

MATERIAL AND EQUIPMENT STANDARD
FOR
GENERAL PURPOSE STEAM TURBINES

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0. INTRODUCTION

This Specification gives the amendment and supplement to API Standard 611, Third edition August 1988:

"General-Purpose Steam Turbines for Refinery Services"

It shall be used in conjunction with data sheets for Steam Turbines.

For ease of reference, the clause or section numbering of API Standard 611 has been used throughout of this specification.

Clauses in API Std. 611 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 the 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 contains the minimum requirements for general-purpose steam turbines 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 Standard Specification does not relieve the vendor of the responsibility of furnishing turbines of proper design, mechanically suited to meet operating guarantees at the specified service conditions.

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 reasons thereof and submitted for company's consideration. (Sub.)

1.2 Alternative design

Equivalent S.I. Unit System dimensions and ratings 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 more stringent realized by company) shall apply :

- 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

1.4.28 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 F in this Standard Specification. (Add.)

1.4.29 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 G in this Standard Specification. (Add.)

1.5 Referenced publications

The edition of 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:

ASTM (AMERICAN SOCIETY FOR TESTING AND MATERIALS)

- | | |
|-------|---|
| A-609 | "Ultrasonic Examination of Carbon and Low-alloy Steel Castings" |
| E-125 | "Magnetic Particle Indications on Ferrous Castings" |

- E-186 "Heavy-walled (51 to 114 mm) Steel Castings"
- E-280 "Heavy-walled (114 to 305 mm) Steel Castings"
- E-446 "Steel Castings up to 51 mm in Thickness"

IPS (IRANIAN PETROLEUM STANDARD)

- E-SF-900 "Noise and Vibration Control"
- M-EL-132 "Induction Motors"
- M-PM-300 "Special Purpose Gear Units"
- M-PM-320 "Lubrication, Shaft Sealing and Control Oil System for Special Purpose Application"
- E-GN-100 "Units"

2. BASIC DESIGN

2.1 General

2.1.1 Turbine ratings shall not exceed the limits of the vendor’s design, but shall be well within the range of the manufacturer’s actual experience. Only equipment which has proven its reliability in service is acceptable. (Mod.)

2.1.7 Single-stage turbine wheels may be of the overhung design if combined with and integral gear where a gear transmission is required. (Mod.)

2.1.10 The combined performance of the turbine and its driven equipment after installation, shall be the responsibility of the vendor, which has been nominated as being responsible for the complete unit. (Mod.)

2.1.12 Equipment trains shall comply with the requirements of IPS-E-SF-900, Noise and Vibration Control and Clauses 2.1.12.1 & 2.1.12.2 of this Standard. (Mod.)

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

Sound Pressure Limit in	dB re 20 μPa
Turbine	87 dB (A)
Turbine + driven equipment	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 the turbine and 85 dB(A) for the turbine + driven equipment.

Noise levels shall have an upper tolerance of + OdB.

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.

2.1.12.2 Noise control measures shall cause no hindrance to operations nor any obstruction to routine maintenance activities.

2.1.14 All equipment covered by this standard specification shall be designed for outdoor operations totally unprotected from weather, unless otherwise specified on steam turbine data sheet. (Mod.)

2.1.16 Delete "When Specified" from this clause. (Mod.)

2.1.19 Vendor shall state the total temperature of the exhaust steam and advise the maximum allowable exhaust steam temperature when running the turbine at low efficiency during start-up. (Add.)

2.2 Pressure Casing

2.2.5 Casing for horizontal turbines rated above 75 kW shall be axially split type. (Mod.)

2.2.7 All casing drains shall be located and arranged for ease of access for piping connection at the job site without removal of turbine from its mounting plate. (Mod.)

2.4 Casing Connections

2.4.3 All turbine casings shall be provided with drains in the lowest parts of the casing. These connections shall not be less than DN-20. Connections for drains, vents, pressure gages, etc. shall be made with threaded extra heavy pipe nipples, back welded to the turbine case when the casing is made of steel. Connections shall be readily accessible when turbine and driven equipment are assembled on the base. (Mod.)

