METRIC
MIL-STD-868B (USAF)
w/CHANGE 1
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SUPERSEDES
MIL-STD-868B
01March 2007

DEPARTMENT OF DEFENSE
STANDARD PRACTICE

NICKEL PLATING, LOW ENBRITTLEMENT, ELECTRO-DESPOSITION

This document is inactive for new design.

AMSC: N/A

AREA: MFFP

FOREWORD

1. This Military Standard is approved for use by 309MXSG/MXR, Department of the Air Force and is available for use by all departments and agencies of the Department of Defense.

2. This standard provides guidance for the Air Force repair process, acquisition, and manufacture of parts and/or spare parts on the landing gear of all military aircraft.

3. Beneficial comments, recommendations, additions, deletions, clarifications, etc. and any data that may improve this document should be sent to: 309MXSG/MXRL, Hill AFB, UT 84056-2609 or e-mailed to: 309MXSG/MXRL@hill.af.mil. Since contact information can change, verification of currency of this address information through ASSIST Online database at http://assist.daps.dla.mil.

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SUMMARY OF CHANGE 1 MODIFICATIONS

The following detail requirement of MIL-STD-868B has been revised, paragraph 5.4.5.l.c:

New Requirement: Operate at 60° to 75°F, 3 to 6 amps per square inch anodic for 45 to 90 seconds.

Old Requirement: Operate at 60° to 75°F, 3 to 6 amps per square foot anodic for 45 to 90 seconds.

1. SCOPE

1.1 Scope. This standard covers the process and materials required for the electro-deposition of nickel on high strength steel substrates. Electro-deposited nickel is used for wear resistance, heat resistance, and as an undercoat for precious metals. Subsequent heat treating techniques needed to insure low hydrogen embrittlement of steel are also described. This standard meets the performance requirements of SAE-AMS-QQ-N-290 and may be used when SAE-AMS-QQ-N-290 is specified provided any unique requirements of SAE-AMS-QQ-N-290 are complied with.

1.2 Classification.

1.2.1 Classes. Nickel plating covered by this standard will be of the engineering class only.

1.2.2 Types. Nickel plating covered by this standard shall be of the following types:

a. Type I – Plated to specified dimensions.

b. Type II – Processed to specified dimensions after plating.

2. APPLICABLE DOCUMENTS

2.1 General. The documents listed in this section are specified in sections 3, 4, and 5 of this standard. This section does not include documents cited in other sections of this standard or recommended for additional information or as examples. While every effort has been made to ensure the completeness of this list, document users are cautioned that they must meet all specified requirements of the documents cited in sections 3, 4, and 5 of this standard, whether or not they are listed in this section.

2.2 Government documents.

2.2.1 Specifications, standards, handbooks and commercial item descriptions. The following specifications, standards, handbooks, and commercial item descriptions form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

DEPARTMENT OF DEFENSE SPECIFICATIONS

MIL-R-81841	Rotary Flap Peening of Metal Parts

DEPARTMENT OF DEFENSE STANDARDS

MIL-STD-866 (Inactive)	Grinding of Chrome Plated Steel and Steel Parts Heat Treated to 180,000 psi or over
MIL-STD-871 (Inactive)	Electro-Chemical Stripping of Inorganic Finishes

MIL-STD-1504 (Inactive)	Abrasive Blast of Aircraft Components

(Copies of these documents are available online at http://assist.daps.dla.mil or from Standardization Document Order Desk, 700 Robbins Avenue, Building 4D, Philadelphia, PA 19111-5094.)

2.3 Non-Government standards and specifications. The following documents form a part of this document to the extent specified herein. Unless otherwise specified, the issues of these documents are those cited in the solicitation or contract.

SOCIETY OF AUTOMOTIVE ENGINEERS INTERNATIONAL (SAE)

SAE-AMS-S-13165	Shot Peening of Metal Parts
SAE-AMS-QQ-N-290	Nickel, Plating (Electrodeposited)

(Copies of these documents are available online at www.sae.org or from the Society of Automotive Engineers International, 400 Commonwealth Drive, Warrendale, PA 15096-1001.)

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)

ASTM Standard F519	Mechanical Hydrogen Embrittlement Evaluation of Plating/Coating Processes And Service Environments

(Copies of these documents are available at www.astm.org or ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.)

2.4 Order of precedence. In the event of a conflict between the text of this document and the references cited herein, the text of this document takes precedence. Nothing in this document, however, supersedes applicable laws and regulations unless a specific exemption has been obtained.

3. DEFINITIONS

3.1 High strength steel. For the purpose of this standard, high strength steel is defined as steel heat treated to 1.24 X 10^9 Pa (180,000 psi and above).

