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Standard Specification for Auxiliary Single Stage Steam Turbines for Shipboard Use[1]

This standard is issued under the fixed designation F 975; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

ϵ^1 NOTE—Section 15 was added editorially in May 1993.

1. Scope

1.1 This specification covers minimum requirements for shipboard auxiliary single-stage steam turbines.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 The following precautionary caveat pertains only to the test method portion, Section 11, of this specification: *This standard does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*

A 367 Test Methods of Chill Testing of Cast Iron[2]

2.2 *Federal Standard:*

H 28/21A Metric Screw Threads[3]

2.3 *ANSI Standards:*

ANSI/AFBMA 9 Load Ratings and Fatigue Life for Ball Bearings[4]

B1.1 Unified Inch Screw Threads (UN and UNR Thread Form)[4]

B16.5 Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys[4]

2.4 *ABS Document:*

Rules for Building and Classing Steel Vessels[5]

2.5 *ASME Document:*

Pressure Vessel Code, Section VIII, Pressure Vessels, Division I[6]

2.6 *NEMA Document:*

SM 23 Steam Turbines for Mechanical Drive Service[7]

3. Terminology

3.1 Unless otherwise specified herein, terms and expressions shall be in accordance with the definitions contained in the following documents, in order of precedence as follows:

3.1.1 NEMA SM 23, Section 2, General; Section 4, Governing Systems; and Section 5, Overspeed Trip Systems.

3.1.2 *Mechanical Engineers Handbook* [6]

3.1.3 *Webster's New International Unabridged Dictionary*.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *constant speed governor*—a governor which, by its control of the steam to the turbine, automatically maintains the speed of the turbine at a predetermined rate, under all specified conditions of load, exhaust, and pressure.

3.2.2 *single-stage turbine*—a steam turbine that has one velocity-compounded stage or pressure stage.

3.2.3 *speed limiting governor*—a governor which, by control of the steam to the turbines, will not permit the turbine to operate at a speed in excess of that to which the governor is adjusted but will permit the turbine to continue in operation at this speed.

4. Ordering Information

4.1 Ordering information to be included is shown in Annex A2.

5. Materials

5.1 Materials of construction shall have a minimum impact strength in accordance with ASME Section VIII, Division 1, Table UG-84. Materials not listed shall be approved by ABS.

5.2 Unless otherwise approved, forgings, rolled plate, and castings shall be of the following materials:

5.2.1 *Carbon Steel*, where the temperature will not exceed 775°F (413°C).

5.2.2 *Carbon-molybdenum Steel*, where the temperature is between 775°F (413°C) and 875°F (468°C).

5.2.3 *Chromium-molybdenum Steel*, where the temperature is between 875°F (468°C) and 1050°F (565°C).

5.2.4 The use of grey cast iron is not permitted. Ductile cast nodular iron may be used in accordance with ASME Section VIII.

[1] This specification is under the jurisdiction of ASTM Committee F-25 on Shipbuilding and is the direct responsibility of Subcommittee F25.11 on Machinery.
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[2] *Annual Book of ASTM Standards*, Vol 01.02.

[3] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[4] Available from American National Standards Institute, 11 W. 42nd St., 13th Floor, New York, NY 10036.

[5] Available from American Bureau of Shipping, 45 Eisenhower Dr., Paramus, NJ 07652.

[6] Available from American Society of Mechanical Engineers, 345 E. 47th St., New York, NY 10017.

[7] Available from NEMA, Suite 300, 2101 L St. N.W., Washington, DC 20037.

5.3 Castings shall be sound and free of shrink holes, blow holes, scale blisters, or other similar defects. Surfaces shall be thoroughly cleaned by sandblasting, shotblasting, pickling, or other standard methods.

5.4 Nozzle rings or blocks shall be of corrosion-resistant steel containing 11 to 13 % chromium.

5.5 Blading shall be of corrosion-resistant steel containing 11 to 13 % chromium and heat treated to produce necessary physical properties. Shrouding shall be of the same material or material having similar chemical properties as the blade. Impulse blades shall normally be machined from bar stock or stock of cross-section approximately the blade shape.

