

MIL-S-6090A
AMENDMENT 1
20 July 1972

MILITARY SPECIFICATION

STEEL, CARBURIZING AND NITRIDING, PROCESSES FOR

This specification is mandatory for use by all Departments and Agencies of the Department of Defense.

Page 1, TITLE: Changed from "Steels Used in Aircraft Carburizing and Nitriding, Process For" to be more descriptive.

Page 2, paragraph 2.2: Add:

" AEROSPACE MATERIAL SPECIFICATIONS (AMS)

2755 Nitriding-Liquid Salt Bath
5643 Bars, Forgings, Mech. Tubing and Rings - 16.5Cr 4.0Ni 4.0Cu
5659 Bars, Forgings and Rings, 15Cr 5Ni 4Cu, Con. Elect. Melted
6475 Bars, Forgings and Tubing, Nitriding 1.1Cr 3.5Ni 0.25Mo 1.25Al
6485 Bars and Forgings - 5.0Cr 1.3Mo 0.50V (0.38 - 0.43C)

(Applications for copies should be addressed to the Society of Automotive Engineers, Inc., 2 Pennsylvania Plaza, New York, N.Y. 10001.)

(Technical society and technical association specifications and standards are generally available for reference from libraries. They are also distributed among technical groups and using Federal agencies.) "

Page 2, paragraph 3.1: Delete and substitute:

"3.1 Furnaces. Furnace temperature control equipment, quenching and the handling equipment used in heat treatment shall comply with the requirements of Section 3 and paragraphs 6.1 and 6.2 of MIL-H-6875. "

Page 2, add new paragraph:

"3.1.1 Furnaces used for carburizing shall not alternately be used for nitriding and vice versa. Furnaces used for nitriding shall not be used for other heat treating processes which may contaminate the furnace lining. "

Page 2, paragraphs 3.2 and 3.2.1: Delete entirely.

Page 3, paragraphs 3.3 and 3.4: Delete entirely.

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Page 3, paragraph 4.1.1: Delete and substitute:

"4.1.1 Any process which will give the required depth and hardness of case may be used. Carburizing and hardening temperatures for commonly used steels are specified in table I. Most carburizing is accomplished by gas carburizing, although salt bath carburizing is particularly effective for distortion control and for case depths less than .010. Pack carburizing is not permitted for aircraft or aerospace gears. Carburizing by this method is influenced by the compound time, and temperature at which the process is carried out. A low carbon carburizing steel will require approximately one hour at a gas carburizing temperature of 1650° F for a 1/64 inch deep effective case depth and approximately 5 hours for a 1/32 inch deep effective case depth. Higher carburizing temperatures will reduce the time. "

Page 3, paragraph 4.1.2.1: Revise the first and second sentences to read:

"Parts which are gas carburized should be cooled in a controlled atmosphere furnace to a temperature of 900° F, after which they may be air cooled. "

Page 3, paragraph 4.1.3, line 4: Change "type" to "types".

Page 4, Table I: Delete and substitute:

Table I. Heat treatments for carburizing steels.

Steel SAE No.	Carburizing temperature ° F. (a)	Hardening for optimum case properties		Hardening for maximum case hardness	
		Austenitizing temperature for core refinement ° F. (b)	Core Hardness Rockwell	Austenitizing temperature for case ° F.	Core Hardness Rockwell
1020	1650-1700	1575-1625	C30-36	1375-1425 ^(c)	B67
4615	1650-1700	1475-1525	C27-43	1425-1475 ^(b)	B95
4620	1650-1700	1475-1525	C34-48	1425-1475 ^(b)	C23
8620	1650-1700	1550-1600	C34-48	1350-1400 ^(b)	C31
9310	1600-1700	1475-1525	C33-41	1350-1400 ^(b)	B95

(a) Carburize to desired depth. Cool in furnace or quench in oil.

(b) Quench in oil maintained at temperature not higher than 150° F.

(c) Quench in water or brine.

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Page 4, paragraph 4.1.3.3: Delete and substitute:

"4.1.3.3 All carburized parts shall be tempered or stress relieved at a temperature not less than 250⁰ F. "

Page 4 and 5, paragraph 4.2: Delete, substitute and add new paragraphs:

"4.2 Nitriding. Nitriding is a process of surface hardening steel by the formation of nitrides. The use of nitriding is normally limited to steels of selected alloy composition. Commonly nitrided steels include those specified in MIL-S-6709, AMS 6475, AMS 5659, AMS 5643 and AMS 6485. Other alloys such as 4140, 4340 and A286 may be nitrided to provide higher strength and moderate hardness. "

"4.2.1 Pre-treatment. The pre-treatment of parts to be nitrided shall be in accordance with the engineering drawing. Normally this includes hardening and tempering to develop the desired core properties to improve nitriding response, and to provide dimensional stability. "

"4.2.2 Surface. Surfaces to be nitrided shall be clean and free of decarburization and all foreign material. "

"4.2.3 Process. Nitriding is generally accomplished by subjecting the parts to the action of dissociated ammonia gas at a temperature of 925 to 1050⁰ F. The percent dissociation of ammonia, temperature, and time shall be as necessary to develop the specified nitrided case properties and minimizing the resultant white surface layer of high concentration of nitrides. The double-stage nitriding process may be used to minimize the thickness of the white layer. Its application is limited primarily to the aluminum-containing steels."

"4.2.4 Liquid (molten salt bath). The liquid (molten salt bath) nitriding employs the same temperature range as gas nitriding. The ratio of cyanide to cyanate must be controlled to insure proper nitriding. Liquid pressure nitriding may be used employing a flow of anhydrous ammonia through the molten bath which is sealed and maintained under a pressure of 1 to 30 psi. "

"4.2.4.1 Aerated bath. The aerated bath nitriding in accordance with AMS 2755 provides a nitrided case which is relatively soft, shallow, and ductile for specific applications. Parts nitrided by the aerated bath process are machined to final dimensions before being nitrided."

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Page 5, paragraph 4.3: Relocate and renumber as 4.1.4.

Page 6, paragraph 5.2.3, line 1: After "tests" insert "for hardness and case depth" .

Page 6, paragraph 5.2.3.1: Add sentence: "Unless otherwise specified, carburized case depth shall be effective case depth to a hardness of Rockwell C 50 equivalent, and nitrided case depth shall be total case depth determined metallographically as the depth from the surface to a point of contrast between the case and core. "

Page 6, paragraph 5.2.3.2: Delete and substitute:

"5.2.3.2 Hardness. Hardness tests shall be made in accordance with ASTM E18. The hardness scale used shall be appropriate for the hardness, case depth and section size being tested. "

Page 6, paragraph 5.2.3.3: Delete entirely.

Page 6, paragraph 5.3, line 4: Delete "bars" and substitute "material samples" .

Page 6, paragraph 6.1, line 7: Add to the end of sentence "(See 6.3)" .

Page 7, paragraph 6.1.2: Renumber as paragraph 6.2.

Page 7, paragraph 6.3, line 1: Delete the word "bar".

Page 7, paragraph 6.3, line 3: Add to the end of sentence "(See 6.1)" .

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