SAE Aerospace
An SAE International Group

AEROSPACE MATERIAL SPECIFICATION

SAE AMS2460 | REV. A

Issued 2007-07
Revised 2013-03

Superseding AMS2460

Plating, Chromium

RATIONALE

AMS2460A results from a Five Year Review and includes additional details for basis metal quality and for stress relief of steel parts before plating.

NOTICE

ORDERING INFORMATION: The following information shall be provided to the plating processor by the purchaser:

1) Purchase Orders shall specify not less than the following:
   - AMS2460A
   - Part number and quantity of pieces to be plated
   - Class of plating. See 1.4.1.
   - For Class 1 plating, type of surface luster. See 1.4.2 and 3.5.1.2.
   - Plating thickness. See 3.4.1.
   - Underplating, if different from 3.3.2
   - Basis metal to be plated
   - Tensile strength or hardness of the basis metal
   - Pre-plate stress relief (time and temperature) if different from 3.2.1, or instructions that pre-plate stress relief has already been performed prior to submitting parts to the plating processor, or statement that pre-plate stress relief is not required
   - Plating coverage; special features, geometry or processing present on parts that requires special attention by the plating processor
   - Hydrogen embrittlement relief to be performed by the plating processor (parameters or requirements document), if different from 3.3.4
   - Peening requirements, if peening is required to be performed by the plating processor. See 3.1.3 and 8.4.1.
   - If tests for hardness, porosity, or hydrogen embrittlement are required for lot acceptance. See 4.2.1.
   - If adhesion is to be evaluated by grinding. See 3.4.2.1. and responsibility (plating processor or part fabricator) to perform this evaluation.

2) Parts manufacturing operations such as heat treating, forming, joining, and media finishing can affect the condition of the substrate for plating, or if performed after plating, could adversely affect the plated part. The sequencing of these types of operations should be specified by the cognizant engineering organization or purchaser and is not controlled by this specification, except as noted herein. Requirements for basis metal quality (3.1.1), peening (3.1.3), and preplating stress relief (3.2.1) require special coordination with the plating processor.

TO PLACE A DOCUMENT ORDER: Tel: 877-606-7323 (inside USA and Canada)
Tel: +1 724-776-4970 (outside USA)
Fax: 724-776-0790
Email: CustomerService@sae.org
SAE WEB ADDRESS: http://www.sae.org

SAE values your input. To provide feedback on this Technical Report, please visit
http://www.sae.org/technical/standards/AMS2460A

1. SCOPE

1.1 Purpose

This specification covers the requirements for electrodeposited chromium plating.

1.2 Application

This plating has been used typically as a decorative finish, to improve corrosion resistance, to increase wear resistance, to extend tool and die life, to maintain accuracy of gauges, and to recondition worn or undersized parts, but usage is not limited to such applications. While this document is primarily intended to address electrodeposition on steels, the process has been performed on aluminum, heat resistant alloys, high nickel alloys, super alloys, and other metals. The requirements of this specification are equivalent to AMS-QQ-320 but generally more stringent than AMS2406A. Thin Dense Chrome plating should be specified by reference to AMS2438.

1.2.1 Restriction

Application of chromium plating to steel parts having a hardness of 48 HRC (ultimate tensile strength of 238 ksi [1641 MPa]) or higher shall not be performed unless authorized by the design documentation of the cognizant engineering organization. (See 4.2.3.1 and 8.4.2.) Application of chromium plating for repair of steel parts having a hardness of 48 HRC(ultimate tensile strength of 238 ksi (1641 Mpa) or higher requires a special design evaluation and shall not be performed unless specific approval has been received from the cognizant engineering organization

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 responsibility of the user to ensure familiarity with the safe and proper use of any hazardous materials, to take precautionary measures to ensure the health and safety of all personnel involved.

1.4 Classification

1.4.1 Classes

Electrodeposited chromium plating shall be one of the following classes.

Class 1 - Corrosion protective plating. See 8.4.3.

Class 2 - Engineering plating. See 8.4.4.

1.4.2 Appearance

Class 1 plating shall have one of the following types of lusters, as specified.

Type I - Bright finish

Type II - Satin finish.

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.

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.

