

Procedure



Magnetic Particle Testing - ASME

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REVISION INDEX

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1.0 SCOPE

- 1.1 This procedure details the method and requirements for performing magnetic particle examination of ferromagnetic welds and components using an electromagnetic yoke as the source of magnetization, and either wet or dry inspection mediums.
- 1.2 This document meets or exceeds the minimum requirements of the ASME Code, Section V, Article 7, and other codes and specifications specifically referencing this code section for the performance of magnetic particle examinations.
- 1.3 The examination described herein shall be limited to the detection of discontinuities that are open to the surface of the part or just below the surface.
- 1.4 When procedure qualification is specified by the referencing Code Section, a change of essential variable, as identified in Table T-721 of Article 7, shall require re-qualification of this procedure by demonstration. A change in nonessential variable does not require requalification. All changes, essential or nonessential, require revision of, or addendum to, this written procedure

2.0 REFERENCE DOCUMENTS

- 2.1 Industrial Performance Services Written Practice, IPS-WP-01, Procedure for Qualification and Certification of Personnel
- 2.2 ASME Section V, Article 1, General Requirements
- 2.3 ASME Section V, Article 7, Magnetic Particle Examination
- 2.4 ASME Section VIII - Pressure Vessels, Divisions 1 and 2
- 2.5 ASME B31.1, Power Piping
- 2.6 ASME B31.3, Process Piping

3.0 RESPONSIBILITY AND AUTHORITY

- 3.1 Industrial Performance Services (IPS) requires all NDT examinations to be performed to a written examination procedure. The technician performing these examinations shall be responsible for carrying out these examinations in accordance with the instructions detailed in this procedure.

4.0 PERSONNEL QUALIFICATIONS

- 4.1 Personnel performing examination of this procedure shall be qualified and certified to NDT Level II or Level III in accordance with ASNT's RP No. SNT-TC-1A, and IPS's Written Practice IPS-WP-01 for the Qualification and Certification of NDT Personnel.
- 4.2 Personnel performing evaluations and/or reporting results in accordance with this procedure shall be certified Level II as a minimum.

5.0 EQUIPMENT AND MATERIALS

5.1 Electromagnetic Yokes

- 5.1.1 The magnetizing force of yokes shall be calibrated at least once a year, or whenever a yoke has been subject to electric repair, periodic overhaul, or damage. If a yoke has not been in use for a year or more, a check shall be performed prior to first use.
- 5.1.2 Alternating current electromagnetic yokes shall be checked daily, prior to use, by lifting a 10 lb. (4.5 kg) weight at the maximum pole spacing that will be used. Direct current or permanent magnet yokes shall be checked daily, prior to use, by lifting at least a 40 lb.(18 kg) weight at the maximum pole spacing that will be used. Each weight shall be weighed with a scale from a reputable manufacturer and stenciled with the applicable nominal weight prior to first use. A weight needs only be verified again if damaged in a manner that could have caused potential loss of material.

5.2 Examination Medium

- 5.2.1 Dry or wet particles having high permeability and low retentivity may be used. The selection of one over the other should be based upon part geometry, surface conditions, inspection temperatures, test objectives and client specifications.
- 5.2.2 Dry particles such as (Magnaflux) shall be of a color that will provide adequate contrast with the background of the examination surface.
- 5.2.3 Wet particles such as (Magnaflux 14 AM Prepared bath (fluorescent) or Magnaflux 7HF (Visible)), shall provide the necessary contrast with the examination surface and appropriately designed for use in liquid suspensions.
- 5.2.4 Both wet and dry particles to be used shall consist of finely divided ferromagnetic material. Magnetic particles to be used shall consist of a mixture of all sizes and shapes (i.e., very fine particles, larger particles, spherical particles, elongated particles).
- 5.2.5 Only dry particles may be used on examination surfaces where temperature exceeds 135°F. Dry particles shall not be used on examination surfaces where temperatures exceed 600°F (316° C).

Note: *For temperatures above 600°F (316° C) Dry Particles may be used provided the item under examination does not exceed the Manufacturer's upper limit for the particles used. Sensitivity performance verification shall also be performed and documented.*

Note: *The above maximum temperature restriction may be waived if it is demonstrated that a higher temperature (and below the flash point if applicable), will yield the desired quality levels. This process shall be documented as an alternative technique and reviewed and approved by the customer representative and IPS personnel prior to use.*

5.3 White Light

- 5.3.1 For non-fluorescent inspection, it shall be determined with a

calibrated and operable white-light meter, that a minimum of 100-foot candles (1076 lux) of visible light is present at the inspection surface. The light source, technique used, and light level verification are required to be demonstrated one time, documented, and maintained on file. For fluorescent inspections, the ambient white light in the darkened area measured on the surface to be examined shall not exceed 2 ftc (21.5 lux).

