Designation: E 1444 – 94a

An American National Standard

Standard Practice for Magnetic Particle Examination[1]

This standard is issued under the fixed designation E 1444; 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 (ϵ) indicates an editorial change since the last revision or reapproval.

This specification has been approved for use by agencies of the Department of Defense.

1. Scope

1.1 This practice establishes minimum requirements for magnetic particle examination used for the detection of surface or slightly subsurface discontinuities in ferromagnetic material. This practice is intended as a direct replacement of MIL-STD-1949. Guide E 709 can be used in conjunction with this practice as a tutorial.

1.2 The magnetic particle examination method is used to detect cracks, laps, seams, inclusions, and other discontinuities on or near the surface of ferromagnetic materials. Magnetic particle examination may be applied to raw material, billets, finished and semifinished materials, welds, and in-service parts. Magnetic particle examination is not applicable to nonferromagnetic metals and alloys such as austenitic stainless steels.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

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

2.2 *ASTM Standards:*

A 275/A 275M Test Method for Magnetic Particle Examination of Steel Forgings[2]

A 456 Specification for Magnetic Particle Inspection of Large Crankshaft Forgings[2]

D 96 Test Methods for Water and Sediment in Crude Oil by the Centrifuge Method (Field Procedure)[3]

E 543 Practice for Evaluating Agencies that Perform Nondestructive Testing[4]

E 709 Guide for Magnetic Particle Examination[4]

E 1316 Terminology for Nondestructive Examinations[4]

2.3 *ASNT Document:*

SNT-TC-1A Recommended Practice and Supplement Magnetic Particle Inspection[5]

2.4 *Society of Automotive Engineers (SAE)-AMS Documents:*[6]

AMS 2300 Premium Aircraft-Quality Steel Cleanliness Magnetic Particle Inspection Procedure[7]

AMS 2301 Aircraft Quality Steel Cleanliness Magnetic Particle Inspection Procedure[7]

AMS 2303 Aircraft Quality Steel Cleanliness Martensitic Corrosion Resistant Steels Magnetic Particle Inspection Procedure[7]

AMS 2641 Magnetic Particle Inspection Vehicle[7]

AMS 3040 Magnetic Particles, Nonfluorescent, Dry Method[7]

AMS 3041 Magnetic Particles, Nonfluorescent, Wet Method, Oil Vehicle, Ready-To-Use[7]

AMS 3042 Magnetic Particles, Nonfluorescent, Wet Method, Dry Powder[7]

AMS 3043 Magnetic Particles, Nonfluorescent, Wet Method, Oil Vehicle, Aerosol Packaged[7]

AMS 3044 Magnetic Particles, Fluorescent, Wet Method, Dry Powder[7]

AMS 3045 Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Ready-To-Use[7]

AMS 3046 Magnetic Particles, Fluorescent, Wet Method, Oil Vehicle, Aerosol Packaged[7]

AMS 5355 Investment Castings[7]

2.5 *Federal Standards:*[6]

FED-STD-313 Material Safety Data Sheets, Preparation and the Submission of[8]

FED-STD-595 Colors[8]

2.6 *Military Standards:*[6]

MIL-STD-1907 Inspection, Liquid Penetrant and Magnetic Particle Soundness Requirements for Materials, Parts, and Weldments[8]

[1] This practice is under the jurisdiction of ASTM Committee E-7 on Nondestructive Testing and is the direct responsibility of Subcommittee E07.03 on Liquid Penetrant and Magnetic Particle Methods.

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[2] *Annual Book of ASTM Standards*, Vol 01.05.

[3] *Annual Book of ASTM Standards*, Vol 05.01.

[4] *Annual Book of ASTM Standards*, Vol 03.03.

[5] Available from American Society for Nondestructive Testing, 1711 Arlingate Plaza, P.O. Box 28518, Columbus, OH 43228-0518.

[6] 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.

[7] Available from Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

[8] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

MIL-STD-410 Nondestructive Testing Personnel Qualification and Certification[8]
MIL-STD-1949 Magnetic Particle Inspection, Method of[8]
MIL-STD-2175 Castings, Classification and Inspection of[8]
MIL-STD-45662 Calibration Systems Requirements
MIL-I-83387 Inspection Process, Magnetic Rubber[8]
DoD-F-87935 Fluid, Magnetic Particle Inspection, Suspension (Metric)[8]

2.7 *OSHA Document:*[9]

29CFR 1910.1200 Hazard Communication

2.8 *DoD Contracts*—Unless otherwise specified, the editions of the documents that are DoD adopted are those listed in the issue of the DoDISS (Department of Defense Index of Specifications and Standards) cited in the solicitation.

