AEROSPACE MATERIAL SPECIFICATION

AMS2759/7	REV. B

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Superseding AMS2759/7A

Carburizing and Heat Treatment of Carburizing Grade Steel Parts

RATIONALE

AMS2759/7B has been reaffirmed to comply with the SAE five-year review policy.

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 (LPC) carburizing and related heat treatment of parts fabricated from carburizing grade steels. It does not cover pack carburizing.

1.1 Classification

Parts to be carburized shall be processed to meet the requirements of 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 1. Surface carbon shall be 0.70 to 1.00% (weight %). 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.

Class 2: Case depth and case hardness shall be as specified. Subsurface case hardness shall be in accordance with Table 1. Surface carbon shall be 0.75 to 1.10% (weight %). Retained austenite shall not exceed 20%. Continuous carbide network shall not be evident in more than 80% of the grain boundaries.

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

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

1.2 Types

Type 1: Gas and vacuum carburizing
Type 2: Liquid (salt bath) carburizing
Type 3: Low Pressure (vacuum) carburizing (0.5 to 35 mbar)

1.2.1 If the type is not specified, Type 1 shall be used.

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http://www.sae.org/technical/standards/AMS2759/7B

1.3 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.

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 724-776-4970 (outside USA), www.sae.org.

AMS2418	Plating, Copper
AMS2750	Pyrometry
AMS2759	Heat Treatment of Steel Parts, General Requirements
AMS2759/1	Heat Treatment of Carbon and Low-Alloy Steel Parts Minimum Tensile Strength Below 220 ksi (1517 MPa)
AMS2759/2	Heat Treatment of Low-Alloy Steel Parts Minimum Tensile Strength 220 ksi (1517 MPa) and Higher
AMS2759/11	Stress Relief of Steel Parts
AMS2769	Heat Treatment of Parts in Vacuum
ARP1820	Chord Method of Evaluating Surface Microstructural Characteristics
J423	Methods of Measuring Case Depth

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 E 3	Preparation of Metallographic Specimens
ASTM E 18	Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials
ASTM E 384	Microindentation Hardness of Materials
ASTM E 415	Optical Emission Vacuum Spectrometric Analysis of Carbon and Low Alloy Steel
ASTM E 1019	Determination of Carbon, Sulfur, Nitrogen, Oxygen, and Hydrogen in Steel and in Iron, Nickel, and Cobalt Alloys

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 09 – Metallography and Microstructures (1985 Edition), ISBN 10: 0-87170-015-8

3. TECHNICAL REQUIREMENTS

3.1 Equipment

Shall conform to the requirements of AMS2759.

3.1.1 Quenching Equipment

Shall be in accordance with AMS2759 and AMS2769 section on inert gas quenching.

3.1.2 Auxiliary Equipment

Shall be in accordance with AMS2759.

3.1.3 Thermal Processing Equipment

Pyrometry shall conform to AMS2750.

3.1.4 Cleaning Equipment

Shall be in accordance with AMS2759.

3.1.5 Carburizing Equipment

The carburizing atmosphere shall be generated with mixtures of hydrocarbon compounds and gases reacting to supply the carbon. Circulation of the atmosphere shall be sufficient to provide uniform carburizing.

3.1.5.1 For Classes 1 and 2 gaseous carburizing, the process (time, temperature, gas flows (Type 1 vacuum only), carbon potential,) shall be automatically controlled, maintained and recorded. Manual equipment may be used to verify the automatic equipment.

3.1.5.2 For Types 1 and 3 vacuum carburizing, precision gas flow meters (±3.5%) or mass flow sensors shall record the additions of carburizing medium. The process (time, temperature, gas flows, vacuum levels, pressure, etc.) shall be automatically controlled, maintained and recorded. The carbon potential shall be determined by correlation of the additions with the results from carbon gradient test specimens.

3.1.5.3 Other carburizing media, such as molten salt bath or fluidized beds, may be used when appropriate, except pack carburizing shall not be used. The carbon potential shall be determined by correlation with the results from carbon gradient test specimens. When molten salt baths are used, the medium shall be analyzed periodically for chemical composition.