5.6 Fastener materials shall be selected with regard to operating environment. Materials compatible with mating surfaces, design operating temperatures, and loading must be used.

5.7 Governor fulcrum points, valve stems, springs, adjusting screws, or similar elements or surfaces where sliding or rotary motion is experienced shall be of corrosion resistant materials.

6. Performance Requirements

6.1 *Steam Conditions*, maximum and minimum pressure and temperature under which the turbine is to meet power requirements shall be specified in the ordering data.

6.2 *Available Steam Flow Conditions*, in accordance with 6.1 to meet power requirements shall be specified in the ordering data.

6.3 *Vibration*:

6.3.1 Turbine rotors shall be dynamically balanced to a value of unbalance no greater than that which will yield a maximum double amplitude vibration of 2.0 mils (0.050 mm), up to 4000 rpm and 1.5 mils (0.038 mm) above 4000 rpm as measured on the shaft adjacent to a bearing during turbine run test.

6.3.2 Horizontal turbines shall have an exposed length of rotor shaft adjacent to a bearing to allow measurement of shaft displacement. The exposed portion of the shaft shall be machined to a surface finish of 32 µin. (0.8 µm) rms maximum. For vertical turbines where the vibration cannot be measured on the shaft, the double amplitude of vibration as measured on the bearing housing shall not exceed 50 % of the shaft limit specified in 6.3.1.

6.3.3 When specified in the ordering data, the turbine manufacturer shall provide a boss on a bearing cap for the purpose of accommodating installation of transducers for vibration measurement.

6.4 *Performance Curves*—When specified in the ordering data, the turbine vendor shall provide performance curves.

7. General Design Requirements

7.1 *Design Life*—Turbines shall operate satisfactorily over the specified life of the ship when operated under specified design conditions and maintained in accordance with good marine engineering practice including maintenance measures outlined in 7.2.2. Ship life is to be specified in the ordering data. Those parts not classified as spare parts shall not require replacement or repair during the design life under conditions of operation specified in the ordering data when maintained in accordance with good marine engineering practice.

7.2 *Accessibility and Maintenance*:

7.2.1 All parts requiring routine examination, maintenance, or replacement shall be readily accessible. Minimum effort shall be required to accomplish planned maintenance and to affect repairs.

7.2.2 Turbines shall be maintainable in accordance with the procedures in Annex A1.

7.3 *Installation Requirements*:

7.3.1 Envelope design shall provide for satisfactory operation when turbine is installed onboard ship as specified and when subjected to the following trim, list, roll, and pitch conditions:

7.3.1.1 Five degrees permanent trim, forward or aft.

7.3.1.2 Fifteen degrees permanent list, port or starboard.

7.3.1.3 Forty-five degrees full period (22.5 degrees half amplitude) roll.

7.3.1.4 Fifteen degrees pitch (bow up to bow down) full period (7.5 degrees half amplitude). Period of motion if required, shall be as specified in the ordering data. Athwartships and fore and aft inclinations occur simultaneously.

7.4 *Environmental Operating Conditions*:

7.4.1 *External Vibrations*—When specified in the ordering data, the turbine shall withstand the following ship-board vibrations without malfunction or requirement for additional maintenance beyond that specified in Annex A1.

Frequency (Hz)	Single Amplitude Displacement, ±	
	in.	(mm)
4 to 15	0.030 ± 0.006	(0.762 ± 0.152)
16 to 25	0.020 ± 0.004	(0.508 ± 0.102)
26 to 33	0.010 ± 0.002	(0.254 ± 0.051)

7.4.2 *Ambient Temperatures*—Turbines shall be suitable for operations in 122°F (50°C) maximum ambient temperature unless otherwise specified in the ordering data. Minimum ambient conditions must be specified in the ordering data.

7.5 *Noise*—When specified in the ordering data, sound pressure levels shall be in accordance with NEMA SM 23, Section 7, Sound Pressure Levels.

8. Minimum Basic Design Requirements

8.1 *Critical Speed*—Turbines shall have the first critical speed at not less than 25 % above the maximum operating speed or not less than 10 % above overspeed trip setting, whichever is greater.

