

LIQUID SALT BATH NITRIDING
Non-Cyanide Bath

1. SCOPE:

1.1 Purpose: This specification covers the engineering requirements for producing a thin epsilon-iron nitride case on parts by means of a low-temperature, aerated, fused salt bath process and the properties of the case.

1.2 Application: Primarily for increasing the resistance to wear and fatigue on ferrous alloys including oil- and air-hardening tool steels, corrosion-resistant steels, and cast irons. This process is not recommended for use on parts which have been plated with silver, copper, zinc, or cadmium or on parts having copper alloy inserts.

2. APPLICABLE DOCUMENTS: The following publications form a part of this specification to the extent specified herein. The latest issue of Aerospace Material Specifications and Aerospace Recommended Practices shall apply. The applicable issue of other documents shall be as specified in AMS 2350.

2.1 SAE Publications: Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

2.1.1 Aerospace Standards:

AMS 2350 - Standards and Test Methods

2.1.2 Aerospace Recommended Practices:

ARP 1820 - Chord Method of Evaluating Surface Microstructural Characteristics

2.1.3 SAE Standards and Recommended Practices:

J423 - Methods of Measuring Case Depth

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AMS 2753A

2.2 ASTM Publications: Available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103.

ASTM E384 - Microhardness of Materials

2.3 U.S. Government Publications: Available from Commanding Officer, Naval Publications and Forms Center, 5801 Tabor Avenue, Philadelphia, PA 19120.

2.3.1 Military Standards:

MIL-STD-794 - Parts and Equipment, Procedures for Packaging and Packing of

3. TECHNICAL REQUIREMENTS:

3.1 Material:

3.1.1 Nitriding Salts: Shall consist of a mixture of sodium and potassium cyanates and sodium and potassium carbonates.

3.1.2 Salt Bath: The cyanate content of the bath shall be controlled within the range 34 - 36% by weight, determined as potassium cyanate (KCNO).

3.2 Preparation:

3.2.1 Hardening: Parts requiring core hardness shall be heat treated prior to nitriding. Tempering or precipitation heat treatment to produce the specified core hardness shall be at a temperature not lower than 1090°F (590°C), except when tempering or precipitation heat treatment is conducted in conjunction with nitriding.

3.2.2 Stress Relief: Parts in which residual stresses may cause cracking or excessive distortion because of thermal shock or dimensional change because of metallurgical transformations during nitriding shall be stress relieved prior to final machining. Stress relieving shall be performed at a temperature not lower than 1090°F (590°C).

3.2.3 Cleaning: Parts, at the time of nitriding, shall be clean and free of scale or oxide, entrapped sand, core material, metal particles, oil, and grease and shall be completely dry.

3.3 Procedure:

3.3.1 Preheating: Parts shall be preheated in air at 500° - 650°F (260° - 345°C) to maintain bath temperature and to avoid thermal shock upon immersion in the nitriding salt.

3.3.2 Nitriding: Parts shall be immersed in an aerated cyanate bath as follows:

Material	Recommended Time		Temperature	
	min	max	°F	°C
Carbon and Low-Alloy Steels	1 hr	2 hr	1075 ± 10	580 ± 5
Tool and Die Steels (Structural)	30 min.	3 hr	1000 - 1075	540 - 580
Tool Steels (Cutting)	5 min.	1 hr	1000 - 1075	540 - 580
Corrosion and Heat Resistant Steels	1 hr	2 hr	1075 ± 10	580 ± 5
Ductile, Malleable, and Gray Cast Iron	1 hr	4 hr	1075 ± 10	580 ± 5
Powder Metal Products (Ferrous)	30 min.	2 hr	1075 ± 10	580 ± 5

3.3.3 Quenching: Following treatment, parts shall be quenched in fused salts, water, oil, soluble oil solution, or air. Parts, except those made of air-hardening and tool steels, may be cooled to 550° - 750°F (290° - 400°C) prior to actual quenching, when permitted by purchaser.

