

MATERIALS AND EQUIPMENT STANDARD

FOR

CENTRIFUGAL PUMPS FOR PROCESS SERVICES

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0. INTRODUCTION

This standard specification gives the amendment and supplement to API Standard 610, seventh edition February 1989 "Centrifugal Pumps for General Refinery Services"

It shall be used in conjunction with data sheets for centrifugal pumps.

For ease of reference, the clause or section numbering of API Standard 610 has been used throughout of this specification.

Clause in API Standard 610 not mentioned remain unaltered.

For the purpose of this specification, the following definitions shall hold.

- Sub. (Substitution) : The API Standard clause is deleted and replaced by a new clause.
- Del. (Deletion) : The API Standard clause is deleted without any replacement.
- Add. (Addition) : A new clause with a new number is added.
- Mod. (Modification) : Part of the API Standard clause is modified, and/or a new description and/or condition is added to that clause.

1. GENERAL

1.1 Scope

1.1.1 This specification, contains the minimum technical requirements for centrifugal pumps for use in refinery services, chemical plants, gas plants, petrochemical plants and where applicable , in exploration, production and new ventures.

This standard shall also apply to hydraulic power recovery turbines. (Sub.)

1.1.3 Selected equipment shall be, in all respect, well within the range of the manufacturer's proven experience, and shall not involve the use or application of any prototype design or components. (Add.)

1.2 Alternative Design

1.2.1 Equivalent SI Unit system, dimensions and ratings shall be substituted. (Mod.)

1.3 Conflicting Requirements

In the case of conflict between documents relating to the inquiry or order, the following priority of documents shall apply:

- First priority : Purchase order and variations thereto
- Second priority : Data sheets and drawings
- Third priority : This standard specification (Sub.)

1.4 Definition of Terms

1.4.39 Pipe size

The international nomenclature diameter nominal written as DN 15, 20, 25, 32, 40, etc. has been used for pipe size in accordance with ISO 6708-1980 and Appendix R in this standard specification. (Add.)

1.4.40 Pressure - temperature ratings

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 B 16.5-1981, ISO 7268-1983, and Appendix S in this standard specification. (Add.)

1.5 Referenced Publications

1.5.1 The latest editions of the following standards, codes and specifications shall be applied in addition to those stated in API Standard 610, 7th. edition 1989.

IPS (IRANIAN PETROLEUM STANDARDS)

- M-EL-132 "Induction Motors"
- M-PM-115 "Centrifugal Pumps for General Services"

M-PM-240	"General Purpose Steam Turbines"
M-PM-250	"Special Purpose Steam Turbines"
M-PM-260	"Combustion Gas Turbines"
M-PM-270	"Expansion Turbines"
M-PM-280	"Internal combustion diesel engine"
M-PM-320	"Lubrication, Shaft Sealing and Control Oil Systems for Special Purpose Application"
E-SF-900	"Noise and Vibration Control"

ISO (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

2954	"Mechanical Vibration of Rotating Machinery"
6708	"Pipe Components-Definitions of nominal pressure"

1.5.3 Delete this clause of API Standard. (Del.)

2. BASIC DESIGN

2.1 General

2.1.9 NPSH required shall be less than NPSH available by at least 500 mm. Where net NPSH is below 500 mm, an alternative pump shall be recommended. (Mod.)

2.1.11 Pumps shall have stable head capacity curves which continuously rise to shut off. The head rise shall be at least 10% of the head at rated capacity. (Mod.)

2.1.12 The rated capacity shall not exceed the capacity by the best efficiency point of the curve. (Sub.)

2.1.13 Pumps shall be designed to minimize the generation of noise and shall not exceed noise limits given in IPS-E-SF-900.

Unless otherwise specified, the following limits shall be met at any measuring location 1 m from the equipment surface:

<u>Sound Pressure Limit in dB re 20 μPa</u>	
Pump	87 dB
Pump + driver	90 dB

If the equipment produces impulsive and/or narrow band noise, the above limits shall be taken 5 dB lower, thus 82 dB for pump and 85 dB for pump + driver.

Noise levels shall have an upper tolerance of +0 dB.

The above requirements apply in absence of reverberation and background noise from other sources and for all operating conditions between minimum flow and rated flow.