3.2 Material batch. All items processed at one time through the plating bath.

4. GENERAL REQUIREMENTS

4.1 Materials and equipment. Materials and equipment used in nickel plating are as follows.

4.1.1 Materials.

a. Boric acid

b. Nickel Chloride

c. Nickel Sulfate

d. Sulfamate Nickel Plating SN, Barrett Chemical Products Division, Baltimore, MD or approved equivalent.

4.1.2 Equipment.

a. Power source. Either generated or rectified DC current may be used. Ripple value shall not exceed 10 percent as measured by dividing the Root Mean Square of the AC voltage component by the DC voltage. This can best be measured by using an RMS voltage meter and dividing this value by the DC voltage. These measurements are to be taken across the anode and cathode bus at the tank.

b. Tanks. Tanks should be resistant to the operating temperature and the chemical environment. Tanks in which any electrolytic action takes place must be free of short circuits.

c. Temperature control. Plating tanks to be operated at temperature other than room temperature shall be equipped with automatic temperature indicating and regulating devices.

d. Instrumentation. An ammeter shall be placed in series with the plating tank cathode. The ammeter shall have sufficient shunts and switches to provide a full-scale reading equal to the maximum capacity of the power source and an accuracy of ± 10 percent of the current being measured.

e. Blast equipment. A blast cabinet shall be located near the plating line. The size of the cabinet shall be adequate to enclose the parts to be plated. Air lines shall be suitably trapped and filtered to prevent in-process contamination of the parts to be cleaned.

f. Bake oven. An oven capable of baking parts at 191 ± 14˚C (375 ± 25˚F) shall be located near the plating line. The size of the oven shall be adequate to enclose the parts to be plated. The oven shall be equipped with temperature indicating, recording, and regulating devices.

4.2 Specification SAE-AMS-QQ-N-290. The requirements of SAE-AMS-QQ-N-290 shall be compiled with on all parts, in conjunction with those specified in this standard. If there is a conflict between the two documents, the requirements of this standard shall govern.

4.3 Finish. The plated part shall have a finish that is smooth, continuous, homogeneous, adherent, and free from pits, blisters, nodules and any other indications of harmful defects.

4.4 Shot peening. All parts hall be shot peened in accordance with SAE-AMS-S13165 or MIL-R-81841 unless otherwise specified.

4.5 Embrittlement. Qualification test specimens and process control test specimens shall be subjected to a sustained load test at 75 percent of the ultimate notched tensile strength. The specimens shall endure this sustained load for 200 hours minimum without failing or cracking.

4.6 Re-processing. Parts rejected for defective plating, requiring stripping and re-plating, shall include all of the pre-plating steps of this standard. Parts shall be stripped in accordance with MIL-STD-871.

4.7 Plating thickness. The plating thickness shall be as specified on the engineering drawing or other applicable directives. Unless otherwise specified the minimum thickness shall be 0.05mm (0.002 inch) and the maximum thickness shall be 0.2mm (0.008 inch) on the finished parts.

4.8 Type I plating. For Type I plating, the item shall be plated to the dimension and surface finish specified on the drawing. The surface finish of the item before plating shall be equal to or better than the required finish after plating. Type I plating may be buffed or lapped after plating if dimensional tolerances and surface conditions cannot be controlled in the plating operation.

4.9 Type II plating. For Type II plating a minimum of 0.05mm (0.002 inch) more nickel than desired shall be deposited (per surface). The excess shall be ground off to give the final dimension and surface finish desired. The minimum thickness for Type II shall be 0.05mm (0.002 inch) on the finished part. Steel parts heat treated to 1240 MPa (112 kg/mm^2) (180,000 psi) shall be ground in accordance with MIL-STD-866.

4.10 Reclaimed materials. Reclaimed materials shall be utilized to the maximum extent possible with the quality limits required by this document and to fulfill compliance with the Resource Conservation/Recovery Act of 1976 (Public law 94-580, 21 October 1976).

5. DETAILED REQUIREMENTS

5.1 General. The information contained in this section provides the process and procedures to follow when performing the plating process.

5.1.1 Prior to plating. Prior to plating, except for finish grinding operations, all machining, forming, welding, and shot peening shall be completed.

5.1.2 Baking. Parts shall be baked for stress relief before plating for four hours minimum at 191 ± 14°C (375 ± 25°F). Shot peening shall be performed before plating and after stress relieving.

5.1.3 Storage of parts. Storage of parts between stress relief and cleaning shall be controlled to prevent contact with water or other corrosive materials. Parts shall be stored to permit free circulation of air around the parts.