2.9 *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 examination, which appear in Terminology E 1316, shall apply to the terms used in this practice.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *alternating current (ac)*—an electrical current that reverses its direction of flow at regular intervals.

3.2.2 *ambient light*—the visible light level measured at the specimen surface with the black light(s) on.

3.2.3 *contracting agency*—a prime contractor, subcontractor, or government agency procuring magnetic particle inspection services.

3.2.4 *gauss (G)*—the unit of flux density or induction in the cgs electromagnetic unit system (1 G = 10^{-4} Tesla (T); in air, 1 G is equivalent to 1 oersted (Oe), which equals 79.58 A/m).

3.2.5 *head shot*—the production of circular magnetization by passing current directly through the part being inspected, or central conductor, while being held in contact with the head stocks in a horizontal wet machine.

3.2.6 *magnetic flux*—a conceptualization of the magnetic field intensity based on the line pattern produced when iron filings are sprinkled on paper laid over a permanent magnet. The magnetic field lies in the direction of the flux lines and has an intensity proportional to the line density.

3.2.7 *magnetization*—the process by which the elementary magnetic domains of a material are predominantly aligned in one direction.

3.2.8 *retentivity*—the ability of a material to retain magnetism after the magnetizing force has been removed.

4. Significance and Use

4.1 Magnetic particle examination consists of magnetizing the area to be inspected, 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 perpendicular to the magnetic flux. In order to detect discontinuities in all directions, at least two magnetic fields, perpendicular to one another in a plane parallel to the surface being inspected, shall be used, except when specifically exempted by the contracting agency.

5. General Practice

5.1 *Acceptance Requirements*—The acceptance requirements applicable to the part or group of parts shall be incorporated as part of the written procedure either specifically or by reference to other applicable documents, such as MIL-STD-1907, containing the necessary information. Applicable drawings or other documents shall specify the acceptance size and concentration of discontinuities for the component, with zoning of unique areas as required by design requirements. These acceptance requirements shall be as approved on or as specified by the contracting agency. Methods for establishing acceptance requirements for large crankshaft forgings are covered in Specification A 456. Methods for establishing requirements for steel forgings are covered in Test Method A 275/A 275M. Methods for classifying metal castings are given in MIL-STD-2175 and AMS 5355. MIL-STD-1907 provides a classification scheme for ferromagnetic forgings, castings, extrusions, and weldments.

5.1.1 *Aircraft-Quality Steel Cleanliness*—The examination of aircraft-quality steel for cleanliness using magnetic particle examination shall be as specified in AMS 2300, 2301, or 2303 as appropriate to the type of steel being inspected. However, inspection of parts fabricated from this material shall be in accordance with the requirements of this practice.

5.2 *Personnel Qualification*—Personnel performing examinations in accordance with this practice shall be qualified and certified in accordance with ASNT Personnel Qualification SNT-TC-1A or MIL-STD-410 for military purposes, or as specified in the contract or purchase order.

5.3 *Agency Qualification*—The agency performing the testing or examination shall meet, as a minimum, the requirements of Practice E 543.

5.4 *Written Procedure*—Magnetic particle examination shall be performed in accordance with a written procedure applicable to the parts or group of parts under testing. The procedure shall be in accordance with the requirements and guidelines of this practice. The procedure shall be capable of detecting the smallest rejectable discontinuities specified in the acceptance requirements. The written procedure may be general if it clearly applies to all of the specified parts being tested and meets the requirements of this practice. All written procedures shall be approved by an individual qualified and certified at Level III for magnetic particle examination in accordance with 5.2. Procedures shall be submitted to the contracting agency when requested.

