Engineering Standard

SAES-K-501 30 September, 2003

Steam Turbines

Saudi Aramco DeskTop Standards

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1 Scope

This Standard defines the minimum mandatory requirements governing the design and installation of general and special purpose steam turbines. This Standard may not be attached to or made a part of purchase orders.

2 Conflicts and Deviations

2.1 Any conflicts between this Standard and other applicable Saudi Aramco Engineering Standards (SAESs), Materials System Specifications (SAMSSs), Standard Drawings (SASDs) or industry standards, codes and forms shall be resolved in writing by the Company or Buyer Representative through the Manager, Consulting Services Department, Saudi Aramco, Dhahran.

2.2 Direct all requests to deviate from this Standard in writing to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward such requests to the Manager, Consulting Services Department, Saudi Aramco, Dhahran.

3 References

The selection of material and equipment and the design, construction, maintenance and repair of equipment and facilities covered by this Standard shall comply with the latest edition of the references listed below, unless otherwise noted.

3.1 Saudi Aramco References

Saudi Aramco Engineering Procedure

SAEP-302	*Instructions for Obtaining a Waiver of a Mandatory Saudi Aramco Engineering Requirement*

Saudi Aramco Engineering Standards

SAES-A-105	*Noise Control*
SAES-J-600	*Safety and Relief Valves*
SAES-L-005	*Limitations on Piping Components*
SAES-L-011	*Flexibility, Support and Anchoring of Piping*
SAES-L-050	*Construction Requirements for Metallic Plant Piping*

Saudi Aramco Materials System Specifications

01-SAMSS-017	*Auxiliary Piping for Mechanical Equipment*

32-SAMSS-009 *General Purpose Steam Turbines*

32-SAMSS-010 *Special Purpose Steam Turbines*

Saudi Aramco Inspection Requirements

Form 175-320200 *Turbines, Steam or Gas Expansion*

Saudi Aramco Forms and Data Sheets

2811-ENG & 2811-M-ENG *Steam Turbine Data Sheet*

3.2 Industry Codes and Standards

National Electrical Manufacturers Association

NEMA SM23 *Steam Turbines for Mechanical Drive Service*

American Society of Mechanical Engineers

ASME PTC 6 *Steam Turbines Performance Test Code*

ASME PTC 6S *Simplified Procedures for Routine Performance Tests of Steam Turbines*

4 Design

4.1 General

4.1.1 General-purpose steam turbines shall only be used when the driven equipment is spared or is not critical to plant operation but shall not be used for applications requiring a rated power exceeding 2,250 kW (3,000 HP) or for a rated speed exceeding 5,000 RPM. General-purpose steam turbines shall comply with 32-SAMSS-009.

4.1.2 Special-purpose turbines shall be used for all applications not covered by paragraph 4.1.1. Special-purpose steam turbines shall comply with 32-SAMSS-010.

4.1.3 Steam turbines shall be supplied by Vendors qualified by experience in manufacturing and field operation of the units proposed. Documentation substantiating Vendor's prior experience shall be submitted through the Company or Buyer Representative for review by the Coordinator, Rotating Equipment Division, Consulting Services Department prior to order placement. Contact names at the user's location shall be provided for referenced turbines to enable verification of satisfactory field operation.

4.1.4 When single lift packaged units are specified, the turbine, the gear (when required), the driven equipment and oil system shall be mounted on a single baseplate and shall be completely piped, wired and tested under controlled conditions at the point of manufacture.

4.1.5 The steam turbine type (back pressure, condensing, extraction/ condensing or induction/condensing) shall be determined by the process steam balance requirements. Extraction/condensing steam turbines shall be considered whenever the plant design uses steam let-down valves to produce process steam at lower pressure than that produced by the boiler design. Consideration shall be given to induction/condensing steam turbines in place of pressure blow-off or let-down valves to maintain the plant intermediate pressure steam headers at their design operating pressure.

4.1.6 Due to the effects of abnormally high exhaust temperatures and deviations from normal thermal patterns associated with slow roll, steam turbines shall not be slow rolled, other than during starting, using steam as the motive force.

4.1.7 The part load steam rates of the steam turbines shall be part of the technical bid evaluation.

4.1.8 Equipment noise levels shall be in accordance with SAES-A-105.

4.2 Shaft Seals

The cost of condensate loss from gland condenser drains shall be calculated to determine whether or not this cost justifies the installation of a pumping system to recover the condensate and return it to a condensate header. Batching steam pressure assisted pumps may be used for this application.

