



AEROSPACE MATERIAL SPECIFICATION

AMS2753**REV. C**

Issued 1985-01
Revised 2008-08
Reaffirmed 2015-06

Superseding AMS2753B

(R) Liquid Salt Bath Ferritic Nitrocarburizing
Non-Cyanide Bath

RATIONALE

AMS2753C has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Purpose

This specification covers the requirements for an epsilon-iron nitride case on ferrous parts produced by immersion in a low-temperature, agitated, fused salt bath.

1.2 Application

Nitrocarburized surfaces have been used typically for increasing the resistance to wear and fatigue on ferrous alloys including carbon steels, low-alloy steels, tool steels, and corrosion-resistant steels, cast irons, and ferrous powder metal products, but usage is not limited to such applications.

1.2.1 This process is not recommended for use on parts that have been plated with silver, copper, zinc, or cadmium or on parts having copper alloy inserts.

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 which 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.

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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.

AMS2759	Heat Treatment of Steel Parts, General Requirements
ARP1820	Chord Method of Evaluating Surface Microstructural Characteristics
SAE J423	Methods of Measuring Case Depth
SAE J864	Surface Hardness Testing with Files

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 D 1193	Reagent Water
ASTM E 140	Hardness Conversion Tables for Metals (Relationship Between Brinell Hardness, Vickers Hardness, Rockwell Hardness, Rockwell Superficial Hardness, and Knoop Hardness)
ASTM E 384	Microhardness of Materials
ASTM E 407	Microetching Metals and Alloys

2.3 ASM Publications

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

ASM Handbook, Metallography and Microstructure, 9th Edition

3. TECHNICAL REQUIREMENTS

3.1 Processing Equipment

3.1.1 Nitrocarburizing salts shall consist primarily of a mixture of alkali metal cyanates and carbonates.

3.1.2 Salt Bath

The cyanate content of the bath shall be controlled within the range 34 to 38% by weight, determined as cyanate ion.

3.1.3 Parts shall be processed in a salt bath retort-type furnace.

3.1.4 Furnace pyrometry shall conform to AMS2750 furnace class 3, instrumentation type D, as a minimum.

3.1.5 Thermocouples

When load thermocouples are required, they shall be sheath protected to prevent deterioration due to immersion in nitrocarburizing salts.

3.1.6 Agitation

The bath shall be agitated by aeration or mechanical means in order to ensure optimum uniformity over the treated surfaces. If aeration is used, it shall be with clean, dry, oil-free compressed or plant air equipped with a desiccant air dryer, a flowmeter for measuring air flow, a gauge for air pressure, and a sparging ring as required equipment. The air flow and pressure shall be in accordance with the salt producer's recommendations.

3.2 Pretreatment

3.2.1 Hardening

Parts requiring core hardening prior to nitrocarburizing, shall be heat treated in accordance with AMS2759, or other procedure acceptable to the cognizant engineering organization, to the required core hardness. Tempering for the specified core hardness shall be performed at a temperature not less than 20 Fahrenheit (11 Celsius) degrees above the highest nitrocarburizing temperature to be used.

3.2.2 Surface Condition

Prior to nitrocarburizing, parts shall be clean and free of scale, oxide, entrapped sand, mold or core material, metal particles, oil, or grease. Parts must be completely dry. Surfaces to be nitrocarburized shall be mechanically or chemically cleaned subsequent to stress relieving and prior to nitrocarburizing.

3.2.3 Stress Relief

Steel parts having a hardness of 40 HRC or higher and in which residual stresses may have been introduced by prior mechanical working or other causes and consequently may crack or change dimensionally during nitrocarburizing shall be stress relieved prior to final part machining. Stress relief shall be performed in accordance with AMS2759 at a temperature not lower than 20 Fahrenheit (11 Celsius) degrees above the nitrocarburizing temperature.

3.3 Procedures

3.3.1 Preheating

Parts shall be preheated in air to a temperature not higher than 900 °F (482 °C), to ensure drying, to maintain bath temperature, and to avoid thermal shock upon immersion in the nitrocarburizing salt.

3.3.2 Nitrocarburizing

Parts shall be immersed and held at temperature in the agitated, fused cyanate-based salt bath for a time sufficient to produce the specified depth of total case or compound layer, as determined by the cognizant engineering organization. Total case consists of the combination of compound layer and diffusion zone. Compound layer consists of epsilon iron nitride and, under microscopic examination, appears as a continuous white layer when etched in accordance with ASTM E 407. See 8.5.

3.3.2.1 Nitrocarburizing temperature shall be at least 20 Fahrenheit (11 Celsius) degrees below final tempering temperature or precipitation hardening temperature to maintain base material hardness but shall not be lower than 1000 °F (538 °C) unless otherwise specified by the cognizant engineering organization.

