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Table I. Heat treatments for carburizing steels.

Column A	Column B	Column C	Column D	Column E	Column F
Steel SAE No.	Carburizing Temperature Degrees F. (a)	Quenching Temperature For Core Refinement Degrees F. (b)	Resulting Core Hardness Rockwell	Quenching Temperature For Case Degrees F.	Core Hardness Rockwell
1020	1650-1700	1575-1625	C 30-36	1375-1425 <sup>(c)</sup> (b)	B 67
4615	1650-1700	1475-1525	C 27-43	1425-1475	B 95
4620	1650-1700	1475-1525	C 34-48	1425-1475 <sup>(b)</sup>	C 23
NE8620	1650-1700	1550-1600	C 34-48	1350-1400 <sup>(b)</sup>	C 31
9310	1600-1700	1450-1525	C 35-42	1450-1525 <sup>(b)</sup>	- -

- (a) Carburize to desired depth. Cool in furnace or quench in oil.  
 (b) Quench in oil.  
 (c) Quench in water or brine.  
 (d) All carburized parts shall be drawn at a temperature between 250 and 350<sup>o</sup>F to remove quenching strains.

\* 4.1.3.2 Case treatment. The case treatment (column E, table I) refines the grain of the case and hardens it. The approximate core hardness after this treatment is shown in column F, table I. This treatment should be omitted in cases when a higher core strength is desired.

4.1.3.3 All carburized parts shall be drawn such that quenching strains are relieved and the desired hardness level obtained.

4.2 Nitriding. Nitriding is a process of surface hardening steel by subjecting the parts to the action of cracked ammonia gas to a temperature of 940 to 980<sup>o</sup>F. Chromium-molybdenum-aluminum steel, in accordance with class 1, MIL-S-6709, is generally used for aircraft parts.

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This steel shall be heat-treated and machined prior to nitriding. This steel shall be hardened by heating to a temperature of 1700 to 1750°F and quenching in oil. Parts shall be drawn for a period of three to five hours after quenching. A drawing temperature of 1200°F gives a tensile strength of approximately 125,000 pounds per square inch. Parts shall then be machined removing at least 1/32 inch of stock from all surfaces to remove scale and decarburized metal. The nitriding operation shall be carried out in specially constructed furnaces through which ammonia gas is circulated. The temperature shall be 940 to 980°F. The parts shall be cooled in the furnace at the conclusion of the nitriding process and have a hard surface without further treatment. A 50 hour nitriding treatment produces a case approximately 0.020 inch thick having a surface hardness of about 1000 Vickers.

4.3 Cyanide hardening. The cyanide hardening operation produces a file hard, shallow, and brittle case on low carbon steels. The parts are usually immersed for 30 to 60 minutes in a bath containing sodium cyanide and operating at a temperature of 1400 to 1650°F. This operation will give a case depth approximately 0.010 inch with a hardness about Rc-65 and a negligible dimensional change is caused.

4.4 All other heat-treating operations required shall be in accordance with MIL-H-6875.

\* 4.5 Case depth. The case depth of the finished parts shall conform to the requirements specified on the engineering drawing.

\* 4.6 Hardness. The hardness of the material when tested on the designated area shall be as follows:

Case - Rockwell Superficial 15N, 90 minimum  
Core - Rockwell C, 35 maximum

## 5. QUALITY ASSURANCE PROVISIONS

5.1 Responsibility for inspection. Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified in the contract or order, the supplier may use his own or any other facilities suitable for the performance of the inspection requirements specified herein. Unless disapproved by the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

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5.2 Method of inspection and tests.

5.2.1 The heat-treating equipment, temperature control devices, and all details of the heat-treating procedure shall be subject to inspection by authorized government inspectors.

5.2.2 Acceptance or approval of material during course of manufacture shall in no case be constructed as a guarantee of the acceptance of the finished product.

5.2.3 Test. When practicable, tests shall be made on actual parts. If tests of actual parts are impracticable, extra samples of the material shall be provided. Samples shall be heat-treated with the parts they represent, and unless otherwise specified, shall be of approximately the same cross sectional area and shape.

- \* 5.2.3.1 Case depth. The sample shall be examined for compliance with 4.5.
- \* 5.2.3.2 Case hardness. Case hardness tests shall be made in accordance with ASTM E-18 and in compliance with 4.6, or equivalent shall be used.
- \* 5.2.3.3 Core hardness. Core hardness tests shall be made in accordance with ASTM E-18 to determine compliance with 4.6.
- \* 5.3 Rejection and retest. Failure of a specimen to meet specified requirements shall cause rejection of the materials represented. At the discretion of the contractor retest will be permitted. A retest sample of five specimens, one from each of five bars, shall be tested to replace each failed specimen from the original sample. If one of the retest specimens fail, the material represented shall be rejected and no further retesting permitted.

6. NOTES

- \* 6.1 Intended use. This specification is drawn to present general instructions for carburizing and nitriding of carbon and alloy steels and cyanide hardening operation used in the fabrication of aircraft and aircraft engine parts. Presents general requirements for acceptable heat-treating equipment. The particular steels to which this specification applies are listed in table I under their commercial designation .