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400 Commonwealth Drive, Warrendale, PA 15096-0001

AEROSPACE MATERIAL SPECIFICATION

SAE AMS 2759/9A

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Superseding AMS 2759/9

Hydrogen Embrittlement Relief (Baking) of Steel Parts

1. SCOPE:

1.1 Form:

This specification covers the requirements for embrittlement relief (baking) of heat treated steel parts to remove hydrogen infused during plating and other chemical processing (e.g., stripping, chemical milling, pickling, and etching).

1.2 Application:

This specification is applicable to parts made from carbon, low-alloy, and martensitic stainless steel heat treated to a minimum strength of 180 ksi (1241 MPa) or higher or heat treated to a minimum hardness of 40 HRC or equivalent, or harder. It is also applicable to threaded fasteners made from carbon, low-alloy, or martensitic stainless steels heat treated to a minimum strength of 150 ksi (1034 MPa) or 34 HRC or equivalent, parts made from high strength precipitation hardening stainless steels other than A-286, and steel parts which have been case hardened (carburized, nitrided, nitrocarburized, or carbonitrided). See 8.2.

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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2750	Pyrometry
AMS 2759	Heat Treatment of Steel Parts

QUESTIONS REGARDING THIS DOCUMENT: (724) 772-7161 FAX: (724) 776-0243
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3. TECHNICAL REQUIREMENTS:

3.1 Pyrometry:

Shall conform to AMS 2750. Temperature uniformity shall be ±25 °F (±14 °C).

3.2 Heat Treatment Equipment:

Shall conform to AMS 2759 and requirements specified herein. Furnaces shall be circulating-air type.

3.3 Baking (See 8.2):

Parts shall be baked after completion of each plating or other chemical process except when not required after etch inspection (surfactant addition to etchant) and under the following multiple step processing conditions:

3.3.1 Baking is not required after preplate strikes and after the nickel plate for diffused nickel-cadmium.

3.3.2 Baking is not required between steps in a multiple step (plating/chemical process) sequence if interruptions do not exceed two hours, baking is started within four hours after the final step, and total time between start of first step and start of baking does not exceed 24 hours.

3.3.2.1 When the conditions of 3.3.1 or 3.3.2 are not met, baking is required but the soaking time may be reduced for parts other than those covered by 3.3.2.2. The minimum soaking time shall be three hours for parts heat treated to a minimum strength of 240 ksi (1655 MPa) or lower, or a minimum hardness of 49 HRC or less; for higher strength or harder parts, the minimum soaking time shall be six hours.

3.3.2.2 For nickel plated parts heat treated to a minimum strength of 200 ksi (1379 MPa) or higher or a minimum hardness of 43 HRC, or equivalent, or harder, no reduction is permitted; baking soak time between steps shall be as specified in Table 1.

3.4 Procedure:

3.4.1 Cleaning: Parts shall be clean prior to baking.

3.4.2 Racking and Spacing: Parts shall be placed in racks or trays, made of mesh or expanded metal, or supported or suspended so as to allow free circulation of the heating medium, except small parts may be randomly arranged in trays providing that layers of parts are not thicker than two inches (51 mm) and the distance between the layers is not less than two inches (51 mm).

3.4.2.1 Thickness of layers of small parts randomly arranged in trays may be greater than two inches (51 mm) providing that tests have been made with load thermocouples to confirm that the center of the coldest load will reach the set temperature minus 25 F (14 C) degrees within one hour of loading.

TABLE 1 - Minimum Baking Time (Hours) at Standard Temperature of 375 °F (191 °C) Except Where Indicated by *

