



AEROSPACE MATERIAL SPECIFICATION

AMS2759™/7**REV. F**

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Superseding AMS2759/7E

Carburizing and Heat Treatment
of Carburizing Grade Steel Parts

RATIONALE

AMS2759/7F results from a Five-Year Review and update with changes to Ordering Information, Authority (see 1.3), Types of Atmospheres (see 3.2.1.1, Type 3), Starting Condition (see 3.5.4.1.1), Masking (see 3.5.4.3), Racking (see 3.5.4.4), Carburizing Temperature (see 3.5.5.1, Type 2), Case Depth (see 3.6.1, 3.6.1.2, 3.6.1.2.1, and 3.6.1.3), Case Hardness (see 3.6.2), Subsurface Case Hardness (see 3.6.3), Finished part case depth and subsurface case hardness (see Table 3), Case Microstructure (see 3.6.5.2, 3.6.5.3, 3.6.5.4, and 3.6.5.5), Alternate microstructure reference photomicrographs (see Table 4), and Acceptance Tests (see 4.2.1).

NOTICE

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

- AMS2759/7F
- Class of carburizing (see 1.1)
- Type of carburizing (see 3.2.1.1)
- Case depth of the finished part (see 3.6.1)
- Amount of material that will be removed during subsequent machining and/or grinding (see 3.6.1.1)
- Case hardness (see 3.6.2)
- Core hardness
- Test part(s), test specimen(s), or specify otherwise

1. SCOPE

This specification, in conjunction with the general requirements for steel heat treatment covered in AMS2759, establishes the requirements and procedures for three classes of gas, vacuum, liquid, and low-pressure carburizing (LPC) and related heat treatment of parts fabricated from carburizing-grade steels. Parts made from steels other than those specified in the detail specifications may be heat treated in accordance with the applicable requirements using processing temperatures, times, and other parameters recommended by the material producer. This specification does not cover pack carburizing.

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1.1 Classification

Parts shall be carburized to meet specified requirements (typically specified on the engineering drawing) by processing to one of the following classes:

Class 1: Case depth and case hardness shall be as specified. Subsurface case hardness shall be in accordance with Table 3. Retained austenite shall not exceed 10%. Intergranular carbides shall be scattered and discontinuous and shall not be evident in more than 40% of the grain boundaries (see 3.6.5.2).

Class 2: Case depth and case hardness shall be as specified. Subsurface case hardness shall be in accordance with Table 3. Retained austenite shall not exceed 20%. Continuous carbide network shall not be evident in more than 80% of the grain boundaries (see 3.6.5.3).

Class 3: Case depth and case hardness shall be as specified.

1.1.1 If class is not specified, parts shall be processed to Class 2 requirements.

1.1.2 Case depth requirements specified to the heat-treat processor are those expected to be developed by the carburizing heat treatment. The case depth must include both the final case depth for the finished part and any machining/grinding stock the purchaser intends to remove.

1.2 Safety - Hazardous Materials

While the materials, methods, applications, and processes described or referenced in this specification may involve the use of hazardous materials, this specification does not address the hazards that may be involved in such use. It is the sole responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials and to take necessary precautionary measures to ensure the health and safety of all personnel involved.

1.3 Authority

The cognizant engineering organization (CEO) may impose requirements or approve allowances that supersede the requirements in this AMS.

2. APPLICABLE DOCUMENTS

In addition to those listed in AS2759, 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: 1-877-606-7323 (U.S. and Canada only) or 1-724-776-4970 (outside U.S. and Canada), www.sae.org.

AMS2418 Plating, Copper

AMS2759 Heat Treatment of Steel Parts, General Requirements

ARP1820 Chord Method of Evaluating Surface Microstructural Characteristics

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, Tel: 610-832-9585, www.astm.org.

ASTM E3 Preparation of Metallographic Specimens

ASTM E18 Rockwell Hardness of Metallic Materials

ASTM E384 Microindentation Hardness of Materials

2.3 ASM Publications

Available from ASM International, 9639 Kinsman Road, Materials Park, OH 44073-0002, Tel: 440-338-5151, www.asminternational.org.