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

5.4.1.1 Procedure identification number and the date it was written;

5.4.1.2 Identification of the parts to which the procedure

[9] Available from Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

applies; this shall include the material and alloy of which the parts are fabricated;

5.4.1.3 Sequence of magnetic particle examination as related to manufacturing process operation, if applicable;

5.4.1.4 Identification of test parts used for system performance verification (see 7.1.2 and 7.1.3);

5.4.1.5 Areas of the part to be examined (include an illustration–either sketch or photo);

5.4.1.6 Part preparation required before testing;

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

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

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

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

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

5.4.1.12 Type of magnetic particle material (dry or wet, visible or fluorescent, etc.) to be used and the method and equipment to be used for its application and, for the case of wet particles, the particle concentration limits;

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

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

5.4.1.15 Postinspection demagnetization and cleaning requirements.

5.5 *Examination Sequence*—When magnetic particle examination is specified, it shall be performed after the completion of operations that could cause surface or near-surface defects. These operations include, but are not limited to, forging, heat treating, plating, passivation, cold forming, welding, grinding, straightening, machining, and proof loading. Unless otherwise approved by the contracting agency or as approved in 6.1.3, production parts shall be magnetic particle inspected before the application of any coatings. Also, parts heat treated to an ultimate tensile strength of 180 ksi or higher that are heat treated and subsequently electroplated shall be inspected after the electroplating operation.

5.6 *Record of Examination*—The results of all magnetic particle inspections shall be recorded. All recorded results shall be identified, filed, and made available for review by the contracting agency upon request. Records shall provide for traceability to the specific part or lot inspected, and they shall identify the inspection contractor or facility and the procedures used in the inspection, the lot size, and the number of parts accepted.

5.7 *Lighting*:

5.7.1 *Visible Light*—Visible light shall be used when examining with nonfluorescent particles. The intensity of the visible light at the surface of the part undergoing examination shall be maintained at a minimum of 100 fc (1000 lx). The intensity measurement shall be conducted with a suitable illuminance meter with a photopic spectral response.

5.7.1.1 *Ambient Visible Light*—Unless otherwise specified, fluorescent magnetic particle examinations shall be performed in a darkened area with a maximum ambient visible light level of 2 fc (20 lx) measured at the part surface.

5.7.1.2 *Special Visible Internal Light Source*—When examinations of internal surfaces must be performed using special visible light sources, the image produced must have sufficient resolution to effectively evaluate the required discontinuities. Light intensity shall be measured at the expected working distance of the equipment.

5.7.2 *Black Lights*—All black lights shall be checked at the intervals specified in Table 1, and after bulb replacement, for output. A longer period may be used if a plan justifying this extension is prepared by the nondestructive testing facility and approved by the contracting agency. The minimum acceptable intensity is 1000 μW/cm^2 at the part being examined. Black light reflectors and filters shall be checked daily for cleanliness and integrity. Damaged or dirty reflectors or filters shall be replaced or otherwise corrected as appropriate.

5.7.3 *Internal Part Examination*—Where lamps are physically too large to directly illuminate the examination surface, special lighting shall be used. Internal features such as bores, holes, and passages less than 0.5 in. (12.5 mm) nominal diameter shall not require magnetic particle examination unless otherwise specified by the contracting agency.

5.8 *Materials*:

5.8.1 *Dry Particle Requirements*—Dry particles shall meet the requirements of AMS 3040. In applying AMS 3040, the particles shall show indications as listed in Table 2 on the test ring specimen of Fig. 1 using the following procedure:

5.8.1.1 Place a conductor with a diameter between 1 and 1.25 in. (25 and 31 mm) and a length longer than 16 in. (40 cm) through the center of the ring. Center the ring on the length of the conductor. Magnetize the ring circularly by passing the current specified in Table 2 through the conductor. Using a squeeze bulb or other suitable applicator, apply the particles to the surface of the ring while the current is flowing. Examine the ring within 1 min after current application under a visible light of not less than 100 fc (1000 lx). The number of hole indications shall meet or exceed those specified in Table 2.

