

# AEROSPACE MATERIAL SPECIFICATION

## Inspection of Ground, Chromium Plated Steel Parts

### 1. SCOPE:

#### 1.1 Purpose:

This specification covers the requirements, procedures, and accept/reject criteria for inspecting ground chromium plated surfaces for grinder-induced damage to the chromium plate and substructure.

#### 1.2 Application:

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

- 1.2.1 It is possible to have areas of overheated chromium plate without damage to the substrate. Overheating sufficient to damage the substrate will be exhibited by indications in the ground chromium plated surface.

### 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 canceled and no superseding document has been specified, the last published issue of that document shall apply.

#### 2.1 SAE Publications:

Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

AMS 2644	Inspection Material, Penetrant
AMS 2649	Etch Inspection of High Strength Steel Parts
AMS 3041	Magnetic Particles, Wet Method, Oil Vehicle
AMS 3042	Magnetic Particles, Nonfluorescent Wet Method, Dry Powder

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright 2000 Society of Automotive Engineers, Inc.  
All rights reserved.

Printed in U.S.A.

QUESTIONS REGARDING THIS DOCUMENT:  
TO PLACE A DOCUMENT ORDER:  
SAE WEB ADDRESS:

(724) 772-7161  
(724) 776-4970  
<http://www.sae.org>

FAX: (724) 776-0243  
FAX: (724) 776-0790

## 2.1 (Continued):

AMS 3044	Magnetic Particles, Fluorescent, Wet Method, Dry Powder
AMS 3045	Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Ready to Use
AMS 3155	Oil, Fluorescent Penetrant, Solvent Soluble
AMS 3157	Oil, Fluorescent Penetrant, High Fluorescence, Solvent Soluble
AMS 3161	Oil, Odorless, Heavy Solvent

## 2.2 ASTM Publications:

Available from ASTM, 100 Barr Harbor Drive, West Conshohocken, PA 19248-2959.

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

## 2.3 ASNT Publications:

Available from American Society for Nondestructive Testing, 4153 Arlington Plaza, Columbus, OH 43221.

SNT-TC-1A	Recommended Practice, Personnel Qualification and Certification in Nondestructive Testing
-----------	---

## 3. TECHNICAL REQUIREMENTS:

## 3.1 Materials:

3.1.1 Magnetic particle materials shall consist of an odorless inspection oil conforming to AMS 3161 and magnetic particles conforming to AMS 3041, AMS 3042, AMS 3044, or AMS 3045 as applicable.:

3.1.2 Fluorescent penetrant materials, emulsifiers, and developers shall have high sensitivity and shall conform to the requirements of AMS 3157 or AMS 2644 Type 1 Level 3 Form d or better. High sensitivity AMS 3155 or AMS 2644 Level 2 penetrants may be used provided equivalent sensitivity to the Level 3 penetrant can be demonstrated in side-by-side tests using crack test specimens equivalent to those defined in AMS 2644. For such demonstrations, both penetrants shall be used with Form d nonaqueous wet developer.

## 3.2 Equipment and Lighting:

Equipment and lighting shall meet the requirements of ASTM E 1417 and ASTM E 1444 as applicable.

## 3.3 Preparation of Parts:

3.3.1 Steel parts shall have been temper etch inspected in accordance with AMS 2649 and magnetic particle inspected in accordance with ASTM E 1444 for damage prior to plating.

3.3.2 All ground chromium plated parts shall be cleaned and dried to remove lubricants, grease, oil, coolants, soaps, alkalies, and other substances which 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.

#### 3.4 Ground Parts:

Parts shall be fluorescent penetrant inspected in accordance with ASTM E 1417 after all plating and grinding operations. Parts made from magnetizable steels shall be magnetic particle inspected in accordance with ASTM E 1444. Parts shall be free of defects indicative of abusive grinding, plating induced damage, or both.

#### 3.5 Fluorescent Penetrant Inspection:

Shall be accomplished only by inspectors qualified in penetrant inspection and certified to SNT-TC-1A, Level II. Questionable indications shall be resolved by a level III penetrant inspector.

3.5.1 Each part shall be fluorescent penetrant inspected in accordance with ASTM E 1417 as follows, using materials specified in 3.1.2 and equipment specified in 3.2.

3.5.1.1 Examine part under black light without developer for evidence of mud-cracks and grinder-induced damage utilizing the criteria of 3.5.2 and Figures 1 through 8.