8.2 *Rotors*:

8.2.1 Materials for rotors shall be as specified in Section 5.

8.2.2 Solid rotors shall be machined from a single forging. For built-up rotors, wheel(s) shall be shrunk and keyed to the shaft.

8.2.3 Turbine shafts having carbon ring packing shall be coated with suitable protective material in the gland sealing areas. Shafts shall have a surface finish of 32 µin. (0.8 µm) rms maximum in the area where seals contact the shaft.

8.2.4 Minimum diameter of turbine rotor shafts, factors of safety, elastic stresses, mean tangential stress, and blade design are to be determined by *ABS Rules for Building and Classing Steel Vessels.*

8.3 *Bearings*:

8.3.1 Bearings and housings shall be match-marked or

designed to ensure proper assembly and position.

8.3.2 Deflectors or other means shall be provided to prevent leakage of lubricant into the gland system or leakage of condensate into the bearings.

8.3.3 Thrust bearings shall take thrust in both axial directions.

8.3.4 Where rolling contact bearings are used they shall be in accordance with ANSI/AFBMA Standard 9 for either grease or oil lubricated application.

8.3.5 Journal bearings shall be lined with babbit metal firmly secured in the bearing shells.

8.3.5.1 Bearing pressure shall not exceed 250 psi (1.724 MPa) of projected area based on static loading.

8.3.5.2 Bearing oil discharge temperature shall not exceed 180°F (82.2°C). Temperature rise shall not exceed 50°F (10°C).

8.4 *Casing and Steam Chest*:

8.4.1 Casing and steam chest materials shall be as specified in Section 5.

8.4.2 Casing and steam chests may be cast, fabricated, or combinations of both, and shall be sufficiently rugged to withstand without fracture or distortion normal strains (that is, temperature, loads, or piping stresses) to which they will be subjected.

8.4.2.1 Sizing of steam connections shall be such that with full load and normal steam conditions, inlet velocity shall not exceed 150 ft/s (45.7 m/s) and exhaust velocity shall not exceed 250 ft/s (76.2 m/s) for noncondensing and 450 ft/s (137 m/s) for condensing applications.

8.4.2.2 Casing and steam chest joints shall be metal to metal; however, sealant materials may be used as specified in 8.9.

8.4.2.3 Provisions shall be made for thorough drainage of all parts of turbine casing and steam chest. Impulse turbines shall be such that water cannot accumulate to the point where shrouds touch the water.

8.4.2.4 On horizontally mounted units inlet steam piping need not be removed to lift the upper half case.

8.4.2.5 Hand nozzle valves (except seats) shall be renewable without turbine case disassembly.

8.4.2.6 Nozzle and reversing chambers shall be mechanically retained.

8.5 *Steam Strainers*—A corrosion resistant steel strainer element will be provided upstream of the turbine governing valve, trip valve, or trip and throttle valve.

8.6 *Shaft Sealing*—Casing shaft seals shall be designed to minimize or prevent loss of steam from the turbine casing and additionally, in condensing operation, preclude the entrance of air and oil to the exhaust system.

8.6.1 Noninterchangeable carbon or metallic seal segments shall be match marked to ensure proper fit on installation.

8.6.2 Where the turbine is operated in condensing service, the gland shall be designed for a steam sealing system.

8.6.3 Air and steam leakage rates or gland sealing requirements data shall be provided by the manufacturer for normal and maximum clearances.

8.6.4 Springs used with carbon packing or labyrinth seals shall be of Methods A 367 or equivalent material suitable for the actual spring operating temperature.

8.6.5 *Carbon Packing Limitations*:

8.6.5.1 Carbon packing shall be limited to a maximum pressure differential of 25 psi (1.7 bar g) per ring.

8.6.5.2 Carbon packing shall not be used where exhaust temperatures exceed 750°F (400°C).

8.6.5.3 For carbon packing seal installation, shaft surface speeds shall not exceed 160 ft/s (48.8 m/s).

8.6.6 *Metallic Labyrinth Packing*:

8.6.6.1 Labyrinth packing projections shall be integral with the packing ring and of softer material than the rotating sealing surface to minimize scoring if contact occurs.

