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WP 13-QA1004

Revision 6

Magnetic Particle Examination

Technical Procedure

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APPROVED FOR USE

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NDE LEVEL III

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INTRODUCTION [1, 2, 3]

This procedure provides guidance for performance of Magnetic Particle Inspection (MT) using the visible dry powder continuous method. This procedure of Nondestructive Examination (NDE) is limited to using the yoke method for the inspection of ferromagnetic materials such as castings, forgings, and machined or welded parts for the presence of surface-breaking and near surface discontinuities of the material being inspected.

This procedure is not approved for magnetic particle examination of coated components (materials or welds).

This procedure is performed in conjunction with general inspection/test requirements contained in WP 13-QA1006.

Performance of this procedure may generate the following records, as applicable:

- EA13QA1004-1-0, Magnetic Particle Inspection Report
- EA13QA1004-2-0, Magnetic Particle Inspection Report Log

Record copies of the completed EA13QA1004-1-0 will be kept with the parent document (documentation which requires the inspection, e.g., work order). Quality Assurance Inspection Services will retain the record copy of EA13QA1004-1-0 not initiated by a parent document.

All records generated by the implementation of this procedure will be handled, stored, and dispositioned in accordance with the department/section's Records Inventory and Disposition Schedule (RIDS).

Washington TRU Solutions LLC (WTS) recognizes that the terms examination, testing and inspection are commonly used as synonyms in nondestructive testing. For uniformity and consistency the term inspection will be used in this procedure when describing the application of nondestructive test methods.

REFERENCES

BASELINE DOCUMENTS

- ASME Section III, Nuclear Vessels
- ASME Section V, Article 7, Magnetic Particle Examination
- ASME Section VIII, Unfired Pressure Vessels
- ASTM E 709, Standard Guide for Magnetic Particle Examination
- ASTM E 1316, Standard Terminology for Nondestructive Examinations

- AWS D14.1, Specification for welding of Industrial and Mill cranes and Other Material Handling Equipment
- AWS Structural Welding Codes
- WP 13-1, Washington TRU Solutions LLC Quality Assurance Program Description

REFERENCED DOCUMENTS

- WP 04-IM1000, Issues Management Processing of WIPP Forms
- WP 13-QA.06, Quality Assurance Department Qualification and Certification of Nondestructive Examination Personnel
- WP 13-QA1006, Quality Assurance Plant Inspections
- WP 13-QA3004, Nonconformance Report
- WP 15-PM3526, Receipt Discrepancies
- EA04IM1000-1-0, WIPP Form
- EA13QA1004-1-0, Magnetic Particle Inspection Report
- EA13QA1004-2-0, Magnetic Particle Inspection Report Log
- EA13QA1006-1-0, Quality Assurance Inspection Report
- EA13QA3004-1-0, Nonconformance Report

EQUIPMENT

NOTE

A calibrated light meter is only required for the one-time light level verification. A change in light source or technique will require re-verification and demonstration.

- Calibrated light meter for the one-time light level verification noted in Performance Section 1.0
- Light source capable of producing a minimum of 100 foot candles at the surface to be examined
- Calibrated temperature measuring device

NOTE

Equipment and materials (or equivalent) used for Magnetic Particle Inspection may include, but are not limited to, the items listed below.

The dry magnetic particles used as the examination medium shall be of high permeability, low retentivity, be non-toxic, and free from contaminants. The color of the particles shall provide adequate contrast with the background of the surface being examined.

Other Magnetic Particle Testing equipment and materials may be used provided they meet the approval of the Level III.

- Parker Probe DA-400 AC/DC Contour Probe
- Magnaflux Magnavis Magnetic Particles 8A Red or 3A Gray
- Magnetic Particle Field Indicator (Pie Gauge)
- 10 pound weight for Alternating Current (AC) inspections
- 50 pound weight/weight assemblies for Half Wave Direct Current (HWDC) inspections
- Gauss meter (Residual Field Indicator)

PRECAUTIONS AND LIMITATIONS

- Safety glasses or safety goggles must be worn while performing the magnetic particle test.
- All safety, environmental, and radiological requirements of the area where the inspection is to be performed shall be complied with.
- Personnel Qualifications – All personnel conducting magnetic particle inspection to this procedure shall be qualified, at a minimum, as a NDE Level II inspector, or a qualified NDE Level I inspector working directly with a qualified Level II or Level III, in accordance with WP 13-QA.06, Quality Assurance Department Qualification and Certification of Nondestructive Examination Personnel.
- Prior to use, verify that dry magnetic particle materials are current and have not exceeded the manufacturer's recommended shelf life.