Sound tests shall be made with the pump operating at rated speed and rated power. (Sub.)

2.1.14 Any pump with constant speed driver, requiring a maximum impeller diameter to meet the rated pumping conditions is not acceptable. The impeller diameter shall be such that at least a 5% increase in head at the rated capacity can be obtained by installing a larger diameter impeller of the same patterns. (Mod.)

2.1.17 Liquid cooling shall be offered for the following pumping temperatures:

Bearing :	Above 150 °C
Pedestals :	Above 260 °C (Mod.)

2.1.29 Unless otherwise specified, pumps and auxiliaries shall be suitable for outdoor installation. (Mod.)

2.2 Pressure Casing

2.2.3 Pump regions that are subject to the suction pressure are to be designed for the maximum allowable working pressure. (Mod.)

2.2.4 The inner casing of double casing pumps shall be designed to withstand the maximum differential pressure plus 5%, or 340 kPa(gage), whichever is greater. (Mod.)

2.2.4.1 Pressure casings shall not be of the multiple segmented type for the inner casing of double casing pumps unless otherwise approved. (Add.)

2.2.9 Horizontal pumps shall be centerline mounted for pumps with pumped liquid temperatures of 120°C or higher. (Mod.)

2.3 Nozzles and Pressure Casing Connections

2.3.1.1 All pumps shall have suction flanges of the same ANS pressures /temperature ratings as the discharge flanges to permit testing under the required full test pressure. If bored and tapped nozzles are the manufacturer's standard practice, they may be used for sizes DN 40 and smaller in non hazardous services. Flanged nozzles shall be used for pipe sizes DN 50 and larger. Screw on flanges shall not be used.(Mod.)

2.3.2.10 For horizontal multistage pumps, a drain shall be provided on the first and final stages unless otherwise specified. (Mod.)

2.5 Rotating Elements

2.5.6 Shaft sleeves are required for all pumps.

Shaft sleeves shall be coated with Colmonoy 6 or Stellite 6 over the area in contact with the flexible sealing member. Materials with better performance may be used if approved by the purchaser. (Mod.)

2.6 Wear Rings

2.6.5 Axial threaded dowels are preferred. (Mod.)

2.7 Seals

2.7.1.1 Mechanical seal selection shall be based on the following criteria:

- a) All normal services, conventional mechanical seals, temperature range 0-120°C.
- b) For temperature range 120°C up to 315°C conventional mechanical seals with auxiliary cooling and product circulation facilities where character of pumping liquid permits such application.
- c) For hot services where pumping liquid is dense viscous and dirty, 232°C to 427°C pumps shall use appropriate approved packing unless otherwise specified on the data sheet.

d) Bellows type seals with oil metallic parts shall be used for hot services where liquid is clean , and dead-end operation is preferred, 232°C up to 427°C. (Mod.)

2.7.1.2 Unbalanced mechanical seals are unacceptable for pumps in process services. (Mod.)

2.7.1.7 The seal end plate at the throttle bushing shall be provided with minimum DN15 NPT vent and drain connections for external water/steam quench. (Mod.)

2.7.1.8 Vertical, in-line close-coupled pumps shall be equipped with a vent line and valve at the highest point of the shaft sealing space. (Mod.)

2.7.1.17 The arrangement of pump stuffing box and seal gland shall be designed to accommodate both mechanical type seals and braided type packing (Add.)

2.7.1.18 Pumps equipped with mechanical seals shall be designed so that the mechanical seals can easily be removable with minimum dismantling of other parts of the pump. (Add.)

2.7.2.1 The inlet and outlet connections shall be suitably plugged where no liquid injection is required, irrespective of whether a mechanical seal or conventional packing is used. (Mod.)

2.8 Dynamics

2.8.2.3 Delete when specified from this clause. (Del.)

2.8.3.4 Delete when specified from this clause. (Del.)

2.8.4.1 Rotor assemblies shall be dynamically balanced. (Mod.)

2.8.4.8 During the shop test of pumps with hydrodynamic radial bearings operating at any speed within the specified operating range, the vibration velocity shall not exceed 4.5 mm/s RMS and maximum allowable unfiltered double amplitude of vibration, including the shaft run out, shall not exceed the following values:

FLOW RANGE IN % OF FLOW AT BEP

Speed	25 - 49	50 - 110	111 - 125
r/min	DOUBLE AMPLITUDE OF VIBRATION IN μm		
Below 1000	100	80	100
1000 - 4500	80	65	80
4501 - 6000	60	50	60
Over 6000	50	40	50

Proximity probes in accordance with API Std 670 shall be used to measure the shaft vibration adjacent and relative to the bearing. (Mod.)