2.4.3.4 Unless otherwise specified, all cooling water and lube oil piping connections shall be located on the lower half of a horizontally split turbine. Auxiliary piping, as well as conduit, etc. shall be installed in such a manner so as to avoid attachment to or interference with the removal of the upper casing half and rotor. (Mod.)

2.4.3.8 Drain connections shall be provided for the steam chest, exhaust casing, casing packing glands, and cooling jackets. Gage connections shall be provided for the steam-ring chamber on single-valve turbines and for the first stage of multistage turbines. Gages shall be furnished and local board mounted when specified on the steam turbine data sheet. (Add.)

2.4.6.5 Vendor shall quote mating flange in the proposal when connections larger than those covered by ASME/ANSI B 16.5 are supplied. (Mod.)

2.4.9 Mounting flanges for vertical turbines shall be made of steel. (Mod.)

2.5 External Forces and Moments

Many factors, such as heavy piping loads, misalignment at operating conditions, and improper supporting structure, may adversely affect site performance. In order to minimize these factors, the manufacturer shall review and comment upon the purchaser's piping and foundation drawings for pump and fan turbine drivers. (Mod.)

2.6 Rotating Elements

2.6.3 Blading

2.6.3.3 Replaceable inlet nozzle blocks shall be preferred.

Welded in design shall be considered. Stationary blading shall be mounted in replaceable diaphragms. (Add.)

2.7 Seals

2.7.4 A gland steam condenser is required for turbines rating 300 kW and above. They shall be of shell and tube type and TEMA "C" construction. (Mod.)

2.7.5 Delete "When Specified" from this Clause. (Mod.)

2.8 Dynamics

2.8.2 Lateral Analysis

2.8.2.2 Delete "When Specified" from this Clause. (Mod.)

2.8.2.3 The actual critical speeds below operation speeds for flexible shaft turbines shall be verified during the shop running test. (Mod.)

2.8.3 Torsional Analysis

2.8.3.5 Delete "When Specified" from this Clause. (Mod.)

2.8.4 Vibration and Blancing

2.8.4.5 For maximum continuous speed of 6001 rpm and above, the vibration measured on the shaft shall not exceed the following:

Peak-to-peak amplitude (including total runout), $2.78 \frac{\mu\text{m}}{\text{rpm}}$ /rpm in mm. (Mod.)

2.9 Bearings and Bearing Housings

2.9.1 Anti-friction bearings are not acceptable on turbines rated above 75 kW. (Mod.)

2.9.2 Multistage turbines shall have hydrodynamic thrust bearings. (Mod.)

2.9.13 Constant-level oilers with Pyrex glass containers and protecting wire cages are required. (Mod.)

2.9.19.6 Provisions for oil mist lubrication to the mechanical governor spindle bearing shall also be supplied. (Add.)

2.9.20 Cooling coils (including fittings) shall be of type 316 stainless steel. (Mod.)

2.9.21 For all multistage turbines and when specified for single stage turbines provision shall be made for mounting two radial-vibration probes. (Mod.)

2.10 Lubrication

2.10.6

c) Oil rings for start-up lubrication shall be supplied.

d) Oil coolers shall have water through the tubes and TEMA class "C" construction. Tubes shall be Admiralty, 5/8" OD and 16 BMG.

e) Dual, full flow lube oil filters with maximum clean pressure drop of 35 kPa. (0.35 bar) to filter particle exceeding 10 micron size and a continuous flow transfer valve shall be provided.

- g) The filter pressure gage shall be a single unit connected to the inlet and the outlet by a 3 way valve. The 3 way valve shall not permit the filter to be bypassed. Gages shall have stainless steel bourdons and movements.
- i) An automatically controlled stand-by pump, separately driven, for equipment requiring rapid starting or operation at idling speeds.
- j) Delete "When Specified".
- k) Delete "When Specified".
- l) Delete "When Specified".
- m) Coolers and filters are to have plugged vent and drain connections. (Mod.)

2.10.8 Delete "When Specified" from this clause. (Mod.)

2.11 Materials

2.11.1 General

2.11.1.1 Materials of construction shall be as specified in the data sheet. The manufacturer may suggest other materials if, based on his experience, these would render equal or better service. (Sub.)