3.1.5.4 Carbon potential shall be determined in accordance with 3.11.8 for Type 1 gas carburizing.

3.1.5.5 Accuracy of Atmosphere Control Instruments

The accuracy of instruments used for measuring and controlling carbon potential of Type 1 gas carburizing furnace atmospheres and the accuracy of instruments used for measuring and controlling pressure of Type 1 vacuum carburizing and Type 3 Low Pressure carburizing furnaces shall be checked as often as necessary to ensure that the equipment is operating properly and shall be calibrated. These activities shall be performed per manufacturers' recommendations.

3.2 Sequence of Operations

Shall be (1) preparation for carburizing, (2) carburizing, (3) cooling after carburizing, (4) hardening, and (5) tempering. The hardening operation may be omitted when cooling after carburizing has incorporated a quench in accordance with 3.6.4, and when the conditions of 3.2.1, 3.2.2, or 3.2.3 are satisfied.

3.2.1 Parts were quenched from the carburizing temperature and both of the following apply:

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

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

3.2.2 Parts were furnace cooled to the austenitizing temperature, stabilized, and quenched in accordance with 3.6.4 and either of the following apply:

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

3.2.2.2 Parts were made from a high hardenability steel (e.g., 4320, 4820, or 9310), and were carburized to meet Class 3 requirements, or parts made to meet Class 1 or 2 requirements that have been approved by the cognizant engineering organization.

3.2.3 Parts made from a low hardenability steel were quenched from the carburizing temperature and either of the following applies:

3.2.3.1 Parts were carburized to meet Class 2 or Class 3 requirements.

3.2.3.2 Parts were carburized to meet Class 1 requirements and quenching from the carburizing temperature was approved by the cognizant engineering organization.

3.3 Preparation for Carburizing

All metallurgical operations, such as brazing or welding, or stress inducing operations, such as forming or bending, should be completed prior to carburizing. Parts shall be free from visible defects, contamination, and corrosion that may retard carburizing or be detrimental to the appearance or performance of the finished parts.

3.3.1 Stress Relief/Normalizing

Parts may be stress relieved per AMS2759/11 or normalized prior to carburizing. Normalizing times and temperatures for commonly carburized steels are given in Tables 2 and 3.

3.3.2 Cleaning

All parts shall have scale, oxides, residual oil film, and any other surface contamination removed prior to carburizing or heat treatment. Parts shall be cleaned as necessary for the process to be performed. Cautionary note: Pre-oxidation following washing has proven useful in Type 3 processing providing the temperature does not exceed 500 °F (260 °C)

3.3.3 Masking

Masking shall be copper plate, not less than 0.0008 inches (20 µm) in thickness, applied in accordance with AMS2418. Other masking may be used if acceptable to the cognizant engineering organization.

3.3.4 Visual Inspection

Masked or plated parts shall be visually inspected prior to and after carburizing. Parts exhibiting blistering, peeling, or porosity in the masking after carburizing shall be rejected.

3.3.5 Loading of Parts

Load parts to minimize distortion at temperature and assure free circulation of atmosphere and quench fluid.

3.4 Carburization

3.4.1 Carburizing Temperature

Shall be at a selected temperature ±25 °F (±14 °C) consistent with the material to be carburized and the depth of case required. Carburizing ranges are as follows:

Type 1 - Gas Carburizing: 1450 to 1750 °F (788 to 954 °C)
Type 1 - Vacuum Carburizing:1550 to 1900 °F (843 to 1038 °C)
Type 2 - Liquid Carburizing: 1500 to 1750 °F (815 to 954 °C)
Type 3 – Low Pressure Carburizing: 1450 to 2100 °F (788 to 1149 °C)

3.4.2 Carburizing Potential

The carbon potential, however controlled, shall be such as to provide the required case carbon content and case depth.

3.4.2.1 For Types 1 and 3 vacuum carburizing, the carbon potential shall be determined by correlation of the additions with the results from carbon gradient test specimens. Cautionary note: Consideration must be given to the production operating conditions when developing a qualification/periodic testing plan for multiple chamber furnaces when evaluating carbon potential. Cautionary note: The surface area needs to be taken into consideration when establishing process control parameters.

