



Designation: E1444/E1444M – 21

## Standard Practice for Magnetic Particle Testing for Aerospace<sup>1</sup>

This standard is issued under the fixed designation E1444/E1444M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the U.S. Department of Defense.*

### 1. Scope\*

1.1 This practice establishes minimum requirements for magnetic particle testing used for the detection of surface or slightly subsurface discontinuities in ferromagnetic material. This practice is intended for aerospace applications using the wet fluorescent method. Refer to Practice [E3024/E3024M](#) for industrial applications. Guide [E709](#) can be used in conjunction with this practice as a tutorial.

NOTE 1—This practice replaces MIL-STD-1949.

1.2 The magnetic particle testing method is used to detect cracks, laps, seams, inclusions, and other discontinuities on or near the surface of ferromagnetic materials. Magnetic particle testing may be applied to raw material, billets, finished and semi-finished materials, welds, and in-service parts. Magnetic particle testing is not applicable to non-ferromagnetic metals and alloys such as austenitic stainless steels. See [Appendix X1](#) for additional information.

1.3 Portable battery powered electromagnetic yokes are outside the scope of this practice.

1.4 All areas of this practice may be open to agreement between the cognizant engineering organization and the supplier, or specific direction from the cognizant engineering organization.

1.5 This standard is a combined standard, an ASTM standard in which rationalized SI units and inch-pound units are included in the same standard, with each system of units to be regarded separately as standard.

1.5.1 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

### 2. Referenced Documents

2.1 The following documents form a part of this practice to the extent specified herein.

2.2 *ASTM Standards:*<sup>2</sup>

[E543 Specification for Agencies Performing Nondestructive Testing](#)

[E709 Guide for Magnetic Particle Testing](#)

[E1316 Terminology for Nondestructive Examinations](#)

[E2297 Guide for Use of UV-A and Visible Light Sources and Meters used in the Liquid Penetrant and Magnetic Particle Methods](#)

[E3022 Practice for Measurement of Emission Characteristics and Requirements for LED UV-A Lamps Used in Fluorescent Penetrant and Magnetic Particle Testing](#)

[E3024/E3024M Practice for Magnetic Particle Testing for General Industry](#)

2.3 *ASNT Documents:*<sup>3</sup>

[SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing](#)

[ANSI/ASNT CP-189 Standard for Qualification and Certification of NDT Personnel](#)

<sup>1</sup> This practice is under the jurisdiction of ASTM Committee [E07](#) on Nondestructive Testing and is the direct responsibility of Subcommittee [E07.03](#) on Liquid Penetrant and Magnetic Particle Methods.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Available from American Society for Nondestructive Testing (ASNT), P.O. Box 28518, 1711 Arlingate Ln., Columbus, OH 43228-0518, <http://www.asnt.org>.

\*A Summary of Changes section appears at the end of this standard

#### 2.4 SAE-AMS Documents:<sup>4,5</sup>

- AMS 2175 Castings, Classification and Inspection of
- AMS 2641 Magnetic Particle Inspection Vehicle
- AMS 3044 Magnetic Particles, Fluorescent, Wet Method, Dry Powder
- AMS 3045 Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Ready-To-Use
- AMS 3046 Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Aerosol Packaged<sup>5</sup>
- AMS 5355 Investment Castings
- AS 4792 Water Conditioning Agents for Aqueous Magnetic Particle Inspection
- AS 5282 Tool Steel Ring Standard for Magnetic Particle Inspection
- AS 5371 Reference Standards Notched Shims for Magnetic Particle Inspection
- SAE AMS-STD-595 Colors Used in Government Procurement

#### 2.5 Federal Standard:<sup>4,6</sup>

- FED-STD-313 Material Safety Data, Transportation Data and Disposal Data for Hazardous Materials Furnished to Government Activities

#### 2.6 Military Standards:<sup>4,6</sup>

- A-A-59230 Fluid, Magnetic Particle Inspection, Suspension
- MIL-STD-1949 Inspection, Magnetic Particle

#### 2.7 OSHA Document:<sup>7</sup>

- 29 CFR 1910.1200 Hazard Communication

#### 2.8 ANSI Document:<sup>4,8</sup>

- ANSI/NCSL Z540.3 General Requirement for Calibration Laboratories and Measuring Test Equipment