8.6.6.2 Packing shall be spring-loaded segments of a full circle, and metal to metal contacting steam sealing surfaces shall be finished to not more than 63 µin. (1.6 µm) rms.

8.7 *Bolting*:

8.7.1 Threads on all fasteners shall be in accordance with one of the following standards: ANSI B1.1 and Federal Standard H 28/21A.

8.7.2 Through bolts shall be used wherever possible. The number of tapped holes in pressure parts shall be minimized. Where tapped holes are necessary, studs should be used in lieu of cap screws, the latter being used only where space precludes clearing a part over the studs.

8.7.3 Fasteners installed in the interior of the turbine case shall be secured to prevent loosening and shall be retained by a method of locking in the event of fastener failure.

8.8 *Auxiliary Piping*:

8.8.1 Threaded connections for flammable fluids and steam above 75 psig (5.2 bar g) shall be seal welded.

8.8.2 Pipe threads and tapped openings shall conform to ANSI B1.1 and B16.5, respectively.

8.8.3 Threaded connections shall not exceed 1.5 in. nominal size.

8.8.4 Flanges and fittings shall conform to ANSI B16, B16.4, and B16.5 as applicable for allowable stresses, flange ratings, and geometry.

8.8.5 Welded lube oil pipe assemblies shall be cleaned of scale by pickling in acid solution, flushing, neutralizing, reflushing, and drying and preserving pending installation.

8.8.6 Prior to final drying and preservation, welded pipe assemblies shall be hydrostatically tested in accordance with 11.2.

8.8.7 Seal welds may be used on permanently assembled threaded joints. Welded threaded joints shall have clean dry threads and no thread compound used during makeup of the joint. Fillet welds shall be made with not less than two passes and shall completely cover the threads.

8.9 *Gaskets and Sealants*:

8.9.1 For steam temperature above 500°F (260°C) or steam pressure above 400 psig, flange gaskets shall be spiral-wound asbestos filled, or metal jacketed. The manufacturer's standard gasket may be used below these limits.

8.9.2 Sealants shall be specified in the operation and maintenance manual.

8.10 *Case Openings and Interface Connections*:

8.10.1 Flanged connections shall conform to ANSI B16.1 or B16.5 as applicable.

8.10.2 Customer connections requiring studs shall have studs installed.

8.10.3 Case openings for steam or lubricating oil services shall terminate with connections outside of turbine lagging line.

8.11 *Baseplates (When Furnished) and Mounting Brackets:*

8.11.1 Each baseplate or mounting bracket shall be sufficiently rigid to permit handling, shipment, and installation with minimal disturbance to the alignment of the machinery mounted thereon.

8.11.2 Turbines mounted directly to gear casings or other equipment shall be of ample strength and rigidity to support the mating equipment.

8.11.3 Baseplate seating surfaces shall be machined.

8.11.4 If a reservoir is located in the baseplate, it shall conform to the requirements in Section 9.

8.12 *External Forces and Moments*—External forces and moments shall be in accordance with NEMA SM 23, Section 9, Installation.

9. Lubrication System

9.1 *Lubricants*:

9.1.1 Lubricating and control oil shall be the same as used in the main propulsion unit as specified in the ordering data, or as otherwise approved.

9.1.2 Lubricants shall be specified in the technical manual.

9.2 *Pumps, Lube Oil (Pressurized Systems):*

9.2.1 The auxiliary turbine shall have an attached positive displacement pump with the suction submerged in the sump oil under the conditions specified in 7.3.

9.2.2 When specified in the ordering data, the turbine shall also have a motor driven pump to do the following:

9.2.2.1 Supply oil to the bearings in event of an attached oil pump failure.

9.2.2.2 Develop sufficient pressure to start the turbine and maintain system oil pressure until the attached pump obtains self-sustaining conditions.

9.3 *Filters*:

9.3.1 Control system oil shall be filtered for removal of particles larger than 25 µm.

9.3.2 Other system oil shall be filtered for removal of particles larger than 40 µm.

9.3.3 Filters shall be cleanable during operation of the turbine without shutdown or loss of oil supply from the system.

9.3.4 Filters shall be located so that they are readily accessible for servicing during turbine operation and remote from high temperature surfaces unless suitably shielded.

