



AEROSPACE MATERIAL SPECIFICATION	AMS2759™/1	REV. J
	Issued 1984-10 Reaffirmed 2014-04 Revised 2021-08	
Superseding AMS2759/1H		
Heat Treatment of Carbon and Low-Alloy Steel Parts Minimum Tensile Strength Below 220 ksi (1517 MPa)		

RATIONALE

AMS2759/1J adds clarification to surface contamination (3.5.2.1) and to periodic test (4.2) regarding Type 1 parts; adds reference to a new note 8.6 in surface contamination (3.5.2.1); separates hardness and surface contamination in acceptance tests (4.1); adds reference to new note 8.7 in acceptance tests (4.1); adds new notes 8.6 and 8.7; updates Tables 2 and 3 to include specific alloys that were listed in Table 6, but inadvertently left out; corrects Table 4 to delete a line separating alloys that should not have been there; corrects Table 6 by moving 4137 to be in line with 4135 and 8735.

NOTICE

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

- AMS2759/1J
- Whether the parts are “damage tolerant,” “maintenance critical,” or “fracture critical” (see 3.4.7). These designations have been previously used to designate parts requiring additional inspection (see 4.1).
- Tensile strength or hardness if other than that stated in Tables 3 and 4 (see 3.4.8 and 3.5.1).
- Cognizant engineering organization approval if dimensions at heat treatment exceed Table 6 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 carbon and low-alloy steel parts to minimum ultimate tensile strengths below 220 ksi (1517 MPa). Parts are defined in AMS2759. Due to limited hardenability in these materials, there are size limits in this specification.

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

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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 supplier 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

3. TECHNICAL REQUIREMENTS

3.1 Heat Treatment

Shall conform to AMS2759 and the requirements specified herein.

3.2 Equipment

Equipment shall conform to AMS2759. Equipment specifically used for tempering of H-11, D6AC, and 9Ni-4Co steels shall conform to 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 requirements 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.

3.4 Procedure

3.4.1 Preheating

Preheating until furnace stabilization in the 900 to 1200 °F (482 to 649 °C) range is recommended before heating parts above 1300 °F (704 °C) if the parts have previously been heat treated to a hardness greater than 35 HRC, have abrupt changes of section thickness, have sharp reentrant 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.

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3.4.2 Soaking

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

3.4.2.1 Parts coated with copper plate or similar reflective coatings that tend to reflect radiant heat shall have their soak time increased by at least 50% 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 set temperature specified in Table 2, soaking for the time specified in Table 5, 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 is obtained.

3.4.3.2 Isothermal annealing shall be accomplished by heating to the annealing set temperature specified in Table 2, soaking for the time specified in Table 5, 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 and 1250 °F (621 and 677 °C), soaking for the time specified in Table 5, 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 prior to hardening by heating to a set temperature between 1000 and 1250 °F (538 to 677 °C), soaking for not less than the time specified in Table 5 and cooling to ambient temperature.

3.4.6 Normalizing

When required, normalizing shall be accomplished by heating to the set temperature specified in Table 2, soaking for the time specified in Table 5, 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 When required, hardening shall be accomplished by heating to the set temperature stated in Table 2, soaking for the time stated in Table 5, and quenching as stated 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 may be gas quenched provided they have been qualified per Appendix A or in accordance with another procedure approved by the cognizant engineering organization. The alloy, part size, and load size shall be qualified prior to processing hardware. Prior to initial tempering parts may be snap tempered for 2 hours minimum at a temperature, usually 400 °F (204 °C), that is lower than the tempering temperature (see 8.4.1).

3.4.7.2 As steel parts hardened to this specification have limited hardenability, which varies by alloy, the size limits in Table 6 shall apply. Parts exceeding size limitations shall be machined to within 0.125 inch (3.2 mm) 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. For welded or brazed alloys that are not normalized (for example H-11; see Table 2), the parts shall be annealed. Welded parts should be preheated in accordance with 3.4.1. Parts identified as damage tolerant, maintenance critical, or fracture critical shall be in the normalized condition before hardening, unless the alloy is not normalized (see Table 2), in which case the part shall be annealed.

3.4.8 Tempering

When required, tempering shall be accomplished by heating quenched parts to the set temperature required to produce the stated properties. Parts should be tempered within 2 hours of quenching. Suggested tempering temperatures for specific tensile strengths and hardnesses for each alloy and quenchant are shown in Table 3. Alternate tempering temperatures for specific alloys, based on as-quenched hardness, are shown in Table 4. 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. Multiple tempering cycles are permitted. When multiple tempering cycles are required, parts shall be cooled to ambient temperature between tempering treatments (see Table 3).

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

For parts having minimum tensile strength below 180 ksi (1241 MPa), straightening may be accomplished cold without stress relieving. For parts hardened and tempered to minimum tensile strength of 180 ksi (1241 MPa) and higher, straightening shall be accomplished during tempering, or by heating to not higher than 50 °F (28 °C) below the tempering temperature. Hot or warm straightening after tempering shall be followed by stress relieving. It is permissible to retemper at a temperature not higher than the last tempering temperature after straightening during tempering.

3.5 Properties

3.5.1 Hardness

Parts shall conform to the specified hardness or the hardness converted from the tensile strength ranges stated in Table 3 or the hardness converted from the tensile strength ranges stated in Table 4 as applicable. Hardness testing shall not be used to reject parts that meet specified tensile properties. Frequency of hardness testing shall be in accordance with AMS2759.

3.5.2 Surface Contamination

Shall be in accordance with AMS2759, except partial decarburization shall not exceed 0.005 inch (0.13 mm).

3.5.2.1 Parts that will be machined after heat treatment, but that will have less than 0.020 inch (0.51 mm) of metal removed from any machined surface, i.e., Type 2 parts, may be reclassified as Type 1 parts and need not meet the requirements of 3.5.2 as heat treated, when it is demonstrated by tests on each lot that all surface contamination exceeding the requirements of 3.5.2 will be removed from all machined surfaces, taking into account distortion after heat treatment (see 8.6).

3.5.2.2 The heat treating processor shall be responsible for determining whether cumulative heat treating operations at their facility have caused surface contamination in excess of that allowed.

3.6 Test Methods

Shall be in accordance with AMS2759.

4. QUALITY ASSURANCE PROVISIONS

The responsibility for inspection, classification of tests, sampling and testing, approval, records, record retention, and report/certification shall be in accordance with AMS2759 and as follows.

4.1 Acceptance Tests

Hardness (3.5.1) is an acceptance test and shall be performed on each lot. Surface contamination (3.5.2) on damage tolerant, maintenance critical, or fracture critical parts is an acceptance test and shall be performed on each lot (see 8.7).