PREREQUISITE ACTIONS

1.0 EQUIPMENT CALIBRATION

1.1 Check the yoke's magnetizing power before each use, not to exceed one (1) year intervals, and whenever the yoke has been damaged or repaired.

1.1.1 Verify that test weights are not damaged and that there is an EA13QA1006-1-0 on file documenting the test weight(s) conformance per Section 6.0 (Conformance Check of Test Weights).

A. If weight damage is suspected, verify the test weight per Section 6.0 prior to use.

1.1.2 Verify that test weights for AC are equal to or greater than 10 lb and that test weight/test weight assemblies for HWDC are greater than or equal to 50 lb.

1.1.3 Place the 10 pound minimum weight on a flat nonmagnetic surface.

1.1.4 Adjust the legs of the yoke to achieve yoke pole leg spacing between 2 to 4 inches.

1.1.5 Position yoke over center of weight and verify that the yoke magnetizing power is capable of lifting the weight approximately 1 inch beyond the surface the weight is resting on.

1.1.6 Record results on EA13QA1004-1-0.

1.1.7 Repeat the verification process for HWDC mode with the 50 pound minimum weight/weight assembly on a flat nonmagnetic surface.

1.1.8 Adjust the legs of the yoke to achieve yoke pole leg spacing between 4 to 6 inches.

1.1.9 Position yoke over center of weight and verify that the yoke magnetizing power is capable of lifting the weight approximately 1 inch beyond the surface the weight is resting on.

1.1.10 Record results on EA13QA1004-1-0.

1.2 If the yoke does not lift the weight, contact the Level III prior to use of the yoke.

2.0 MAGNETIC FIELD STRENGTH

2.1 Verify the adequacy and direction of the magnetic field strength by the use of a Magnetic Field Indicator (Pie Gauge).

2.1.1 Place the Magnetic Field Indicator (Pie Gauge) in direct contact with the part to be tested (pie pieces facing down on part) between the center of the poles of the yoke (pole spacing required is the maximum pole spacing of the yoke that will be used during the examination).

2.1.2 Turn on the magnetizing current.

2.1.3 Dust the magnetic powder across the face of the Pie Gauge.

NOTE

A clearly defined line of magnetic particles is indication that the magnetic field induced is adequate.

2.1.4 Verify that an adequate magnetic field is induced.

2.1.5 Move the Pie Gauge to several locations on the part and repeat the steps above to verify that the magnetic field is of the proper direction and is of adequate strength.

PERFORMANCE

1.0 PREPARATION

NOTE

The surface under inspection shall have sufficient lighting (natural or artificial white light). Sufficient lighting is defined by the ability to detect a 1/32 inch (0.8 mm) black line on an 18 percent neutral gray card or a 1/32 inch increment on a Starrett machinist's scale or equivalent under the conditions of inspection. The minimum light intensity at the surface being inspected shall be 100 foot candles.

1.1 Demonstrate sufficient lighting, one time, for each light source and technique used for that light source.

1.1.1 Verify light level using a calibrated light meter.

1.1.2 Document the demonstration on EA13QA1006-1-0 and maintain on file.

1.1.3 If light source or technique is changed, reverify and demonstrate sufficient lighting.

NOTE

Surface Condition – material may be inspected in the as-welded, as-rolled, as-cast, or as-forged condition if the surface condition will not mask the indication of an unacceptable discontinuity. Surfaces must be free of scale grease, oil, weld splatter, or any condition that will interfere with the magnetic particle inspection or mask an indication.

Chlorinated solvents shall not be used on parts containing crevices. Cleaning may be accomplished using detergents, organic solvents, descaling solutions, paint removers, vapor degreasing, sand or grit blasting, or ultrasonic cleaning methods.