3.3.3 Quenching

Following nitrocarburizing, parts shall be intermediate quenched in a fused salt bath in a temperature range of 750 to 850 °F (399 to 454 °C) or in water. After parts have stabilized at the bath temperature set point, parts shall be water rinsed or air cooled.

3.4 Properties

Nitrocarburized parts shall conform to the following requirements, determined on parts or on test specimens. See 4.3.1.

3.4.1 Compound Layer Hardness

The layer shall be equivalent of 55 HRC or greater, determined in accordance with SAE J 864 for file hardness. Light load microhardness testing of the surface shall be performed when specified. See 8.7.

3.4.2 Depth of compound layer shall conform to drawing or customer requirements, and shall be determined in accordance with procedures of SAE J423, microscopic method at not less than 500X magnification. See 8.6 for suggested compound layer thicknesses

3.4.3 Quality of Compound Layer

3.4.3.1 Not less than three fields shall be examined at 500X magnification employing acceptable quantitative metallographic procedures of line intercept or grid analysis (as described in ASM Handbook, 9th Edition, Metallography and Microstructure, pages 123 to 134). The upper half of the total compound-thickness, as in 3.4.2, shall not contain more than 50% residual porosity and oxides in any one field viewed. The compound layer at the substrate interface and the lower quarter of the total compound thickness shall not exhibit residual porosity and oxides exceeding 5% for steel and corrosion-resistant steel components and 15% for cast iron components.

3.4.3.2 For parts treated in liquid ferritic nitrocarburizing baths using sulfur bearing salts, the resultant compound layer shall be free of sulfur. Quantitative surface analysis shall be performed to verify the absence of sulfur.

3.4.4 Case hardness shall be as shown in Table 1, determined by microhardness measurements at a depth not greater than 0.001 inch (0.025 mm) below the compound layer in accordance with ASTM E 384 or by the chord method of ARP1820 on prepared cross sections of the nitrocarburized case using Knoop or other appropriate hardness tester acceptable to the cognizant engineering organization.

3.4.4.1 For corrosion resistant steels, microhardness measurement shall be taken at the mid-point of the total case, as measured in accordance with procedures SAE J423 microscopic method at not less than 500X magnification.

TABLE 1 - CASE HARDNESS

Material	Hardness, minimum HK100 or equivalent
Carbon Steels	300
Low-Alloy Steels	460
Tool & Die Steels	600
Cast Iron (Gray, Ductile, or Malleable)	300
Corrosion & Heat Resistant Steel	600
Ferrous Powder Metal Products (minimum density 7.0 g/cc)	300

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor of treated parts shall supply all samples for processor's tests and shall be responsible for performing all required tests. When parts are to be tested, the parts shall be supplied by purchaser. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the parts conform to the specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Core hardness (3.2.1), depth of compound layer (3.4.2), quality of compound layer (3.4.3), and case hardness (3.4.4) are acceptance tests and shall be performed on each heat treatment load. See 8.6.

4.2.2 Periodic Tests

Cyanate content (3.1.2) analysis is a periodic test and shall be performed at a frequency established by the processor unless frequency of testing is specified by the cognizant engineering organization. See 8.8.

4.2.3 Preproduction Tests

All property verification tests (3.4) are preproduction tests and shall be performed prior to production and when the cognizant engineering organization requires confirmatory testing.

4.3 Sampling for testing shall be not less than the following; a heat treatment load shall be all parts of the same part number treated simultaneously in the same set of solutions and presented for processor's inspection at one time.

4.3.1 Not less than one part, or sample (when permitted), shall be processed for evaluation for each test requirement:

4.3.2 Sample Configuration

Test pins or specimens of the same nominal composition and heat treat condition as the parts may be processed with the heat treatment load when permitted by the cognizant engineering organization for destructive tests.

4.4 Approval

4.4.1 The process and control factors or a preproduction part, or both, whichever is specified, shall be approved by the cognizant engineering organization before production parts are supplied.

4.4.2 The processor shall make no significant change to materials, processes, or control factors from those on which the approval was based, unless the change is approved by the cognizant engineering organization. A significant change is one which in the judgment of the cognizant engineering organization could affect the properties or performance of the parts.

4.4.3 The processor shall have a copy of the procedure available for review by purchaser's cognizant quality assurance organization. It shall include a full description of all equipment and procedures used to process parts.

4.5 Reports

The heat treating processor shall furnish, with each shipment of parts, a certified quality assurance report, traceable to the heat treat control number(s), stating that the parts were processed in accordance with the requirements of this specification AMS2753C (or other applicable specification). The report shall include: purchase order number, part number or product identification, alloy, temper/strength designation, quantity of parts in the shipment, identification of furnace(s) used, actual thermal processing times and temperatures used. Additionally, when applicable, the report shall also include actual test results, (e.g., hardness, conductivity, tensile, shear) and a statement of their conformance/nonconformance to requirements. This data shall be reported in accordance with the heat treater's documented procedures.