2.11.2 Casting

2.11.2.3.2 Pressure retaining cast iron parts, shall not be repaired by welding. (Mod.)

2.11.3 Welding

2.11.3.2 Details of all repairs, and of the heat treatment or plugging where applicable shall be recorded and reported to the purchaser. (Mod.)

2.12 Nameplates and Rotating Arrows

2.12.2 The text on nameplates shall be in English and unless otherwise specified the data shall be in SI units. The information on nameplates shall include the year of manufacture. The equipment Item No. also shall be stamped on the nameplate of both gear and turbine. On insulated turbines the nameplate shall be extended so as to be visible. (Mod.)

3. ACCESSORIES

3.1 Gear Units

3.1.2 Integral gears are not acceptable. (Mod.)

3.1.3 Gears shall be of double helical type and at least equal to AGMA 420.04 for shaft speeds less than 3600 revolutions per minute. For shaft speeds of 3600 revolutions per minute or higher, gears shall comply with AGMA 421.06 and IPS-M-PM-300 as specified on the gear data sheet. (Mod.)

3.1.5 The AGMA service factor will be specified on the gear data sheet. (Add.)

3.2 Coupling and Guards

3.2.2 Dry flexible disk coupling with restrained spacer and stainless steel disks shall be used. (Mod.)

3.2.8 The assembled coupling shall be balanced to a tolerance which will permit satisfactory performance at speeds up to 110% of maximum continuous speed of the turbine without damage at 110% of tripping speed. (Mod.)

3.2.9 Non-sparking guards shall be furnished. (Mod.)

3.3 Mounting Plates

3.3.1 General

3.3.1.1 The equipment shall be furnished with a baseplate unless specified otherwise.

The baseplate shall be common to the turbine and driven equipment. Turbine drawings must define maximum dimensions, including insulation and jacketing where supplied. The supplier of the driven equipment will furnish the baseplate and coordinate whatever information and data are required to complete the mounting. (Mod.)

3.3.1.2.9 The manufacturer shall supply all necessary foundation bolts unless otherwise specified. (Sub.)

3.3.1.2.11 Sufficient clearance shall be provided between the case drain connection and the baseplate for installation of a threaded pipe elbow and a valve for drain connection. (Add.)

3.3.2 Baseplate

3.3.2.2 When lifting the baseplate complete with all equipment mounted, beam deflection shall not exceed $l/1200$, where 'l' is the total length of the beam in millimeters. (Mod.)

3.3.2.5 Decking covering all walk and work areas shall be provided on the top of the baseplate. (Sub.)

3.4 Controls and Instrumentation

3.4.2 Control system

3.4.2.2 For parallel driven equipments NEMA class D governors shall be supplied. (Mod.)

3.4.2.3 A hand speed changer is required for all turbines, except those turbines equipped with remote speed control signals. Individual requirements will be specified. (Mod.)

3.4.4 Instrumentation

3.4.4.1 Delete "When Specified" from this clause. (Mod.)

3.4.5 Alarms and shutdowns

3.4.5.3.2 Alarm and shutdown systems shall be normally energized, de-energized to alarm or trip. (Sub.)

3.5 Piping and Appurtenances

3.5.1 General

3.5.1.12 Spiral-wound metal or metal-jacketed flange gaskets shall be used. Flat-faced piping flanges shall have full-faced gaskets. (Add.)

3.5.1.13 All piping shall be thoroughly cleaned of rust and weld spatters and properly protected on the inside (Add.)

3.5.2 Oil piping

3.5.2.3 18-8 Cr-Ni stainless steel piping shall be provided for all circulating lube and control oil systems without filters. 18-8 Cr-Ni stainless steel piping or tubing for pressurized oil systems shall be provided downstream of the lube oil filter to the turbine bearings and any control oil system. Copper or copper base alloys are unacceptable. (Add.)

3.7 Insulation and Jacketing

3.7.1 Ceramic tile blanket type insulation shall be furnished unless otherwise specified. (Insulation shall not interfere with access to turbines for operation or maintenance). Insulation shall not contain asbestos. (Mod.)