4.3 Materials

Alternative materials proposed as equivalent to the specified ASTM, AISI, or ASME requirements shall be submitted through the Company or Buyer Representative for review and approval by the Coordinator, Rotating Equipment Division, Consulting Services Department.

4.4 Couplings

Lubricated couplings are not permitted.

4.5 Baseplates

4.5.1 Baseplate designs shall be reviewed for good access to all components for operation and for maintenance. This applies particularly for packaged units where accessibility of valves, reservoirs, pumps, etc. is of prime importance.

4.5.2 Packaged units shall be considered for ease of installation and for the increased reliability obtainable when all instrumentation, piping and electrical connections can be made under controlled conditions in the Vendor's shop.

4.6 Controls, Protective Devices and Instrumentation

4.6.1 Controls and instrumentation shall be adequate to control the turbine at all specified operating conditions. The control method shall be determined by the process requirements.

Turbines required to start automatically, without operator intervention shall be equipped with governors having acceleration rate control and critical speed avoidance.

4.6.2 The turbine casing shall be protected with a pressure relief valve installed in the piping in accordance with SAES-J-600.

4.7 Piping

Piping requirements shall be determined for each project individually. Process piping shall comply with SAES-L-005 and SAES-L-011. Steam velocities shall not exceed those specified in NEMA SM23.

5 Inspection and Testing

5.1 Hydrostatic Test

All pressure containing parts shall be hydrostatically tested. Witnessing shall be specified on the Data Sheet and Saudi Aramco Inspection Form 175-320200 and shall be required for new manufacturing sources, the first casing of a series, or when previous experience dictates.

5.2 Mechanical Running Test

All steam turbines shall receive a mechanical running test, witnessed for turbines rated above 1000 kW (1350 HP). Turbines rated 1000 kW (1350 HP) and below shall be run tested, Vendor's test certificates being provided. The contract governor shall be used during the shop test. Bearings shall be inspected following the mechanical running test.

5.3 Optional Tests

5.3.1 A complete unit test shall be considered for cases if early detection of any critical string test equipment malfunction is essential. If such a test is deemed necessary, the requirement shall be included in the request for quotation or in the purchase order. The test shall comprise the turbine, the gear unit (when installed), the driven equipment and the lube oil system etc., preferably mounted on the job baseplate or module. The test procedures shall be submitted through the Company or Buyer Representative for the review and approval of the Coordinator, Rotating Equipment Division, Consulting Services Department.

5.3.2 The bearings and seals shall be dismantled for inspection only in the event of an unsuccessful test.

5.4 Field Testing

As soon as possible following installation of the equipment train, special-purpose steam turbines shall be load tested to verify performance, efficiency and steam consumption. The test procedure shall be agreed with the vendor at the time of purchase and shall be generally in compliance with ASME PTC 6/ ASME PTC 6S. The results of these tests shall form the basis for performance acceptance.

6 Installation

6.1 Main Steam Piping

Turbine inlet steam piping shall be designed to branch upwards from the main horizontal steam header, to reduce entry of condensate slugs into the turbine. Piping installation, fit up and connection tolerances shall be in accordance with SAES-L-050.

SAES-L-011 prohibits the use of expansion joints. However, should an expansion joint be required between the turbine and the condenser, a written request shall be submitted to the Company or Buyer Representative, who shall follow internal company procedure SAEP-302 and forward this request to the Coordinator, Rotating Equipment Division, Consulting Services Department, Saudi Aramco, Dhahran.

Cold springing of piping shall only be permitted when all alternative methods of reducing piping loads have been exhausted and then only with the written permission of the turbine Vendor and the Coordinator, Mechanical and Civil Engineering Division, Consulting Services Department.

Local temperature and pressure gauges shall be installed within three diameters of each steam turbine casing inlet, extraction, induction or exhaust nozzle.

For special-purpose steam turbines, the number and location of temperature and pressure devices shall be in accordance with ASME PTC 6, to ensure that an acceptable field test can be performed. As a minimum, tappings shall be located on the piping to allow for the necessary instrumentation for testing.

Header warming lines and trip and throttle valve blow down connections shall be vented to atmosphere through a silencer discharging horizontally in a safe direction. Piping and valves connecting to the trip and throttle valve blow down connection shall not be smaller than the blow down flange size.

