacturer's proven experience and shall not involve the use or application of any prototype design or components.

No deviations or exceptions from this Standard shall be permitted, without explicit approval of the company.

Intended deviations shall be separately listed by the vendor, supported by reason thereof and submitted for company's consideration. (Sub.)

1.2 Alternative Design

Equipment SI Unit System, dimension and rating in accordance with IPS-E-GN-100 shall be used, Unless otherwise specified. (Mod.)

1.3 Conflicting Requirements

In the case of conflict between documents relating to the inquiry or order, the following priority of documents (whichever is more stringent realized by company) shall govern:

- First priority** : Purchase order and variations thereto.
- Second priority** : Data sheets and drawings.
- Third priority** : This Specification.

All conflicting requirements shall be referred to the purchaser in writing.

The purchaser will issue confirmation document if needed for clarification. (Sub.)

1.4 Definition of Terms

1.4.22 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 G in this Standard Specification. (Add.)

1.4.23 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 H in this Standard Specification. (Add.)

1.5 Referenced Publications

The editions of the following standards and codes that are in effect at the time of publication of this Standard shall, to the extent specified herein, form a part of this Standard. The applicability of changes in standards and codes that occur after the date of this Standard shall be mutually agreed upon by the company and the vendor:

IPS (IRANIAN PETROLEUM STANDARDS)

M-PM-240	"General Purpose Steam Turbine"
M-PM-250	"Special Purpose Steam Turbine"
M-PM-260	"Industrial Combustion Gas Turbine for Process Services"
M-EL-132	"Induction Motors"
M-PM-300	"Special Purpose Gear Units for Process Services"
E-GN-100	"Units"
M-PM-320	"Lubrication, Shaft Sealing and Control Oil System for Special Purpose Application"
E-SF-900	"Noise and Vibration Control System"
E-EL-110	"Electrical Area Classification and Extend"
M-PM-110	"Special Purpose Couplings"

2. BASIC DESIGN

2.1 General

2.2.1 Compressor ratings shall not exceed the limits of the Vendor’s design but shall be well within the manufacturer’s actual experience. Only equipment which has proven its reliability is acceptable (Mod.).

2.1.8 Unless otherwise specified, compressors and auxiliaries shall be suitable for outdoor installation in the climatic zone specified (Mod.).

2.1.9 Compressors shall be designed to minimize the generation of noise and shall not exceed the noise limits given in the following Table, at any measuring location not less than 1m from the equipment surface.

Sound Pressure Limit in dB re 20 μPa	

Compressor	87 dB

Compressor + Driven	90 dB

If the equipment produces impulsive noise, the above limits shall be taken 5dB lower, thus 82dB for compressor and 85dB for the compressor + driver.

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.

Where excessive noise from equipment can not be eliminated by low noise design, corrective measures may take the form of acoustic insulation for pipes, gearboxes, etc. Where acoustic insulation and/or 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 operations nor any obstruction to routine maintenance activities (Sub.).

2.1.14 All electrical components and installations shall be suitable for the area classification, gas grouping and temperature classes specified by the purchaser on the data sheets, and, shall meet the requirements of IPS Standards M-EL-132 and E-EL-110 (Sub).

2.2 Casing

2.2.6 Casings shall be made of cast steel unless otherwise noted on compressor data sheet (Sub.).

2.2.7 Cast Iron casings are not acceptable (Sub.).

2.2.8 Radially split (barrel) casings and their end covers shall be forged steel if the design pressure exceeds 6900 kPa (69 Bar) or any molecular weight specified is less than 15. (Mod.)

2.3 Inter Stage Diaphragms and Inlet Guide Vanes

2.3.6 When flushing is specified, width of diffuser Passages at no point shall be less than the width of the narrowest impeller gas passage (Add.).