9.4 *Coolers*:

9.4.1 A cooler shall be installed in the lubricating oil system of all turbines. The cooler shall have a capacity not less than the total oil flow requirements downstream of the cooler. Cooler size shall be based upon an oil outlet temperature not greater than 130°F (54°C) and for inlet water characteristics not less than that specified in the ordering data.

9.4.2 Cooler shall be designed so that water flows through the tubes and arranged so that cooler or the tube bundles, or both, can be readily removed and replaced.

9.4.3 Tubes and tube sheets for seawater service shall be 90-10 copper nickel and bronze heads.

9.5 *Valves*:

9.5.1 The lubricating oil system shall have oil pressure regulating or relief valves and check valves in the discharge line of the pumps. Such valves are installed at other locations as required by system design. A cooler bypass valve shall be installed ahead of the cooler and designed so that the cooler can be bypassed without interruption of the oil flow.

9.6 *Indicators Required*:

9.6.1 *Temperature*:

9.6.1.1 Oil cooler inlet and outlet oil temperatures.

9.6.1.2 Journal and thrust bearing oil drain temperatures (except for integral turbine/gear designs).

9.6.1.3 Thermometers shall have a range of 30 to 240°F (approximately 0 to 115°C) and shall be located in an accessible and readable location. Thermometers may be combined with sight flows.

9.6.2 *Pressures*:

9.6.2.1 Lube oil pump discharge pressure.

9.6.2.2 Pressure drop across the oil filters.

9.6.2.3 Pressure at the bearing with the lowest oil pressure.

9.6.3 *Switches*:

9.6.3.1 System low oil pressure alarm. Alarm power requirements to be specified in the ordering data.

9.6.3.2 Pressure switches shall be installed for automatic starting and securing of the motor driven pump (when furnished).

9.6.4 *Sight Flows (Bearing Drain Lines)*——Flow indicators shall be located in the oil supply line where bearing drains are internal.

9.7 *Oil Piping*—Lubricating and oil control system piping shall be of seamless steel pipe or tubing using flanged or compression type fittings. Flexible lube oil pipe sections may be used to minimize strain on piping systems. Oil piping shall not be run close to hot surfaces, but where unavoidable, shall be adequately shielded.

9.8 *Sumps*:

9.8.1 Each auxiliary turbine shall have its own oil sump with an operating capacity not less than double the flow per minute of oil required by the control and lubrication system when operating at rated speed. Connections shall be provided for oil sampling and draining sumps. An oil level indicator shall be fitted on each sump. Internal heating or cooling coils are not permitted.

9.8.2 In a case in which it is impractical to remove the oil sump, access holes shall be provided for cleaning.

10. Controls and Protective Devices

10.1 *Control Accessibility*:

10.1.1 Manual startup and shutdown of each turbine shall be capable of being accomplished locally at the unit. Automatic or manual means of shutdown and controlling turbine speed remotely must be specified in the ordering data.

10.1.2 Controls and protective devices that require manual operation or adjustments shall be mounted in an accessible location on each unit.

10.2 *Turbine Protection Systems*:

10.2.1 The turbine shall be provided with overspeed protective devices to prevent the rated speed from being exceeded by

more than 15 %. It shall, unless otherwise specified in the ordering data, consist of a trip valve separate from the normal governor valve, closing by spring action to stop the turbine upon overspeeding, manual tripping, or actuation by other protective devices. Seating surfaces and stem shall be of corrosion resistant material.

10.2.2 The turbine is to be provided with a means of automatically shutting off the steam supply to stop fully the turbine under low oil pressure conditions.

10.2.3 Exhaust pressure protection by a back-pressure trip to shut off the steam supply or a full flow relief valve is required. The method shall be specified in the ordering data.

10.2.4 The turbine shall be fitted with sentinel warning valve set at the pressure specified in the ordering data.

10.2.5 The turbine shall be fitted with an automatic governing system driven through a gear train or directly from the main shaft.