3.5 Cooling after Carburizing

Shall be in accordance with one of the following:

3.5.1 Quenching from the Carburizing Temperature

3.5.1.1 Cooling in a protective atmosphere or vacuum to 900 °F (482 °C) or lower, followed by cooling at a rate not faster than that provided by fan circulated air or atmosphere. Fan cooling from the carburizing temperature is permitted.

3.5.1.2 Furnace cooling from the carburizing temperature to the austenitizing temperature in Table 2, stabilizing, and quenching, including press quenching. The press quenching procedure will require cognizant engineering approval.

3.6 Hardening

Shall consist of austenitizing and quenching. It may be preceded by subcritical annealing in accordance with Tables 2 and 3, and cooling to ambient temperature.

3.6.1 Atmosphere

Protective atmosphere or masking or both shall be used to protect part surfaces from decarburization, carburization, intergranular oxidation, and other surface damage during sub- critical annealing or austenitizing. Parts exhibiting blistering or peeling of the masking in the prior masked areas after exposure to elevated temperature shall be subject to rejection.

3.6.2 Rate of Heating

Hard parts (>35 HRC) shall be preheated or stress relieved in accordance with AMS2929/11 prior to hardening. Preheating in air is permitted.

3.6.3 Austenitizing

Temperature shall be as specified in Table 2. For steels not listed in Table 2, austenitizing temperatures shall be specified by purchaser. The charge shall be held within the specified temperature range for sufficient time for necessary diffusion and transformation to take place. The soak times shown in Table 3 are recommended times. Soaking time shall commence when all control, thermocouple(s) reach a temperature 5 °F (3 °C) below the austenitizing temperature or, and when the last of any other monitoring and recording thermocouples (excluding load thermocouples and thermocouples used only to monitor over-temperature) reach the minimum of the required temperature range. When soaking time is based on one or more load thermocouples, it shall start when all load thermocouples have reached the minimum of the required temperature range. . The proper time interval will vary with the type of steel, power input to furnace and size of charge, as well as the nominal thickness and configuration of the individual parts.

3.6.4 Quenching

Following austenitizing, parts shall be quenched in the media specified in Table 2 and as follows:

3.6.4.1 Oil Quenching

Type 1 – Gas Carburizing: Quench in circulating oil at a temperature between 60 to 160 °F (16 to 71 °C) at the start of the quenching operation. The circulation of the oil shall be controlled so that the oil temperature does not exceed 200 °F (93 °C) at any time during the quenching operation. Parts may be quenched in a die or in an open basket, but in either case, the oil shall circulate around every part.

Type 1 and Type 3 – Vacuum and Low Pressure Carburizing: Oil Quenching shall be performed by transferring the parts from a heating chamber to a separate chamber that has been backfilled with an inert gas or under vacuum/partial pressure and immersing the parts in circulating oil. Quench oil shall be compatible with the vacuum level used during initial evacuation/transfer and shall be capable of quenching the parts at a rate sufficient to meet specified property requirements. The oil temperature should be consistent with the manufactures recommendation.

3.6.4.2 Molten salt or synthetic quenchants are permitted.

3.6.4.3 Marquenching

Parts shall be marquenched in a nitrate salt bath, oil bath, or alternate quenchant operated between 300 to 450 °F (149 to 232 °C). The parts shall be in the marquenching bath only for sufficient time to stabilize the parts at the bath temperature, but not less than two minutes, followed by cooling in still air.

3.6.4.4 Positive Pressure Gas Quenching (PPGQ, > 1 bar)

When gas quenching is specified, it shall be accomplished by transferring the parts from a heating chamber to a separate chamber or backfilling the heating chamber with a gas that has no detrimental metallurgical effect on the material being processed or on the furnace equipment. The system and the pressure of the backfilling gas selected shall be capable of cooling the parts at a rate sufficient to meet the material property requirements specified. The use of hydrogen as a quenching gas must be approved by the cognizant engineering organization.