5.8.2 *Wet Particle Requirements*—Wet particles shall meet the requirements of AMS 3041, 3042, 3043, 3044, 3045, or 3046, as applicable. In applying these specifications, the particles shall show indications as listed in Table 2 on the test

TABLE 1 Required Verification Intervals

Item	Maximum Time Between Verification
Lighting:	
Black light intensity	1 day
Ambient light intensity	1 day
Visible light intensity	1 day
System Performance using the test piece or ring specimen of Fig. 1	1 day
Wet particle concentration	8 hours, or every shift change
Water break test	1 day
Wet particle contamination	1 week
Equipment calibration check:	
Gaussmeter reading (Teslameter) zero	Prior to Use
Gaussmeter (Teslameter) accuracy	6 months
Ammeter accuracy	6 months
Timer control	6 months
Quick break	6 months
Dead weight check	6 months

TABLE 2 Required Indications When Using the Ring Specimen of Fig. 1

Particles Used	Central Conductor FWDC Amperage	Minimum Number of Holes Indicated
Wet suspension, Fluorescent, or Nonfluorescent	1400	3
	2500	5
	3400	6
Dry powder	1400	4
	2500	6
	3400	7

ring specimen of Fig. 1 using the following procedure:

5.8.2.1 Place a conductor with a diameter between 1 and 1.25 in. (25 and 31 mm) and a length longer than 16 in. (40 cm) through the center of the ring. Center the ring on the length of the conductor. Magnetize the ring circularly by passing the current specified in Table 2 through the conductor. Apply the suspension to the ring using the continuous method. Examine the ring within 1 min after current application (examination of nonfluorescent baths shall be conducted under visible light of not less than 100 fc (1000 lx); examination of fluorescent baths shall be conducted under a black light of not less than 1000 $\mu W/cm^2$). The number of hole indications shall meet or exceed those specified in Table 2.

5.8.3 *Suspension Vehicles*—The suspension vehicle for the wet method shall be a light petroleum distillate conforming to AMS 2641 (Type I) or DoD-F-87935, or a suitably conditioned water that conforms to the requirements of 5.8.4. When approved by the contracting agency, AMS 2641 (Type II) may be used. The flash point and viscosity shall be in accordance with the requirements of AMS 2641 or DoD-F-87935. The background fluorescence of the suspension vehicle shall be less than the limit specified in DoD-F-87935.

5.8.4 *Conditioned Water Vehicle*—When water is used as a suspension vehicle for magnetic particles, it shall be conditioned suitably to provide for proper wetting, particle dispersion, and corrosion protection. Proper wetting shall be determined by a water break test (see 7.1.4.2). Smoother test surfaces generally require that a greater percent of wetting agent be added than rough surfaces. Nonionic wetting agents are recommended. However, wetting agent additions shall be controlled in all cases by pH measurements to limit the alkalinity of the suspension to a maximum pH of 10.0 and the acidity to a minimum pH of 6.0.

5.8.5 *Particle Concentration*—The concentration of particles in the test bath shall be as specified in the written procedure. Particle concentrations outside of the range of 0.1 to 0.4 mL in a 100-mL bath sample for fluorescent particles and 1.2 to 2.4 mL for nonfluorescent particles shall not be used unless authorized by the contracting agency. Fluorescent particles and nonfluorescent particles shall not be used together.

6. Specific Practice

6.1 *Preparation of Parts for Test*:

6.1.1 *Preinspection Demagnetization*—The part shall be demagnetized before examination if prior operations have produced a residual magnetic field that may interfere with the examination.

6.1.2 *Surface Cleanliness and Finish*—The surface of the part to be inspected shall be essentially smooth, clean, dry, and free of oil, scale, machining marks, or other contaminants or conditions that might interfere with the efficiency of the inspection.

6.1.3 *Coatings*—Magnetic particle examination shall not be performed with coatings in place that could prevent the detection of surface defects in ferromagnetic substrate. Such coatings normally include paint or chrome plate greater than 0.003 in. (0.08 mm) in thickness and ferromagnetic coatings such as electroplated nickel greater than 0.001 in. (0.03 mm) in thickness. If coatings greater than these limits are present during examination, it must be demonstrated that the minimum rejectable discontinuities can be detected through the maximum coating thickness applied. When such coatings are nonconductive, they must be removed where electrical contact is to be made. In high stress applications when detection of fine defects such as grinding cracks and nonmetallic stringers is required, examination with coatings in place shall be performed only when it has been verified that the minimum rejectable discontinuities can be detected in the presence of the coating.

6.1.4 *Plugging and Masking*—Unless otherwise specified by the contracting agency, small openings and oil holes leading to passages or cavities that could entrap or remain contaminated with inspection media shall be plugged with a suitable nonabrasive material that can be removed readily and, in the case of engine parts, is soluble in oil. Effective masking shall be used to protect those components, such as certain nonmetallics, that may be damaged by contact with the suspension.