10.2.5.1 The ordering data shall specify the governing system required as classified and defined by NEMA SM 23, Section 4, Governing Systems.

10.2.5.2 The ordering data shall specify whether the governor is to be constant speed or speed-limiting type.

11. Test Methods

11.1 *Production Unit Tests*:

11.1.1 The turbines shall be given a no-load running test in accordance with 11.3.

11.1.2 When specified in the ordering data, load testing and steam rate testing shall be conducted in accordance with 11.4 and 11.5 and the ASME Performance Test Code.

11.2 *Hydrostatic Pressure Test*:

11.2.1 Turbine parts that contain steam or oil under pressure, including appurtenant fittings, connections, and piping, shall be pressure tested prior to assembly at no less than 150 % of their design pressures. Where temperature exceeds 650°F (343°C), values of test pressure shall be multiplied by a factor obtained by dividing the maximum allowable hoop-stress value of the material at room temperature by that of the corresponding stress value at temperature. For hoop-stress values, refer to Section VIII, Division 1 of the ASME Pressure Vessel Code.

11.2.2 Exhaust casings of condensing turbines shall be pressure tested to 25 psig (0.17 bar).

11.2.3 Test pressures shall be maintained for a minimum of 15 min.

11.3 *No Load Running Test*:

11.3.1 The turbine shall be tested at rated speed with no load and available steam conditions.

11.3.2 During testing, units should be observed for general overall mechanical operation and the following data recorded:

11.3.2.1 Shaft vibration (mils or millimetres total displacement).

11.3.2.2 Governor valve setting and operation.

11.3.2.3 Overspeed trip setting.

11.3.2.4 Steam and oil tightness.

11.3.2.5 Bearing and lubricating oil temperature rise.

11.3.2.6 Other safety devices as specified in the ordering data.

11.3.2.7 A post-test inspection of bearings and related shaft areas shall be conducted except for rolling contact bearing applications.

11.4 *Load Test*—When specified in the ordering data, a load test shall be conducted under conditions as close as practicable to rated conditions to determine the turbine capability to meet its rated horsepower.

11.5 *Steam Rate Test*—When specified in the ordering data, steam rate testing shall be conducted under conditions as close as practicable to rated conditions to determine the turbine capability to meet its guaranteed steam rate.

11.6 *Required Test Data*—When specified in the ordering data, the following reports shall be made available to the purchaser.

11.6.1 Physical and chemical data for Mill Report (or certification) of inlet pressure boundary parts and forgings.

11.6.2 Hydrostatic pressure tests, 11.2.

11.6.3 No-load running tests, 11.3.

11.6.4 Load tests, 11.4.

11.6.5 Steam rate test, 11.5.

11.7 *Witness of Tests and Submittals*:

11.7.1 Customer witness requirements of any test shall be as specified in the ordering data.

11.7.2 ABS inspection and submittal requirements shall be as specified in Section 33 and Section 44 of *ABS Rules for Building and Classing Steel Vessels* when specified in the ordering data.

12. Preservation and Shipping Preparation

12.1 After tests are complete and the bearings and shaft areas have been inspected, the turbine shall be preserved and prepared for shipment. The preservation method should protect the unit from corrosion for a minimum of one year for indoor storage unless otherwise specified in the ordering data.

12.2 Shaft areas inside bearing cases and the interiors of bearing cases shall be cleaned and flushed with a suitable solvent and dried.

12.3 Hardboard covers shall be bolted securely to turbine inlet and exhaust connections.

12.4 Steel plugs or caps shall be used to seal threaded connections.

12.5 Exposed studs for customer connections shall be suitably protected to prevent damage to the threads. The turbine and parts to be shipped loose shall be properly tagged and identified.

12.6 Rust preventive compound should be used which is soluble in steam or oil as applicable in order that complete removal is not necessary before startup. The rust preventive compound shall be applied to the following if subject to corrosion:

12.6.1 Shaft areas, bearings, overspeed governor, and internal surfaces of bearing cases before bearing liners and bearing case caps are replaced.