2.8.4.9 For vertical, in-line, close-coupled pumps vibration readings shall be taken on both bearings of the electric motor driver in the horizontal plane at 90° to each other. For vertical pumps with a flexible coupling, additional readings shall be taken at the pump top bearing. (Mod.)

2.10 Lubrication

2.10.5 Where a pressure lubrication system is specified, the system shall be designed in accordance with IPS-M-PM-320. (Sub.)

2.11 Materials

2.11.1.4 Outer barrels of enclosed pumps shall be of carbon steel or alloy steel. (Mod.)

2.11.3.3 Visual inspection plus magnetic particle or liquid penetrant inspection plus radiographic or ultrasonic inspections are required for attachment of suction and discharge nozzles. (Mod.)

2.11.1.14 The manufacturer's quality control program shall be made available for review by the purchaser, or his representative, at the inquiry stage or whenever requested. (Add.)

2.12 Nameplates and Rotation Arrows

2.12.2 The text on nameplates shall be in English language and the data shall be as specified in data sheets. (Mod.)

3. ACCESSORIES

3.1 Drivers

3.1.5 Motors for the pump drivers shall be in accordance with IPS-M-EL-132, and characteristics specified in data sheets. (Sub.)

3.1.10 Steam turbines shall comply with the requirements of IPS-M-PM-240, or IPS-M-PM-250. (Mod.)

3.1.11 Unless otherwise specified, gears shall conform to IPS-M-PM-300. (Sub.)

3.1.14 Gas turbine for the pump drivers shall be in accordance with IPS-M-PM-260.

Diesel engines for the pump drivers shall be in accordance with IPS-M-PM-280. Gas engines shall comply with the requirements of IPS-M-PM-290. (Add.)

3.1.15 For motor drivers, the gland connection of the conduit box shall be so arranged as to permit cable connection without excessive bending. (Add.)

3.2 Coupling and Guards

3.2.2 The couplings shall be metastream flexible spacer type made of steel hubs and laminated disc of stainless steel construction, unless otherwise specified. (Mod.)

3.2.7 Couplings of operating at speeds above 4000 revolutions per minute and couplings for high energy pumps shall be dynamically balanced. (Mod.)

3.2.14 The coupling guard shall be of non sparking material. (Mod.)

3.3 Mounting Plates

3.3.1.13 The support pedestals shall be cooled when pumping temperature is 260°C or higher. (Mod.)

3.3.1.15 In addition to alignment screws, vertical leveling screws shall be provided for pumps weighing over 600 kg. (Mod.)

3.3.1.19 Unless otherwise specified anchor bolts will be furnished by the vendor. (Sub.)

3.4 Instrumentation

3.4.4 Vibration, position, and temperature detectors

3.4.4.1 Sleeve bearing pumps shall have a provision to permit shaft vibration measurements using a non contact vibration probe at each bearing, when required by specific condition. (Mod.)

3.5 Piping and Appurtenances

3.5.1 General

3.5.1.1 Standard materials for cooling water piping shall be seamless steel piping.

Copper tubing and brass fittings are not acceptable. (Mod.)

3.5.1.13 Openings shall be identified with metal tags preferably riveted as to their intended services. (Add.)

4. INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

4.1 General

4.1.4 The vendor shall operate a quality management system to ensure that the technical requirements of this Standard are achieved. Purchaser may require demonstration of the quality system, but this may be waived if the system has been verified recently by an accreditation scheme acceptable to purchaser.

The vendor shall ensure that QA requirements specified in the enquiry and purchase documents are applied to all materials, equipment and services provided by sub-contractors and to any free-issue materials. (Mod.)

4.1.7 Purchaser's representative shall have the right to reject any parts of equipment which do not conform to the Purchase Order. (Add.)