6.2 *Magnetization Methods*:

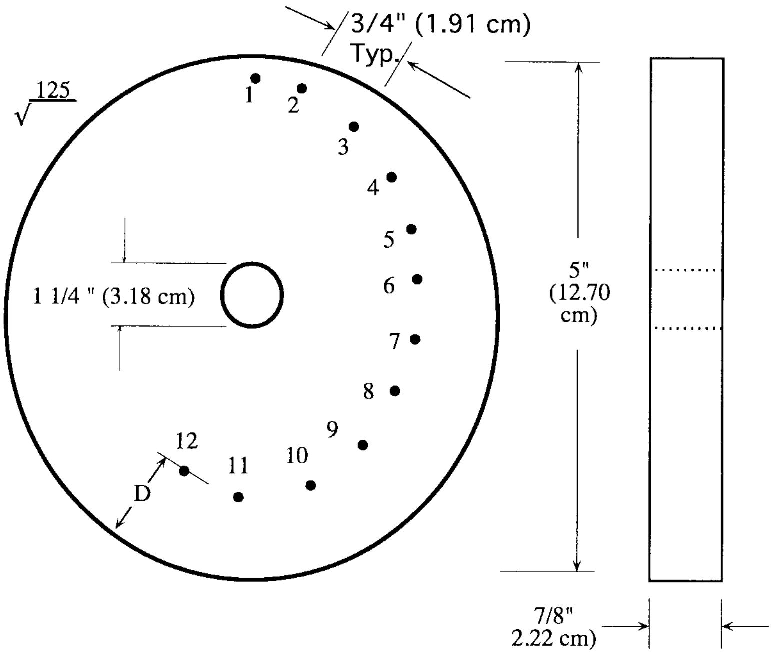
6.2.1 *Types of Magnetizing Current*—The types of currents used for magnetic particle examination are full-wave rectified alternating current (3 or 1 phase), half-wave rectified alternating current, and alternating current. The equipment used shall fulfill the magnetizing and demagnetizing requirements adequately, as outlined herein, without damage to the part under testing, and they shall include the necessary features required for safe operation.

6.2.2 *Permanent Magnets*—Permanent magnets are not to be used for magnetic particle examination unless specifically authorized by the contracting agency. When permanent magnets are used, adequate magnetic field strength shall be established in accordance with 7.1.5.4.

6.2.3 *Yokes*—When using yokes (electromagnetic probes) for magnetic particle examination, adequate magnetic field strength shall be established in accordance with 7.1.5.4.

6.2.4 *Magnetizing Current Application*—Alternating current is to be used only for the detection of defects open to the surface. Full-wave rectified alternating current has the deepest possible penetration and must be used for inspection for defects below the surface when using the wet magnetic particle method. Half-wave rectified alternating current is advantageous for the dry powder method because it creates a pulsating unidirectional field that gives increased mobility to the particles.

6.2.5 *Magnetic Field Directions*—Discontinuities are difficult to detect by the magnetic particle method when they make an angle less than 45° to the direction of magnetization. To ensure the detection of discontinuities in any direction, each



Hole	1	2	3	4	5	6	7	8	9	10	11	12
Diameter Note 1	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)	0.07 (0.18 cm)
"D" Note 2	0.07 (0.18 cm)	0.14 (0.36 cm)	0.21 (0.53 cm)	0.28 (0.71 cm)	0.35 (0.90 cm)	0.42 (1.08 cm)	0.49 (1.26 cm)	0.56 (1.44 cm)	0.63 (1.62 cm)	0.70 (1.80 cm)	0.77 (1.98 cm)	0.84 (2.16 cm)

Notes:

NOTE 1—All hole diameters are ±0.005 in. (±0.01 cm). Hole numbers 8 thru 12 are optional.

NOTE 2—Tolerance on the D distance is ±0.005 in. (±0.01).

NOTE 3—All dimensions are ±0.03 in. (±0.08) or as noted in Notes 1 and 2.

NOTE 4—All dimensions are in inches, except as noted.

NOTE 5—Material is ANSI 01 tool steel from annealed round stock.

NOTE 6—The ring may be heat treated as follows: Heat to 1400 to 1450°F (760 to 790° C). Hold at this temperature for 1 h. Cool at a maximum rate of 40°F/hr (22°C/hr) to below 1000°F (540°C). Furnace or air cool to room temperature. Finish the ring to RMS 25 and protect from corrosion.