3.5.1.2 Apply nonaqueous developer and repeat inspection under black light as in 3.5.1.1.

#### 3.5.2 Acceptance Criteria:

##### 3.5.2.1 Mud-Cracking:

3.5.2.1.1 Mud-cracking in chromium plate is not invariably indicative of abusive grinding (See Figure 1) and, consequently, is not always a rejectable penetrant indication. Mud-cracking due to grinding is always rejectable except when permitted by the drawing.

3.5.2.1.2 When crack indications are in chromium runout areas, or areas designated on the drawing where imperfect chromium is acceptable, the part may be accepted provided magnetic particle inspection verifies that no cracks exist in the substrate.

3.5.2.1.3 If there is a directional quality to the mud-crack pattern, where it occurs in bands or spirals, it is a clear indication of abusive grinding and is unacceptable. Typical patterns and directions of abusive grinding are shown on Figures 2 and 6, but size of indications shall not be considered when determining acceptability of the indication.

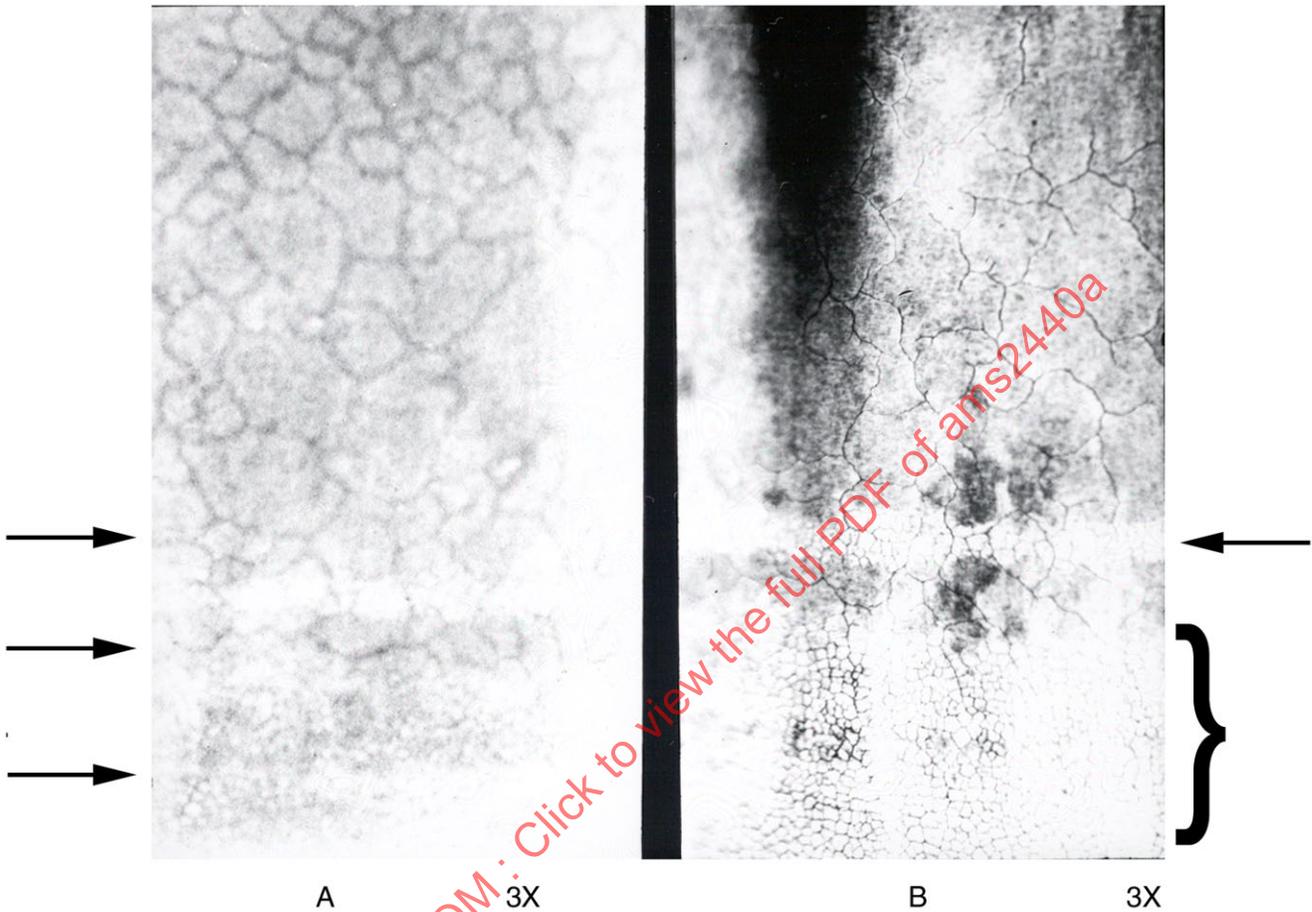
3.5.2.2 **Crazed Surface:** A more closely knit network of smooth microcracks normally present in chromium plating is acceptable. Generally this pattern cannot be resolved with the unaided eye and appears as a crazed surface on the chromium plating. Figures 3 and 4 illustrate the difference between mud-cracks and microcracks.