AMS2403 Plating, Nickel, General Purpose

AMS2406 Plating, Chromium, Hard Deposit

AMS2438 Plating, Chromium, Thin, Hard, Dense Deposit

AMS2759/9 Hydrogen Embrittlement Relief (Baking) of Steel Parts

AMS-QQ-C-320 Chromium Plating, Electrodeposited

AMS-QQ-N-290 Nickel Plating (Electrodeposited)

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 B 253 Standard Guide for Preparation of Aluminum Alloys for Electroplating

ASTM B 487 Measurement of Metal and Oxide Coating Thickness by Microscopic Examination of a Cross Section

ASTM B 499 Measurement of Coating Thick nesses by the Magnetic Method: Nonmagnetic Coatings on Magnetic Base Metals

ASTM B 504 Measuring the Thickness of Metallic Coatings by the Coulometric Method

ASTM B 556 Thin Chromium Coatings by the Spot Test, Guideline for Measurement of

ASTM B 567 Method for Measurement of Coating Thickness by Beta Backscatter Method

ASTM B 568 Measurement of Coating Thickness by X-Ray Spectrometry

ASTM B 571 Qualitative Adhesion of Metallic Coatings

ASTM B 748 Measurement of Thickness of Metallic Coatings by Measurement of Cross Section with a Scanning Electron Microscope

ASTM B 764 Simultaneous Thickness and Electrochemical Potential Determination of Individual Layers on the Multilayer Nickel Deposit (STEP Test)

ASTM E 384 Test Method for Microhardness of Materials

ASTM F 519 Mechanical Hydrogen Embrittlement Testing of Plating Processes and Service Environments

2.3 Aerospace Industries Association Publications

Available from Aerospace Industries Association, 1000 Wilson Boulevard, Suite 1700, Arlington, VA 22209-3928, Tel: 703-358-1000, www.aia-aerospace.org.

NASM1312-12 Fastener Test Methods, Thickness of Metallic Coatings

3. TECHNICAL REQUIREMENTS

3.1 Material

3.1.1 Basis Metal Quality

The basis metal (parts) shall be submitted to the plating processor free from visible defects such as blemishes, prior pitting from corrosion, nicks, scratches, burrs or other geometrical or base metal defects that could be detrimental to the appearance or performance of the plating. The plating processor shall perform such cleaning and plating procedures as necessary to yield a deposit that conforms to the specified requirements.

3.1.2 Parts dimensions should be such that, after plating, specified tolerances will be met (See 8.2).

3.1.3 Peening

When specified, parts shall be peened prior to plating. Unless otherwise specified, such peening shall be accomplished on all surfaces for which the plating is required and on all immediately adjacent surfaces that contain notches, fillets or other abrupt changes of section size (See 8.4.1). Peening shall be performed by or on behalf of the part fabricator, unless specifically delegated to the plating processor

3.2 Preparation

3.2.1 Stress Relief Treatment

Unless otherwise specified, steel parts 34 HRC (ultimate tensile strength 152 ksi [1048 MPa]) and higher and that have been machined, ground, cold formed, or cold straightened after heat treatment shall be cleaned to remove surface contamination and thermally stress relieved before plating. Acid cleaning shall not be used. See 8.4.2.3. (Residual tensile stresses have been found to be damaging during electrofinishing.) Temperatures to which parts are heated shall be such that maximum stress relief is obtained while still maintaining hardness of parts within drawing limits. Unless otherwise specified, the following treatment temperatures and times shall be used:

3.2.1.1 For parts, excluding nitrided parts, having a hardness of 55 HRC and above, including carburized and induction hardened parts, stress relieve at 275 °F ± 25 (135 °C ± 14) for 5 to 10 hours.

3.2.1.2 For parts having a hardness less than 55 HRC, stress relieve at 375 °F ± 25 (191 °C ± 14) for a minimum of 4 hours. Nitrided parts fall into this category. Higher temperatures shall be used only when specified or approved by the cognizant engineering organization.

3.2.1.3 For peened parts: If stress relief temperatures above 375 °F (191 °C) are elected, the stress relieve shall be performed prior to peening or the cognizant engineering organization shall be consulted and shall approve the stress relief temperature.