Steel/Part Description	Specified Temper, Minimum Strength or Minimum Hardness (1)	Platings (9) Cd & Cd-Ti	Platings (9) Ni (2)	Platings (9) Cr	Platings (9) Ag	Platings (9) Au	Platings (9) Sn	Platings (9) Zn-Ni	Chemical Treatments Chem (3)	Chemical Treatments Etch (4)
AISI 1095	180 ksi (1241 MPa) or 40 HRC (5)	23	23	8	3	3	5	8	3	4
Nitrided Nitrocarburized	All	8	8	3	3	3	3	8	3	4
Music Wire Carburized Carbo-nitrided	All	23*	23*	8* (8)	8*	5*	5*	23*	8*	8*
52100	All	23*	23*	8* (8)	8*	5*	5*	23*	8*	4*
AF1410 HP 9Ni-4Co -0.3C AerMet 100	All	23	23	8	8	5	5	23	8	4
Other High Strength Carbon, Low-Alloy, Tool	220 ksi (1517 MPa) 46 HRC (6)	23	23	23	3	3	5	23	8	4
Lower Strength Carbon, Low-Alloy, Tool	180 ksi (1241 MPa) or 40 HRC (5)(7)	8	8	3	3	3	3	8	3	4
440C Stainless	46 HRC (6)	23*	23*	8* (8)	5*	5*	8*	23*	8*	NA
Martensitic Stainless other than 440C	220 ksi (1517 MPa) or 46 HRC (6)	23	23	8	3	3	5	23	8	NA
Martensitic Stainless	180 ksi (1241 MPa) or 40 HRC (7)	3	3	3	3	3	3	8	3	NA
17-7PH, 15-7PH 17-4PH, 15-5PH Stainless	CH900, H900, H925, H950, RH950	23	23	8	3	3	3	8	3	NA
CUSTOM 455 PH13-8 MO Stainless	H950, H1000	3	3	3	3	3	3	8	3	NA

NOTES:
*Nonstandard Temperatures: 275 °F (135 °C) for carburized: 300 °F (149 °C) for 52100 and 440C; 325 °F (163 °C) for music wire
NA - Not applicable
(1) Or equivalent
(2) Includes electroless nickel unless age hardened within four hours
(3) Chemical Processing: Etching, Stripping, Pickling, Chemical Milling
(4) Etch Inspection, without surfactant addition to etchant, to detect abusive grinding/machining
(5) Or higher, but having minimum less than 220 ksi (1517 MPa) or 46 HRC
(6) Or higher minimum
(7) Threaded fasteners - minimum 150 ksi (1034 MPa) and higher or 34 HRC or equivalent but minimum less than 180 ksi (1241 MPa) or 40 HRC or equivalent - three hours for all processes
(8) 96 hours, if thin dense chromium (AMS 2438)
(9) For platings not listed, use baking time shown for cadmium.

3.4.3 Delay Time: The elapsed time between completion of plating or other chemical processing operations and start of heating parts in the baking furnace shall not exceed four hours except, when baking is required after etch inspection to detect abusive grinding or machining, the elapsed time may be 24 hours.

3.4.4 Baking Set Temperature: Standard baking set temperature shall be 375 °F (191 °C); nonstandard baking set temperatures shall be used for parts made from the following materials/conditions, as specified.

3.4.4.1 Carburized carbon and low-alloy steels, 275 °F (135 °C).

3.4.4.2 AISI 52100 and 440C heat treated to a minimum strength of 220 ksi (1517 MPa) or higher, or a minimum hardness of 46 HRC, or equivalent, or higher, 300 °F (149 °C).

3.4.4.3 Music wire, 325 °F (163 °C).

3.4.5 Baking Soak Times: Shall conform to Table 1.

3.4.5.1 Start of Soak Time: Soaking time shall commence when parts are placed in the furnace, the furnace door(s) are closed, and the temperature indicated by the furnace control instrument is within 25 F (14 C) degrees of the set temperature.

3.4.5.2 Soaking Interruptions: If the delay time (3.4.3) is less than two hours, soaking may be interrupted for the purpose of adding or removing parts. If the delay time (3.4.3) is two hours or more, parts shall be soaked for at least one hour before any such interruption.

3.4.5.2.1 If the temperature indicated by the control instrument drops more than 25 F (14 C) degrees below the set temperature, the time during which the indicated temperature was below that temperature shall not be considered part of the soaking time of any parts in the furnace.

3.5 Records:

Records shall be maintained which show the identification and the following for each lot:.

3.5.1 Date and time of completion of the plating or other chemical process.

3.5.2 Date and time of start of baking.

3.5.3 Date and time of start of soak.

3.5.4 Date and time of completion of baking.

3.5.5 Furnace control instrument set temperature.

3.5.6 Furnace identification.