ASM Handbook Volume 9 - Metallography and Microstructures (1985 Edition), ISBN 10: 0-87170-015-8

ASM Handbook Volume 9 - Metallography and Microstructures (2004 Edition), ISBN: 978-0-87170-706-2

2.4 Definitions

Terms used in AMS are defined in AS7766, AMS2759, and as follows:

2.4.1 SNAP TEMPERING

An intermediate low-temperature treatment to relieve stresses and prevent cracking prior to the next operation. Final tempering to the specified requirements is performed after snap tempering.

3. TECHNICAL REQUIREMENTS

3.1 Pyrometry

Shall be in accordance with AMS2759.

3.2 Furnace Equipment

Shall be in accordance with AMS2759. Carburizing furnaces shall be Class 5 or better.

3.2.1 Heating Environment

Protective atmosphere, masking, or both shall be used for all heat treatments over 1000 °F (538 °C) to protect part surfaces from unintentional carburization, decarburization, intergranular oxidation, and oxide scale. Protective atmospheres are argon, nitrogen, endothermic gas, exothermic gas, or vacuum. Allowed quench gases used in vacuum furnace processing are listed in 3.5.8.4.

3.2.1.1 Types of Atmospheres

Type 1: Gas

Type 2: Liquid (Salt Bath) Carburizing

Type 3: Vacuum and Low-Pressure Carburizing

3.2.1.1.1 If the type is not specified, any atmosphere type is acceptable provided all requirements stated herein are met.

3.2.1.2 Carburizing Atmosphere Control

The carburizing atmosphere shall be generated with mixtures of hydrocarbon compounds and/or gases. Circulation and/or through flow of the atmosphere shall be sufficient to provide uniform carburizing.

3.2.1.3 Carbon Potential and Carburizing Devices

For Classes 1 and 2, Type 1, the carbon potential shall be controlled and recorded. For Type 3, gases shall be added using flow meters or mass flow controllers, and the furnace pressure shall be recorded. For Type 2 salt baths, the medium shall be analyzed periodically for chemical composition and shown to conform to a specified quality standard.

3.2.1.3.1 The accuracy of devices used for measuring and controlling carbon potential of Type 1 atmospheres and the accuracy of devices used for measuring and controlling gas flow and pressure of Type 3 atmospheres shall be checked as often as necessary to ensure that the equipment is operating properly and shall be calibrated. Calibration shall be performed per manufacturers' recommendations or by a comparison method assuring that the accuracy of the device(s) is sufficient to meet requirements stated herein.

3.3 Auxiliary Equipment

Shall be in accordance with AMS2759.

3.4 Quenching Media

Shall be in accordance with AMS2759.

3.5 Sequence of Operations

Standard practice shall be (1) preparation for carburizing, (2) carburizing, (3) cooling after carburizing, (4) hardening, (5) subzero cooling (if required, see 3.5.9), and (6) tempering. Other treatments, such as normalizing before carburizing and subcritical annealing and stress relieving performed during the sequence of operations, are permitted at the discretion of the processor. The hardening operation may be omitted when cooling after carburizing has incorporated a quench in accordance with 3.5.6 and when the conditions of 3.5.1, 3.5.2, or 3.5.3 are satisfied.

3.5.1 Parts that were quenched from the carburizing temperature and when both of the following apply:

3.5.1.1 Case depth is 0.020 inch (0.51 mm) or less.

3.5.1.2 Carburizing temperature was not higher than 1600 °F (871 °C).

3.5.2 Parts that were furnace cooled to the austenitizing temperature, stabilized, and quenched in accordance with 3.5.6 and when either of the following apply:

3.5.2.1 Parts were made from a low-hardenability steel (e.g., 1020, 4615, 4620, 8615, or 8620).

3.5.2.2 Parts were made from a high-hardenability steel (e.g., 4320, 4820, or 9310) and were carburized to meet Class 3 requirements.

3.5.3 Parts made from a low-hardenability steel that were quenched from the carburizing temperature and were carburized to meet Class 2 or Class 3 requirements.

3.5.4 Preparation for Carburizing

3.5.4.1 Starting Condition

The material starting condition shall be annealed, normalized, normalized and tempered, or quenched and tempered. Conditions such as hot rolled, as cast, as forged, severely formed, or as welded may exhibit unusual and unacceptable growth and/or shrinkage resulting from processing and are undesirable starting conditions. When annealing, normalizing, and austenitizing are performed by the processor, the recommended temperatures to be used are stated in Table 1. Quenching shall be as stated in Table 1. Tempering, if required, shall be performed to meet hardness requirements.