# AEROSPACE MATERIAL SPECIFICATION

| AMS2759™/2 | REV. K |
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Superseding AMS2759/2J

## Heat Treatment of Low-Alloy Steel Parts
## Minimum Tensile Strength 220 ksi (1517 MPa) and Higher

RATIONALE

AMS2759/2K results from correcting the table reference in the ordering information, deleting “Parts with finished machined surfaces” from preheating (3.4.1) because not all finished machined require stress relief, and adding 3.4.1.1 allowing preheating in separate furnaces.

NOTICE

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

- AMS2759/2K
- Tensile strength and/or hardness if other than that listed in Table 3 (see 3.4.8 and 3.5.1)
- Cognizant engineering organization approval if dimensions at heat treatment exceed Table 5 size limits

1. SCOPE

This specification, in conjunction with the general requirements for steel heat treatment covered in AMS2759, establishes the requirements for heat treatment of low-alloy steel parts to minimum ultimate tensile strengths of 220 ksi (1517 MPa) and higher. Parts are defined in AMS2759. The requirements for heat treatment of alloy Aermet100 are no longer part of this specification and can be found in AMS2759/3. Due to the limited hardenability of these materials, size limits have been added to this specification.

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

2. APPLICABLE DOCUMENTS

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.

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

AMS2424 Plating, Nickel, Low-Stressed Deposit

AMS2750 Pyrometry

AMS2759 Heat Treatment of Steel Parts, General Requirements

AMS2759/11 Stress Relief of Steel Parts

AMS2769 Heat Treatment of Parts in a Vacuum

3. TECHNICAL REQUIREMENTS

3.1 Heat Treatment

Shall conform to AMS2759 and the requirements specified herein.

3.2 Equipment

Equipment shall conform to AMS2759 except that tempering furnaces shall be in accordance with AMS2750 Class 2.

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). Atmosphere Class and Part Type are described in AMS2759.

***Table 1 - Atmospheres***

| Part Type | Atmosphere Classification | | |
|---|---|---|---|
| | Class A | Class B | Class C |
| Type 1 | Permitted | Permitted | Permitted |
| Type 2 | Permitted | Prohibited(1) | Prohibited |

NOTES:
(1) Permitted provided the atmosphere is controlled to meet the surface contamination requirement in 3.5.2.

3.3.1 Protective Coatings

A supplemental coating or plating is permitted when approved by the cognizant engineering organization. Fine grain copper plating in accordance with AMS2418, or nickel plating in accordance with AMS2424, may be used without approval but the surface contamination specimens in AMS2759 shall not be plated. Failure of the unplated specimen to meet contamination requirements shall result in investigation and remedial action taken against the furnace. Additional surface contamination specimens, which include supplemental coating or plating may be processed and tested, and shall be used to represent the parts within the load.

3.4 Procedure

3.4.1 Preheating

The following parts shall be preheated in the range of 900 to 1250 °F (482 to 677 °C) before heating above 1300 °F (704 °C) until the furnace is stabilized at the required temperature:

Parts previously heat treated to a hardness of greater than HRC 35.

Parts that have been welded.

Parts that have been cold formed or straightened.

Parts that have geometries that would result in high thermally induced stresses such as: abrupt changes in section, sharp angular changes, have holes or slots, sharp or slightly rounded notches or corners.

Parts that have been normalized without tempering.

3.4.1.1 Preheating in a separate furnace is allowed provided that parts are transferred without delay into the heat treatment furnace.

3.4.2 Soaking

The start of soaking time shall be in accordance with AMS2759.

3.4.2.1 Parts coated with copper or nickel plate or similar reflective coatings that tend to reflect radiant heat shall have their soak time increased by at least 50%, for annealing, normalizing, sub-critical annealing, or austenitizing, unless load thermocouples are used. This increase does not apply to salt bath heat treating, tempering, or sub-zero processing.

3.4.3 Annealing

3.4.3.1 When required, annealing shall be accomplished by heating to the temperature specified in Table 2, soaking for the time specified in Table 4, and cooling to below the temperature specified in Table 2 at the rate shown in Table 2, followed by air cooling to ambient temperature. Isothermal annealing treatments may be used provided equivalent hardness and microstructure are obtained.