Back pressure turbines with upward exhausts shall have exhaust casing drains and piping low point drains connected to both a valved drain to atmosphere and a steam trap.

Condensing turbines with upward exhausts shall have provisions for removing and collecting condensate from the exhaust casing and piping. Condensate collected shall be disposed of by pumping to a condensate header.

6.2 Relief Valves

Relief valves shall be installed between the turbine casing flange and the first block valve at:

- turbine exhaust
- turbine extraction
- turbine induction

For condensing steam turbines, main steam condenser vacuum breaker valves shall be furnished with an integral manual vacuum breaker. A water seal sight glass, valved demineralized water (or condensate) source and a piped overflow drain with sight glass shall be provided as part of the vacuum breaker installation. The vacuum breaker shall be installed such that the level and sight glasses are readily visible and the manual vacuum breaker valve easily accessible for operation.

6.3 Non Return Valves and Trip and Throttle Valves

Trip and throttle valves shall be spring supported, independent of the turbine inlet flange and steam piping.

Non-return valves and trip and throttle valves shall be located not more than five pipe diameters from the turbine flange being served by the valve.

Non-return valves shall have a closing time not exceeding 1.5 times that of the main steam inlet trip and throttle valve.

6.4 Main Condensers

Main condenser hot well level control shall use two valves arranged for split range control of the condenser hot well. One valve shall control condensate flow to the plant condensate recovery system and the other valve shall control condensate return to the hot well. Condenser hot well level control systems using orifices are not acceptable.

Condenser hot well connections shall be located or protected such that hot well turbulence does not result in control difficulties.

Water cooled condensers shall have water piping arranged to permit back flushing of the condenser water side.

6.5 Sealing Steam Supply, Seal Leak-off, and Gland Condenser Leak-off Piping

Auxiliary sealing steam shall be supplied from a steam header which is positively known to be superheated. The steam turbine Vendor shall indicate his agreement with the steam temperature.

Auxiliary sealing steam supply headers shall be kept warm at all times either by a bypass orifice to a lower pressure header or with steam traps. Whichever method is chosen, the system must be designed and built with absolute assurance that liquid will not be admitted to the turbine glands.

Seal steam leak-off headers for special purpose steam turbines shall be provided with low opening differential check valves.

Auxiliary sealing steam, sealing steam, sealing steam leak-off, gland condenser leak-offs and all other auxiliary steam connections shall be well supported and shall not impose objectionable forces on the turbine.

Gland condenser leak-off headers shall be insulated only at those locations required for personnel protection to prevent undue heating of turbine supports. All other auxiliary steam headers shall be fully insulated.

Gland condenser leak-off piping between the turbine skid and gland condenser shall be one pipe size larger than the turbine Vendor's manifolded flange connection.

6.6 Gland Condensers

Gland condensers shall be installed below the centerline elevation of the steam turbine and shall have a minimum water leg for the drain of 1.83 m. Gland condenser vacuum piping shall be kept as short as possible and shall be insulated only in those locations required for personnel protection or to prevent undue heating of turbine supports.

Gland condenser air removal ejector discharge piping shall have a liquid drain to grade as well as a steam discharge to atmosphere at a safe location. Ejector discharge piping shall be at least one pipe size larger than the ejector exhaust connection.

Local temperature and pressure gauges shall be installed on the gland condenser inlet piping. Temperature gauges shall be installed in thermowells.

6.7 Air Removal Systems

Air removal systems inter and after condenser drains shall use piping loop seals whenever the required vertical height is available. Float and thermostatic traps shall only be used when it is impossible to install piping loop seals. Strainers shall be installed upstream of each trap inlet.

The atmospheric exhaust of the air removal system shall be furnished with a low pressure loss variable area positive displacement flow meter for air flow measurement.

6.8 Auxiliary Steam Piping

Steam supply piping to accessory items such as sealing steam systems and ejectors shall have in line "Y" type strainers with valved blow downs. Header drain and warm-up valves shall be installed adjacent to the auxiliary system supply connection.

Steam turbine casing drains and header warm up connections shall be individually valved and piped to a collector at a drain and/or vent location which precludes steam created fog hindering turbine or driven equipment startup operations.

Revision Summary

30 September, 2003	Revised the "Next Planned Update". Reaffirmed the contents of the document, and reissued with minor changes.