1.2 Ensure that the surface to be inspected is prepared in accordance with the following:

- The cleaned surface will include the inspection area and at least 1 inch beyond the inspection area.
- The surface shall be free of grease or other matter which might interfere with the proper distribution and concentration, or with the intensity, character and definition of magnetic particle indications from the surface undergoing the tests.
- All openings shall be plugged with a suitable nonabrasive material, which is readily removable, to prevent accumulation of magnetic particles or other matter where it cannot be completely or readily removed by washing and air blasting.

NOTE

A514, A517, and A709 grades 100 and 100W steels require not less than 48 hours to pass after completion of all welding, prior to visual inspection (or magnetic particle inspection).

1.3 Complete visual inspection prior to magnetic particle inspection.

1.4 Perform acceptance inspection on an item in the final surface condition and final heat-treated condition, unless otherwise specified herein or in the applicable specification.

1.5 Verify temperatures with a calibrated temperature measuring device only when the temperature is suspected of being significantly above the ambient temperature. Do not perform Magnetic Particle Inspection if the surface temperature of the part exceeds 600˚ F, per particle manufacturer's recommendations.

2.0 MAGNETIZATION – YOKE METHOD

NOTE

Alternating Current (AC) shall be used for magnetic particle testing of welds and heat affected zones in ferromagnetic weldments. HWDC or Alternating Current (AC) may be used for magnetic particle testing of castings, forgings, wrought, machine products. HWDC will be used for the detection of subsurface discontinuities.

Pole spacing of the adjustable legs on the yoke shall not exceed eight inches.

2.1 Position the yoke poles on the component so that the area of examination is essentially between the poles (it is recognized that the magnetic field extends out to the sides a distance of one half the total pole spacing).

2.2 Configure the legs of the yoke so that their ends are, as nearly as possible, flat on the examination surface.

NOTE

The "continuous method" shall be used. In this method, the current will remain on continuously during particle application and while excess particles are removed during the interpretation process.

2.3 Turn on the magnetizing current.

2.4 Apply the dry magnetic particles in such a manner that a light, uniform dust-like coating settles onto the surface being examined.

2.5 Avoid broad areas of particle accumulation, which might mask indications from discontinuities. Clean and re-inspect any such areas.

NOTE

Excess particles shall be removed by means of dry air current of sufficient force to remove the excess particles without disturbing those particles that are indicative of a discontinuity. A hand activated air syringe or equivalent is recommended for the purpose.

2.6 Remove the excess magnetic particles while the current remains on.

2.7 Repeat the examination with the lines of magnetic flux essentially at a right angle to the first examination.

2.8 If additional surface area is to be examined, repeat Steps 2.1 through 2.7. Overlap those areas which were under and adjacent to the yoke legs, ensuring complete coverage of the test surface.

3.0 EVALUATION

3.1 Evaluate indications resulting from retention of the magnetic particles.

3.2 Regard any indication believed to be nonrelevant as a defect and re-examine to verify whether or not an actual defect exists. Nonrelevant indications that could mask indications of defects are unacceptable.

3.3 Evaluate relevant indications further to determine size and shape.

- Linear indications are those indications in which the length is more than three times the width.
- Rounded indications are circular or elliptical with the length equal to or less than three times the width.

3.4 Record all relevant indications on EA13QA1004-1-0 (Magnetic Particle Inspection Report).

NOTE

Minor indications in the weld crown may be removed by grinding without rejecting the weld if the following criteria are met:

- The weld shall not be reduced in size beyond the nominal dimensions specified for the joint.
- The weld shall be reinspected per this procedure following grinding.

3.5 If minor indications in the weld crown are removed by grinding, reinspect the weld per this procedure.

3.6 Evaluate indications with respect to the acceptance criteria delineated in applicable work instructions, or specific contract requirements.

3.7 Describe rejectable indications, using sketches if necessary with respect to an identifiable reference point on the examination part or surface.

3.8 Determine acceptance (accept/reject) in accordance with the following:

- Acceptance criteria shall be as specified in the drawing, parent document, applicable specification, or code.
- When required by the engineering specification or other parent documentation, specific acceptance will be written as an addendum to this procedure (i.e., Quality Assurance Inspection Plan [QAIP]).

NOTE

Discrepant material identified during the initial receipt and/or receipt inspection processes at the warehouse will be documented and resolved through the use of a Receipt Discrepancy Report (RDR) in accordance with WP 15-PM3526. A Nonconformance Report (NCR) will be required only for discrepant items to be retained and dispositioned for use by WTS and subcontractors obligated to our program.