5.1.4 Handling of parts. After the parts have been cleaned, they shall be handled in such a manner (white gloves, etc) that will ensure a minimum of contamination.

5.1.5 Masking. Sections or areas of a part that are not to be plated shall be masked off. Plug and masking materials that do not contaminate the plating solution shall be used. Masking shall be performed at the most convenient step prior to plating.

5.1.6 Racking. Sufficient contact area and pressure shall be provided to carry the current without overheating. Racking should be performed at the most convenient step prior to plating.

5.2 Plating procedure. The preferred method of cleaning is by dry blasting (Method I). Other methods, such as Method 2, that can be demonstrated to be non-embrittling (paragraph 5.7) can be used with the approval of the procuring activity.

5.3 Method I. The nickel plating procedure shall be as described below:

5.3.1 Step 1. Parts shall be degreased as necessary.

5.3.2 Step 2. Parts shall be dry blasted using 80 – 320 grit aluminum ($Al_2 0_3$), silicon dioxide ($Si0_2$) or garnet per MIL-STD-1504. Elapsed time between completion of cleaning and the next step shall not exceed sixty (60) minutes.

5.3.3 Step 3. Rinse parts in cold water (optional).

5.3.4 Step 4. Nickel plate at 3.2 to 5.4 A/dm^2 (30 to 50 A/ft^2) to the required thickness. Nickel plate in either of the following solutions:

a. Solution 1.

Nickel Sulfate	300 – 360 g/l (40 – 48 oz/gal)
Nickel Chloride	30 – 60 g/l (4 – 8 oz/gal)
Boric Acid	30 – 45 g/l (4 – 6 oz/gal)
pH	1.5 – 4.5
Temperature	46 – 60˚C (115 - 140˚F)

b. Solution 2.

Nickel Sulfamate	327 g/l (43.6 oz/gal) Make up
Nickel Metal	69 – 90 g/l (9.2 – 12 oz/gal)
Boric Acid	22.5 – 49 g/l (3 – 6.5 oz/gal)

NOTE: The boric acid concentration should be maintained at or near saturation. At 120° - 140°F saturation is approximately 6.0 – 6.5 oz/gal.

pH	3 – 5

Temperature	38 - 60˚C (100 - 140˚F)

NOTE: Additional anode corrosion aids and anti-pit aids may be used in accordance with the vendor's instructions.

5.3.5 Step 5. Rinse all parts in cold water.

5.3.6 Step 6. Rinse parts in hot water and blow dry with compressed air. Elapsed time between completion of plating and start of baking, Step 7, shall not exceed four (4) hours.

5.3.7 Step 7. Bake all parts heat treated above 1240 MPa (180,000 psi) after plating for twenty-three (23) hours minimum, at 191 ± 14˚C (375 ± 25˚F).

5.4 Method 2. The nickel plating procedure shall be as described below:

5.4.1 Step 1. Parts shall be degreased as necessary.

5.4.2 Step 2. Parts shall be dry blasted using 80 – 320 grit aluminum oxide ($Al_2 0_3$), silicon dioxide ($Si0_2$), or garnet per MIL-STD-1504.

5.4.3 Step 3. Anodic etch in the following solution or a proprietary equivalent at 3 to 6 volts for ninety (90) seconds or in accordance with the vendor's recommendations.

Sodium Hydroxide	3.8 – 11.2 g/l (0.5 – 1.5 oz/gal)
Sodium Phosphate	30 – 90 g/l (4.0 – 12.0 oz/gal)
Sodium Carbonate	7.5 – 45 g/l (1.0 – 6.0 oz/gal)
Temperature	52 - 58˚C (125 - 135˚F)

5.4.4 Step 4. Rinse all parts in cold water.

5.4.5 Step 5. Acid dip – sulfuric acid concentrate (approximately 93% by weight acid) diluted to 10 – 20 percent by volume or a proprietary acid mix at room temperature for fifteen (15) to thirty (30) seconds or in accordance with the vendor's instructions.

5.4.5.1 Alternate Step 5. The following sulfuric-hydrofluoric acid solution may be used on high silicon alloys such as 300M. It may also be applicable to other difficult to plate alloys.

a. Sulfuric acid concentrate (approximately 93% by weight acid) diluted to 22 to 30% volume.

b. Hydrofluoric acid or ammonium bifluoride – 3.0 to 6.0 oz per gallon as total fluoride.

c. Operate at 60° to 75°F, 3 to 6 amps per square inch anodic for 45 to 90 seconds.

d. This etch should leave an adherent dark gray to black film. If these conditions are not met the process must be stopped and the part baked per paragraph 5.4.10.

