



# AEROSPACE MATERIAL SPECIFICATION

**AMS2759™/12****REV. C**Issued 2007-07  
Revised 2025-09

Superseding AMS2759/12B

**Automated Gaseous Nitrocarburizing  
Controlled by Potentials**

## RATIONALE

AMS2759/12C results from a Five-Year Review and update of this specification with changes to Ordering Information, Purpose (see 1.1), Authority (see 1.4), Definitions (see 2.2), Classification (see 3.1), Shutdowns and Alarms (see 3.2.1), Atmosphere Control (see 3.2.2), Stress Relieving (see 3.4.1.2), Racking (see 3.4.1.6), Nitrocarburizing (see 3.4.2), Nitrocarburizing process parameters (see Table 1), Cooling (see 3.4.2.1), Surface Hardness (see 3.5.1), Core Hardness (see 3.5.3), Case Depth (see 3.5.4), Thickness of Compound Zone (see 3.5.5), Compound zone thickness (see Table 3), Presence of Compound Zone (see 3.5.6), Porosity (see 3.5.7), Acceptance Tests (see 4.1.1), Sampling and Testing (see 4.2.1), and Figures 2, 3, 4, 5, and 6.

## NOTICE

**ORDERING INFORMATION:** In addition to that listed in AMS2759, the purchaser shall supply the following information to the nitrocarburizing processor:

- AMS2759/12C
- Complete requirements for the part and processing if the engineering drawing is not provided
- Part material designation
- Heat-treat condition of parts to be processed
- Areas to be nitrocarburized, areas to be masked, and areas that are optional (see 3.4.1.4)
- Class of porosity, if required (see 3.1)
- Required compound zone (white layer) thickness
- Surface hardness, if required (see 3.5.1)
- Case hardness, if required (3.5.2)
- Core hardness, if required (see 3.5.3)
- Case depth, if required (see 3.5.4)

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- If parts are to be used for testing (see 4.2.1)
- Grind stock allowances to be reflected in case depth measurements, if applicable (see 3.5.4)
- If there are critical dimensions to be held through nitrocarburizing (3.4.1.2)

## 1. SCOPE

### 1.1 Purpose

This specification covers the requirements for producing a continuous compound zone (white layer) with controlled extent of porosity by means of a gaseous process, automatically controlled to maintain nitriding and carburizing potentials that determine properties of the nitrocarburized surface. Automatic control is intended to ensure repeatability of nitrogen and carbon content of the compound zone, which influences properties such as wear and corrosion resistance, ductility, and fatigue strength.

### 1.2 Application

The nitrocarburizing process described herein is used typically for enhancement of wear resistance and fatigue strength, as well as corrosion resistance in ferrous alloys, but usage is not limited to such applications.

### 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 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.

### 1.4 Authority

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

## 2. REFERENCES

### 2.1 Applicable Documents

In addition to those listed in AMS2759, 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 processor 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.

#### 2.1.1 SAE Publications

Available from SAE International, 400 Commonwealth Drive, Warrendale, PA 15096-0001, Tel: 877-606-7323 (U.S. and Canada only) or +1 724-776-4970 (Outside U.S. and Canada), [www.sae.org](http://www.sae.org).

|           |                                                                                                       |
|-----------|-------------------------------------------------------------------------------------------------------|
| AMS2418   | Plating, Copper                                                                                       |
| AMS2429   | Plating, Bronze, Nitriding Stop-off, 90Cu - 10Sn                                                      |
| 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       |
| AMS2759/9 | Hydrogen Embrittlement Relief (Baking) of Steel Parts                                                 |

|            |                                                                    |
|------------|--------------------------------------------------------------------|
| AMS2759/11 | Stress Relief of Steel Parts                                       |
| ARP1820    | Chord Method of Evaluating Surface Microstructural Characteristics |
| AS7766     | Terms Used in Aerospace Metals Specifications                      |
| SAE J423   | Methods of Measuring Case Depth                                    |
| SAE J864   | Surface Hardness Testing with Files                                |

## 2.1.2 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](http://www.astm.org).

|            |                                                                                                                                                                                                        |
|------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| ASTM D1193 | Standard Specification for Reagent Water                                                                                                                                                               |
| ASTM E18   | Standard Test Method for Rockwell Hardness of Metallic Materials                                                                                                                                       |
| ASTM E140  | Standard Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness |
| ASTM E384  | Standard Test Method for Microindentation Hardness of Materials                                                                                                                                        |

## 2.2 Definitions

Terms used in AMS2759/12 are defined in AMS2759, AS7766, and as follows:

### 2.2.1 COMPOUND ZONE (WHITE LAYER)

External, non-etching portion of nitrocarburized layer composed of compact epsilon or gamma prime nitrides or a combination thereof. When etched with nital reagent, the compound zone appears white when viewed under magnification. This is where the term “white layer” came from.

### 2.2.2 CORE HARDNESS

The hardness below the nitrocarburized case, as determined by a Knoop or a Vickers hardness traverse, where the average measured hardness does not change. A minimum of three hardness readings taken at a minimum distance of 2X the case depth usually corresponds to this hardness.

