



AEROSPACE MATERIAL SPECIFICATION

AMS2440

REV. B

Issued 1984-07
Revised 2007-05
Reaffirmed 2013-07

Superseding AMS2440A

(R) Inspection of Ground, Chromium Plated Steel Parts

RATIONALE

AMS2440B has been reaffirmed to comply with the SAE five-year review policy.

1. SCOPE

1.1 Purpose

This specification covers the requirements for inspection of ground chromium plated surfaces for grinder-induced damage to the chromium plate and substructure. The specification also provides users with criteria for distinguishing between such damage and acceptable indications inherent to the chromium plate.

1.2 Application

This procedure is used for nondestructive testing of heat treated, high strength (180 ksi (1240 MPa) or higher tensile strength), low-alloy steel parts that have been chromium plated and subsequently ground, but usage is not limited to such applications.

2. APPLICABLE DOCUMENTS

The issue of the following documents in effect on the date of the purchase order form 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.

AS9100 Quality Management Systems - Aerospace - Requirements

2.2 ASTM Publications

Available from ASTM International, 100 Barr Harbor Drive, P. O. Box C700, West Conshohocken, PA 19248-2959, Tel: 610-832-9585, www.astm.org.

ASTM E 1417 Liquid Penetrant Examination
ASTM E 1444 Magnetic Particle Examination

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SAE WEB ADDRESS:

2.3 NAS Publications

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

NAS 410 NAS Certification & Qualification of Nondestructive Test Personnel

3. TECHNICAL REQUIREMENTS

3.1 Preparation of Parts

All ground chromium plated parts shall be cleaned to remove lubricants, grease, oil, coolants, soaps, alkalies, and other substances that would interfere with inspection. Rinsing with or immersion in a corrosion inhibited hot alkaline cleaner or hand wiping or immersion in a suitable solvent, or both, are suitable for this purpose.

3.2 Inspection Procedure

3.2.1 All ground chromium plated surfaces shall be inspected as follows:

3.2.1.1 Parts with ground chromium plating thickness of less than or equal to 0.004 inch (0.10 mm) shall be fluorescent penetrant inspected in accordance with 3.2.2 and magnetic particle inspected in accordance with 3.2.3. Unless otherwise specified, the inspection sequence between the penetrant inspection and magnetic particle inspection shall be determined by the inspection facility. The transition area of the part from chrome plated surface to the non-plated surface shall also be inspected as specified herein. Parts shall meet the acceptance criteria of section 3.3.

3.2.1.2 Parts with ground chromium plating thickness of greater than 0.004 inch (0.10 mm) shall be penetrant inspected in accordance with 3.2.1. Parts shall meet requirements of 3.3.

3.2.2 Fluorescent Penetrant Inspection

Parts shall be fluorescent penetrant inspected in accordance with ASTM E 1417 and as specified herein.

3.2.2.1 Penetrant Inspection Personnel

3.2.2.1.1 Inspection shall be performed by inspectors qualified for liquid penetrant inspection in accordance with NAS 410. The evaluation of parts to meet acceptance criteria specified in 3.3.1 shall be by an inspector qualified to Level 2 or Level 3. Questionable indications shall be resolved and accepted or rejected by a Level 3 inspector.

3.2.2.1.1.1 The inspector making accept/reject decision shall have a minimum of 80 hours hands-on testing experience in evaluation of chrome plated surfaces. The inspector shall be trained for a minimum of ten hours in evaluating defects on unground and ground chrome plated surfaces. The practical test for inspector certification shall include validation that the inspector is able to distinguish difference between crazed surface with a pattern similar to mud cracks resulting from the plating process and that within a pattern of the grinding wheel resulting from the abusive grinding process.

3.2.2.2 Penetrant Inspection Facility

The inspection facility shall, as a minimum, be that qualified to AS9100 or equivalent authorized or approved by the cognizant engineering organization.

3.2.2.3 Penetrant Inspection of the part

Each part shall be fluorescent penetrant inspected in accordance with ASTM E 1417 using Type I, Method optional, Sensitivity level 2 or higher penetrant material. Use and type of developer in accordance with ASTM E 1417 is optional.

3.2.3 Magnetic Particle Inspection

Magnetic particle inspection shall be in accordance with ASTM E 1444 and as specified herein.

3.2.3.1 Magnetic Particle Inspection Personnel

Inspection shall be performed by inspectors qualified for magnetic particle inspection in accordance with NAS 410. The evaluation of parts to meet acceptance criteria specified in 3.3 shall be by an inspector qualified to Level 2 or Level 3. Questionable indications shall be resolved and accepted or rejected by a Level 3 inspector.

