

Magnetic Particle Inspection Procedure

- <http://www.inspection-for-industry.com/magnetic-particle-inspection.html>
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This article provides you with a sample magnetic particle inspection / Testing procedure. This sample procedure covers AC electromagnetic yoke method. This procedure is a draft magnetic particle testing procedure and you need to modify it to meet your project specification.

1.0 MAGNETIC PARTICLE INSPECTION - SCOPE

1.1 This procedure give the general requirements for carrying out the examination of welds in ferric materials using the AC electro magnetic yoke technique.

1.2 This procedure meets the requirements of ASME Section V Article 7 and ASTM E-709-95.

2.0 MAGNETIC PARTICLE INSPECTION - DESCRIPTION OF METHOD

2.1 This method involves the magnetisation of an area to be examined and the application of ferromagnetic particles to the surface. The particles gather at areas of magnetic flux leakage and form indications characteristic of the type of discontinuity detected.

2.2 Maximum sensitivity is achieved when linear discontinuities are oriented perpendicular to the lines of flux.

2.3 The AC electromagnetic yoke technique is restricted to the detection of surface breaking discontinuities.

3.0 MAGNETIC PARTICLE INSPECTION - EQUIPMENT AND MATERIALS

3.1 This procedure is intended for use with the following equipment and consumables or their equivalent.

- Magnaflux Y6 AC Yoke
- Portable ultra violet light
- Magnaflux WCP-1 White contrast paint
- Magnaflux WCP-2 White contrast paint
- Magnaflux 7HE Black Ink
- Magnaflux SKC-NF cleaner
- Magnaflux SKC-S cleaner

- Magnaflux dry powder (red, yellow or grey colour)
- Magnaflux 14 HF Fluorescent Ink
- Magnaflux 20A Fluorescent Ink concentrate (water based)
- Burmah Castrol magnetic field indicators Type 1 Brass finish.

4.0 MAGNETIC PARTICLE INSPECTION - PARTS TO BE EXAMINED

4.1 Welds in ferritic materials, whether in the as welded or dressed condition and the associated heat affected zones and parent material within at least one inch of the weld on both sides of the weld.

5.0 MAGNETIC PARTICLE INSPECTION - SURFACE PREPARATION

5.1 Prior to the test the area to be inspected and at least one inch either side shall be free from any features that may inhibit the test or mask unacceptable discontinuities. These include but are not limited to, slag, spatter, oil, scale, rough surface and protective coatings.

5.2 Surface preparation by grinding, machining or other methods may be necessary where surface irregularities could mask indications of unacceptable discontinuities.

5.3 The temperature of the test surface shall not exceed 135°F for magnetic inks and 600°F for dry powders. (For dry powders, test surface be clean and dry).

5.4 For parts to be inspected using magnetic inks the area to be inspected may, if necessary, be precleaned with a cloth lightly moistened with cleaner.

5.5 Where parts are to be examined using powders or fluorescent inks, the surface finish as detailed in 5.1 to 5.4 is adequate.

5.6 When using black magnetic inks the surface may be given contrast enhancement by applying a thin, even coating of white contrast paint of a type as detailed in Section 3.1.

6.0 MAGNETIC PARTICLE INSPECTION - EQUIPMENT AND CONSUMABLE CONTROL

6.1 The magnetising force of yokes shall be checked at least once a year or after any damage and/or repair. The yoke shall be able to lift a weight of at least 10 pounds at the maximum pole spacing that will be used.

6.2 Magnetic powders shall be used on a once only, expendable basis. Care shall be taken to avoid possible contamination.

6.3 Magnetic inks are also once only, expendable materials and care shall be taken to thoroughly agitate the ink before use.

6.4 Magnetic inks mixed from concentrates shall be subject to a settlement test before use. Settlement time shall be 30 minutes and settlement volume for the solids shall be as below.

- Fluorescent ink 0.1 - 0.4%
- Non fluorescent ink 1.2 - 2.4%

6.5 The black light intensity at the examination surface (15 in from the face of the light lens filter) shall be not be less than 1000 $\mu\text{W}/\text{cm}^2$. Any increase in this value to suit clients specific requirements shall be detailed on the technique sheet. The bulb shall be allowed to warm up for at least 5 minutes before use.

6.6 The black light intensity shall be checked at least every 8 hours of use in accordance with 6.5 using a calibrated black light meter.

7.0 MAGNETIC PARTICLE INSPECTION - LIGHTING CONDITIONS

7.1 When conducting an examination under white lighting conditions, the inspector shall ensure that the level of lighting is adequate at the surface of the part (recommended minimum 100 foot candles or 1000 lux). 50 foot candles (500 lux) lighting may be used if agreed with customer, for field inspections.

7.2 Examinations under ultra violet lighting should have a background white light level of less than 20 lux and an ultra violet intensity at the test surface of not less than 1000 $\mu\text{W}/\text{cm}^2$. Any increase in these values shall be specified in the technique sheet.