12.6.2 External components of the speed governor system and overspeed governor system.

12.6.3 Internal surfaces of turbine casing and casing sealing glands.

12.6.4 Rotor surfaces.

12.6.5 Steam inlet connection.

12.6.6 Machined external surfaces.

12.7 When provided with independent oil reservoirs, governors shall be filled with oil to minimize corrosion of internal components. The shaft extension shall be protected from corrosion.

13. Spare Parts

13.1 *Spare Parts, Standard Complement*— A standard shipboard spare parts complement as required by *ABS Rules for Building and Classing Steel Vessels* shall be included in the manufacturer's quotation and supplied with each turbine.

13.2 *Additional Recommended Spare Parts, Price Quotation*—When specified in the ordering data, the manufacturer shall provide a priced list of additional recommended shipboard and shorebased spare parts appropriate for the number of turbines installed on each ship and the number of ships in the class. This list will serve as a guide to the purchaser in selecting the fleet's complement of spare parts. Procurement of any spare parts so selected may be under separate purchase order.

13.3 *Special Tools*—Special tools required to perform normal adjustment, maintenance or repair of turbines aboard ship shall be listed and included in the manufacturer's quotation and supplied with each shipset of turbine(s).

14. Operation and Maintenance Manual

14.1 Maintenance manual describing installation, operation, and maintenance procedures shall conform to the manufacturer's standard format. The manual shall be delivered no later than the date of equipment shipment. The manual shall contain information on auxiliaries and instruments furnished by the manufacturer, as well as the turbine.

14.2 Each manual shall consist of the following:

14.2.1 Be organized and indexed by principal equipment items.

14.2.2 Include sequence of installation, tests, and checks before initial startup.

14.2.3 Include instructions for erecting, general piping information, and alignment.

14.2.4 Include instructions for preparing the turbine and auxiliary equipment for use.

14.2.5 Include instructions for start-up, normal shutdown, emergency shutdown, operating limits, and routine operational and maintenance procedures.

14.2.6 Describe construction features and functioning of component parts and systems.

14.2.7 Include outline, sectional assembly, and schematic drawings to identify each part, illustrate its function and identify location in the equipment.

14.2.8 Describe methods of disassembly, repair, adjustment, inspection, and re-assembly, and name and type of sealant if required.

14.2.9 List fits and clearances needed for maintenance and repair.

15. Keywords

15.1 baseplates; bearings; bolting; coolers; filters; metallic labyrinth packing; mounting brackets; rotors; single-stage steam turbines; shaft sealing; steam strainers; valves

ANNEXES

(Mandatory Information)

A1. MAINTENANCE PROCEDURES

A1.1 Each Watch

A1.1.1 Visually inspect for external damage, steam, and oil leaks.

A1.1.1.1 Check all oil levels in reservoirs (including governors with separate oil system).

A1.1.1.2 Check for unusual noise or vibration levels. (Each operator shall become accustomed to normal operating levels).

A1.1.1.3 Check all operating pressures. Clean or replace strainers/filters as dictated by pressure drops.

A1.1.1.4 Visually evaluate condition of all lubricating oil to determine need for oil change. Change or clean filter element when oil changed.

A1.2 Weekly

A1.2.1 Operate turbines (and related safety devices) used for standby services at regular intervals (weekly as a minimum) to ensure operability when needed. If steam is not available, turn units over by hand a minimum of three revolutions.

A1.2.2 Test the operation of all shutdown devices in accordance with the technical manual procedures.

A1.2.3 Exercise the trip valve to ensure freedom of movement.

A1.2.4 Check operation of auxiliary oil pumps.

A1.2.5 Check emergency alarm systems.

A1.3 Monthly

A1.3.1 Test oil sample for water and particle count to determine need for an oil change.

A1.3.2 Check the operation of the speed limiting governor.

A1.4 Quarterly

A1.4.1 Lubricate flexible couplings.

A1.4.2 Measure thrust clearance.

A1.5 Annually

A1.5.1 Remove and clean steam strainer.

A1.5.2 Remove sentinal valve where installed and check for proper operation using air pressure.

A1.5.3 Clean and inspect lube oil sump.

A1.5.4 Drain governor oil, flush clean, and refill.