3.6.4.5 For steels other than those listed in Table 2, quench media shall be as specified by the purchaser.

3.6.5 Sub-Zero Treatment

Sub-zero treatment is required for parts carburized to Class 1 and Class 2 requirements and for steels containing 2.5% (total) or more of alloying elements when carburized to Class 3 requirements. Other parts shall be sub-zero treated when specified. Parts shall be held at -100 °F (-73 °C) or lower, for 1 hour per inch (25 mm) of thickness, but not less than 1 hour, and warmed in air to room temperature. The sub-zero treatment shall be initiated within 2 to 4 hours after start of quench or completion of a snap temper. Parts less than 2.5 inches thick shall follow the 2 hour time and parts 2.5 inches and thicker shall meet the 4 hour time.

3.6.5.1 When authorized by the cognizant engineering organization, a snap temper between 250 and 300 °F (121 and 149 °C) may be used after quenching and prior to the sub-zero treatment when part design and thermal stresses may result in part cracking. The snap temper treatment shall be initiated within 2 hours after start of quench.

3.6.6 Cleaning

Parts may be cleaned before tempering. Marquenching salts shall be removed, before tempering in air, by a hot water rinse.

3.7 Tempering

Tempering shall be started within 2 hours after start of quench or sub-zero treatment except as permitted in 3.7.1.

3.7.1 If hardened parts cannot be tempered within 2 hours after removal from sub-zero cooling, they shall be snap tempered for not less than 2 hours at a temperature between 250 °F and 300 °F (121 °C and 149 °C).

3.7.2 Unless otherwise specified, parts shall be tempered for not less than 2 hours at a temperature consistent with the case hardness requirements but within the range of 275 to 475 °F (135 to 246 °C). Soak time shall be per AMS2759/1 or AMS2759/2.

3.8 Cleaning Carburized Surfaces

Shall be by one of the following methods; blast cleaning, detergent cleaning, vapor blast cleaning, degreasing, abrasive honing, or anodic electrolytic cleaning. Acid pickling or cathodic electrolytic cleaning is not permitted.

3.9 Removal of Masking

Masking shall be removed from parts after the carburizing operation. If plating is used, it shall be removed by a method that is controlled to prevent etching, pitting or hydrogen embrittlement of the part.

3.10 Straightening

Straightening carburized areas of parts is permitted only if done prior to sub-zero treatment and/or tempering and if approved by the cognizant engineering organization.

3.10.1 Warm straightening is permitted in uncarburized areas of the parts. Part temperature shall not exceed 275 °F (135 °C) during the straightening operation.

3.11 Properties

3.11.1 Case Depth

3.11.1.1 Case Depth Measurement

Shall be determined in accordance with 3.11.1.1.1, 3.11.1.1.2, or 3.11.1.1.3.

3.11.1.1.1 Case Depth Determination by Microhardness Method

Shall be by microhardness traverse of a test specimen sectioned perpendicular to the carburized surface and prepared in accordance with ASTM E 3. Hardness shall be determined in accordance with ASTM E 384 or SAE J423, starting 0.002 inch (0.05 mm) from the carburized edge and traversing inward in increments of 0.004 inch (0.10 mm) to the depth where a hardness of 542 HK500 or 513 HV500 or less is reached. The case depth shall be the distance from the surface to the location where the hardness is equivalent to 50 HRC.

3.11.1.1.2 Case Depth Determination by Metallographic Method

Shall be by examination of a test specimen sectioned perpendicular to the carburized surface and prepared in accordance with ASTM E 3. Etch the sectioned surface with a suitable reagent to get maximum contrast between phases and constituents, then examine at 40X to 60X magnification. The case depth shall be the distance from the surface to the location where the contrast is greatest. In case of dispute, the method of 3.11.1.1.1 shall apply.

3.11.1.1.3 The method of ARP1820 may be used to determine depth of thin cases.

3.11.1.2 Case Depth Requirements and Allowances

3.11.1.2.1 The depth of the applied case on the as-carburized and hardened part shall be sufficient to assure that engineering drawing required finished case depth and surface hardness requirements are met. The case depth is defined as the depth below the surface of the finished part where the hardness is the equivalent of 50 HRC. (See also 3.11.3.) This is often referred to as the “effective case depth”.