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 necessarily the result of abusive grinding.

FIGURE 1

SAENORM.COM : Click to view the full PDF of ams2440a



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.

FIGURE 2



10X

The nature of micro-cracking revealed in this enlarged black light photograph of a specimen during fluorescent penetrant inspection shows the acceptable condition designated as a crazed surface.

FIGURE 3



10X

This photo compares the unacceptable condition designated "Mud-cracking" in a grinder pattern (left side of photo) with the crazed surface indication of Figure 3

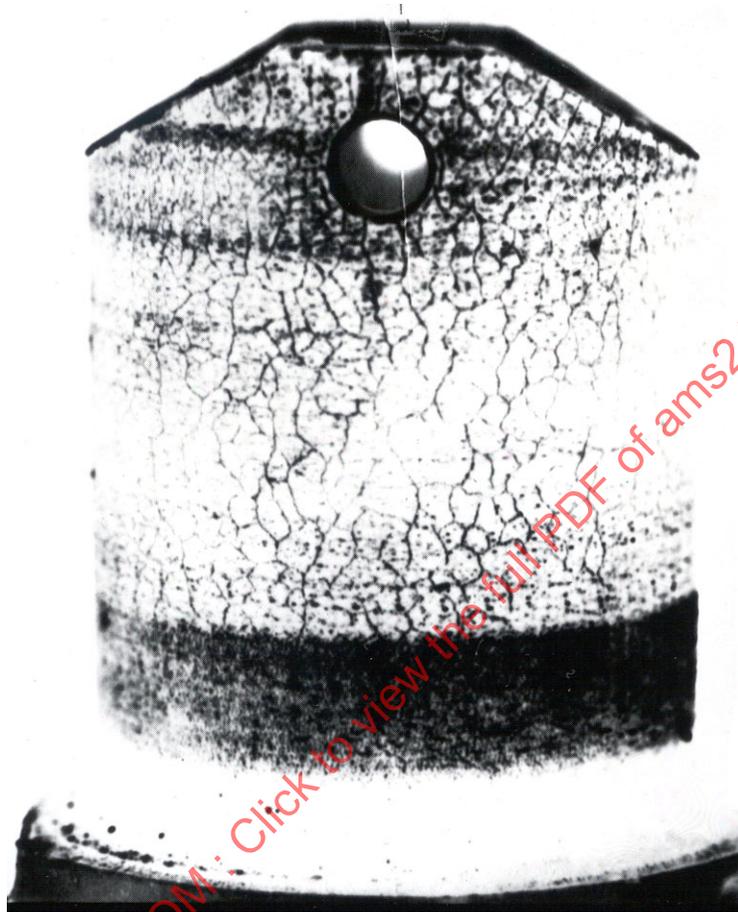
FIGURE 4

SAENORM.COM : Click to view the full PDF of ams2440a



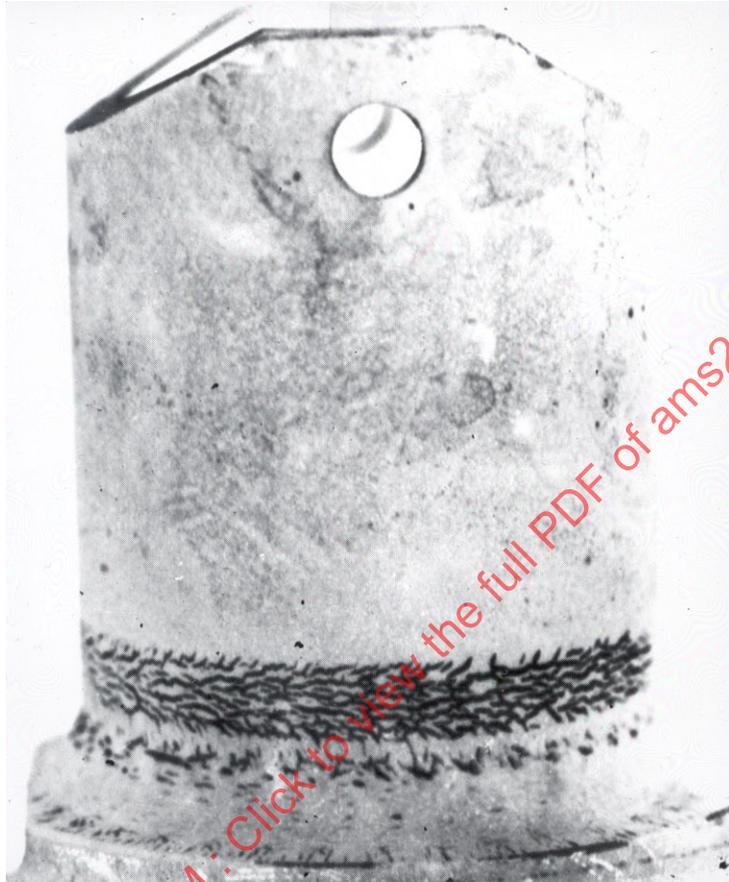
Abusive grinding of a chromium plated cylindrical part. Spiraling, banding, and plunge grinding indications are all illustrated on this part. Photographed under black light during fluorescent penetrant inspection.

FIGURE 5



Fluorescent penetrant inspection of an abusively ground part reveals mud-cracking and banding indications. See figure 7.

FIGURE 6



The same pin illustrated in Figure 6 is shown during fluorescent penetrant inspection of the steel substrate after the chromium plate was removed. Actual crack damage is in the area adjacent to and in the radius where the severe plunge ground band was indicated in fluorescent inspection of the chromium surface.

FIGURE 7



Two parts compare extraneous indications to abusive grinding indications. The specimen on the right exhibited metallurgical damage when stripped and nital etched. The other specimen had no steel damage.

FIGURE 8

- 3.5.2.3 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 Figure 5). A combination of two or more patterns may be superimposed and cover the entire ground surface or any portion of it.
- 3.5.2.4 Plunge: Abusive plunge grinding is indicated by patterns like spiraling and banding except that they form a single band of constant width. Figures 6 and 7 illustrate severe plunge grinding resulting in unacceptable damage to the steel substrate adjacent to a radius.
- 3.5.2.5 Any distinct pattern uncommon to chromium plating, such as a spider web pattern, or one or more linear indications with or without branching, or a cluster of indications, may be indicative of mechanical damage to the plating, and is not acceptable.