3.2.3.1.1 The inspector making accept/reject decision shall have a minimum of 80 hours hands-on testing experience in evaluation of chrome plated surfaces. The inspector shall be trained for a minimum of ten hours in evaluating defects on unground and ground chrome plated surfaces. The practical test for inspector certification shall include validation that the inspector is able to distinguish difference between crazed surface with a pattern similar to mud cracks resulting from the plating process and that within a pattern of the grinding wheel resulting from the abusive grinding process.

3.2.3.2 Magnetic Particle Inspection Facility

The inspection facility shall, at minimum, be that qualified to AS9100 standard or equivalent authorized or approved by the cognizant engineering organization.

3.2.3.3 Magnetic Particle Inspection of the part

The magnetic particle inspection shall be in accordance with ASTM E 1444 using wet continuous fluorescent particle method.

3.3 Acceptance Criteria

3.3.1 Fluorescent Penetrant

3.3.1.1 Mud-Cracking

Cracks with a pattern as seen in dry or drying mud with closely knit network of smooth microcracks and prevalent on almost the entire plated surface is indicative of cracking resulting from the plating process and not a result of abusive grinding. Mud cracking due to the plating process as seen in Figure 1 shall not be a cause of rejection

3.3.1.2 Cracking due to abusive grinding is usually accompanied by impression of the grinding wheel and in a pattern of grinding wheel motion. A pattern of mud-cracking or any other form of cracking within bands, spirals, or chatter marks indicates abusive grinding and is unacceptable. Typical patterns and directions of abusive grinding are shown on Figures 2 through 5.

3.3.2 Magnetic Particle Inspection

3.3.2.1 Spiraling and Banding

A part is unacceptable if a clear grinder pattern consisting of spirals, bands, or chatter marks (interrupted spirals or bands) is evident (See Figures 2 and 3). Also unacceptable is any combination of two or more patterns may be superimposed and cover the entire ground surface or any portion of it.

3.3.2.2 Plunge

Abusive plunge grinding is indicated by patterns such as spiraling and banding except that they form a single band of constant width. Figures 4 and 5 illustrate severe plunge grinding resulting in unacceptable damage to the steel substrate adjacent to a radius.

3.3.2.3 Any distinct pattern different from Figure 1 and uncommon to chromium plating may be indicative of mechanical damage to the plating, and is not acceptable as determined by a Level 3 inspector.

3.3.2.4 Suspect Indications

Sometimes scratches or wear patterns are shown by fluorescent penetrant inspection. Such patterns may or may not be rejectable but caution shall be exercised to distinguish between patterns on undamaged chromium and patterns indicating chromium damage. Using the procedures outlined in 3.3.2, reclean and reinspect as required for resolution.

3.3.2.4.1 Procedure for Resolving Suspect Indications

Parts showing suspected indications shall be wiped free of magnetic medium. The magnetic particle inspection shall be repeated and, if the indications remain, exploration of the defect indications shall be made by burnishing or repolishing the suspected area with fine, 220 grade or equivalent abrasive paper acceptable to a Level 3 inspector. If the indications reappear after remagnetizing the part and applying the magnetic test medium, the part is unacceptable.

3.3.2.5 Figure 6 illustrates some typical indications of cracks in the steel substrate as revealed by magnetic particle inspection of a chromium plated part damaged during grinding of the chromium.

4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for Inspection

The processor shall be responsible for performance of all required tests and inspections. The cognizant engineering organization reserves the right to sample and to perform any confirmatory testing deemed necessary to ensure that the product conforms to specified requirements.

4.2 Acceptance Tests

All tests herein shall be performed to determine product acceptance.

4.3 Periodic Tests

Tests to maintain the cleaning solutions used herein are periodic tests and shall be performed at a frequency selected by the processor unless frequency of testing is specified by the cognizant engineering organization (See 8.6).

4.4 Reports

The processor shall report for each shipment the number of parts inspected. This report shall also include a statement that all parts in the shipment were processed and inspected in accordance with AMS 2440B, and conform to the acceptance standards specified by the cognizant engineering organization.

4.5 Retesting

When approved by the cognizant engineering organization, rejected parts may be stripped, temper etch inspected in accordance with AMS 2649, and magnetic particle inspected in accordance with 3.2.3. The stripping method shall not pit or embrittle the basis metal. Procedures used for stripping shall be acceptable to the cognizant engineering organization.