#### 2.9 ISO Standards:<sup>9</sup>

- ISO 10012 Measurement Management Systems—Requirements for Measurement Processes and Measuring Equipment (ISO 10012 is not intended as a substitute for, or as an addition to, the requirements of ISO/IEC 17025.)
- ISO 9712 Non-destructive Testing — Qualification and Certification of NDT Personnel
- ISO/IEC 17025 General Requirements for the Competence of Testing and Calibration Laboratories

#### 2.10 AIA Document:<sup>10</sup>

- NAS 410 NAS Certification and Qualification of Nondestructive Test Personnel

#### 2.11 ASD-STAN Document:<sup>11</sup>

- EN 4179 Qualification and Approval of Personnel for Non-Destructive Testing

2.12 *Order of Precedence*—In the event of conflict between the text of this practice and the referenced documents cited herein, the text of this practice takes precedence.

### 3. Terminology

3.1 *Definitions*—The definitions relating to magnetic particle testing, which appear in Terminology E1316, shall apply to the terms used in this practice.

### 4. Significance and Use

4.1 *Description of Process*—Magnetic particle testing consists of magnetizing the area to be examined, applying suitably prepared magnetic particles while the area is magnetized, and subsequently interpreting and evaluating any resulting particle accumulations. Maximum detectability occurs when the discontinuity is positioned on the surface and perpendicular to the magnetic flux.

4.2 This practice establishes the basic parameters for controlling the application of the magnetic particle testing method. This practice is written so that it can be specified on the engineering drawing, specification, or contract. It is not a detailed how-to procedure to be used by the examination personnel and, therefore, must be supplemented by a detailed written procedure that conforms to the requirements of this practice.

### 5. General Practice

5.1 *Personnel Qualification*—Personnel performing examinations in accordance with this practice shall be qualified and certified in accordance with SNT-TC-1A, ANSI/ASNT CP-189, NAS 410, EN4179, ISO 9712, or as specified in the contract or purchase order.

5.2 *Agency Qualification*—The agency performing this practice may be evaluated in accordance with Specification E543.

5.3 *Written Procedure*—Magnetic particle testing shall be performed in accordance with a written procedure applicable to the part or group of parts under examination. The procedure shall be in accordance with the requirements of this practice. The process, when conducted in accordance with the written procedure, shall be capable of detecting discontinuities specified in the acceptance criteria. The written procedure may be general if it clearly applies to all of the specified parts being examined and meets the requirements of this practice. All written procedures, including technique sheets for specific parts, shall be approved by an individual qualified and certified at Level 3 (III) for magnetic particle testing in accordance with the requirements of 5.1. Procedures shall be submitted to the cognizant engineering organization for review, or approval, or both, when requested.

<sup>4</sup> Copies of standards, specifications, drawings, and publications required by manufacturers in connection with specification acquisition should be obtained from the contracting activity or as directed by the contracting officer.

<sup>5</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

<sup>6</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

<sup>7</sup> Available from U.S. Government Printing Office Superintendent of Documents, 732 N. Capitol St., NW, Mail Stop: SDE, Washington, DC 20401, <http://www.access.gpo.gov>.

<sup>8</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>9</sup> Available from International Organization for Standardization (ISO), ISO Central Secretariat, Chemin de Blandonnet 8, CP 401, 1214 Vernier, Geneva, Switzerland, <https://www.iso.org>.

<sup>10</sup> Available from Aerospace Industries Association of America, Inc. (AIA), 1000 Wilson Blvd., Suite 1700, Arlington, VA 22209-3928, <http://www.aia-aerospace.org>.

<sup>11</sup> Available from ASD-STAN, [asd-stan.org](http://asd-stan.org).