5.4.6 Step 6. Rinse parts thoroughly in cold water.

5.4.7 Step 7. Nickel plate in nickel plating solution (paragraph 5.3.4) to required thickness.

5.4.8 Step 8. Rinse parts in cold water.

5.4.9 Step 9. Rinse part in hot water and blow dry with compressed air. Elapsed time between completion of plating and start of baking, Step 10, shall not exceed four (4) hours.

5.4.10 Step 10. Bake all parts heat treated above 1240 MPa (180,000 psi) after plating for twenty-three (23) hours minimum, at 191 ± 14˚C (375 ± 25˚F).

5.5 Inspection. Inspection shall be in accordance with the production control inspection and tests in SAE-AMS-QQ-N-290 and this standard.

5.6 Process controls. Solutions and equipment used in the plating process shall be checked periodically and maintained in accordance with the requirements of this process standard.

5.7 Qualification embrittlement test. The processor shall demonstrate the ability to provide nickel plating which meets the requirements of paragraph 4.5 of this standard as follows:

a. Four round notched 4340 steel specimens per ASTM F519, Type 1a.1 or 1a.2 shall be prepared.

b. The specimens shall be prepared for plating and plated in accordance with all of the requirements of this specification. During plating the specimens shall be mounted symmetrically on a rack by themselves. All areas of the rack except the contact area shall be coated with a suitable maskant. An ammeter, having a sensitivity of 0.5 amperes or better shall be connected in the plating circuit near the specimens being plated. The ammeter shall either be built into the rectifier being used or shall be inserted between the rectifier and the cathode. The specimen shall be plated at 4.8 amperes per square decimeter (45 amps per square foot) to a minimum of 0.05mm (0.002 inches) thick. The specimen shall be baked for twenty-three (23) hours at 191°± 14°C (375°± 25°F) within four hours of removal from the bath.

c. The specimens will be subjected to 200 hours of static loading at 75 percent of the ultimate notched tensile strength. The test shall be considered passed if all four (4) specimens meet the requirement of paragraph 4.5.

d. Upon successful completion of the static load test one of the notched tensile specimens shall be sectioned across the notch parallel to the axis of the

specimen. Photo-micrographs shall be taken of the notched area and examined for complete coverage of the notch (use 80 -180 magnifications).

5.7.1 Analysis report. When and as requested a complete analysis report of the plating bath shall be submitted to the procuring activity with the qualification tests.

5.8 Process control embrittlement acceptance test. The process control embrittlement acceptance test shall be as follows:

a. Two (2) standard specimens of the type noted in paragraph 5.7.a shall be plated per paragraph 5.7.b in conjunction with the plating of items. The specimens shall be subjected to a sustained load test of 75 percent of the ultimate notched tensile strength of the material for two hundred (200) hours minimum and shall meet the requirement paragraph 4.5. Failure of any one of these specimens shall constitute failure of the test and production shall cease until the bath is re-qualified. Acceptance of items completed after the last successfully completed acceptance test shall be withheld until the extent and cause of failure has been determined.

b. The test for embrittlement shall be conducted as often as deemed necessary with a maximum interval of every thirty (30) calendar days. If the embrittlement test has not been performed in the thirty (30) proceeding the processing of the material batch, the bath must be re-qualified in accordance with paragraph 5.7.

5.8.1 Hydrogen detection instrument testing. Hydrogen detection instrument testing can be used for the process control testing with the approval of the procuring activity.

5.9 Safety and health. This document specifies the use of certain materials, which have been listed in 29 CFR 1910 (OSHA Standards) as “Toxic and Hazardous Substances.” Personnel exposure to these materials during the process must be limited to the values specified in applicable portions of the OSHA Standard 1910.1000.

6. NOTES
(This section contains information of a general or explanatory nature that may be helpful, but not mandatory.)

6.1 Intended use. This standard provides guidance on the processes and procedures for low embrittlement nickel electro-deposition for the repair of existing or procurement of new parts on the landing gear for all military aircraft. It may be used for other applications where low embrittlement disposition is desired.

6.2 Subject term (key word) listing.

Classification
Plating procedure
Qualification

6.3 Change notations. The margins of this standard are marked with vertical lines to indicate modifications generated by this change. This was done as a convenience only and the Government assumes no liability whatsoever for an

inaccuracies in these notations. Bidders and contractors are cautioned to evaluate the requirements of this document based on the entire content irrespective of the marginal notations.

CONCLUDING MATERIALS

Custodian:
Air Force – 70

Preparing Activity:
Air Force – 70

(Project: MFFP-2008-008)

NOTE: The activities listed above were interested in this document as of the date of this document. Since organizations and responsibilities can change, verification of the currency of the information above using the ASSIST Online database at: http://assist.daps.dla.mil.