2.4.2 Main Process Connections

2.4.2.4 Delete this clause. (Del.)

2.6 Rotating Elements

2.6.2 Shaft ends for coupling fits shall conform to IPS-M-PM-310. (Sub.)

2.6.7 Normally the impellers shall be of the closed type.

Revited type impellers are not acceptable. (Mod.)

2.6.9 Crack defect repair is not acceptable. (Mod.)

2.6.18 Impellers shall be designed to limit the maximum stress at maximum continuous speed to a value of 70% of the material yield strength (Add.).

2.7 Bearings and Bearing Housings

2.7.1 General

2.7.1.2 Delete unless otherwise specified. (Mod.)

2.8 Shaft Seals

2.8.3 Shaft seals in inert gas service shall be of the labyrinth type. Shaft seals in toxic gas services shall be of the liquid-film type unless otherwise specified. (Mod.)

2.8.4 The guaranteed figure for total waste seal oil leakage for both seals (per case) shall not exceed 50 lit/day. No waste oil shall be returned to the oil system unless all contaminating components are removed. (Mod.)

2.8.7 When buffer gas injection is required for compressor the supplier shall specify gas requirement and furnish complete system. The piping system for continuous buffer gas injection shall include dual 100 mesh (150µm) strainer, auto-

matic differential pressure controller, low pressure alarm and buffer gas pressure gage and cooler if required. Piping down stream, of strainer shall be stainless Steel (Mod.).

2.8.9 Various supplemental devices shall be provided to ensure sealing when the compressor is pressurized but not running and the seal oil system is shutdown. (Mod.)

2.9 Dynamics

2.9.1.7 Unless otherwise specified the compressor Vendor shall be unit responsible for train critical speed calculations and shall furnish satisfactory verification of critical speed calculations, including all driver train components prior to submittal of certified composited outline drawing.

Both torsional and lateral vibration analysis are the complete responsibility of the compressor Vendor. The Vendor shall furnish a copy of this analysis and related data for review (Mod.).

2.9.2.3 A train lateral analysis, considering the effect of other equipment in the train on the damped unbalance response analysis, shall be quoted as an option by the vendor who is assigned unit responsibility. (Sub.)

2.9.2.4.b Calculated unbalance response curves of shaft deflection against rotor speed at each bearing, at shaft mid span, and at two shaft ends shall be submitted to purchaser for review.

e. Delete "when specified". (Mod.)

2.10 Lube-oil and Seal-oil Systems

2.10.5 Lubricating Oil and Seal Oil systems shall comply with API Std 614 as amended/supplemented by M-PM-320. (Sub.)

2.11 Material

2.11.1.2 When vendor's quoted material specification is DIN, JIS or other foreign standards, the proposal shall include the nearest above named American specification equivalent along with exact and specific deviations, (chemical properties, physical properties, tests, type of heat treatment, etc.) if such exist, for purchaser's evaluation of equivalence for service intended. (Mod.)

Radiographic inspection procedure shall be applied wherever possible. Butt welded joints of pressure casing shall be 100% radiographed (Mod.).

2.12 Nameplates and Rotation Arrows

2.12.3 The text on nameplates shall be in English and, the data shall be in SI Units, Unless otherwise specified (Mod.).

3. ACCESSORIES

3.1 Drivers

3.1.4 Steam turbine drivers shall conform to API Std. 611 as supplemented by IPS Std M-PM-240 or with API Std. 612 as supplemented by IPS Std. M-PM-250 whichever is applicable (Mod.).

3.1.5 Electric motor drivers shall comply with IPS Std. M-EL-132 (Mod.).

3.1.6 Gas turbine drivers shall conform to API Std. 616 as supplemented by IPS Std. M-PM-260. (Mod.)

3.1.7 Gears shall be in accordance with API Std. 613 as supplemented by IPS-M-PM-300. (Mod.)

3.1.8 Motors for auxiliary equipment shall comply with IPS Std. M-EL-132. (Mod.)

3.3 Mounting Plates

3.3.2.8 Unless otherwise specified a common baseplate extended as practically as possible to support the driver, other compressors, gears shall be provided (Sub.).

