



AEROSPACE MATERIAL SPECIFICATION

AMS03™-27**REV. A**Issued 2015-05
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Superseding AMS03-27

Electro-Deposition of Nickel for Engineering Purposes

RATIONALE

AMS03-27A stabilizes this document because this document contains mature technology that is not expected to change and thus no further revisions are anticipated.

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AMS03-27A has been declared "STABILIZED" by SAE AMS Finishes, Processes and Fluids Committee B. This document will no longer be updated and may no longer represent standard industry practice. Users of this document should refer any certification issues (e.g., exceptions listed on the certification report) to the cognizant engineering organization for their disposition.

NOTE: In many cases the purchaser may be a sub tier supplier and not the cognizant engineering organization.

AMS Committee B recommends that the following similar (e.g., properties, fit, form, function) specifications be considered for future procurement. This listing does not constitute authority to substitute these specifications for the "STABILIZED" specification.

AMS2403	Plating, Nickel General Purpose
AMS2423	Plating, Nickel, Hard Deposit
AMS2424	Plating, Nickel Low-Stressed Deposit

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FOREWORD

REVISION NOTE

This Defence Standard was raised to Issue 3 to update its content and incorporate the latest MoD/DStan policy in place at the time.

HISTORICAL RECORD

This standard supersedes the following:

DTD 905A dated 1937

QTM dated June 1975 (in respect of nickel-plating)

Def Stan 03-27 Issue 1 dated 13 February 1987

Def Stan 03-27 Issue 2 dated 9 January 1998

INTRODUCTION

This SAE Standard provides the requirements for the electro-deposition of nickel plating for engineering purposes and has been reviewed and updated in conjunction with the Surface Engineering Association.

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1. SCOPE

1.1 This SAE Standard specifies the requirements for the nickel-plating of ferrous metals, copper alloys, aluminum alloys and zinc alloys for one or more of the following purposes:

- a. the production of wear-resistant surfaces;
- b. the building up of worn or over-machined surfaces;
- c. corrosion resistance;
- d. to provide an undercoat for subsequent deposits, e.g., chromium.

1.2 The following publications may also be found useful in the application of this Standard:

BS 4641	Method for Specifying Electroplated Coatings of Chromium for Engineering Purposes.
BS 4758	Method for Specifying Electroplated Coatings of Nickel for Engineering Purposes.
BS 6200-3.5.2	Methods of Analysis: Determination of Boron
BS 6200-3.20.1	Methods of Analysis: Determination of Nickel
BS 6783-2	Method for Determination of Nickel in Ferronickel (Dimethylglyoxime Gravimetric Method).

2. WARNING

This section which appeared in DEF STAN 03-27 Issue 3 has been deliberately deleted.

3. NORMATIVE REFERENCES

3.1 The publications shown below are referred to in the text of this standard. Publications are grouped and listed in alpha-numeric order.

BS EN ISO 385	Laboratory Glassware. Burettes.
BS EN ISO 3696	Water for Analytical Use. Specification and Test Methods
BS EN ISO 6507-1	Metallic Materials. Vickers Hardness Test. Test Method
BS EN ISO 1042	Specifications for One-mark Volumetric Flasks
BS 558 & 564	Specification for Nickel Anodes, Anode Nickel and Nickel Salts for Electroplating
BS 1583	Specifications for One-mark Pipettes
BS 1752	Specification for Laboratory Sintered or Frittered Filters including Porosity Grading
BS 6200-3.22.1	Methods of Analysis: Determination of Nitrogen
Def Stan 03-2	Cleaning and Preparation of Metal Surfaces

AMS03-2	Cleaning and Preparation of Metal Surfaces
Def Stan 03-4	The Pre-treatment and Protection of Steel Items of Specified Maximum Tensile Strength Exceeding 1450 MPa
AMS03-4	The Pre-treatment and Protection of Steel Items of Specified Maximum Tensile Strength Exceeding 1450 MPa
Def Stan 03-14	Electro-deposition of Chromium for Engineering Purposes
AMS03-14	Electro-deposition of Chromium for Engineering Purposes
Def Stan 03-21	Mechanical Methods for the Inducement of Compressive Surface Residual Stresses

3.2 This section which appeared in DEF STAN 03-27 Issue 3 has been deliberately deleted.

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4. DEFINITIONS

4.1 For the purposes of this Part of the Standard the following definitions apply:

4.2 PROCESS CONTROL SCHEDULE

The document which specifies/defines:

- a. The sequence of manufacturing operations and processes.
- b. The control parameters and their tolerances for each individual process within the total sequence.