3.2.2 Cleaning

The plating shall be applied over a surface free from water breaks. The cleaning procedure shall not produce pitting, intergranular attack, or hydrogen embrittlement of the basis metal and shall preserve dimensional requirements. See 8.4.2.

3.2.3 Electrical Contact Points

For parts which are to be plated all over, locations shall be acceptable to purchaser. For parts which are not to be plated all over, locations shall be in areas on which plating is not required.

3.2.4 Aluminum alloys shall be zincate treated in accordance with ASTM B 253 or other method acceptable to purchaser prior to plating.

3.3 Procedure

3.3.1 Parts shall be plated by electrodeposition of chromium plating onto a properly prepared surface. Procedures and operating parameters shall be adequate to meet the properties and quality requirements of this specification.

3.3.2 Underplating

Unless otherwise specified, the following apply:

3.3.2.1 Class 1 plating shall be applied over an intermediate plating of nickel in accordance with AMS2403 or AMS-QQ-N-290 on steel, zinc, and copper alloys.

3.3.2.2 Class 2 plating shall be deposited directly on the basis metal without a preliminary plating of another metal, except parts made from maraging steel, or corrosion resistant steel, or aluminum alloy may receive a preliminary deposit of nickel or other suitable metal to a thickness not greater than 0.0002 inch (5 μm).

3.3.2.3 Underplate shall not be substituted for any portion of the specified chromium plate thickness.

3.3.3 Plating re-start procedures, if used, shall be approved by the cognizant engineering organization. See 4.4.3.

3.3.4 Hydrogen Embrittlement Relief (Baking)

Hydrogen embrittlement relief baking applies only to steel alloys unless otherwise specified by the cognizant engineering authority. At the option of the processor, hydrogen embrittlement relief baking may be performed on other families of alloys. If performed on other alloy families, all hydrogen embrittlement relief baking operations shall be documented. Hydrogen embrittlement relief baking shall be in accordance with AMS2759/9, except as shown in Table 1. Depending on the metallurgical condition of the parts at time of plating (i.e. alloy, hardness, prior heat treatment - carburized, induction hardened, etc.), the cognizant engineering authority may elect to prescribe hydrogen embrittlement relief baking temperatures and times different from those shown in Table 1.

TABLE 1 - HYDROGEN EMBRITTLEMENT RELIEF (BAKING) REQUIREMENTS (1)

Ultimate Tensile Strength Inch/Pound Units	Ultimate Tensile Strength SI Units	Hardness	Time in Hours at 375 °F (191 °C)
160 ksi to 182 ksi, excl.	1103 MPa to 1255 MPa, excl.	36 to 39 HRC	3
182 ksi to 221 ksi, excl.	1255 MPa to 1518 MPa, excl.	40 to 45 HRC	8
221 ksi, and higher	1518 MPa, and higher	46 HRC and higher	23

(1) NOTE: All times shown are minimum times. For high strength steels 40 HRC (ultimate tensile strength 182 ksi [1255 MPa]) and higher, it may be beneficial, and the processor is permitted, to extend the baking time to 23 hours to ensure complete relief from hydrogen embrittlement.

3.4 Properties

The plating shall conform to the following requirements:

3.4.1 Thickness

Thickness shall be as specified on the drawing, determined in accordance with any of the following methods as applicable: ASTM B 487, ASTM B 499, ASTM B 504, ASTM B 556, ASTM B 567, ASTM B 568, ASTM B 748, ASTM B 764 or by other method acceptable to the purchaser. NASM1312-12 may be used for thickness measurement of plated fasteners. ASTM B 556 (spot test) may be used for Class 1 plating, when a destructive procedure is applicable.

3.4.1.1 All surfaces of the part, except those which cannot be touched by a sphere 0.75 inch (19 mm) in diameter, shall be plated to the specified thickness. Unless otherwise specified, surfaces such as holes, recesses, threads and other areas where a controlled deposit cannot be obtained under normal plating conditions, may be under the specified limit provided they show visual plating coverage. The plate shall be substantially uniform in thickness on significant surfaces except that build-up at exterior corners or edges shall be permitted provided finished drawing dimensions are met.

3.4.1.2 Class 1

Unless otherwise specified, the minimum thickness of Class 1 chromium plating shall be 0.00001 inch (0.25 μm).