3.4 Controls and Instrumentation

3.4.3.1 Minimum Instrumentation and process controls shall be furnished as specified and listed in Table 1 on page 12.

Any additional instrumentation and controls as deemed necessary for the smooth and safe operation of the unit under all specified operating conditions shall be provided.

Compatibility of overall compressor control system with the furnished instrumentation and controls, shall be ensured.

The nominal supplies and location of each instrument written in the table shall be indicated by the following coded notes:

- (F)** Furnished by compressor manufacturer
- (C)** Furnished by others
- (LM)** Locally mounted
- (LP)** Local panel mounted
- (MB)** Main control board mounted (Mod.)

TABLE 1 - CONTROLS AND INSTRUMENTATION

INSTRUMENTS	SUPPLY & LOCATION
a) PRESSURE AND LEVEL GAGES, PRESSURE CONTROLS CONTROL VALVES, THERMOMETERS, PRESSURE AND TEMPERATURE SWITCHES, AND RELIEF VALVES AT THE COMPRESSOR FOR SEPARATE LUBE OIL SYSTEMS.	LM-(F)
b) PRESSURE AND LEVEL GAGES, LEVEL CONTROLS, PRESSURE CONTROLS, CONTROL VALVES, THERMOMETERS; PRESSURE AND TEMPERATURE SWITCHES FLOW METERS OR INDICATORS, AND RELIEF VALVES, FOR SEAL OIL SYSTEM.	LM-(F)
c) START AND STOP PUSH BOTTON STATION WITH PILOT LIGHTS FOR LUBE OIL PUMP MOTOR AND SEAL OIL PUMP MOTOR.	LP-(F)
d) DIAL SPEED INDICATOR FOR COMPRESSOR.	LM-(F)
e) PRESSURE GAGE FOR COMPRESSOR SUCTION.	LP-(F)
f) PRESSURE GAGE FOR LUBE OIL PUMP DISCHARGE.	LM-(F)
g) PRESSURE GAGE FOR SEAL OIL PUMP DISCHARGE.	LM-(F)
h) PRESSURE GAGE ON AIR SUPPLY FOR FLOW REGULATOR TO SEALS.	LM-(F)
i) PRESSURE GAGE FOR LUBE OIL TO COMPRESSOR BEARINGS.	LP-(F)
j) PRESSURE GAGE FOR LUBE OIL TO TURBINE BEARINGS.	LP-(F)
k) PRESSURE GAGE FOR TURBINE INLET STEAM.	LP-(F)
l) PRESSURE GAGE FOR TURBINE EXHAUST STEAM.	LP-(F)
m) PRESSURE GAGE FOR FIRST STAGE PRESSURE FOR MULTIVALVE TURBINES, OR FOR STEAM CHEST FOR SINGLE VALVE TURBINES.	LP-(F)
n) SPEED INDICATOR FOR TURBINE.	LM-(F)
o) HAND INDICATING SPEED CONTROLLER FOR TURBINE GOVERNER.	LP-(F)
p) DIFFERENTIAL PRESSURE GAGE FOR SEAL OIL.	LP-(F)
q) GAGE GLASS FOR SEAL OIL OVERHEAD TANK.	LM-(F)
r) HIGH SEAL OIL RETURN TEMPERATURE.	LM-(F)

A free standing local control panel shall be supplied by the Vendor, completely enclosed and sealed and suitable for pressurizing to keep out dust.

The panel shall include all the applicable items listed, together with alarm lights suitably screened to be easily visible in bright sunlight and other process instruments as required.

Access for easy maintenance to this panel shall be provided, and location of the panel shall be so as to facilitate easy control of the equipment.

Consideration may also be given to the installation of a separate ground mounted panel to cover auxiliary equipment mounted on the console if easier operation would result (Mod.).