- 3.5.2.6 Extraneous Indications: Sometimes scratches or wear patterns are shown by fluorescent penetrant inspection. Such patterns are not rejectable but caution shall be exercised to distinguish between patterns on undamaged chromium and patterns indicating chromium damage. Using the procedures outlined herein, reclean and reinspect as required for resolution. Figure 8 illustrates some extraneous patterns compared with patterns indicative of abusive grinding.
- 3.6 Magnetic Particle Inspection:
- Each steel part acceptable by fluorescent penetrant inspection shall be magnetic particle inspected. Inspection shall be accomplished by inspectors qualified in magnetic particle inspection and certified to SNT-TC-1A, Level II. Questionable indications shall be resolved by a Level III magnetic particle inspector.
- 3.6.1 Magnetic particle inspect each part in accordance with ASTM E 1444 as follows, using materials as in 3.1.1 and equipment as in 3.2.
- 3.6.1.1 A petroleum distillate liquid vehicle with a fluorescent paste suspension or black oxide suspension shall be used.
- 3.6.1.2 Under the required lighting (black light for fluorescent suspension or white light for black oxide suspension), examine the part for grinder or plating-induced damage, or both, utilizing the acceptance criteria of 3.6.2.
- 3.6.1.3 Care shall be exercised during magnetic particle inspection of ground chromium plated surfaces to ensure that indications are not washed off by suspension oil flowing down the part. Multiple applications of current (one following right after another) shall be used to reduce the danger of washing off indications.
- 3.6.1.4 Carefully evaluate all indications to ensure that they are the results of plating or grinding-induced damage. Magnetic particle inspection can induce extraneous indications such as magnetic writing or flow lines.
- 3.6.1.5 The effectiveness of magnetic particle inspection of a steel substrate through the chromium plate is limited by the thickness of the plate.
- 3.6.1.6 Figure 9 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.
- 3.6.2 Evaluation Procedure: 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 in accordance with the following: