



AEROSPACE MATERIAL SPECIFICATION

AMS2759™/5**REV. F**

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Revised 2020-09

Superseding AMS2759/5E

Heat Treatment Martensitic Corrosion-Resistant Steel Parts

RATIONALE

AMS2759/5F makes changes to ordering information regarding qualification test specimens and properties, gas pressure quenching (3.4.6.1), and Note 1 of Table 2 deleting reference to vacuum to allow for non vacuum furnaces, 440 °C tempering temperature correction (Table 3), and improvements to Appendix A.

ORDERING INFORMATION: In addition to that listed in AMS2759, the purchaser shall supply the following information to the heat treating processor.

- AMS2759/5F
- Hardness or tensile strength if other than that listed in Table 3 (see 3.4.8 and 3.5.1)
- When required for qualification of gas quenching, tensile properties and number of specimens (see A.1 and A.2.4)

1. SCOPE

1.1 Purpose

This specification, in conjunction with the general requirements for steel heat treatment covered in AMS2759, establishes the requirements for heat treatment of martensitic corrosion-resistant steel parts. Parts are defined in AMS2759. General ordering instructions are specified in AMS2759.

1.2 Application

This specification is applicable to parts made from the following steels: Alloy types 403, 410, 416, 420, 422, 431, 440C, Greek Ascoloy, XD15NW, XD16N, and CX13VDW (UNS S40300, S41000, S41600, S42000, S42200, S43100, S44004, S41800, S42025, S42716, and S64152, respectively). Parts made from other martensitic stainless steels other than those specified may be heat treated in accordance with the applicable requirements using processing temperatures, times, and other parameters recommended by the material producer unless otherwise specified by purchaser.

1.3 The provisions of this specification revision shall become effective 90 days after publication.

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<https://content/AMS2759/5F/>

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2. APPLICABLE DOCUMENTS

In addition to those listed in AMS2759, the issue of the following documents in effect on the date of the purchase order forms a part of this specification to the extent specified herein. The processor may work to a subsequent revision of a document unless a specific document issue is specified. When the referenced document has been cancelled and no superseding document has been specified, the last published issue of that document shall apply. In the event of conflict between the text of this document and references cited herein, the text of this document takes precedence.

2.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (inside USA and Canada) or +1 724-776-4970 (outside USA), www.sae.org.

AMS2418	Plating, Copper
AMS2750	Pyrometry
AMS2759	Heat Treatment of Steel Parts, General Requirements
AMS2769	Heat Treatment of Parts in a Vacuum
AS1260	Equivalent Sections of Certain Shapes to Round Bars

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM A370	Mechanical Testing of Steel Parts
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3. TECHNICAL REQUIREMENTS

3.1 Pyrometry

Shall be in accordance with AMS2750 and as specified herein.

3.2 Furnace Equipment

Shall be in accordance with AMS2759. Furnaces used for annealing, subcritical annealing, hardening, straightening, and baking shall be a minimum of Class 5 and for tempering shall be a minimum of Class 3 in accordance with AMS2750.

3.3 Heating Environment

Parts shall be controlled by type and heat treated in the class of atmosphere permitted in Table 1 for that type when heating above 1250 °F (677 °C). When heating parts at 1250 °F (677 °C) or below, Class A, B, or C atmosphere may be used (see 8.2). Types of parts and classes of atmosphere are defined in AMS2759. Atmosphere furnaces shall be controlled to ensure that the surfaces of heat treated parts are within the limits specified in 3.5.2. Salt baths shall be controlled and tested in accordance with AMS2759. Vacuum furnaces shall be controlled and tested in accordance with AMS2769.

Table 1 - Atmospheres ⁽¹⁾⁽⁵⁾

Part Classification ⁽³⁾	Class A	Class B ⁽⁴⁾	Class C
Type 1	Permitted	Permitted	Permitted
Type 2 ⁽²⁾	Permitted	Prohibited	Prohibited

NOTES:

- (1) Austenitizing in atmospheres containing hydrogen with a dewpoint greater than -40 °F (-40 °C) shall be limited to parts to be tempered above 1000 °F (538 °C). Annealing in hydrogen-containing atmospheres is permitted.
- (2) Except for stainless steels, which have been purposely enriched with nitrogen during their manufacture, atmospheres containing nitrogen at 1800 °F (982 °C) and higher shall not be permitted when finished machined surfaces exist.
- (3) Refer to AMS2759 regarding reclassification of part type for surface contamination testing.
- (4) Endothermic and carbon-containing nitrogen-base atmosphere are prohibited for Alloy 431 and when heat treating any alloy to 180 ksi (1241 MPa) or higher.
- (5) Types of parts and classes of atmospheres are defined in AMS2759.

3.4 Procedure**3.4.1 Cleaning**

Shall be in accordance with AMS2759.