3.4.5 Alarms and Shutdown

3.4.5.1 Alarms and instruments in Table 2 shall be furnished. Local alarm lights shall indicate green for normal operation and red, independent of shutdown devices (Mod.).

TABLE 2 - ALARMS AND SHUTDOWNS

SERVICE	ALARM LIGHTS	ALARM SWITCHES	SHUTDOWN DEVICE
LOW LUBE OIL PRESSURE	LP-(F) MB-(C)	LM-(F)	(F)
LOW DIFFERENTIAL PRESSURE OF SEAL OIL (LOW LEVEL IN OVERHEAD TANK)	LP-(F)	LM-(F)	None
HIGH DIFFERENTIAL PRESSURE OF SEAL OIL (HIGH LEVEL IN OVERHEAD TANK)	LP-(F)	LM-(F)	None
HIGH LUBE OIL TEMP. OF OIL COOLER	LP-(F)	LM-(F)	None
HIGH COMPRESSOR DISCHARGE TEMPERATURE	MB-(C) LP-(F)	LM-(F)	(F)
LOW LEVEL IN LUBE OIL RESERVOIR	LP-(F)	LM-(F)	None
LOW LEVEL IN SEAL OIL RESERVOIR	LP-(F)	LM-(F)	None
AXIAL MOVEMENT OF COMPRESSOR SHAFT	LP-(F)	LM-(F)	(F)
HIGH VIBRATION OF COMPRESSOR	LP-(F)	LM-(F)	(F)
MAIN SEAL OIL PUMP FAILURE	LP-(F) MB-(C)	LM-(F)	None
MAIN LUBE OIL PUMP FAILURE	LP-(F) MB-(C)	LM-(F)	None
START STANDBY LUBE OIL PUMP	LP-(F) MB-(C)	LM-(F)	None
START STANDBY SEAL OIL PUMP	LP-(F)	LM-(F)	None
HIGH TEMPERATURE IN LUBE OIL RESERVIOR (IF HEATING COIL FITTED)	LP-(F)	LM-(F)	None
HIGH TEMPERATURE IN LUBE OIL RESERVIOR (IF HEATING COIL FITTED)	LP-(F)	LM-(F)	None

3.4.7 Vibration, position and bearing temperature detectors

3.4.7.1 a) Vibration and axial displacement measurement probes shall be installed in removable, externally mounted probe holders. Each holder shall be shouldered so that probe location is maintained when the probe is removed and reinstalled. Both the probes and the holders shall be securely locked in place. Mountings shall permit removal and installation during compressor operation with a minimum spillage of oil.

b) The shaft, in the region of the radial probes, shall present an un-plated, ground surface, having a total run-out not exceeding 25% of the specified test level or 6 microns, which ever is greater. The shaft shall be demagnetized prior to the installation of the probes.

c) Readout equipment provided for continuous monitoring of the vibration/axial displacement shall match the characteristics of the detector-probe system and shall not require field calibration. Standardized cable lengths shall be used to interconnect the detector probe and readout equipment. Radial vibration readout equipment shall be suitable for combining the two signals from H/V probes in the right phase and shall indicate the real value of the maximum peak to peak displacement. Readout equipment shall be mounted on the local panel. Each monitor shall be provided with jack connectors, one per probe to permit connection of portable analysis equipment (oscilloscope, etc.). The supplier shall indicate the settings for the alarm and shutdown in case of excessive radial vibration and axial displacement. Alarm and shutdown signals shall be individually connected to the alarm and shutdown alarm annunciation system of the compressor unit (Mod.).

3.5 Piping and Appurtenances

3.5.1.2 All interconnecting piping between the twin units, the lube and seal oil console(s) and the various equipment groupings shall also be provided. All piping for utilities (cooling water, steam, instrument air, purge gas, buffer gas etc.) shall be provided and arranged in a way that will permit single inlet/outlet connections. (Mod.)