4.5.1 After stripping and temper etching, parts exhibiting evidence of abusive grinding either by magnetic particle inspection or the presence of untempered martensite light etching streaks or areas shall be subject to rejection. Parts exhibiting localized overtempered areas (dark streaks or areas) not exceeding 10% of the surface area may be reworked including replating and reinspecting in accordance with this specification when permitted by the cognizant engineering organization.

5. PREPARATION FOR DELIVERY

5.1 Identification

Parts that have satisfactorily passed this inspection process shall be individually packaged and the package marked to indicate conformance. Packaging shall conform to 5.2.1.

5.2 Packaging

- 5.2.1 Parts shall be handled and packaged to ensure that the required physical characteristics and properties of the plating are preserved.
- 5.2.2 Packages of 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 processed parts to ensure carrier acceptance and safe delivery.

6. ACKNOWLEDGMENT

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

7. REJECTIONS

Parts not conforming to this specification or to modifications authorized by the cognizant engineering organization will be subject to rejection.

8. NOTES

- 8.1 A change bar (I) 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 specification. An (R) symbol to the left of the document title indicates a complete revision of the specification, including technical revisions. Change bars and (R) are not used in original publications, nor in specifications that contain editorial changes only.
- 8.2 The sequencing of operations should be specified by the cognizant engineering organization and is not controlled by this specification. Parts should be etch inspected in accordance with AMS 2649 and magnetic particle inspected in accordance with ASTM E 1444 prior to chromium plating.
- 8.3 ARP 4992, Periodic Test Plan for Process Solutions, is recommended to satisfy the requirements for the control of processing solutions.
- 8.4 Terms used in AMS are clarified in ARP1917.
- 8.5 Dimensions and properties in inch/pound units Fahrenheit temperatures are primary; dimensions and properties in SI units and Celsius temperatures are shown as the approximate equivalents of the primary units and are presented only for information.
- 8.6 Purchase documents should specify not less than the following:

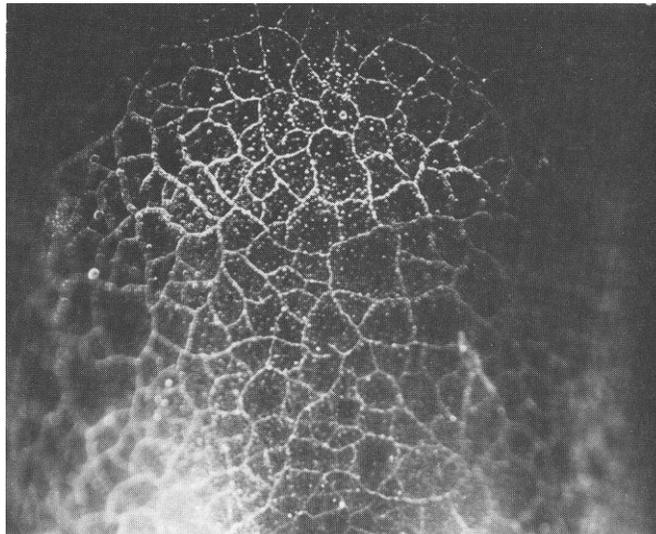
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Quantity of parts to be tested

Material composition

Frequency of dimensional inspection and surface finish testing.