### 2.2.3 CARBURIZING POTENTIAL

The carburizing potential is a measure of the carburizing capability of the carburizing atmosphere, which determines the surface carbon concentration in steel at a given temperature, and is described by either of the two following equations:

$$K_c = p^2\text{CO}/p\text{CO}_2$$

based on the Boudouard reaction  $2\text{CO} = \text{CO}_2 + \text{C}$

(Eq. 1)

$$K_c = p\text{CO} * p\text{H}_2/p\text{H}_2\text{O}$$

based on the water gas shift reaction:  $2\text{CO} = \text{CO}_2 + \text{C}$

(Eq. 2)

## 2.2.4 NITRIDING POTENTIAL

The nitriding potential is a measure of the nitriding capability of the nitriding atmosphere, which determines the surface nitrogen concentration in steel at a given temperature, and is described by the following equation:

$$Kn = P_{NH_3} / \sqrt{P_{H_2}^{3/2}} \quad (\text{Eq. 3})$$

where:

$P_{NH_3}$  = partial pressure of ammonia in the outgoing atmosphere

$P_{H_2}$  = partial pressure of hydrogen in the outgoing atmosphere; the hydrogen being a product of dissociated ammonia

## 3. TECHNICAL REQUIREMENTS

Shall be in accordance with AMS2759 and as follows:

### 3.1 Classification

The nitrocarburizing process described herein is classified as follows:

Class 1: Porosity 15% and less of the thickness of the compound zone.

Class 2: Porosity between 10 and 50% of the thickness of the compound zone.

If no class is specified, no limitations shall be placed on the degree of porosity.

### 3.2 Furnace Equipment

Shall be in accordance with AMS2759. Nitrocarburizing furnaces shall be Class 3 or better.

#### 3.2.1 Shutdowns and Alarms

The furnace system shall be capable of automatically and safely shutting down the process in the event of a malfunction of the equipment, such as power failure or interruption of gas flow. Alarms for parameters exceeding their tolerance limits shall be recorded during the run.

#### 3.2.2 Atmosphere Control

Equipment shall be capable of introducing ammonia, dissociated ammonia, a combination of both, as well as carbon-bearing gases into the furnace at a controlled rate.

#### 3.2.3 Thermocouples

Load thermocouples, if used, shall be sheath-protected to prevent deterioration due to furnace atmospheres.

#### 3.2.4 Auxiliary Equipment

Shall be in accordance with AMS2759.

### 3.3 Atmosphere

The nitrocarburizing atmosphere shall consist of a mixture of gases that supply nitrogen and carbon. Any mixture of gases is acceptable, as long as it enables effective control of the nitriding and carburizing potentials.

### 3.3.1 Control

The composition of the ingoing gas mixture, outgoing gaseous atmosphere, and the nitriding and carburizing potentials for the process shall be automatically controlled, maintained, and recorded (see 4.3). Devices for accurate control of flow rates of the individual gases shall operate automatically in response to signals from the atmosphere analyzer.

### 3.3.2 Pressure

The gas pressure shall be above atmospheric in the furnace throughout the process.

## 3.4 Procedure

### 3.4.1 Pre-Nitrocarburizing Operations

#### 3.4.1.1 Heat Treatment

When heat treatment is specified for parts to be nitrocarburized, it shall be performed as specified prior to nitrocarburization. If a heat-treatment document is not called out, then it shall be performed in accordance with AMS2759 and to AMS2759/1 or AMS2759/2, as applicable.

#### 3.4.1.2 Stress Relieving

Parts that have specified critical dimensions to be held through nitrocarburizing shall be stress relieved in accordance with AMS2759/11.

#### 3.4.1.3 Cleaning

Shall be in accordance with AMS2759.

#### 3.4.1.4 Masking

Part surfaces that are not to be nitrocarburized shall be masked.

##### 3.4.1.4.1 Maskant Application

Masking shall be copper plate per AMS2418, bronze plate per AMS2429. Alternative methods, such as masking paste, may be used if acceptable to the cognizant engineering organization. Copper plate shall be fine-grained and nonporous, not less than 0.001 inch (0.025 mm) in thickness. Bronze plate shall be not less than 0.0005 inch (0.0127 mm) thick.

##### 3.4.1.4.2 Masking of Specimens

Specimens, if used, shall be masked on a portion of the surface the same as the parts.

##### 3.4.1.4.3 Alternative to Masking

When specified as an alternative to masking, the nitrocarburized case may be removed by mechanical or by chemical means from surfaces specified to be free from nitrocarburizing.

##### 3.4.1.5 Inspection

Prior to nitrocarburizing, masking shall be visually inspected without magnification for blistering, peeling, or porosity. Parts with masking exhibiting these defects shall be rejected.

##### 3.4.1.6 Racking

Rack or support parts to best prevent distortion and to ensure free circulation of the nitrocarburizing gas to all surfaces. If used, specimens are to be placed in the same working area of the furnace as the parts.