3.4 Properties: Nitrided parts shall conform to the following requirements, \emptyset determined on parts or on test specimens as in 4.3.1:

3.4.1 Depth of Compound Layer: Shall be as follows, determined in accordance with SAE J423, microscopic method, at 500X magnification:

Material	Case Depth			
	Inch		Millimetre	
	min	max	min	max
Carbon and low-alloy steels	0.00015	0.001	0.0038	0.02
Tool and die steels (structural)	0.0001	0.0005	0.003	0.012
Tool and die steels (cutting)	--	0.0001	--	0.002
Corrosion and heat resistant steels	0.00015	0.001	0.0038	0.02
Ductile, malleable, and gray cast iron	0.00015	0.001	0.0038	0.02
Powder metal products (ferrous)	0.00015	0.001	0.0038	0.02

3.4.2 Quality of Compound Layer: Any continuous surface porosity present shall not extend deeper than one-half the observed depth of the compound layer, determined by examining specimens metallographically at 500X magnification.

- 3.4.3 Hardness of Compound Layer: Shall be as follows, determined by microhardness measurements in accordance with ASTM E384 on the nitrided surface or on chordal ARP 1820 metallographically prepared cross-sections of the nitrided case using Knoop or other appropriate hardness tester, as agreed upon by purchaser and vendor:

Material	Hardness, min (HK/100) (or equivalent)
Carbon steels	300
Low-alloy steels	450
Tool and die steels	700
Corrosion and heat resistant steels	900
Ductile, malleable, and gray cast iron	600
Powder metal products (ferrous)	600

- 3.4.4 For parts hardened in accordance with 3.2.1, core hardness after nitriding shall be as specified by purchaser.

4. QUALITY ASSURANCE PROVISIONS:

- 4.1 Responsibility for Inspection: The vendor of treated parts shall supply all samples for vendor's tests and shall be responsible for performing all required tests. Results of such tests shall be reported to the purchaser as required by 4.5. Purchaser reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the parts conform to the requirements of this specification.

4.2 Classification of Tests:

- 4.2.1 Acceptance Tests: Tests to determine conformance to requirements for case depth (3.4.1), quality (3.4.2), hardness of compound layer (3.4.3), and core hardness (3.4.4) are classified as acceptance tests and shall be performed on each heat treat lot.

- 4.2.2 Periodic Tests: Tests to determine conformance to requirements for bath composition (3.1.2) are classified as periodic tests and shall be performed at a frequency selected by the vendor unless frequency of testing is specified by purchaser.

- 4.2.3 Preproduction Tests: Tests to determine conformance to all technical requirements of this specification are classified as preproduction tests and shall be performed prior to or on the first-article shipment of nitrided parts to a purchaser, when a change in material or processing, or both, requires reapproval as in 4.4.2, and when purchaser deems confirmatory testing is required.

- 4.2.3.1 For direct U.S. Military procurement, substantiating test data and, when requested, preproduction test material shall be submitted to the cognizant agency as directed by the procuring activity, the contracting officer, or the request for procurement.

4.3 Sampling: At least one sample shall be processed for evaluation to each acceptance test requirement.

4.3.1 Evaluation Samples: Test pins or specimens of the same nominal composition shall be processed with the work when requested by purchaser.

4.4 Approval:

4.4.1 Nitriding on parts shall be approved by purchaser before parts for production use are supplied, unless such approval be waived by purchaser. Results of tests on production parts shall be essentially equivalent to those on the approved sample parts.

4.4.2 Vendor shall use manufacturing procedures, processes, and methods of inspection on production parts which are essentially the same as those used on the approved sample parts. If necessary to make any change in established limits of the compound layer or in nitriding procedures, vendor shall submit for reapproval of the process a statement of the proposed changes in material or processing, or both, and, when requested, sample nitrided parts. Production parts nitrided by the revised procedure shall not be shipped prior to receipt of reapproval.

4.5 Reports: The vendor of nitrided parts shall furnish with each shipment a report showing the results of tests to determine conformance to the acceptance test requirements of this specification. This report shall include the purchase order number, AMS 2753A, contractor or other direct supplier of parts, part number, and quantity.

4.6 Resampling and Retesting: If any specimen used in the above tests fails to meet the specified requirements, disposition of the parts may be based on the results of testing three additional specimens for each original non-conforming specimen. Failure of any retest specimen to meet the specified requirements shall be cause for rejection of the parts represented and no additional testing shall be permitted. Results of all tests shall be reported.

5. PREPARATION FOR DELIVERY:

5.1 Identification: Each container of parts shall be legibly marked with not less than AMS 2753A, purchase order number, vendor's identification, part number, and quantity.

5.2 Packaging:

5.2.1 Packaging shall be accomplished in such a manner as to ensure that nitrided parts, during shipment and storage, will not be permanently distorted and will be protected against damage from exposure to weather or any other normal hazard.