FIG. 1 ANSI KETOS Tool Steel Ring

part must be magnetized in at least two directions at right angles to each other. Depending on part geometry, this may consist of circular magnetization in two or more directions, of both circular and longitudinal magnetization, or of longitudinal magnetization in two or more directions. Exceptions necessitated by part geometry, size, or other factors require specific approval of the contracting agency.

6.2.6 *Multidirectional Magnetization*—Multidirectional magnetization may be used to fulfill the requirement for magnetization in two directions if it is demonstrated that it is effective in all critical areas. Artificial flaws that are etched or machined, as shown by a device equal to Fig. 2, may be used to establish field direction. It is vitally important that the field intensity be balanced in all directions so that one direction does not overwhelm another direction. In using this method, the particle application must be timed so that the magnetization reaches its full value in all directions during the time particles are mobile on the surface under testing (that is, the continuous method).

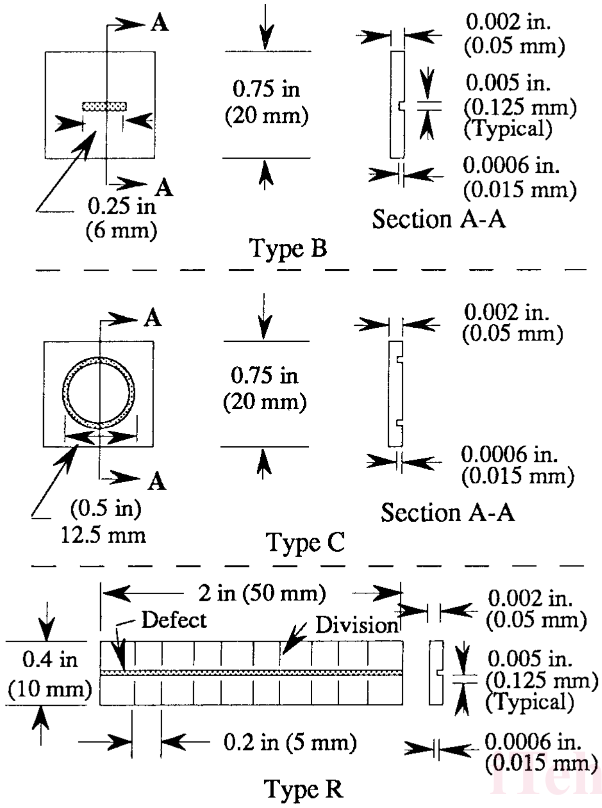
6.2.7 *Direct Magnetization*—Direct magnetization is accomplished by passing current directly through the part under testing. Electrical contact is made to the part using head and tail stock, prods, clamps, magnetic leeches, or by other means. Precaution shall be taken to ensure that the electrical current is not flowing while contacts are being applied or removed and that excessive heating does not occur in the contact area. Unless otherwise specified by the contracting agency, prods shall not be used for the examination of aerospace components (flight hardware) or on finished surfaces.

6.2.8 *Indirect Magnetization*—Indirect part magnetization uses preformed coils, cable wraps, yokes, field flow fixtures, or a central conductor to produce a magnetic field of suitable strength and direction to magnetize the part under test.

6.2.9 *Induced Current Magnetization*—Induced current magnetization (toroidal or circumferential field) is accomplished by inductively coupling a part to an electrical coil to create a suitable current flow in the part as illustrated in Fig. 3. This method is often advantageous on ring-shaped parts with a central aperture and with an *L/D* ratio less than three, especially where the elimination of arcing or burning is of vital importance.

6.3 *Magnetic Field Strength*:

6.3.1 *Magnetic Field Strength*—The applied magnetic field shall have sufficient strength to produce satisfactory indications, but it must not be so strong that it causes the masking of relevant indications by nonrelevant accumulations of magnetic



Examples of artificial shims used in magnetic particle inspection system verification. (Not drawn to scale.) The shims are made of low carbon steel (1005 steel foil). The artificial flaw is etched or machined on one side of the foil to a depth of 30% of the foil thickness. In use, the shims are firmly attached to the test part (e.g. with tape around the edges) with the flaw toward the part.