7.3 The inspector shall allow at least 5 minutes for dark adaptation before beginning the inspection.

7.4 If the examiner wears glasses or lenses, they shall not be photosensitive.

8.0 MAGNETIC PARTICLE INSPECTION - DIRECTION OF MAGNETISING FIELD

8.1 The magnetising field shall be applied sequentially in two directions approximately perpendicular to one another.

8.2 The direction of the field may be determined by using the Burmah Castrol magnetic field

indicator. This will give its strongest indications when placed across the flux direction.

8.3 Determination of field direction shall be carried out for each geometry of weld to be inspected.

9.0 MAGNETIC PARTICLE INSPECTION - SEQUENCE OF OPERATIONS

9.1 The surface to be inspected shall be prepared as section 5.0.

9.2 The continuous magnetisation technique is to be employed.

9.3 Ensure in all operations that the pole faces remain in maximum contact with the surface.

9.4 Position the poles as described in 8.0 and turn on the magnetising field.

9.5 For the wet magnetic particle method, apply the ink onto the area under test and allow to flow over the surface such as to allow maximum exposure of the magnetic particles to any flux leakage present, excess material may be GENTLY blown across the surface to aid interpretation.

9.6 Dry magnetic powders should be applied in such a manner that a light, uniform, dust like coating settles on the surface of the area under inspection. Excess power may be GENTLY blown across the surface to aid interpretation and increase exposure of magnetic particles to any flux leakage present.

9.7 Maintain the magnetising field for at least two seconds after step 9.5 or 9.6 and inspect immediately.

9.8 Repeat the above sequence at approximately 90° to the above.

9.9 Repeat the above steps to cover the complete weld area under inspection ensuring an overlap between inspected areas of at least 25% of the pole spacing.

9.10 The area to be inspected shall be limited to a maximum distance of one fourth of the pole spacing on either side of line joining the two legs.

9.11 Pole area to be inspected shall be limited to a maximum distance of one fourth of the pole spacing on either side of line joining the two legs.

9.12 Pole spacing shall be limited to a maximum value equal to or less than that used when conducting the lift test of the standard weight but shall be not less than 3 inches.

10.0 MAGNETIC PARTICLE INSPECTION - EVALUATION OF INDICATIONS

10.1 An indication may be the evidence of a surface imperfection. All indications need not be relevant. Relevant indications are those caused by leakage flux. Relevant indications due to unacceptable mechanical discontinuities are to be noted, located and sized.

10.2 Any indication which is believed to be non relevant shall be re-examined again. Only indications having major dimension of greater than one sixteenth of an inch shall be considered relevant.

10.3 A linear indication is one having a length greater than its width. A rounded indication is shape with a length equal to or less than three times its width.

10.4 Unacceptable indications shall be removed by chipping or grinding and shall be re-tested if the repaired surface is free of sharp notches or corners / grinding marks. When a defect appears to be fully removed the area can be repaired and re-examined by the same method. Repaired area shall be blended into the surrounding surface so as to avoid sharp notches, crevices or corners.

10.5 If required the repaired area shall also be re-examined by another suitable NDT method.

11.0 MAGNETIC PARTICLE INSPECTION - ACCEPTANCE CRITERIA

The acceptance criteria given hereunder for relevant indications for various codes shall be used in general. The inspector using this is cautioned that Code requirements do change, and that in the case of conflict it shall be referred (in writing) to the appointed NDT Level III or to the Divisional Manager (NDT).

11.1 ANSI/ASME B31.1, Power Piping

11.1.1 Evaluation of Indications

11.1.1.1 Mechanical discontinuities at the surface will be indicated by the retention of the examination medium. All indications are not necessarily defects since certain metallurgical discontinuities and magnetic permeability variations may also produce similar indications which are not relevant to the detection of unacceptable discontinuities.

11.1.1.2 Any indications which are believed to be non relevant shall be re-examined to verify whether or not actual defects are present. Surface conditioning may precede the re-examination. Non

relevant indications which would mask indications of defects are unacceptable.

11.1.1.3 Relevant indications are those which result from unacceptable mechanical discontinuities. Linear indications are those indications in which the length is more than three times the width. Rounded indications are indications which are circular or elliptical with the length less than three times the width.

11.1.1.4 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.

11.1.2 Acceptance Standards

The following relevant indications are unacceptable:

11.1.2.1 Any cracks or linear indications.

11.1.2.2 Rounded indications with dimensions greater than 3/16 in. (5.0 mm)

11.1.2.3 Four or more rounded indications in a line separated by 1/16 in. (2.0 mm) or less, edge to edge.

11.1.2.4 Ten or more rounded indications in any 6 sq. in of surface with the major dimension of this area not to exceed 6 in (150 mm) with the area taken in the most unfavourable location relative to the indications being evaluated.

11.2 ASME Boiler and Pressure Vessel Code, Sec. VIII Div. 1 Pressure Vessels

11.2.1 Evaluation of Indications

Indications will be revealed by retention of magnetic particles. All such indications are not necessarily imperfections, however, since excessive surface roughness, magnetic permeability variations (such as at the edge of Heat Affected Zones), etc. may produce similar indications. An indication is the evidence of a mechanical imperfection. Only indications which have any dimension greater than 1/16 in. shall be considered relevant.