3.6 Special Tools

3.6.1 For radially split units, vendor shall furnish a cradle or similar device for ease of removal of the compressor rotor and diaphragm. (Mod.)

4. INSPECTION, TESTING AND PREPARATION FOR SHIPMENT

4.1 General

4.1.2 Auxiliary equipment such as drivers, gears, and oil systems shall be inspected and tested in accordance with the specified IPS and/or API standards for the equipment as well as the requirements (including specified optional test) of this standard. (Sub.)

4.1.3 The vendor shall notify the purchaser not less than 15 days before the date that equipment will be ready for test. (Mod.)

4.1.5 The purchaser's representative shall have the right to reject any parts of the equipment which do not conform to purchase order. (Mod.)

4.2 Inspection

4.2.5 Any portion of the oil system furnished shall meet the cleanliness requirements of the IPS-M-PM-320. (Sub.)

4.2.6 Final inspection for cleanliness of the compressor piping and auxiliary equipment shall be performed (Mod.).

4.2.7 Delete "when specified" from this clause.

4.3 Testing

4.3.1 General

Acceptance of shop test does not constitute a waiver of equipment to field performance under specified operating conditions nor does inspection relieve the vendor of his responsibilities. (Mod.)

4.3.3 Each impeller shall be subjected to an over speed test at not less than 115 percent of maximum continuous speed for a minimum duration of 3 minutes (Mod.).

4.3.4 Mechanical running test

4.3.4.1.2 During the mechanical running test the lubricating oil and seal oil temperatures shall be held for a minimum period of 30 minutes at the temperature corresponding to the minimum allowable viscosity and per 30 minutes at the temperature corresponding to the maximum allowable viscosity (Mod.).

4.3.4.1.3 Delete "API standard 614" and substitute IPS standard M-PM-320. (Mod.)

4.3.4.2.4 The amount of inward oil leakage (contaminated oil) from each seal with approximate design differential pressure established, shall be measured during the fear hours test. Seal leakage, rates, per seal shall not exceed the guaranteed maximum rates stated in vendor's proposal. (Mod.)

4.3.4.3.6 Delete "when specified" and add following paragraph.

Vendor shall make tapes starting with initial shop run, even if not witnessed or observed. (Mod.)

4.3.4.3.7 Delete "when specified" from this clause. (Mod.)

4.3.6 Optional test

4.3.6.1.1 If a performance test is specified. it shall be conducted in accordance with ASME PTC-10, and the following information shall be furnished prior to the test :

- a) Identification of the class of test (I,II or III) required to meet objectives and selection of operating conditions to satisfy the limitations outlined in Table 1,2,3 and 4 of ASME PTC-10.
- b) The nature of the test gas, if the design or specified gas can not be used and the means for establishing its physical and thermodynamic properties.
- c) Procedures to be employed for adjusting test results to specify operating conditions with respect to test classifications I,II and III (Mod.).

4.3.6.8 Following the mechanical run test, the compressor shall be opened for internal inspection. Leak test per para. 4.3.5 shall be conducted after assembly (Mod.).

4.4 Preparation for Shipment

4.4.1 The preparation shall make the equipment suitable for 12 months of outdoors storage from the time of shipment (Mod.).

4.4.3.6 The height of shanks shall be at least 35mm (Mod.).

4.4.3.9 Separate shipment of the material is not permitted (Mod.).

5. VENDOR'S DATA

5.2 Contract Data

5.2.7 Installation and Instruction manuals.

5.2.7.4 An illustrated part list shall be furnished. (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.

6.2 Performance

The compressor shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheet. Performance tolerances should be as detailed in API 617 para. 4.3.6.1.

APPENDICES**APPENDIX A**

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

APPENDIX G (Add.)

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.

**APPENDIX H (Add.)
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 sys

PN RATING-* Bar	ANSI RATING 1b
20	150
50	300
65	400
100	600
150	900
250	1500
420	2500

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