3.4.3.2 Isothermal annealing shall be accomplished by heating to the annealing temperature specified in Table 2, soaking for the time specified in Table 4, cooling to a temperature below the critical, holding for sufficient time to complete transformation, and air cooling to ambient temperature.

3.4.4 Subcritical Annealing

When required, subcritical annealing shall be accomplished prior to hardening by heating to a set temperature between 1150 °F and 1250 °F (621 °C and 677 °C), soaking for the time specified in Table 4, and cooling to ambient temperature. Steel parts of the 9Ni-4Co type shall be subcritical annealed as specified in Table 2.

3.4.5 Pre-Hardening Stress Relief

When required, pre-hardening stress relieving shall be done in accordance with AMS2759/11.

3.4.6 Normalizing

When required, normalizing shall be accomplished by heating to the temperature specified in Table 2, soaking for the time specified in Table 4, and cooling in air or atmosphere to ambient temperature. Circulated air or atmosphere is recommended for thicknesses greater than 3 inches (76 mm). Normalizing may be followed by tempering or subcritical annealing.

3.4.7 Hardening (Austenitizing and Quenching)

3.4.7.1 All parts, except those made from H-11 (see Table 2, Note 3), 52100 (see Table 2, Note 7), or M-50 steels, shall be in one of the following conditions prior to austenitizing: normalized, normalized and tempered, or hardened and tempered. If such parts have been normalized only, without tempering, they shall be preheated per 3.4.1 before exposure to the austenitizing temperature (see Table 2, Note 2).

3.4.7.2 As steel parts hardened to this specification have limited hardenability, which varies by alloy, the size limits in Table 5 shall apply. Parts exceeding size limitations shall be machined to within 0.125 inch of the final dimensions prior to hardening. With cognizant engineering organization approval, parts may be greater than 0.125 inch (3.2 mm) of the final dimensions prior to hardening.

3.4.7.3 Welded parts and brazed parts with a brazing temperature above the normalizing temperature shall be normalized before hardening. Welded parts should be preheated in accordance with 3.4.1.

3.4.7.4 Hardening shall be done by heating to the austenitizing temperature specified in Table 2, soaking for the time specified in Table 4, and quenching as specified in Table 2. The parts shall be cooled to or below the quenchant temperature or to a temperature low enough to achieve complete transformation, before tempering. Parts made from alloys specifically noted in Table 2 as allowing inert gas quenching shall have gas quenching qualified per Appendix A or per another procedure approved by the cognizant engineering organization.

3.4.8 Tempering

When required, tempering shall be accomplished by heating to the set temperature specified in Table 3. Parts should be tempered within 2 hours from the end of quenching (see 3.4.8.1). 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 2 hours. When multiple tempering cycles are required, parts shall be cooled to ambient temperature between tempering treatments, see Table 3. When a strength or hardness not listed in Table 3 is specified, the parts shall be processed at times and temperatures appropriate to achieve the specified properties.

3.4.8.1 When tempering cannot be started within 4 hours from the end of quenching, parts shall be snap tempered for 2 hours minimum at a temperature that is lower than the final tempering set temperature (see 8.4.1), usually 400 °F (204 °C).

3.4.9 Straightening

When approved by the cognizant engineering organization, straightening shall be accomplished as stated in an approved procedure.

3.4.10 Post-Tempering Stress Relieving

When required, post-tempering stress relieving shall be in accordance with AMS2759/11.

3.5 Properties

3.5.1 Hardness

Parts shall conform to the hardness range stated in Table 3. Hardness testing shall not be used to reject parts that meet specified tensile properties. Frequency of hardness testing shall be in accordance with AMS2759.

3.5.1.1 If tensile strength testing is specified to be performed and the hardness readings, converted to tensile strength, do not meet the specified tensile properties, the parts shall not be rejected as long as the tensile test results are conforming.

3.5.2 Surface Contamination

When heating to a temperature above 1250 °F (677 °C), surface contamination shall be in accordance with AMS2759.