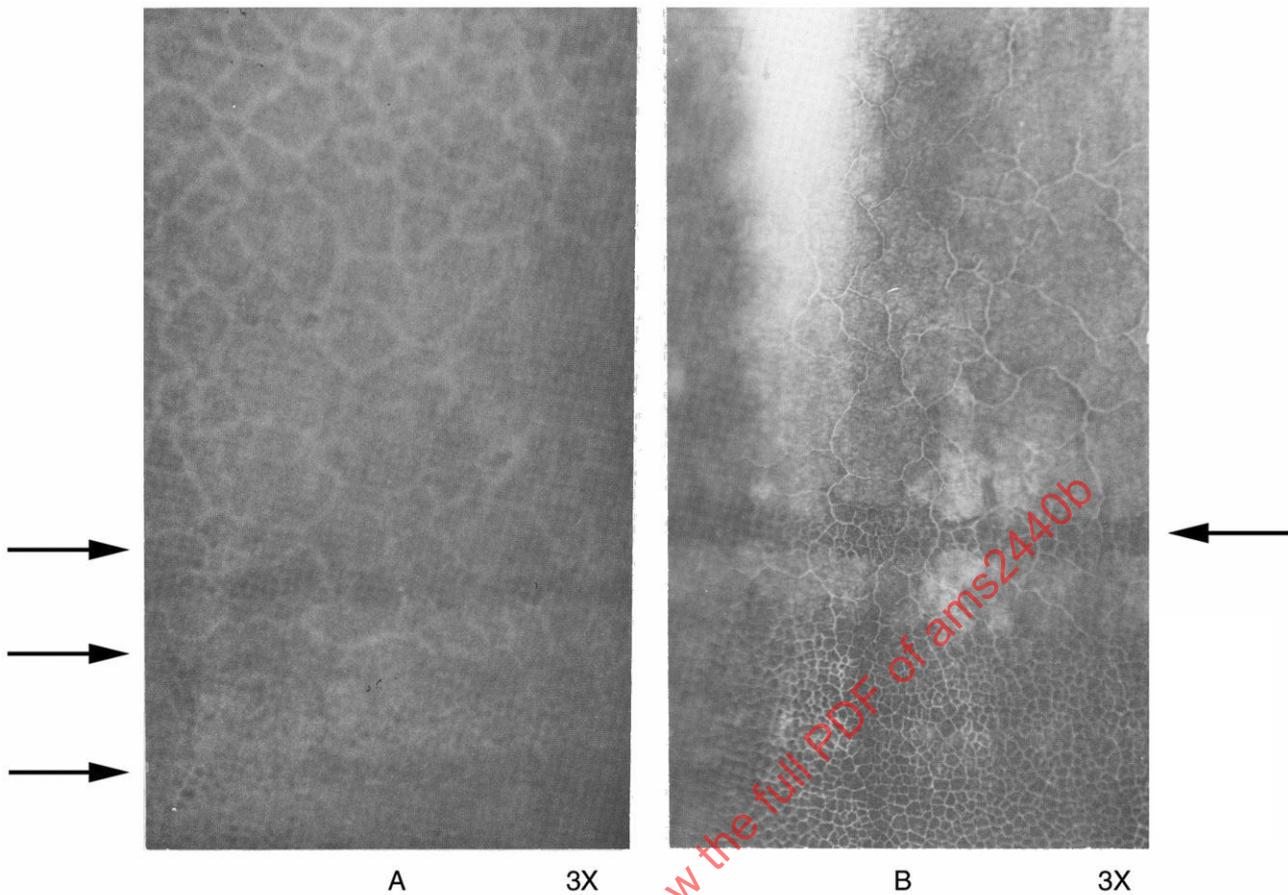
PREPARED BY AMS COMMITTEE "B"



Fluorescent penetrant inspection of an as-plated cylindrical specimen (photographed in black light) reveals cracks resulting from plating stresses. The photo illustrates the fact that mud-cracking is not the result of abusive grinding.

FIGURE 1

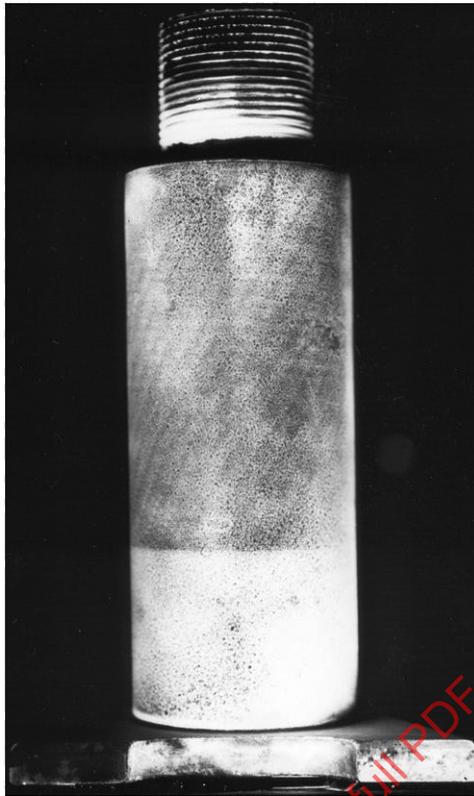
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- A. An abusively ground specimen, photographed during fluorescent penetrant inspection in black light, shows typical grinder-induced pattern present on an abusively ground surface.
- B. The same view of the specimen, with the penetrant developer removed, in order to reveal the exact nature of the rejectable indications in the grinder-induced pattern.

Note: Arrows point to banding subject to rejection.

FIGURE 2



Abusive grinding of a chromium plated cylindrical part. Spiraling, banding, and plunge grinding indications are all illustrated on this part. Photographed under black light during fluorescent penetrant inspection.

FIGURE 3

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