MATERIAL AND EQUIPMENT STANDARD

FOR

SPECIAL PURPOSE STEAM TURBINES

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APPENDICES

0. INTRODUCTION

This specification gives the amendment and supplement to API Standard 612, Third Edition November 1987: "Special-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 Std. 612 has been used throughout of this Specification.

Clauses in API Std. 612 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	:	A new clause or section 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

1.1.1 This Specification, contains the minimum requirements for special-purpose steam turbines for use in refinery services, in chemical, gas, and 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 his 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 the Company's consideration. (Sub.)

1.2 Alternative Designs

Equivalent SI Unit System dimensions and ratings shall be substituted unless otherwise specified. (Sub.)

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 the 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.)

1.5 Referenced Publications

The latest edition of the following standards, codes, and specifications shall to the extent specified herein be applied.

IPS (IRANIAN PETROLEUM STANDARDS)

M-PM-105	"Centrifugal Pumps for Process Services"
M-PM-300	"Special Purpose Gear Units"
M-PM-310	"Special Purpose Coupling"
M-PM-320	"Lubrication, Shaft Sealing, and Control Oil System for Special Purpose Applications"
M-ME-250	"Miscellaneous Heat Exchanger"
M-ME-245	"Air-Cooled Heat Exchanger"
E-SF-900	"Noise and Vibration Control"

IS0 (INTERNATIONAL ORGANIZATION FOR STANDARDIZATION)

6708	"Pipe Components-Definition of Nominal Size"
6268	"Pipe Components-Definition of Nominal, Pressure"(Mod.)

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.

Manufacturer shall prepare and submit in his proposal the lists showing steam turbines of the same frame size or model previously manufactured and operating under similar conditions of service,speed and power, and location of such installations. (Mod.)

2.1.3 The manufacturer shall specify the limits of variation from rated steam conditions which the turbine can accept.

If this point is not specified on the data sheet by the purchaser, the vendor of the driven equipment shall provide this data to the turbine vendor.

Turbines will be washed at normal speed and reduced load. The turbine vendor shall confirm suitability of its turbine for the following procedure in its proposal,and recommend any special precautions required to protect the equipment.

1) Method of washing:

Washing of a steam turbine down to about 8°C of superheat, holding the temperature at this near saturation value for a definite period of time and then gradually restoring the temperature to its initial value.

2) Facility requirements:

Desuperheating shall be by the injection of high pressure, high purity water such as condensate or polished demineralized water. The desuperheated steam shall pass through a steam separator drum to remove any free water prior to entering the turbine. The change in steam temperature during washing shall be automatically controlled such that the temperature shall not vary by more than 1°C per minute. (Mod.)

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

2.1.6 Delete "when specified" from last sentence of this clause. (Mod.)

2.1.11 Control of the sound pressure level (SPL) of all equipment furnished shall comply with IPS-E-SF-900.

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

Sound Pressure level 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 and driven equipment.

Sound pressure 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. (Sub.)

2.1.17 On multistage condensing type turbines care should be exercised in the design to eliminate the possibility of interstage silicate deposit, build-up on turbine blading and to minimize erosion on the last stages of turbine blading (Add.)

2.2 Pressure Casings

2.2.9 Drains shall be DN 40 flanged minimum. (Mod.)

2.3 Casing Appurtenances

2.3.2 A sentinel warning valve shall be installed on the exhaust casing of all turbines. (Mod.)

2.4 Casing Connections

2.4.6.4 For nozzle connections over DN 600. Vendor shall furnish mating pipe flanges per the following:

a) Flanges shall be welding neck type with bolt hole spacing and bolt circle diameter exactly matching the machine flanges.

b) Each flange shall be furnished with at least 3 dowel pins each machined with a close fit tolerance to the diameter of the bolt holes bore.

c) The turbine shall be shipped with flanges bolted in place and with dowel pins installed. Each flange (turbine and pipe), dowel pin and bolt replacement for the dowel pin shall be positively identified.

For connections to surface condenser, expansion bellows shall be provided as a separate flanged spool connection for condensing steam turbines. (Sub.)