3.11.1.2.2 The drawing case depth applies to the finish machined surfaces. The effective case depth at external corners, internal corners, boundaries, internal bores and gears and splines shall be as follows:

3.11.1.2.2.1 For external edges with a radius less than two times the maximum specified case depth, the case depth may be exceeded for a distance from the corner equal to three times the minimum specified case depth.

3.11.1.2.2.2 For internal corners with a radius less than two times the maximum specified case depth, the case depth may be less than the minimum specified for a distance from the theoretical corner equal to two times the minimum specified case depth but not less than one half of the minimum specified case depth.

3.11.1.2.2.3 For boundaries between carburized and uncarburized areas, the case depth may be less than the minimum specified case depth for a distance from the boundary equal to two times the minimum specified case depth but not less than one half the minimum specified case depth at the boundary. The carburized case may extend by normal diffusion beyond the boundary by not more than twice the minimum specified case depth.

3.11.1.2.2.4 For gears and splines, the specified case depth applies to the tooth surface at the pitch diameter. Case depth at the root radius shall be not less than 0.75 times the minimum specified case depth.

3.11.1.2.2.5 For internal bores, the case depth is applicable at the entrance and midpoint depth of bores open at both ends, and at the entrance and closed end of bores open at only one end.

3.11.2 Case Surface Hardness

Shall be determined in accordance with 3.11.2.2.

3.11.2.1 The roots of splines or gear teeth may exhibit a hardness not more than 2 HRC or equivalent numbers lower than that required at the pitch line. When approved by the cognizant engineering organization, a reduction of 4 HRC or equivalent is acceptable.

3.11.2.1.1 If a suitable surface is not accessible for hardness testing, the hardness at 0.002 inch (0.05 mm) obtained as in 3.11.1.1 shall be the case hardness.

3.11.2.2 Case Hardness Determination

Shall be in accordance with ASTM E 18 on the carburized and hardened surface, of the finished part using a superficial hardness test appropriate for the depth of case specified.

3.11.3 Sub-Surface Case Hardness

For parts carburized to Class 1 and Class 2 requirements, the subsurface hardness shall meet the requirements of Table 1, determined in accordance with 3.11.3.2. Where a different hardness is specified, the subsurface hardness shall be as specified, when applicable.

3.11.3.1 Sub-surface hardness requirements do not apply to roots of splines or gear teeth.

3.11.3.2 Sub-surface Case Hardness Determination

The hardness traverse or 3.11.1.1 shall be used to determine the sub-surface case hardness. The microhardness conversion for 58 HRC shall be 690 HK500 or 653 HV500 and for 60 HRC shall be 732 HK500 or 697 HV500.

3.11.4 Core Hardness

Shall be as specified, determined in accordance with 3.11.4.1.

3.11.4.1 Core hardness shall be determined in accordance with ASTM E 18 on a noncarburized surface of the part, or at a location not less than five times the case depth from the surface, or at the approximate center of the microstructure specimen (See 3.11.6.6). As an alternate method the core hardness can be established in accordance with ASTM E 384 at a location not less than five times the case depth from the surface.

3.11.5 The hardness of non-carburized surfaces shall be in accordance with specified core hardness.

3.11.6 Case Microstructure

Shall be predominantly tempered martensite, determined in accordance with 3.11.6.6.

3.11.6.1 Intergranular oxidation shall not exceed 0.0005 inch (0.013 mm) in depth from the unmachined surface.

3.11.6.2 For Class 1 parts, any intergranular carbides on a finish machined working surface shall be scattered and discontinuous and shall not be evident in more than 40% of the grain boundaries. Only dispersed intergranular spheroidal (secondary) carbides are permitted more than two grains below the finish machined working surface. Massive or blocky carbides are unacceptable.