5.4 Ultraviolet Light

- 5.4.1 For fluorescent inspections, filtered ultraviolet radiation shall be used in a darkened area when performing examinations using fluorescent particles.
- 5.4.2 Black light intensity at the surface under examination shall be measured with a calibrated and operable black light meter prior to use, whenever the lights power source is interrupted or changed, and at the completion of the examination or series of examinations. A minimum of 1000 microwatts/per square centimeter ($1000\mu\text{w}/\text{cm}^2$) at the inspection surface shall be required.
- 5.4.3 Black lights shall be allowed to warm up for at least 10 minutes prior to use or measurement of the intensity of the ultraviolet light emitted.
- 5.4.4 Reflectors and filters should be checked and, if necessary, cleaned prior to use. Cracked or broken filters shall be replaced immediately.
- 5.4.5 The technician shall be in the darkened area for at least 5 minutes prior to performing the examination to allow for eye adaptation to dark viewing. If the technician wears glasses or lenses, they shall not be photosensitive (photo chromic).

5.5 Light Meters

- 5.5.1 Light meters used in accordance with this procedure must be calibrated at least annually or when the meter has been repaired.

5.6 Magnetic Particle Field Indicator

- 5.6.1 When it is necessary to verify the adequacy or direction of the magnetizing field, a field indicator, or equivalent, shall be used by positioning the indicator on the surface to be examined.
- 5.6.2 When using this indicator, a suitable flux strength is indicated when a clearly defined line of magnetic particles forms across the copper face of the indicator when the magnetic particles are applied simultaneously with the magnetizing force.
- 5.6.3 When a clearly defined line of particles is not formed, or is not formed in the desired direction, the magnetizing technique shall be changed or adjusted.

6.0 SURFACE PREPARATION

- 6.1 Surfaces may be in the as-welded, as-rolled, as-cast, or as-forged condition.

However, surface preparation by grinding or machining may be necessary in some cases where surface irregularities could mask indications of discontinuities.

- 6.2 Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1 inch of the area to be examined shall be dry and free of any dirt, grease, lint, scale, welding flux, spatter, oil, or other extraneous matter that could interfere with the examination.
- 6.3 Cleaning may be accomplished using detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand/grit blasting, or ultrasonic cleaning methods.
- 6.4 If nonmagnetic coatings are left on the part in the area being examined, it shall be demonstrated that indications can be detected through the existing maximum coating thickness applied. For the AC yoke technique, the demonstration shall be in accordance with ASME V, Article 7, Mandatory Appendix I.

7.0 MAGNETIC PARTICLE TEST PROCEDURE

- 7.1 Unless otherwise required by customer specifications, the continuous method shall be used. That is, the magnetizing current shall remain on while the particles are being applied and any excess is being removed. At least two separate examinations shall be carried out on each area. The second examination shall be with the lines of magnetic flux approximately perpendicular to those used for the first examination in that area. Examination shall be conducted with sufficient overlap to assure 100% coverage of the test area at the required sensitivity.
- 7.2 Inspection Sequence
 - 7.2.1 Dry Particles
 - a) Position the yoke on the surface to be examined.
 - b) Apply the magnetizing current.
 - c) Apply the dry particles using a hand powder applicator (powder bulb) or a specially designed powder blower. Apply the particles in such a manner that they reach the part surface being magnetized in a uniform cloud with a minimum of force. Dry particles shall not be applied by pouring, throwing, or spreading with the fingers.
 - d) Carefully observe the formation of indications while the powder is being applied and while the excess is being removed. Remove the excess particles with a gentle air stream using a bulb while the current remains on. Sufficient time for indication formation and examination should be allowed before switching the current off.
 - e) Switch off the magnetizing current and remove the yoke from the item.
 - f) Evaluate the magnetic particle pattern for discontinuity patterns.
 - g) Repeat steps a) through f) with the yoke poles positioned 90° from the original position.

Note: *Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.*

7.2.2 Wet Particles

- a) Position the yoke on the surface to be examined.
- b) Apply the medium to the entire area under examination by flowing or spraying.

Flow of particles should stop with the application of current.

1) Wet particles applied from aerosol spray cans may be applied before and/or after magnetizing current is applied.

2) Wet particles may be applied during the application of magnetizing current if they are not applied directly to the examination area and are allowed to flow over the examination or are applied with low velocities insufficient to remove accumulated particles.

c) Apply the magnetizing current.

d) Carefully observe the formation of indications while the medium is being applied and while the excess is being removed. Sufficient time for indication formation and examination should be allowed before switching the current off.

e) Switch off the magnetizing current and remove the yoke from the item.

f) Evaluate the magnetic particle pattern for discontinuity patterns.

g) Repeat steps a) through f) with yoke positioned 90° from the original position.