4.2 Inspection

4.2.1 General

4.2.1.3 Pressure-containing castings shall be inspected in accordance with the requirements of the relevant inspection category. The inspection category shall be determined from the relationship of maximum allowable working pressure and pumping temperature as shown in Fig. 1 of this Standard. However, Category A shall be limited to casing manufactured from cast iron and cast steel. For other materials within the Category A envelope, Category B inspection is required.

The minimum inspection requirements shall be as follows:

Category A

Visual inspection in accordance with following para.

All surfaces shall be visually inspected to ensure conformity with relevant specification.

Prior to inspection, the surfaces shall be prepared by shot blasting, grinding, or both.

Category B

Visual inspection (Category A) and magnetic particle or liquid penetrant inspection in accordance with 4.2.2.4 or 4.2.2.5 of this IPS Standard and/or API Standard.

Liquid penetrant inspection shall be employed only when magnetic particle inspection is not feasible.

Category C

Category B inspection, together with radiography or ultrasonic inspection in accordance with 4.2.2.2 or 4.2.2.3 of this IPS Standard and API Std.

Ultrasonic inspection shall be employed when radiography is not feasible, and its application shall always be considered when section thickness exceeds 50 mm.

Defect acceptance levels for ultrasonic inspection shall be subject to approval by the purchaser. (Sub.)

4.2.2 Material inspection

4.2.2.2 Radiography

4.2.2.2.1 Areas of the casting to be examined by radiography shall be subject to approval by purchaser prior to examination, but shall include any regions of abrupt section change, weld ends, and areas adjacent to feeders and risers. (Mod.)

4.2.2.4 Magnetic particle inspection

4.2.2.4.1 Magnetic particle inspection when specified shall be applied to all accessible surfaces, including those exposed by machining. (Add.)

4.2.2.4.2 For each type of defect, the degree of severity shall not exceed the following limits.

TYPE	DEFECT	MAXIMUM SEVERITY LEVEL
I	LINER DISCONTINUITIES (HOT TEARS AND CRACKS)	NOT ACCEPTABLE
II	SHRINKAGE	2
III	INCLUSIONS	2
IV	INTERNAL CHILLS AND UNFUSES CHAPLETS	1
V	POROSITY	1
VI	WELDS	1

(Mod.)

4.3 Testing

4.3.1 General

4.3.1.2 Change 6 weeks to 8 weeks. (Mod.)

4.3.1.3 Change 5 days to 15 days. (Mod.)

4.3.2 Hydrostatic test

4.3.2.4 Change 30 minutes to 4 hours. (Mod.)

4.3.3 Performance test

4.3.3.1.3 Oil system components downstream of the filters shall meet the cleanliness requirements of IPS-M-PM-320. (Mod.)

4.3.3.2.3 Variable speed pumps shall be tested additionally at maximum continuous speed and at minimum allowable speed. (Mod.)

4.3.3.2.4 Tests shall include a 4 hour run at maximum continuous speed and rated capacity (Add.)

4.3.3.3.1 Vibration shall also be measured at all specified operating flows, at minimum continuous stable flow and at 125% rated flow. (Mod.)

4.3.3.3.2 When pumps are fitted with hydrodynamic thrust bearings, axial loads shall be measured during the performance test. The flow rates at which axial loads are to be measured shall be subject to agreement between purchaser and the vendor, but should normally be shutoff, minimum continuous stable flow, midway between minimum and rated flow, and 125% of rated flow. For variable speed units, axial loads shall be measured at maximum continuous speed and minimum continuous speed. (Mod.)