4.3 SIGNIFICANT SURFACE

That area of the item, covered or to be covered by the coating, and for which the coating is essential for serviceability and/or appearance.

4.4 TENSILE STRENGTH OF STEELS

4.4.1 TENSILE STRENGTH

Throughout this Standard the tensile strength figures refer to specified maximum tensile strength. Steels shall be categorized according to specified maximum tensile strength in accordance with Table 1. Where the steel specification specifies only the minimum tensile strength, the equivalent maximum tensile strength category shall be determined from Table 1:

4.4.2 TENSILE STRENGTH/HARDNESS RELATIONSHIP

If no maximum or minimum tensile strength is specified for the steel, hardness values of 310HV, 340HV, 435HV, 450HV, and 545HV (as measured in accordance with BS EN ISO 6057-1) shall be regarded as equivalent to 1000, 1100, 1400, 1450, and 1800 MPa respectively. Steels which have been wholly or partly surface hardened shall be considered as being in the category appropriate to the hardness of the surface hardened layer.

Table 1 - Tensile strength of steels

Specified Minimum Tensile Strength MPa	Specified Maximum Tensile Strength MPa
up to 1000	up to 1100
over 1000 up to 1400	over 1100 up to 1450
over 1400 up to 1800	over 1450 up to 1800
over 1800	over 1800

5. INFORMATION TO BE SUPPLIED TO THE PROCESSOR

The following information shall be given on the drawing, contract or order:

- The number of this AMS Material Specification or its superseded Defence Standard.
- The specification and metallurgical condition of the basis metal.
- The details of stress relieving and shot peening.
- The significant surface. This may be indicated on the drawing or by a marked sample.
- The thickness of the coating required.
- The details of any post-deposition heat treatment.
- The details of any necessary undercoat to be applied.
- The details of any finishing treatment required.
- The details of any special requirements (e.g., masking).

6. PROCESS CONTROL

- A Process Control Schedule suitable of achieving the requirements of this Standard shall be prepared by the processing contractor(s) prior to the commencement of production.
- Details of the coating process, including all preparatory treatments, post coating treatments, processing, significant surfaces, tests and all other processes and treatments shall be included in the Process Control Schedule.
- All stages in the complete Schedule shall follow each other without delay.

7. PREPARATION FOR COATING

- All items to be coated shall be treated in accordance with the general requirements of AMS03-2/Def Stan 03-2. Items made from steel of specified maximum tensile strength exceeding 1450 MPa (see 4.4.1) shall also be subject to the special limitations and requirements of AMS03-4/Def Stan 03-4.
- Unless otherwise specified in the Process Control Schedule, one of the nickel-plating processes described in Annex A shall be used. The methods of analysis of the electrolyte listed in Annex B, or other methods specified in the Process Control Schedule, shall be applied.

8. RECLAMATION OF WORN OR OVER-MACHINED ITEMS

- Worn or over-machined items shall not be repaired by nickel plating unless expressly agreed between the supplier and purchaser.
- Surfaces which have been damaged, e.g., by wear, scoring, or corrosion, shall be machined or ground to provide a new surface free from sharp changes of section. Consideration shall be given to the use of shot peening or stress relieving, prior to plating.

8.3 Before nickel plating, worn items shall be inspected to ensure freedom from cracks and grinding abuse.

NOTE: See Section C.1.

9. CONDITION OF SUBSTRATE (PROCESS REQUIREMENTS)

- 9.1 All cold-working, e.g., forming or straightening, shall be completed before any stress relieving treatment, preparation, and coating of the item.
- 9.2 Where machining of the item is required, it shall be completed before preparation and coating.
- 9.3 The Significant Surface shall be free from defects such as blisters, pits, cracks, previous coatings, stains or discoloration, etc. Where possible, all edges and re-entrant angles shall be rounded.
- 9.4 Surfaces shall be clean, free from grease, oil, oxide, scale, or other foreign matter. All items shall be degreased prior to the commencement of the cleaning sequence, which shall be in accordance with AMS03-2/Def Stan 03-2, to produce a chemically clean surface.
- 9.5 Although most nickel coatings complying with this Standard normally require machining, items on which the nickel coating is not to be machined after electro-deposition shall have an initial surface texture at least as smooth as that required for the nickel coating as specified in the Process Control Schedule.