3.4.2 Preheating

Preheating, in the 1200 to 1500 °F (649 to 816 °C) range, is recommended before heating parts above 1500 °F (816 °C), if the parts have previously been heat treated to a hardness greater than 35 HRC, have abrupt changes of section thickness, have sharp re-entrant angles, have finished machined surfaces, have been welded, have been cold formed or straightened, have holes, or have sharp or only slightly rounded notches or corners.

3.4.3 Soaking

Start of soak shall be in accordance with AMS2759. Soak times for annealing and hardening are shown in Table 4. Parts that are copper plated or coated with reflective coatings which tend to reflect radiant heat shall have the soak time increased by at least 50% when processing at setpoints above 1200 °F (649 °C), unless load thermocouples are used.

3.4.4 Annealing

Shall be accomplished by heating to the temperature shown in Table 2, soaking for the time shown in Table 4, and cooling to below the temperature shown in Table 2 at the rate shown in Table 2, followed by air cooling or equivalent to ambient temperature. Isothermal annealing treatments may be used providing equivalent hardness and microstructure are obtained. Isothermal annealing shall be accomplished by heating to the annealing temperature shown in Table 2, soaking for the time shown in Table 4, cooling to a temperature below the critical, holding for sufficient time to complete transformation, and air cooling or equivalent to ambient temperature.

3.4.5 Subcritical Annealing

When subcritical annealing is required, it shall be performed prior to hardening by heating in the range 1350 to 1450 °F (732 to 788 °C), except 431 alloy, which shall be at 1150 to 1200 °F (621 to 649 °C) and 440C alloy, which shall be at 1250 to 1350 °F (677 to 732 °C), soaking for the time shown in Table 4, and cooling to ambient temperature.

3.4.6 Hardening (Austenitizing and Quenching)

Shall be accomplished by heating to the austenitizing temperature shown in Table 2, soaking for the time shown in Table 4, and quenching as shown in Table 2. The parts shall be cooled to or below the liquid quenchant temperature or to a temperature low enough to achieve complete transformation before tempering. Quench liquids shall be controlled and tested as specified in AMS2759. Vacuum quench media shall be controlled and tested as specified in AMS2769.

3.4.6.1 Furnace Gas Pressure Quenching

For all materials listed in Table 2, forced gas quenching is permitted for parts where the minimum dimension of the maximum thickness of the part is 1 inch or less. For thickness greater than 1 inch (25.4 mm) qualification is required in accordance with Appendix A.

- 3.4.6.1.1 Quench gases shall be in accordance with AMS2769. Single gas types or mixtures may be used for gas pressure quenching provided the quenching process is qualified in accordance with the requirements contained in this document.

3.4.7 Subzero Cooling

After quenching and prior to tempering, subzero cooling may be required as shown in Table 2. It is recommended that subzero cooling begin within 2 hours from end of quench. For subzero treatments, interruptions of the soaking period are permitted. The total soak time shall not include any time when the temperature is warmer than -90 °F (-68 °C) due to interruptions.

3.4.8 Tempering

- 3.4.8.1 Shall be accomplished by heating quenched parts to the temperature required to produce the required properties. Suggested tempering temperatures for specific hardness or tensile strengths for each alloy are shown in Table 3. Initial tempering should begin within 2 hours from end of quench or within 2 hours from when subzero cooled parts have reached ambient temperature. Soaking time shall be not less than 2 hours plus 1 hour additional for each inch (25 mm) of thickness or fraction thereof greater than 1 inch (25 mm). Thickness is defined in AMS2759. When load thermocouples are used, the soaking time shall be not less than 1 hour. Multiple tempering is permitted for all alloys and required for some as shown in Table 3. When multiple tempering is used, parts shall be cooled to ambient temperature (or below, if specified) between tempering treatments.
- 3.4.8.2 If parts cannot be tempered within 2 hours from end of quench or within 2 hours from when subzero cooled parts have reached ambient temperature, parts may be snap tempered for a minimum of 2 hours at 300 °F (149 °C). If the tempering temperature is below 325 °F (163 °C), the snap temper shall be no greater than 25 °F (14 °C) below the final tempering temperature.

3.4.9 Straightening

When straightening of heat treated parts is required and the procedure is not specified, straightening shall be performed as follows:

- 3.4.9.1 Hardened parts shall be straightened during tempering, in between tempers, or after the tempering operation.
- 3.4.9.2 Hardened and tempered parts shall be straightened at ambient temperature or at an elevated temperature not exceeding 50 °F (28 °C) below the tempering temperature. Ambient or elevated temperature straightening shall be followed by stress relieving at a temperature 50 °F (28 °C) below the tempering temperature, unless otherwise specified.

3.4.10 Stress Relieving

When required, parts shall be stress relieved in accordance with AMS2759/11.

3.5 Properties

3.5.1 Hardness

Parts shall conform to the minimum hardness converted from the required tensile strength stated in Table 3. Frequency of hardness testing shall be in accordance with AMS2759.