2.4.10 Vendor shall provide readily accessible flanged casing connection(s) for injection of dry gas purge during extended outage. If connection for other purpose exist which can also be used for this purpose, vendor shall indicate it in proposal and on general arrangement drawing(s). (Add.)

2.6 Rotating Elements

2.6.1 Rotors

2.6.1.1 Rotors shall be of integrally-forged construction. (Mod.)

2.6.3 Blading

2.6.3.2 All blades shall also be mechanically suitable for operation with steam conditions at the pressure relief valve settings in the inlet, extraction, and exhaust system or any combination of maximum or minimum attainable steam conditions. (Mod.)

2.6.3.3 Replaceable blade inlet nozzle blocks are preferred. Welded-in design shall be considered. Stationary blading shall be mounted in replaceable diaphragms. (Add.)

2.7 Shaft Seals

2.7.1 Outer glands shall be sealed with replaceable labyrinth packing. Details and materials of construction of the outer gland shall be clarified. (Sub.)

2.9 Bearing and Bearing Housings

2.9.3 Bearing housing

2.9.3.1 All bearing housings shall be furnished with either vendor's standard breather or a DN 25 minimum vent connection fitted with a steel pipe plug. (Mod.)

2.9.4 Grounding

Grounding brushes shall be replaceable while the turbine is operating. (Mod.)

2.10 Lubrication and Control - Oil System

2.10.4 All oil systems and components shall conform to IPS-M-PM-320. (Sub.)

2.10.5 Unless otherwise specified, the driven equipment and turbine shall have a common lube oil system. The turbine vendor and the driven equipment vendor shall mutually decide and agree on oil characteristics. (Mod.)

2.11 Materials

2.11.1 General

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

(See API Standard 612 paragraph 3.6 for requirements for auxiliary piping material). (sub.)

2.11.1.2 When vendor's quoted material specification is DIN, JIS or other acceptable international standard, the proposal shall indicate the nearest above named specification equivalent along with exact and specific deviations, (chemical & physical properties, testing, etc.) for purchaser's evaluation of equivalence for service intended. (Mod.)

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

2.11.1.15 Delete when specified from first sentence and add following:

For materials and thicknesses not covered by code the vendor shall indicate in the proposal the recommended inspection and testing level. For materials other than austenitic stainless steel, in service below -29°C. Vendor shall require a charpy V-notch impact test of the base metal and of the weld joint. (Mod.)

2.11.2 Casting

2.11.2.3.3 All repairs shall meet the inspection requirement and acceptance standards for the original material. (Add.)

2.11.3 Welding

2.11.3.6.1 All welds in auxiliary piping, including seal welds and pipe to case welds, shall be heat treated, hardness tested in accordance with ANSI B 31.3 and examined by magnetic particle or dye penetrant. Vendor may propose radiography for special cases in the proposal. (Sub.)

2.12 Nameplates and Rotation Arrows

2.12.2 The text on nameplates shall be in the English language and unless otherwise specified the data shall be in SI Units. The information on nameplates shall include the year of manufacture. (Mod.)

3. ACCESSORIES

3.1 Couplings and Guards

3.1.2 Couplings and guards shall conform to IPS-M-PM-310 (Mod.).

3.2 Mounting Plates

3.2.1.1 The turbine shall be provided with a baseplate, unless otherwise specified. (Sub.)

3.2.1.2.6 Delete the bullet. (Mod.)

3.2.1.2.9 Anchor bolts will be furnished by the manufacturer unless otherwise specified. (Sub.)

3.3 Gear Units

Gear units shall conform to IPS-M-PM-300. (Sub.)

3.4 Controls and Instrumentation

3.4.2 Control system

3.4.2.1 Unless otherwise specified, the governor shall be of the woodward or approved equivalent oil hydraulic type. (Mod.)

3.4.3 Protective devices

3.4.3.1 The trip & throttle valves shall include a 110 Volt D.C. solenoid trip mechanism. (Mod.)

3.4.4 Instrument and control panels

3.4.4.1 A free stand instruments panel shall be provided and shall include all panel-mounted instruments for the turbine and driven units.