10. MINIMIZING THE RISK OF HYDROGEN EMBRITTLEMENT OF STEEL ITEMS

Electro-deposition on ferrous metals may result in hydrogen embrittlement of the substrate. The procedures for reducing susceptibility to hydrogen embrittlement are careful selection of the cleaning process, stress relief before plating (as detailed in Section 11) and post-plating heat treatment (as in Section 15).

11. STRESS RELIEF

- 11.1 Before being plated, steel items shall be stress relieved in accordance with AMS03-2/Def Stan 03-2 or AMS03-4/Def Stan 03-4, as appropriate.
- 11.2 Steels of specified maximum tensile strength exceeding 1450 MPa, or equivalent hardness, shall be subject to the special limitations and requirements of AMS03-4/Def Stan 03-4 for stress relief (see Section 15).

12. INTRODUCTION TO SURFACE COMPRESSIVE STRESSES

12.1 Shot Peening

- 12.1.1 Where required, shot peening to produce surface compressive stresses shall be carried out in accordance with Def Stan 03-21.
- 12.1.2 When shot peening is required, its location and intensity shall be given on the drawing, contract, or order (see 5(c)). The intensity shall be such as to give acceptable fatigue properties and not to cause micro-cracking of the surface.

12.2 Other Methods

Surface compressive stresses may be introduced into some classes of items by other methods, e.g., thread rolling or ballizing. The control considerations are essentially the same as those given above for shot peening (see Def Stan 03-21).

13. PREPARATION FOR PLATING

13.1 General Requirements

All items to be coated shall be treated in accordance with the "General Requirements" section of AMS03-2/Def Stan 03-2.

13.2 Cleaning

Surfaces shall be cleaned free from grease, oil, oxide, or other foreign matter. All items shall be degreased prior to the commencement of the cleaning sequence, which shall be in accordance with AMS03-2/Def Stan 03-2, to produce a chemically clean surface.

13.2.1 The preparation of all iron and steel items shall include a suitable anodic etching treatment as described in AMS03-2/Def Stan 03-2.

13.2.2 The preparation of items made of copper alloys, aluminum alloys, and zinc alloys shall include a suitable chemical etching treatment in accordance with AMS03-2/Def Stan 03-2.

NOTE: See Section C.2.

13.3 Areas not required to be coated. Areas on which nickel coating is not required shall be masked prior to coating.

NOTE: See Section C.2

14. ELECTRO-DEPOSITION OF NICKEL

14.1 The composition of the bath and the conditions of deposition will depend on the hardness value required (see Annex A). The distribution of nickel over the surface being plated will depend on the shape of the item, degree of agitation, current density, operating temperature, area of cathode surface and the anodes, which shall conform to BS 558. Electro-deposition shall be continuous.

14.2 Any failure of current, unless of momentary duration, is liable to result in the production of a laminated deposit. In the case of a current interruption, the work shall be removed from the plating bath and rinsed, alkaline degreased, rinsed, re-etched, rinsed, and replated with the least possible delay. Where nickel may have been deposited after the interruption of the current, the nickel already deposited shall be stripped off and the items replated.

NOTE: See Sections C.3 and C.4.

14.3 If the items are to be chromium plated in accordance with AMS03-14/Def Stan 03-14, they shall be thoroughly rinsed.

14.4 For other applications, the items shall be thoroughly rinsed, dried and any masking material removed.

NOTE: See Section C.5.

15. POST PLATING HEAT TREATMENT

15.1 Steel

15.1.1 Heat treatment of nickel-plated steels shall be carried out to minimize the risk of hydrogen embrittlement due to electro-deposition (see Section 10).

15.1.2 Post-plating heat treatment shall be carried out in accordance with AMS03-4/Def Stan 03-4.

15.2 Aluminum and Aluminum Alloys

When heat treatment is required to improve adhesion on aluminum and aluminum alloys, the plated items shall be heated at 2 to 3 °C/min until a temperature of 130 to 140 °C is attained. This temperature shall then be maintained for a period of not less than 2 hours and not more than 3 hours.

NOTE: The mechanical properties of some aluminum alloys may be adversely affected by these temperatures.