5.3.1 *Elements of the Written Procedure*—The written procedure shall include at least the following elements, either directly or by reference to the applicable documents:

5.3.1.1 Name and address of facility to which the procedure applies, containing the unique procedure identification number and the date it was written;

5.3.1.2 Identification of the part(s) to which the procedure applies; this shall include the material, or alloy, or both;

5.3.1.3 For new components, sequence of magnetic particle testing as related to manufacturing process operation (for example, post plating, after heat treat, etc.);

5.3.1.4 Identification of test parts used for system performance verification (see 7.1.1 and 7.1.2);

5.3.1.5 Process controls (see Table 1);

5.3.1.6 Identification of the areas of the part to be examined and include an illustration, a drawing, or photos as necessary;

5.3.1.7 Part preparation required before examination;

5.3.1.8 Directions for positioning the item with respect to the magnetizing equipment;

5.3.1.9 The type of magnetizing current and the equipment to be used;

5.3.1.10 Method of establishing the magnetization (head, coil, yoke, cable wrap, etc.);

5.3.1.11 Directions of magnetization to be used, the order in which they are applied, and any demagnetization procedures to be used between shots;

5.3.1.12 The current level, or the number of ampere turns, to be used and the duration of its application;

5.3.1.13 Type of magnetic particle material to be used, the particle concentration limits, and the method and equipment to be used for its application. If a suspension dwell time is required, the length of suspension drain time prior to examination shall be defined;

5.3.1.14 Type of records and method of marking parts after examination;

5.3.1.15 Acceptance requirements to be used for evaluating indications, arc burns, and disposition of parts after evaluation;

5.3.1.16 Post-examination demagnetization and cleaning requirements; and

5.3.1.17 The method and measurement frequency will be defined for meeting the minimum examination intensity for all UV-A lamps, including battery-powered lamps. Any requirements for documentation of the measurements will also be defined.

5.4 *Examination Sequence*—Perform magnetic particle examination after all operations which might cause or reveal discontinuities. Such operations include, but are not limited to, forging, heat treating, electroplating, forming, welding, grinding, straightening, machining, and proof loading.

5.4.1 Perform magnetic particle examination prior to shot peening (to provide a beneficial compressive layer) and prior to applying protective finishes such as priming, painting, plating (see 5.4.3 through 5.4.3.5), or other coatings.

5.4.2 In-process examinations may not be substituted for final examination.

5.4.3 *Plating and Coatings*—Examine parts which will receive either a plating or coating as follows:

5.4.3.1 Examination is required prior to all non-electroplated coatings.

5.4.3.2 Electroplated surfaces with a final plating thickness of 0.0008 in. [0.02 mm] or less shall be examined either before or after electroplating, or grinding, or both.

5.4.3.3 Electroplated surfaces with a final plating thickness of between 0.0008 in. [0.02 mm] and 0.0050 in. [0.13 mm] shall be examined both before and after electroplating, or grinding, or both, of electroplated surfaces.

(1) Electroplated surfaces with a final plating thickness of 0.0050 in. [0.13 mm] or greater shall be examined before electroplating, or grinding, or both, of electroplated surfaces.

(2) Magnetic particle examination after electroplating is not required for steels with a tensile strength less than or equal to 160 ksi.

**TABLE 1 Process Controls and Calibrations**

Item	Maximum Time Between Verification <sup>A</sup>	Paragraph
Lighting: <sup>B</sup>		
Visible light intensity	Weekly	7.3.1.1
Ambient light intensity	Weekly	7.3.1.2
UV-A lamp intensity	Daily	7.3.2, 7.4.5
Battery powered	Prior to and after each use	7.4.5.2
UV-A lamp intensity check		
UV-A lamp integrity <sup>C</sup>	Daily	7.3.2
System Performance: <sup>B</sup>	Daily	7.1, 7.1.1, 7.1.2
Wet particle concentration	8 hours, or every shift change	7.2.1.1
Wet particle contamination: <sup>B</sup>	1 week	7.2.1.2
Water break test	Daily	7.2.2
Equipment calibration check: <sup>B</sup>		
Ammeter accuracy	6 months	7.4.1
Timer control	6 months	7.4.2
Quick break	6 months	7.4.3
Yoke dead weight check	6 months	7.4.4
UV-A Radiometer and Photometer	6 months	7.4.7
Hall-Effect Gaussmeter or Field Indicator accuracy	6 months	7.4.6

<sup>A</sup> When the test system is in operation.

<sup>B</sup> The maximum time between verifications may be reduced or extended when substantiated by actual technical/reliability data.

<sup>C</sup> Need not be recorded.