3.4.1.3 Class 2

The thickness of Class 2 plating shall be as specified by the purchaser. If the as-plated thickness is not specified, the minimum thickness shall be 0.002 inches (51 μm) plus any grinding or finishing allowance such that the minimum thickness of the finished part is 0.002 inches (51 μm).

3.4.2 Adhesion

The plating and any underplate shall be tightly adherent to the substrate as determined in accordance with ASTM B 571, knife-chisel or bend test with no mandrel. When examined at a magnification of approximately 4X, neither the chromium plating nor any electrodeposited underplate(s) shall show separation from the basis metal or from each other. The formation of cracks in the plating or the basis metal which do not result in flaking, peeling, or blistering of the plating shall not be cause for rejection.

3.4.2.1 Class 2 Adhesion Evaluation – Optional Method

When specified, Class 2 plating may be evaluated by grinding as an alternative to the bend test or knife-chisel test. The plating shall withstand the grinding operations with no evidence of delamination of plated layers or separation from the basis metal.

3.4.3 Hardness (Class 2 Only)

When tested in accordance with ASTM E 384 using a Vickers indentor and 100 gram load, the minimum hardness of a cross section Class 2 plating shall be 600 Vickers Hardness Number (HVN) if the plating is finished to a semi-bright or matte luster. If the plating is finished to a bright pebbly bright lusters, the minimum hardness shall be 850 HVN. Any Alternative hardness requirement or test method shall be as specified by the cognizant engineering organization. There is no hardness requirement for Class 1

3.4.4 Porosity (Class 2 Only)

Class 2 plating shall be porosity free to the extent that it protects the basis metal from corrosion due to pits, pores, or cracking. Criteria for evaluating this characteristic shall be as shown in 3.4.4.1 and 3.4.4.2. There is no porosity requirement for Class 1 – (See 8.4.3)

3.4.4.1 Class 2 plating, when subjected to the test specified in 3.4.4.2, shall show no more than 15 isolated blue spots or pits, none larger than 0.03 inch (0.8 mm) in diameter, in a total of 150 square inches (967 cm^2) of test area. In addition no more than five isolated spots or pits are permitted, none larger than 0.03 inch (0.8 mm) in any 30 square inches (193 cm^2) of test area. Isolated linear indications are acceptable. Linear cracking or crazing indications occurring over 5% or more the surface area are not acceptable. Panel edges, identification markings, and electrical contact locations are exempt from these requirements.

3.4.4.2 Potassium Ferricyanide (Ferroxyl) Porosity Test

Plated low alloy steel parts or low steel specimens shall be evaluated. See 4.3.3.2. Note: Panels subjected to distortion or flexing during processing can exhibit cracking or crazing type indications, so care should be exercised to prevent such false indications. All specimen surfaces shall be cleaned to remove any oil or grease. Contamination removal shall be accomplished with a solvent acceptable to the purchaser. A sheet of filter paper or other suitable adsorbent paper, saturated in the ferroxyl solution shall be applied for 10 minutes to the flat surface of the specimen or the article. Complete contact of the filter paper with the chrome plated test specimen shall be ensured using strokes with a soft bristle brush. Filter paper shall be kept saturated during the duration of the 10 minute test. Pits, pores, or cracking of the chrome are revealed by dark blue spots or lines. For a permanent record, the filter paper may be dried. The approximate solution composition shall be as follows:

Potassium ferricyanide ($K_3Fe(CN)_6$) 1 gm
Sodium Chloride (NaCl) 10 gm
Water (distilled or deionized) to make 1 liter

3.4.5 Hydrogen Embrittlement

The plating process shall not cause hydrogen embrittlement in steel parts determined in accordance with 4.3.3.3 or alternative acceptable to the cognizant engineering organization. Control of and testing for hydrogen embrittlement shall include all aspects of the process including stripping, surface preparation, reagent or electro cleaning, electrodeposition of the chromium onto the basis steel using acceptable bath chemistries, and the subsequent hydrogen embrittlement relief (baking) operation. Care should be exercised to control all aspects of the chromium plating process. See 8.4.2 and 4.6.1.1.

3.5 Quality

3.5.1 Plating, as received by purchaser, shall be smooth, continuous, adherent, free from delamination within the plating, uniform in appearance, fine grained, and shall be free from blisters, nodules, excessive pits, and other imperfections detrimental to usage of the plate. Slight staining or discoloration is permissible. The plating shall show no indication of contamination or improper processing such as excessively powdered or darkened plating, excessive edge build up, or other defects.

3.5.1.1 Boundaries of Class 2 plating between plated and unplated area shall be free from beads, nodules, jagged edges or other irregularities.

3.5.1.2 Luster

Class 1, Type I plate shall be fully bright in appearance. Class 1, Type II plate shall be a satin finish in appearance. Unless otherwise specified either a fully bright or a dull matte finish shall be acceptable for Class 2 plate. See 8.4.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall supply all samples for processor's tests and shall be responsible for the performance of all required tests. When parts or special specimens are to be tested, the parts or special test specimens shall be provided by the purchaser. Purchaser reserves the right to sample and perform any testing deemed necessary to ensure that processing conforms to specified requirements.

4.2 Classification of Tests

4.2.1 Acceptance Tests

Thickness (3.4.1), adhesion (3.4.2), and quality (3.5) are acceptance tests and shall be performed on parts or samples representing parts from each lot. When specified by the purchaser, hardness of Class 2 plating (3.4.3), porosity of Class 2 plating (3.4.4), and hydrogen embrittlement (3.4.5) are also acceptance tests.

4.2.2 Periodic Tests

Periodic (Production Control) are tests performed on a regular monthly basis and are intended to control the quality of the production process. Thickness (3.4.1), adhesion (3.4.2), hardness of Class 2 plating (3.4.3), porosity of Class 2 plating (3.4.4), and tests of cleaning and plating solutions are periodic tests and shall be performed at least monthly on each plating bath. Hydrogen embrittlement (3.4.5) is a periodic test and shall be performed at least once each month on each plating bath in which steel parts 36 HRC (ultimate tensile strength 161 ksi [1110 MPa]) and higher are plated.

4.2.2.1 Process Control Records

The supplier shall maintain a record of each processing bath, showing all additions of chemicals or treatments to the bath, the results of all tests and chemical analysis performed, and the quantity of parts plated during operation. These records shall be maintained and made available for review for not less than one year after completion of the contract or purchase order.

4.2.2.2 Interruption of Production

If continuous month to month production ceases for a particular plating bath, the processor is not required to continue periodic production control testing (4.2.2.1). However, all property verification tests of section 3.4 shall be performed on the idled plating bath prior to processing of production parts.

4.2.3 Preproduction Tests

All property verification tests of section 3.4 are preproduction tests and shall be performed prior to production and when the purchaser deems confirmatory testing is required.

4.2.3.1 Steel parts 40 HRC (ultimate tensile strength 182 ksi [1255 MPa]) and higher shall not be plated until approval has been received from the purchaser concerning acceptance of hydrogen embrittlement test results. See 4.4 and 8.4.2.

4.3 Sampling

Sampling for testing shall be not less than the following; a lot shall be all parts of the same part number processed in a continuous operation to the same thickness range, in the same set of solutions, in not longer than 24 consecutive hours, and presented for processor's inspection at one time. Adhesion verified by grinding on parts, thickness, and quality are classified as non-destructive tests. Adhesion verified by knife-chisel or bend test, hardness, porosity, and hydrogen embrittlement render actual parts not useable after testing and are classified as destructive tests.

4.3.1 Nondestructive Tests

Samples shall be randomly selected from all parts in the lot. The minimum number of parts tested shall be as indicated in Table 2.

TABLE 2 - SAMPLING FOR NONDESTRUCTIVE ACCEPTANCE TESTS

Number of Parts in the Lot	Number of Parts to be Tested
15 or less	7 (1)
16 to 40	10
41 to 110	15
111 to 300	25
301 to 500	35
501 and over	50

(1) If the number of parts in the lot is less than 7, then all parts shall be tested.

4.3.2 Destructive Tests

Sample quantities shall be as shown in Table 3.

TABLE 3 - SAMPLING FOR DESTRUCTIVE TESTS

Test	Class of Coating	Number of Samples to be Tested	Requirement Paragraph	Specimen Paragraph	Test Method Paragraph
Thickness	1 & 2	4	3.4.1	4.3.3.1	3.4.1
Adhesion	1 & 2	4	3.4.2	4.3.3.1	3.4.2
Hardness	2	4	3.4.3	4.3.3.1	3.4.3
Porosity	2	5	3.4.4	4.3.3.2	3.4.4.1
Hydrogen Embrittlement	1 & 2	4	3.4.5	4.3.3.3	4.3.3.3

4.3.3 Sample Configuration

Separate test specimens may be used under the following circumstances: When plated parts are of a configuration, size, quantity or value as to not be readily adaptable to a specified tests, when nondestructive testing is not practical on actual parts, or when it is not economically acceptable to perform destructive tests on actual parts. When used, separate test specimens shall be made of the same generic class of alloy as the parts as defined in 8.6, distributed within the lot of parts to be cleaned, plated and post treated with the actual parts.

4.3.3.1 Separate test specimens for thickness, adhesion, and hardness tests shall be four (4) samples approximately 1 × 4 × 0.040 inches (25 × 100 × 1 mm).

4.3.3.2 Separate test specimens for porosity test shall be five (5) samples of low alloy steel and approximately 3 × 10 × 0.040 inches (75 × 250 × 1 mm).

4.3.3.3 Hydrogen Embrittlement Test

Test shall be in accordance with the requirements of ASTM F 519 Type 1a.1 using round notched specimens, unless a different specimen is specified by the purchaser, stressed in tension under sustained load. For test purposes, the plating thickness shall be a minimum of 0.002 inch (51 μm) measured on the smooth section of the test specimen, but with visual plating at the root of the notch. Testing beyond the 200 hour test period is not required. The test samples shall be exposed to all steps of the documented plating process including surface preparation (reagent, electro-cleaning or abrasive blasting as applicable), underplate, electrodeposition of the chromium onto the basis metal, and the prescribed baking schedule per Table 1 and AMS2759/9.

4.3.3.4 Periodic and Preproduction Test Specimens for Thickness, Adhesion, Hardness, and Porosity

When Class 2 plating is performed, separate test specimens shall be chromium plated onto bare steel to a nominal thickness of 0.002 inch (51 μm).

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 processed.

4.4.1.1 When specified, records of process control and all pre-production control test results shall be approved by the cognizant engineering organization before production parts are processed.

4.4.2 If the processor makes a significant change to any material, process, or control factor from that which was used for process approval, all preproduction tests shall be performed and the results submitted to the purchaser for process reapproval 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 Control factors shall include, but not limited to the following:

Stress relief performed by plating processor (temperature and time)
Surface preparation and cleaning methods
Plating material trade name and manufacturer
Plating bath composition and composition control limits
Plating bath temperature limits and controls
Plating interruption and restart procedures, when applicable
Stripping procedure, when applicable
Rack locations
Current density (amps per part or amps per total surface area of the parts plated at one time in each tank)
Hydrogen embrittlement relief (bake) temperature and time, when applicable
Periodic test plan for process solutions and records. See 4.2.2, 8.5, and 4.2.2.1.

4.5 Reports

The processor shall furnish with each shipment a report stating that the parts have been processed and tested in accordance with the specified requirements and that they conform to the acceptance test requirements. This report shall include the purchase order number, AMS2460A, the part number, lot identification, and quantity.

4.6 Resampling and Retesting

4.6.1 If any acceptance test for quality or thickness, and when specified, adhesion, hardness, or porosity fails to meet specified test requirements, the parts in that lot may be stripped, pretreated, plated and post treated as defined herein and retested. Alternatively, all parts in the lot may be inspected for the non-conforming attribute, and the non-conforming parts may be stripped, pretreated, plated, and post treated as defined herein and then retested. When specified for acceptance testing, if hydrogen embrittlement fails to meet test requirements, retesting in accordance with the procedures of ASTM F 519 is permitted

4.6.1.1 When stripping is performed, the method shall be acceptable to the purchaser and shall not roughen, pit, or embrittle the basis metal or adversely affect part dimensions. When parts have been stripped and replated, the reprocessing shall be documented and the purchaser shall be informed.

4.6.2 If any periodic test fails to meet specified requirements, the process is nonconforming. No additional parts shall be plated until the process is corrected and new specimens are plated and tested. Results of all tests shall be recorded and, when requested, reported. Purchasers shall be notified of all parts coated since the last acceptable periodic test.

5. PREPARATION FOR DELIVERY

5.1 Plated parts shall be handled and packaged in such as manner as will ensure that the required physical characteristics and properties of the plating are preserved.

5.2 Packages of plated parts shall be prepared for shipment in accordance with commercial practice and in compliance with applicable rules and regulations pertaining to the handling, packaging and transportation of the plated parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGEMENT

The processor shall mention this specification number and its revision letter in all quotations and when acknowledging purchase orders.

7. REJECTIONS

Parts on which plating does not conform to this specification or to modifications authorized by purchaser will be subject to rejection.

8. NOTES

8.1 A change bar (|) located in the left margin is for the convenience of the user in locating areas where technical revisions, not editorial changes, have been made to the previous issue of this document. An (R) symbol to the left of the document title indicates a complete revision of the document, including technical revisions. Change bars and (R) are not used in original publications, nor in documents that contain editorial changes only.

8.2 This plating process alters the product dimensions. Compliance with dimensional tolerances affected by the plating process requires communications of manufacturing planning information between the part fabricator and the plating processor. The cognizant engineering organization should specify the stage at which the plating thickness and the product dimensions (e.g., threads, features) apply such as before plating, as-plated, or after metal removal operations that are to follow plating.

8.3 The purchaser is expected to provide the processor with a properly dimensioned part that allows for the change in dimensions expected from this process. The purchaser should also provide any special instructions that may need to be observed concerning plating thickness or plated part dimensions.

8.4 The information in this section is provided for guidance, but does not alter the requirements of this specification.

8.4.1 Peening

A reduction in the fatigue life of chromium plated parts attributed to the chromium adhesion, physical characteristics, mechanical properties, and state of stress, should be expected. Parts designed for unlimited fatigue life under dynamic loads (including Class 2c and 2e of AMS-QQ-C-320) should be peened prior to plating, particularly surfaces for which the plating is required and on all immediately adjacent surfaces that contain notches, fillets or other abrupt changes of section size where stresses may be concentrated. AMS2430, AMS2432, AMS2546, or AMS-R-81841 are recommended peening specifications. eening is normally performed by the part fabricator or their subcontractor, and, unless specifically directed, is not the responsibility of the plating processor.

8.4.2 Hydrogen Embrittlement

Chromium plating and the associated precleaning processes can produce a cracking condition in the base metal known as hydrogen embrittlement. Hydrogen embrittlement sensitivity increases with increasing hardness or strength. Plating of steel parts 48 HRC (ultimate tensile strength 238 ksi [1641 MPa]) and higher requires specific authorization from the cognizant engineering organization that the item is suitable and intended for chromium plating. Plating of steel parts 40 HRC (ultimate tensile strength 182 ksi [1255 MPa]) and higher requires preproduction process approval of hydrogen embrittlement test results. See 4.2.3.1 Plating of steel parts 36 HRC (ultimate tensile strength 161 ksi [1110 MPa]) and higher requires post plating hydrogen embrittlement relief baking. See 3.3.4. Plating of steel parts 34 HRC (ultimate tensile strength 152 ksi [1048 MPa]) and higher with residual stresses requires thermal stress relief prior to plating. See 3.2.1. Additional guidance follows:

8.4.2.1 Control of and testing for hydrogen embrittlement includes all aspects of the process including surface preparation, reagent or electro cleaning, electrodeposition of the chromium onto the basis steel using acceptable bath chemistries, and the subsequent embrittlement relief (baking) operation. Care should be exercised to control all aspects of the chromium plating process.

8.4.2.2 Steel parts 40 HRC (ultimate tensile strength 182 ksi [1255 MPa]) or higher may be alkaline cleaned using anodic current, but cathodic or periodic reverse current should not be used.

8.4.2.3 An acid dip may be used for surface activation or neutralization of residual alkaline cleaner, however the immersion should be minimized, as measured in seconds, to preclude pitting or hydrogen embrittlement.

8.4.2.4 Except as noted in 8.4.2.2, the final step in cleaning should consist of anodically etching the parts in a chromic acid solution of a concentration approximately to that of the chromic acid solution used in the plating bath.