4. INSPECTION AND TESTING

4.1 General

4.1.1 All turbines shall be inspected during fabrication and assembly by purchaser’s representative. (Mod.)

4.2 Inspection

4.2.1 General

4.2.1.3 Full non-destructive inspection shall be carried out, on all critical areas, such as abrupt changes in section, weld ends, at the junction of riser, and areas of high stress. Radiographic inspection shall be applied when magnetic-particle inspection is not feasible. (Mod.)

4.2.2 Material inspection

4.2.2.1 General

4.2.2.1.1 Following visual inspection and if specified, magnetic particle inspection shall be carried out on all surfaces including machined gasket sealing surfaces. (Mod.)

4.2.2.2 Radiography

4.2.2.2.2 For each type of defect, the degree of severity shall not exceed the limits in the following Table:

Thickness mm	Gas and blow holes	Sand spots and inclusions	Internal shrinkage	Cracks and hot tears
			Types 1, 2, 3 and 4	

Below 25	2	2	2	
25-50	3	3	2	Not
51-114	3	3	2	allowed
over 114	3	3	2	

(Mod.)

4.2.2.4 Magnetic particle inspection

4.2.2.4.2 Type I defect (linear discontinuities) in Table 4 is not allowed. (Mod.)

4.2.3 Mechanical inspection

4.2.3.2 Any portion of the oil system furnished shall meet the cleanliness requirements of API Standard 614 as amended and supplemented by IPS-M-PM-320. (Sub.)

4.3 Testing

4.3.1 General

4.3.1.2 Replace 5 working days by 15 working days. (Mod.)

4.3.2 Hydrostatic test

4.3.2.3 The hydrostatic test shall be considered satisfactory when neither leaks nor seepage through the casing or casing joint is observed for a minimum of 4 hours. (Mod.)

4.3.3 Mechanical running test

4.3.3.1.2 Delete "When Specified" from this clause. (Mod.)

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

4.3.3.2 Delete 1-hour from this Clause and substitute 4-hour. Multistage turbines shall be no load tested at max. continuous speed for a minimum period of two hours. (Mod.)

4.3.3.3.4 Vibration, oil temperature and speed shall be recorded every 20 minutes throughout the mechanical running test. (Mod.)

4.3.3.8 The test shall be carried out with the half coupling and idling adaptor in place (resulting in a moment equivalent to that of the contract half coupling plus one half of the coupling spacer.) (Add.)

4.3.4 Optional test

4.3.4.4 The sound-level test shall be performed in accordance with IPS-E-SF-900 "Noise and Vibration Control". (Sub.)

4.4 Preparation for Shipment

4.4.3.9 Separate shipment of materials is not permitted. (Mod.)

5. VENDOR'S DATA

5.1 Proposals

a) All drawings and other data shall be listed in specific requirements. Additional drawings required to completely define the unit and accessories being furnished shall be supplied intime, if necessary.

h) A spare parts quotation will be required with the proposal. Spare parts recommended for purchase for each item furnished (including any auxiliary equipment) shall include sufficient parts for continuous operations for a period of 2 years. (This list normally shall include all rotating parts, all stationary wearing parts and valve parts, spring and other parts subject to possible wear or breakage). Proposal shall include a complete priced spare part 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.

6.2 Performance

The turbine and all auxiliaries shall be guaranteed for satisfactory performance at all operating, conditions specified on the data sheet, and the operating range between those points. The thermodynamic performance guarantee point shall be the normal operating point or other point indicated "Guarantee" on the data sheets. The steam rate at the guarantee point shall not exceed the value stated in the proposal.

APPENDICES**APPENDIX A
TURBINE DATA SHEET**

A.1 SI unit data sheets shall apply unless otherwise specified.

**APPENDIX F
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 F-1

Nominal DN(1)	Size NPS(2)	Nominal DN	Size PNS	Nominal DN	Size NPS	Nominal DN	Size 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.

**APPENDIX G
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 G-1

PN (1)	PSIG (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.