11.2.2 Acceptance Standards

All surfaces to be examined shall be free of:

11.2.2.1 Relevant linear indications

11.2.2.2 Relevant rounded indications greater than 3/16 in.

11.2.2.3 Four or more relevant rounded indications in a line separated by 1/16 in. or less, edge to edge.

11.3 AWS D1.1 Structural Welding Code - Steel

Inspections may be performed immediately after the completed welds have cooled to ambient temperature. Magnetic Particle Testing on welds in ASTM steels A514 and A517 shall be performed no sooner than 48 hours after completion of the weld.

Indications revealed by Magnetic Particle Testing shall be evaluated as per applicable categories as follows:

11.3.1 Statically Loaded Structures:

Acceptance criteria shall be as per 8.15.5 (i.e. 8.15.1) of AWS D1.1 (1992 Edition)

11.3.2 Dynamically Loaded Structures:

Acceptance criteria shall be as per 9.25.2 of AWS D1.1 (1992 Edition).

11.3.3 Tubular Structures:

Acceptance criteria shall be as per 10.17.5 (i.e. 10.17.1) of AWS D1.1.

11.4 API Standard 1104 Pipelines and Related Facilities

11.4.1 Classification of Indication

Any indication with a maximum dimension of 1/16 in. (1.59 mm) or less shall be classified as non relevant. Any larger indication believed to be non relevant shall be regarded as relevant until re-examined by magnetic particle or another non-destructive testing method to determine whether or not an actual discontinuity exists. The surface may be ground or other wise conditioned before re-examination. After an indication is determined to be non relevant, other non relevant indication of the same type need not be re-examined.

Relevant indications are those caused by discontinuities. Linear indications are those in which the length is more than three times the width. Rounded indications are those in which the length is three times the width or less.

11.4.2 Acceptance Standards

Relevant indications shall be unacceptable when any of the following conditions exists:

a. Linear indications evaluated as crater cracks or star cracks exceed 5/32 inch (3.96 mm) in length.

b. Linear indications are evaluated as cracks other than crater cracks or star cracks.

c. Linear indications are evaluated as IF and exceed 1 inch (25.4 mm) in total length in a continuous 12-inch (304.8 mm) length of weld or 8 percent of the weld length.

d. Rounded indications shall be evaluated as follows:

i) Individual or scattered porosity (P) shall be unacceptable when any of the following conditions exists:

- The size of an individual pore exceeds 1/8 inch (3.17 mm).
- The size of an individual pore exceeds 25 percent of the thinner of the nominal wall thickness joined.
- The distribution of scattered porosity exceeds the concentration permitted by the porosity charts supplied by API for radiography testing.

ii) Cluster porosity (CP) that occurs in any pass except the finish pass shall comply with the criteria of (i). CP that occurs in the finish pass shall be unacceptable when any of the following conditions exists:

- The diameter of the cluster exceeds 1/2 inch (12.7 mm).
- The aggregate length of CP in any continuous 12 inch (304.8 mm) length of weld exceeds 1/2 inch (12.7 mm).
- An individual pore within a cluster exceeds 1/16 inch (1.59 mm) in size.

11.5 ANSI/ASME B31.3, Chemical Plant and Petroleum Refinery Piping

11.5.1 Acceptance Criteria:

11.5.1.1 Any crack or linear indication is unacceptable.

12.0 MAGNETIC PARTICLE INSPECTION - PERSONNEL QUALIFICATION

12.1 Personnel performing examinations to this procedure shall be qualified and certified in accordance with the requirements of ASNT document SNT-TC-1A (1992 edition), ISO 9712, PCN or Accepted level equivalent.

12.2 Only individuals qualified to NDT Level II or individuals qualified to NDT Level I and working under the supervision of an NDT Level II may perform the examinations in accordance with this procedure.

12.3 Evaluation of test results shall be by NDT Level II only.

13.0 MAGNETIC PARTICLE INSPECTION - POST CLEANING

13.1 The inspection area shall be cleaned after inspection with solvent (unless otherwise specified) to remove any excess residues from the inspection process.

14.0 MAGNETIC PARTICLE INSPECTION - DEMAGNETISATION

14.1 Demagnetisation shall be carried out where specifically requested by the client. The method to be employed shall be subject to agreement with the client.

15.0 MAGNETIC PARTICLE INSPECTION - REPORTING

15.1 A report shall be prepared detailing the results of the examination.

15.2 The report shall contain sufficient information to enable a full assessment of quality and to ensure that any non-acceptable areas can be accurately located should repair be necessary.

15.3 Any datum's used shall be unambiguous.

15.4 Any restrictions to test shall be noted.

15.5 A statement of acceptability against the acceptance standard should be made.

16.0 MAGNETIC PARTICLE INSPECTION - REFERENCED DOCUMENTS

- ASME SECTION V ARTICLE 7;
- ASME SECTION VIII, Division I
- ANSI/ASME B31.1
- ANSI/ASME B 31.1
- ANSI/AWS D1.1
- ASTM E 709
- API 1104
- SNT-TC-1A of ASNT