Followings are the minimum requirement of panel-mounted instruments for turbine.

1) Steam inlet pressure gage.

2) Exhaust steam pressure gage.

3) Steam chest pressure gage.

4) First stage pressure gage on multistage turbines.

5) Extraction pressure gage.

6) Pressure gage for first stage after extraction section.

7) Steam seal pressure gage.

8) Lube oil pressure gage.

9) Indicator for an electronic tachometer.

10) Gages for driven equipment.

11) Each bearing oil temperature gage.

12) Bearings oil pressure gage.

13) Temperature recorder for thrust bearing shoes.

14) Alarms and indicator light.

15) Other instrument specified on data sheet and recommended by Vendors. (Mod.)

3.4.4.2 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. (Mod.)

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

3.4.6 Alarms and shutdowns

3.4.6.1.1 As a minimum following alarm and trip switches shall be furnished.

1) Low lube oil pressure alarm and trip.

2) High vibration level alarm and trip.

3) High oil filter differential pressure.

4) High and low level alarm for condenser.

5) Low oil reservoir level alarm.

6) Inlet steam temperature alarm and trip.

7) Turbine back pressure alarm.

8) Steam low pressure alarm.

9) Shaft position alarm and trip.

10) High thrust bearing shoe temperature alarm and trip.

3.6 Piping and Appurtenances

3.6.1 General

3.6.1.3 Where needed for start-up and operation, drains with valve and plugs shall be provided at low points in the piping systems and vent connections with valves and plugs shall be provided at all high points of the piping system.

Vents and drains, including casing drains, shall be piped to the edge of base plates or subassemblies, unless mutually agreed otherwise. Horizontal drainsuns shall slope continuously 40 mm per meter toward the reservoir. (Mod.)

3.6.2 Oil piping

3.6.2.3 Following fabrication, stainless steel oil and control oil pipes shall be flushed clean with solvent prior to shipment. (Mod.)

3.6.2.4 By-passing system for the bearing during shop and field prestart up oil flushing operation shall be provided without disassembling bearing housing. (Add.)

3.7 Insulation and Jacketing

3.7.1 Delete "when specified" from first sentence. Ceramic insulation blanket-tile shall be required. (Mod.)

3.7.2 Insulation materials shall be furnished by the turbine vendor. (Mod.)

3.9 Turning Gear

3.9.1 A turning gear shall be furnished by the vendor if the turbine requires rotation of the shaft to avoid shaft thermal distortion (during turbine start-up or immediately following a shut down. Turning gear drive type shall be specified on the data sheet. (Mod.)

3.10 Turbine Exhaust Condenser (Add.)

3.10.1 Condensers, if Water-Cooled, shall comply with the requirements of IPS-M-ME-250. If air-cooled condensers are specified, the equipment shall be in accordance with IPS-M-ME-245. (Add.)

3.10.2 Water-Cooled condensers shall be designed to be split into two independent halves on the water side, to allow for cleaning of the separate halves without interruption to operation of the turbine at loading which will be specified in the data sheet. (Add.)

3.10.3 The connection between turbine and condenser shall be designed so that it can be removed and replaced without the need for dismantling the turbine casing. (Add.)

3.10.4 Adequate inspection openings shall be provided in the end covers of the water boxes and in the condenser hot well for inspection and access. (Add.)

3.10.5 For steam-driven air ejectors, the ejector nozzles shall be of 13% Cr-type stainless steel and protected against clogging by 32 mesh basket-type steam strainers.

The ejector equipment shall be complete with all interconnecting piping, including valves, traps, etc., and with connections for pressure gages required for proper operation. Ejector equipment shall be fully spared. (Add.)

3.10.6 Two condensate extraction pumps shall be installed, one for normal operation and one for stand-by duty. Unless otherwise specified, the main pumps shall be steam-turbine driven and the stand-by pump shall be electric-moter-driven.

Each pump shall be capable of handling the maximum flow of condensate plus 20%, and shall be provided with a minimum flow protection. Pumps shall be centrifugal-type and shall comply with IPS-M-PM-105 (Add.)