3.11.6.3 For Class 2 parts, a continuous carbide network shall not be evident in more than 80% of the grain boundaries. Photomicrograph 13 on page 220 of ASM Handbook, Volume 09, 1985 Edition, is an illustration of the maximum acceptable continuous carbide microstructure. Photomicrographs 12 and 14 on page 220 of ASM Handbook, Volume 09, 1985 Edition, are illustrations of non-acceptable microstructures containing excessive carbides around the grain boundaries and massive carbides.

3.11.6.4 The microstructure of a finished Class 1 part shall not show evidence of retained austenite in excess of Figure 16 on page 220 of ASM Handbook, Volume 09, 1985 Edition. If interpretation of the microstructure is questionable, or if it appears to represent retained austenite in excess of this figure, x-ray diffraction shall be performed to determine the acceptability. When inspected by x-ray diffraction, retained austenite greater than 10% is unacceptable.

3.11.6.5 The microstructure of a finished Class 2 part shall not show evidence of retained austenite in excess of Figure 17 on page 221 of ASM Handbook, Volume 09, 1985 Edition. If interpretation of the microstructure is questionable, or if it appears to represent retained austenite in excess of this figure, x-ray diffraction shall be performed to determine the acceptability. When inspected by x-ray diffraction, retained austenite greater than 20% is unacceptable.

3.11.6.6 Case Microstructure Determination

Shall be by examination of a test specimen sectioned perpendicular to the carburized surface and prepared in accordance with ASTM E 3. Examine at 900X to 1100X magnification for retained austenite, 400X to 600X for intergranular oxidation and carbides, and 200X to 300X for core structure. For part surfaces that are to be subsequently machined, the stock to be removed in finish machining need not be evaluated.

3.11.7 Core Microstructure

The transformed microstructure of the core shall be consistent with the steel composition and the thickness of the part at the time of quenching.

3.11.8 Carbon Content of Case (Carbon Potential or surface carbon)

Shall be 0.70 to 1.00% for parts carburized to Class 1 requirements and 0.75 to 1.10% for parts carburized to Class 2 requirements, determined in accordance with 3.11.8.1, 3.11.8.2, or 3.11.8.3

3.11.8.1 A machined specimen, not less than 0.50 inch (12.7 mm) in diameter and 6 inches (152 mm) in length shall be carburized, preferably with a furnace load, for each alloy processed. The specimen shall be carburized to a depth not less than the maximum depth normally carburized or 0.020 inch (0.51 mm), whichever is greater. The specimen shall not be hardened after carburizing. 0.005 inch (0.13 mm) shall be machined from the diameter of the carburized specimen and the chips discarded. Chips for analysis shall be taken from the next 0.005 inch (0.13 mm) machined from the diameter. The chips shall be free of oil, grease, dirt, scale, or other foreign substances. Carbon determination may be by any method acceptable to purchaser, but in case of dispute, the combustion analysis method of ASTM E 1019 shall govern.

3.11.8.2 A second method requires a specimen, not thicker than 0.01 inch (0.25 mm), of the same material as is required to be carburized, may be tested. In this case, the entire thickness of the specimen is analyzed for carbon content using the combustion analysis method of ASTM E 1019.

3.11.8.3 A final alternative method requires a specimen, not less than 0.5 inches (12.5 mm) thick of the same material as is to be carburized, to be tested using Optical Emission Spectroscopy (OES) to ASTM E 415 or similar methods acceptable to the purchaser.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

Shall be in accordance with AMS2759. Where test specimens are required, except for specimens for case carbon determination, these shall be supplied by purchaser.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Tests for case depth (3.11.1), case surface hardness (3.11.2), sub-surface case hardness (3.11.3), core hardness (3.11.4), hardness of noncarburized surfaces (3.11.5), case microstructure (3.11.6), and core microstructure (3.11.7) are acceptance tests and shall be performed on each lot.

4.2.2 Periodic Tests

Tests for carbon content of the case (3.11.8) are periodic tests and shall be performed every six months unless frequency of testing is specified by purchaser.

4.2.3 Preproduction Tests

All tests specified are preproduction tests and shall be performed on specimens for each piece of carburizing equipment to be used, as applicable for the carburizing class or classes (See 1.2) to be processed, and prior to any production carburizing.

