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Standard Specification for Heat Stability of Steam Turbine Shafts and Rotor Forgings¹

This standard is issued under the fixed designation A472/A472M; 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.

1. Scope

1.1 This specification covers the determination of heat stability of steam turbine shafts and rotor forgings to ensure stability at operating temperature. This specification is not ordinarily applicable to generator rotor forgings.

1.2 This specification is expressed in both inch-pound units and in SI units; however, unless the purchase order or contract specifies the applicable M specification designation (SI units), the inch-pound units shall apply. The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the specification, the SI units are shown in brackets. The values stated in each system ~~may~~ are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other. Combining other, and values from the two systems may result in nonconformance with the standard; shall not be combined.

1.3 Supplementary requirements of an optional nature are provided for use at the option of the purchaser. The supplementary requirements shall apply only when specified individually by the purchaser in the purchase order or contract.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and ~~health~~ environmental practices and determine the applicability of regulatory limitations prior to use.*

1.5 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Ordering Information

2.1 It shall be the responsibility of the purchaser to specify all requirements necessary for testing under this specification. Requirements to be considered include, but are not limited to, the following:

2.1.1 ASTM designation and year date,

2.1.2 The minimum test temperature,

2.1.3 The portion of the forging to be subjected to the heat stability test temperature, and

2.1.4 Supplementary or other special requirements.

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.06 on Steel Forgings and Billets.

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3. Procedure

3.1 The heat stability test shall be conducted by the forging supplier after final heat treatment and after the forging has been centered and machined with allowance to finish to the purchaser's drawing. Material for mechanical tests may be removed before or after the stability test at the manufacturer's option, unless check tests after the stability test are required by the purchaser.

3.2 With prior approval from the purchaser, the forgings may be stress-relieved as part of the heat stability test. When this is done, the stress-relieving temperature shall be within $50\text{--}500\text{ }^{\circ}\text{F}$ to $100\text{ }^{\circ}\text{F}$ [$30\text{--}300\text{ }^{\circ}\text{C}$ to $55\text{ }^{\circ}\text{C}$] below final tempering temperature. Rotate the forgings at $2\text{--}20\text{ r/min}$ to 4 r/min and hold at stress-relieving temperature for at least 2 h/in. [2 h/25 mm] of maximum radial thickness, after which the temperature may be decreased to the specified heat stability test temperature and the test performed.

4. Heat Stability Test Bands

4.1 The supplier shall mark positions A, B, C, and D, spaced 90° apart circumferentially, preferably on an end of the forging. Markings shall be retained throughout all subsequent operations.

4.2 Preferably, there shall be a minimum of 5 test bands, denoted as 1, 2, 3, 4, and 5, machined on the circumference of the forging. Numbering shall start at the left side of the forging drawing. Bands 1 and 5 shall be located as close to the end of the forging as practical. Band 3 shall be located as near to midlength as practical. Bands 2 and 4 shall be located approximately equidistant between 1 and 3, and 3 and 5, respectively.

4.3 When the shipped length of the barrel portion of the forging is less than 8 ft [2.4 m], bands 2 and 4 may be omitted.

4.4 The purchaser's drawing may show the desired number and location of bands and shall indicate that portion of the forging that shall be located within the heating chamber. Bands 1 and 5 are to be located outside of the heating chamber. Preferably, the gland areas/packing seal areas are inside the heating chamber.

4.5 The test bands shall be machined with the forging running on centers except in the cases of forgings weighing over $125\text{ }000\text{ lb}$ [56.7 metric tons] the machining shall be performed with the forgings running on steady rests. Readings shall be taken with the forging running on centers except in the cases of forgings weighing over $125\text{ }000\text{ lb}$ [56.7 metric tons] where readings may be taken with the forgings running on steady rests. Between readings, the forgings may be rotated on steady rests.

5. Surface Preparation

5.1 Remove oil, grease, dirt, and other foreign material from the surface of the forging prior to the heat stability test. A suitable coating may be applied to provide uniform emissivity.

6. Heating and Cooling

6.1 Place the forging in the heating chamber and rotate the forging at a speed of $2\text{--}20\text{ r/min}$ to 4 r/min .

6.2 Place thermocouples in contact with the forging at each test band within the heating chamber. Shield the thermocouples from the heat source.

6.3 Apply heat uniformly to avoid localized overheating. Heat the forging at a rate not exceeding $200\text{ }^{\circ}\text{F/h}$ [$110\text{ }^{\circ}\text{C/h}$] to the stability test temperature specified by the purchaser. Maintain the specified testing temperature until the forging is heated uniformly. A uniform temperature condition shall be considered to exist when three consecutive hourly deflection measurements taken at the test temperature are within 0.0005 in. [0.013 mm]. To consider a uniform test temperature condition to exist, it is also necessary that the axial thermal expansion be consistent within 0.010 in. [0.25 mm] for three consecutive hourly readings at the test temperature.

6.4 After uniform test conditions as described in 6.3 have been reached, cool the forging, while rotating, to below $100\text{ }^{\circ}\text{F}$ [$40\text{ }^{\circ}\text{C}$]. The heating chamber may be opened during cooling, but the cover shall not be removed until the temperature of the forging is less than $500\text{ }^{\circ}\text{F}$ [$260\text{ }^{\circ}\text{C}$]. After the forging has cooled to approximately room temperature, rotate it for at least 2 h before the second cold measurements (see 7.4) are recorded.