3.10.7 A water-sealed atmospheric relief valve shall be provided, and sized for full steam flow at 2 kPa (ga) back pressure. The condenser shall be capable of withstanding this pressure for prolonged periods. (Add.)

3.10.8 The manufacturer shall provide a connection for a pressure switch to activate an alarm under high-pressure conditions. (Add.)

3.10.9 The main condenser condensate sump or hot well shall be sized to provide a three-minute hold-up at maximum flow rate,and shall be provided with suitable level glasses and connections for level controller, condensate outlet, drains and high/low-level alarms. (Add.)

3.11 Washing Facilities

In case of requirement for blade washing and drying facilities, vendor shall specify the system and its equipment in the proposal. (Add.)

4. INSPECTION, TESTING, AND PREPARATION FOR SHIPMENT

4.2 Inspection

4.2.1 General

4.2.1.1 a. AS a minimum the certificate shall contain the following information:

- Name of manufacturer
- 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 specified otherwise)
- Material charge number, batch number or heat-lot number
- Chemical composition recorded from results of chemical analyses
- Mechanical properties recorded from test results
- NDT methods and results, where applicable
- Heat treatment procedures, furnace charge number and heat treatment records, where applicable
- Such supplementary or additional information as may be required.

e. Delete "when specified" from this item. (Mod.)

4.2.1.3 Shaft and wheel forgings shall be ultrasonically inspected. Vendor shall identify blading inspection method(s) in proposal.(Mod.)

4.2.2 Material inspection

4.2.2.1.1 When the thickness of pressure containing parts to be welded exceeds the thickness limits of table UCS-56 of ASME code Sec. VIII div. I, welds shall be 100% radiographed in accordance with paragraph 4.2.2.1.1 of API 612. (Mod.

4.2.2.3 All surfaces of the steel casting including machined faces shall be magnetic particle examined. (Mod.)

4.2.3 Mechanical inspection

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

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

4.2.3.5 Delete "when requested by the purchaser" from this clause. (Mod.)

4.3 Testing

4.3.2 Hydrostatic test

4.3.2.6 Use of any type of gaskets in axial split joint, including string or tape, is not permitted during hydrostatic testing.(Add.)

4.3.3 Mechanical running test

4.3.3.2.7 Reading shall be logged, as a minimum, every 20 minutes during the 4 hours run at maximum continuous speed. (Add.)

4.3.3.3.3 The measurement shall be recorded on deceleration (coast down). (Mod.)

4.3.3.3.5 Delete "when specified" from this Clause.(Mod.)

4.3.5 Rotor overspeed test

Each rotor shall be subjected to an overspeed test of at least 115% of maximum continuous speed for a minimum duration of 3 minutes.

After the overspeed test, the rotor shall be checked for cracks and defects by magnetic particle inspection, and shall then be rebalanced. (Add.)

4.4 Preparation for Shipment

4.4.3.9 No material shall be shipped separately. Miscellaneous parts shall be identified with securely-affixed, corrosion-resistant metal tags indicating the item and serial number of the equipment for which it is intended. All such parts shall be suitably boxed and shipped with the unit. (Mod.)

5. VENDOR'S DATA

5.1 Proposals

Replace the first sentence of item "b" by the following sentence:

A specific statement that the system and all components are in strict accordance with API Standard 612 as amended or modified by this standard specification.

Add the following sentence to item J:

The proposal shall include separate price list for spare parts for start-up and two years of continuous operation including spare rotors. (Mod.)

5.2 Contract Data

5.2.3 Drawing

5.2.3.3 The information shall include the documents for controls and instrumentation.

5.2.7.2 The manufacturer shall recommend safe operating vibration amplitudes, along with alarm and shutdown criteria, and include them in the operating manual. (Refer to page 72 of API-612 3rd Edition).

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
TYPICAL DATA SHEETS

A.1 SI Units data sheets shall be used unless otherwise specified. (Mod.)

APPENDIX F (Add.)
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 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	3/4	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 FLANGE 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	PSIG
20	150
50	300
68	400
100	600
250	1500
420	2500

1) Pressure Nominal, bar.

2) Pounds per square inch, gage.