3.9 If deficiencies are identified during inspection/test, perform the following, as applicable:

3.9.1 Issue ONE of the following:

- RDR in accordance with WP 15-PM3526.
- WIPP Form (EA04IM1000-1-0) in accordance with WP 04-IM1000
- NCR (EA13QA3004-1-0) in accordance with WP 13-QA3004

3.9.2 Record the WIPP Form or NCR number, as applicable, on EA13QA1004-1-0.

3.9.3 Initiate and hang hold tags in accordance with WP 13-QA3004.

4.0 DEMAGNETIZATION

4.1 When required, demagnetize localized areas of large test objects as follows:

4.1.1 Place the current switch on the Yoke in the A.C. position.

4.1.2 Place the yoke legs on the test surface.

4.1.3 Turn the current "ON" and slowly withdraw the yoke about two or three feet from the test surface prior to turning the current off.

4.1.4 Repeat this operation several times with the yoke 90° to the original direction of the magnetic field.

4.1.5 Check for the presence of any residual magnetic field exceeding 3 Gauss, using a Magnetometer (Residual Field Indicator).

A. If the Magnetometer indicates a residual magnetic field exceeding 3 Gauss is still present, repeat Steps 4.1.1 through 4.1.5. If no reading(s) above 3 Gauss is indicated, the demagnetization process is complete.

4.2 When required, demagnetize small parts as follows:

4.2.1 Place the current switch on the Yoke in the A.C. position.

4.2.2 Turn the current "ON" and slowly pass the part through the legs of the yoke.

4.2.3 Withdraw the part about two or three feet from the yoke prior to turning the current off.

4.2.4 Check for the presence of any residual magnetic field exceeding 3 Gauss, using a Magnetometer (Residual Field Indicator).

A. If the Magnetometer indicates a residual magnetic field exceeding 3 Gauss is still present, repeat Steps 4.2.1 through 4.2.4. If no reading(s) above 3 Gauss is indicated, the demagnetization process is complete.

5.0 POST-INSPECTION ACTIVITIES

5.1 If the requirements document requires post-examination cleaning, use compressed air to blow off the examined surface and surrounding area (or equivalent method).

5.2 Assign the next available Magnetic Particle Inspection Report Log number found on EA13QA1004-2-0 (example: MT-09-001) and complete data entry on EA13QA1004-1-0 (Magnetic Particle Inspection Report).

5.3 Document required information on EA13QA1004-2-0 (Magnetic Particle Inspection Report Log) applicable to parent document.

5.4 If not generated by a parent document, identify by writing "no parent document" in Comment section on EA13QA1004-1-0 (Magnetic Particle Inspection Report).

5.5 Attach the completed EA13QA1004-1-0 (Magnetic Particle Inspection Report) to the parent document, if applicable, or retain in accordance with the QA department RIDS.

6.0 CONFORMANCE CHECK OF TEST WEIGHTS

6.1 Verify weight(s) every five years not to exceed the end of the due month. If weight damage is suspected, verify the test weight prior to use.

6.1.1 Perform a visual inspection of test weights to verify no damage to weight exists that would indicate a loss of material or other damage that could impede the use of the test weight.

6.1.2 Weigh each test weight(s), using a calibrated scale.

6.1.3 Document, on EA13QA1006-1-0, calibrated scale M&TE information (scale description, identification number, and due date) followed by a list of test weight serial #(s) with weight descriptions, actual weight in pounds, and the results of the visual inspection.

6.1.4 Place a copy of the completed EA13QA1006-1-0 in the Magnetic Particle Inspection Logbook.

7.0 M&TE USEAGE LOG

7.1 Designated Quality Engineer, perform the following:

7.1.1 Maintain an M&TE usage log on the QA database (\\Gallina\QRA\QAIS).

7.1.2 Compile any M&TE data from the completed EA13QA1006-1-0 (Quality Assurance Inspection Report), as applicable.

7.1.3 Enter compiled data on the M&TE usage log.

7.1.4 Generate and complete an EA13QA1006-1-0 (Quality Assurance Inspection Report) each month in accordance with WP 13-QA1006, documenting the M&TE usage.

7.1.5 Forward a copy of the monthly Quality Assurance M&TE Usage Log to the Metrology Office.