FIG. 2 Configuration of Artificial Flaws and Their Designation

particles. Factors that determine the required field strength include the size, shape, and material permeability of the part, the technique of magnetization, the method of particle application, and the type and location of the discontinuities sought. Adequate magnetic field strength may be determined by one or a combination of three methods:

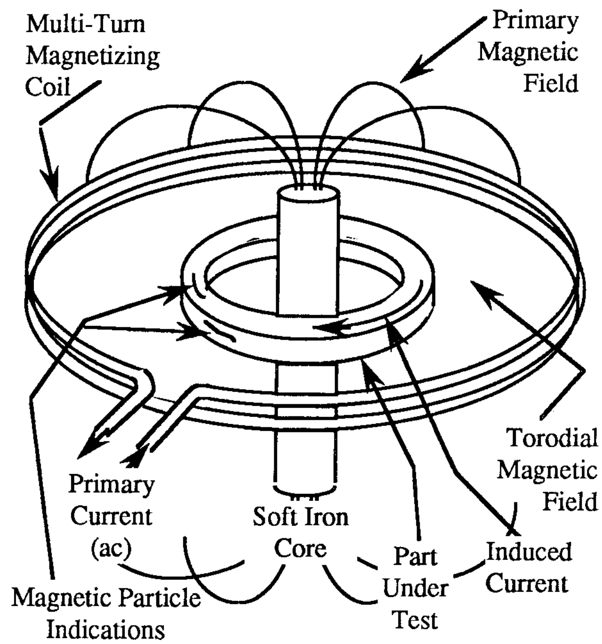
6.3.1.1 By testing parts having known or artificial defects of the type, size, and location specified in the acceptance requirements;

6.3.1.2 By using a Hall effect probe gaussmeter capable of measuring the peak values of the tangent field; and

6.3.1.3 By using the formulas given in 6.3.7.1-6.3.7.4.

6.3.2 When using a Hall effect probe gaussmeter, tangential-field strengths, measured on the part surface, in the range of 30 to 60 G (2.4 to 4.8 kAm^{-1}) peak values are normally adequate magnetization levels for magnetic particle examination. It is important to ensure that field strengths in this range are present in all areas to be inspected on the part.

6.3.3 *Magnetization Current Levels*—The current values given are peak current values and are applied directly to full-wave rectified current. For other types of current, the operator's manual or the equipment manufacturer should be consulted to determine what correction factor, if any, is to be used to convert the meter reading to equivalent peak currents.



The primary current sets up an oscillating field. This primary magnetic field in duces a current in the ring shaped part under test.

FIG. 3 Example of Induced Current Magnetization

6.3.4 *Prod Current Levels*—When using prods on material ¾ in. (19 mm) in thickness or less, 90 to 115 A/in. of prod spacing (3.5 to 4.5 A/mm) shall be used. For material greater than ¾ in. (19 mm) in thickness, 100 to 125 A/in. of prod spacing (4.0 to 5.0 A/mm) shall be used. Prod spacing shall not be less than 2 in. (50 mm) or greater than 8 in. (200 mm). The effective width of the magnetizing field when using prods is one fourth of the prod spacing on each side of a line through the prod centers.

6.3.5 *Direct Circular Magnetization*—When magnetizing by passing current directly through the part (that is, using head shots), the current shall be from 300 to 800 A/in. of part diameter (12 to 32 A/mm). The diameter of the part shall be taken as the greatest distance between any two points on the outside circumference of the part. Currents will normally be 500 A/in. (20 A/mm) or lower, with the higher currents (up to 800 A/in.) being used to inspect for inclusions or to inspect low-permeability alloys such as precipitation-hardened steels. For tests used to locate inclusions in precipitation-hardened steels, even higher currents, up to 1000 A/in. (40 A/mm), may be used.

6.3.6 *Central Conductor Circular Magnetization*—Circular magnetization may be provided by passing current through a conductor that passes through the inside of the part. In this case, alternating current is to be used only when the sole purpose of the test is to inspect for surface discontinuities on the inside surface of the part. If only the inside of the part is to be inspected, the diameter shall be the greatest distance between two points, 180 degrees apart on the inside circumference. Otherwise, the diameter is determined as in 6.3.5. The following two paragraphs cover centrally located and offset central conductors:

6.3.6.1 *Centrally Located Conductor*—When the axis of the central conductor is located near the central axis of the part, the