4.3 Sampling and Testing

Shall be as specified in AMS2759 and the following; other methods of sampling, including statistical sampling, are permitted when authorized by purchaser.

4.3.1 Lot

Shall be in accordance with AMS2759 and the following:

4.3.2 Process Control Specimens

At least one test specimen shall accompany each lot through each carburizing cycle. One specimen shall be hardened, tempered, and tested for properties required by 4.2.1. Purchaser may request one or more additional specimens to be quenched and tempered with the production parts. Additional specimens are required for parts with two or more carburized surfaces that are of different case depths, or of different shapes or sizes or materials, and when using multiple chamber furnaces. Multiple chamber furnaces shall require a minimum of two samples located at the front and back of each load).

4.3.2.1 Test specimens shall represent the part thickness of the heaviest cross-section carburized and shall be of the same alloy as the parts, or shall represent the part configuration such as a section of gear or spline teeth or an internal bore if the bore has a depth to diameter ratio greater than one.

4.3.2.1.1 At least one specimen per lot shall be cut perpendicular to carburized surfaces and the section metallographically prepared in accordance with ASTM E 3. The examination may be performed on a finished part or an as-hardened and tempered part.

4.3.2.1.2 Where metallographic examination is conducted before finish machining, the test procedure shall provide evidence that finished case requirements will be met after finish machining.

4.3.2.1.3 For gears and splines, the test piece shall consist of not less than four teeth of an actual gear or spline. For internal bores, the bore diameter and depth shall be the same as the actual parts.

4.3.2.1.4 Metallographic examination shall include a microhardness traverse sufficient to show the actual effective case depth and surface hardness at all required surfaces.

4.3.2.1.5 Microstructure of each metallographically prepared section shall be examined for compliance with the metallographic requirements of this specification.

4.3.2.2 Test specimens shall be uniformly distributed throughout the furnace load.

4.3.2.3 Actual parts or part sections may be used in lieu of the test specimen.

4.4 Approval

Shall be in accordance with AMS2759.

4.5 Furnace Log and Recorder Chart Entries

Shall be in accordance with AMS2759.

4.6 Records

Shall be in accordance with AMS2759. In addition whenever gas quenching is used the gas and pressure shall be recorded.

4.7 Reports

Shall be in accordance with AMS2759. In addition whenever gas quenching is used the gas and pressure shall be reported.

4.8 Resampling and Retesting

If any specimen used in the above tests fails to meet the specified requirements, disposition of the heat treated parts may be based on the results of testing three additional specimens or two actual parts for each original nonconforming specimen. Except as permitted in 4.8.1, failure of any retest specimen or part to meet the specified requirements shall be cause for rejection of the parts represented. Results of all tests shall be reported.

4.8.1 Parts that do not meet the minimum case depth or minimum hardness limits after processing as herein specified may be reprocessed by recarburizing, rehardening, or retempering as necessary to meet specified requirements except that parts may be recarburized only once. Except for retempering, reprocessing is not applicable to parts that exhibit excessive case depth. Test samples for such reprocessing shall be the remaining portions of specimens or parts used to determine the original nonconformance.

5. PREPARATION FOR DELIVERY

Shall be in accordance with AMS2759.

6. ACKNOWLEDGMENT

Shall be in accordance with AMS2759.

7. REJECTIONS

Shall be in accordance with AMS2759.

8. NOTES

8.1 A change bar (l) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 Dimensions in inch/pound units and the Fahrenheit temperatures are primary; dimensions in SI units and the Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.

8.3 Purchase documents should specify not less than the following:

AMS2759/7B
Part number, alloy designation, and quantity of parts to be carburized
Class of carburizing (See 1.1)
Type of carburizing (See 1.2)
Case depth desired (include maximum amount to be removed during subsequent machining and measurement technique if other than 3.11.1.1).
Case surface hardness desired
Periodic test frequency if other than in 4.2.2
If Positive Pressure Gas Quenching, the gas(es) and the minimum pressure allowed.