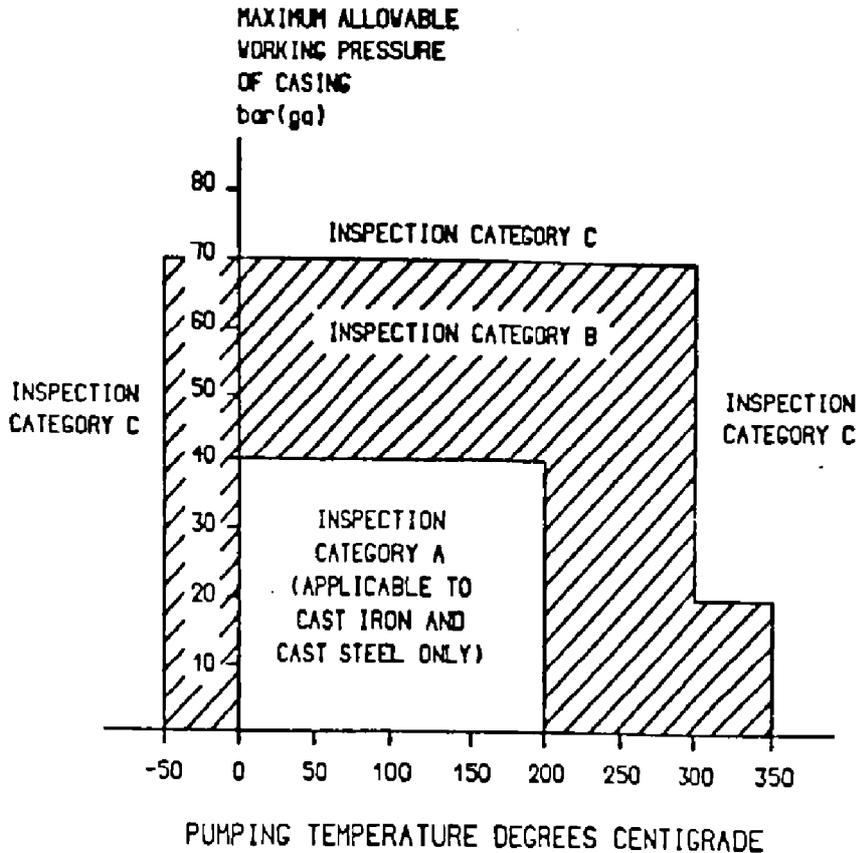
4.3.4 Optional tests

4.3.4.1 NPSH test

4.3.4.1.2 For critical service pumps such as boiler feed water and multistage feed pumps a drop of 1% of the total head determines the NPSH required. (Mod.)

4.3.4.1.4 Where NPSH margin is below 0.6m, water a witness test shall be performed. (Add.)

4.3.4.1.5 The NPSH required test data shall be presented as a curve on the combined graph specified in clause 4.3.3.2 of API standard 610. (Add.)



INSPECTION CATEGORIES FOR PRESSURE - CONTAINING CASTINGS
Fig. 1

4.3.4.3 Sound level test

Sound level tests shall be performed in accordance with IPS-E-SF-900. (Sub.)

4.4 Preparation for Shipment

4.4.3.1 Packing used in tests shall be removed from the pump and new packing furnished for installation in the field suitable to the duty. (Sub.)

4.4.3.10 Each pump shall be properly identified as required by the purchaser order. No material shall be shipped separately. Miscellaneous parts shall be properly tagged or marked with the item number for which they are intended. All such parts shall be suitably boxed, firmly attached to the baseplate, and shipped with the unit. (Mod.)

5. VENDOR'S DATA

5.1 Proposal

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

5.2 Contract Data

5.2.5 Data

5.2.5.4 The Vendor shall furnish an illustrated parts list for all equipment supplied. (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 pump shall be guaranteed for satisfactory performance at all operating conditions specified on the data sheet.

Performance tolerances should be as detailed in API 610 clause 4.3.3.3.3.

APPENDICES**APPENDIX A
NONCONFORMING PUMPS**

A.1 Pumps that do not require full compliance with API Standard 610 should meet the requirements of IPS-M-PM-115.

**APPENDIX B
CENTRIFUGAL PUMP DATA SHEETS**

B.1 SI Unit data sheets shall apply.

B.2 On sheet No. 4 "Motor Drive" shall be substituted by steam turbine drive, gas turbine drive, and/or internal combustion engine drive whenever they apply.

**APPENDIX R
PIPE COMPONENTS - NOMINAL SIZE**

The purpose of this Appendix is to establish an equivalent identity for the piping components-nominal sizes in Imperial System and SI System.

TABLE R - 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 S
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 S - 1

PN (1)	ANSI RATING (CLASS) (2)
20	150
50	300
68	400
100	600
150	900
250	1500
420	2500

1 Pressure Nominal, bar

2 Pounds per square inch, gage

(Add.)