Note: *Each separate application of the examination shall overlap a proceeding application until the extent of the area under examination has been completely covered.*

7.2.3 The use of nonmagnetic surface contrast enhancement may be applied by the examiner to uncoated surfaces, only in the amount sufficient to enhance particle contrast, prior to the application of the magnetic field or magnetic particles. Sufficient time shall be allowed for the coating to dry prior to the application of magnetic field and magnetic particles.

7.2.3.1 When nonmagnetic surface contrast enhancement is used, it shall be demonstrated that indications can be detected through the enhancement. Thickness measurement of this nonmagnetic surface contrast enhancement is not required.

7.3 Demagnetization

7.3.1 Demagnetization following an examination is required where residual magnetism can interfere with subsequent processes or usage or if required by the client. Local demagnetization on small parts or areas may be accomplished with an alternating current yoke by moving the

poles around slowly and withdrawing the yoke from the part surface while it is still energized.

7.4 Post-Cleaning

7.4.1 When post examination cleaning is required, it should be conducted as soon as practical using a process that does not adversely affect the part. (Specific client requirements may vary). Typically, compressed air can be used to remove unwanted dry particles and cleaning solvents may be used to assist in removing wet particles/solutions.

8.0 MARKING

8.1 When required, the locations of unacceptable indications will be marked on the test surface using approved marking devices and techniques.

9.0 INTERPRETATION AND EVALUATION OF INDICATIONS

9.1 An indication of a discontinuity may be larger than the discontinuity that causes it; however, the size of the indication and not the size of the discontinuity is the basis of acceptance or rejection.

9.2 The interpretation shall identify if an indication is false, non-relevant, or relevant. False and non-relevant indications shall be proven as false or non-relevant. Interpretations shall be carried out to identify the location of indications and the character of the indications.

9.3 Indications appearing sharp and distinct are likely open to the surface, while subsurface discontinuities produce broad and fuzzy indications.

9.4 Non-rejectable indications shall be recorded as specified by the referencing Code Section or when requested by the client.

9.5 Rejectable Indications shall be recorded. As a minimum, the type of indication (linear or rounded), location and extent (length or diameter or aligned) shall be recorded.

9.6 Examination of repaired areas shall be made using the same procedure(s) and technique(s) as the original examination. The examination of repaired areas shall be indicated by placing the letter "R" or writing "Repaired" on the report.

10.0 DOCUMENTATION

10.1 A magnetic particle examination report shall be prepared and furnished to the client. A standard report form will be used unless otherwise specified by the client.

10.2 The report shall include the following information:

- a) Part Identification
- b) Procedure identification and revision
- c) Acceptance code and criteria
- d) Date Examination was performed
- e) Technician's name and certification level

- f) Examination results
- g) Magnetic Particles used: type, color and batch number.
- h) Equipment make, model, and serial number & type of current used.
- i) Map or record of indications
- j) Material & thickness
- k) Lighting equipment

11.0 SAMPLE REPORT

12.0 ACCEPTANCE CRITERIA - ASME

- 12.1 Acceptance standards of ASME Section VIII Div. 1 & 2, B31.1 and B31.3 are defined in the following:

- 12.1.1 Section VIII, Division 1

- 12.1.1.1 An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.
- 12.1.1.2 A relevant indication is an indication that is greater than 1/16" in its major dimension.
- 12.1.1.3 All Surfaces to be examined shall be free of:

- a) Relevant linear indications
- b) Relevant rounded indications greater than 3/16"
- c) Four or more relevant indications in a line separated by 1/16" or less.

12.1.2 Section VIII, Division 2

- 12.1.2.1 An indication of an imperfection may be larger than the imperfection that causes it; however, the size of the indication is the basis for acceptance evaluation.
- 12.1.2.2 A relevant indication is an indication that is greater than 1/16" in its major dimension.
- 12.1.2.3 All Surfaces to be examined shall be free of:
 - a) Relevant linear indications
 - b) Relevant rounded indications greater than 3/16"
 - c) Four or more relevant indications in a line separated by 1/16" or less.
- 12.1.2.4 Crack like indications detected, irrespective of surface conditions, are unacceptable.

12.1.3 B31.1 and B31.3

- 12.1.3.1 A relevant indication is an indication that is greater than 1/16" in its major dimension
- 12.1.3.2 All surfaces to be examined shall be free of:
 - a) Relevant linear indications
 - b) Relevant rounded indications greater than 3/16"
 - c) Four or more relevant indications in a line separated by 1/16" or less.
 - d) Ten or more rounded indications in any 6 in. of surface with the major dimension of this area not to exceed 6 in. with the area taken in the most unfavorable location relative to the indications being evaluated.