



MOGAS INDUSTRIES, INC.

Nondestructive Examination Procedure: Magnetic Particle Testing



Specification: NDT 0300

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Magnetic Particle Testing
NDT – 0300**

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Magnetic Particle Examination

1.0 Scope

- 1.1. This procedure provides a nondestructive means for locating surface discontinuities using magnetic particle test method.
- 1.2. This procedure defines the method for performing wet or dry continuous magnetic particle inspection of ferromagnetic materials. This procedure is based on the AC or DC magnetization technique using wet or dry magnetic particles.
- 1.3. This procedure is applicable to the examination of components fabricated in accordance with the American Society of Mechanical Engineers (ASME) Code. ASME Section V, Article 7 requirements are addressed in this procedure is intended to meet the requirements of ASME Section VIII Division 1 "Pressure Vessels" Latest Edition. ASME B 16.34 requirements for Flanged, Threaded and Welding End valves are also addressed. The sizes and shapes of items to be examined in accordance with this procedure shall be unrestricted, provided the required magnetic flux can be proven adequate and maintained for the technique utilized.
- 1.4. The requirements contained in this procedure apply to all nondestructive testing personnel who perform, monitor, evaluate wet or dry powder magnetic particle testing in accordance with this procedure. The method will be used primarily for detecting surface discontinuities in weldments used in construction of tubular structures.

2.0 References

The latest effective editions of the following specification have been used as references in the composition of this procedure:

- 2.1. ASME Boiler and Pressure Vessel Code Section V, Article 7 and Article 25, Latest Edition.
- 2.2. ASME E-709, "Standard Practice for Magnetic Particle"
- 2.3. ASME Boiler and Pressure Vessel Code Section VIII, Division I, Latest Edition.
- 2.4. ASME B 16.34 Valves, Appendix II – Flanged, Threaded and Welding End, Latest Edition.
- 2.5. MOGAS Written Practice: MST-0001, Qualification and Certification of NDT Personnel, Latest Edition

3.0 Equipment and Materials

- 3.1. The Parker Research AC/DC Probe, Magnaflux Y-6 AC Yoke, ES-X AC Yoke, Solid State Systems 480 amp unit or similar equipment.
- 3.2. Magnetic particle field indicator, per Reference ASME Boiler and Pressure Vessel Code Section V, Article 7 and Article 25 (Latest Edition).
- 3.3. Powder blower and hand powder applicator for use with dry MT.
- 3.4. A white light source that will provide adequate illumination of the test area. [100 Foot Candles]
- 3.5. A black light source capable of proving a UV intensity of 1000 microwatts / CM² at the inspection surface.
- 3.6. Wet or dry powder magnetic particles manufactured by Parker, Magnaflux, or equivalent shall be used. Red, black, white, or gray particles shall be used for the dry examination. Wet particles can be either visible or fluorescent. The particles shall be selected to exhibit the best contrast to the surface under examination.

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- 3.7. The temperature of the wet particle suspension and the test part surface shall not exceed 135° F and for dry particles the maximum surface temperature shall not exceed 600° F.
- 3.8. Application of wet particles to the inspection surface shall be made by use of the manufacturer's aerosol can, and only after active shaking of the can to assure even dispersal of the particles.

4.0 Testing Personnel

- 4.1. The examiner shall be responsible for implementing the requirements of this procedure.
- 4.2. Personnel performing examinations shall be certified in accordance with the MOGAS' MST-0001, Qualification and Certification of NDT Personnel, Latest Edition, which is in accordance to the guidelines set forth in ASNT Document SNT-TC-1A.
- 4.3. Personnel performing examinations shall have at the minimum of Level I certification. Personnel evaluating test results shall have a minimum Level II certification.

5.0 Calibration of Equipment

- 5.1. Each piece of equipment associated with the testing in accordance with this procedure shall be calibrated at the time intervals listed below:

<u>Item</u>	<u>Performance Verifications</u>
5.1.1 Visible Light Intensity	At beginning of each testing day
5.1.2 Black light intensity	At beginning of each testing day
5.1.3 System performance Using test specimen	At beginning of each testing day
5.1.4 Dead Weight Check for Yoke[s]	At beginning of each testing day [10# Wt]
5.1.5 Light Meter Check	6 months

6.0 Surface Preparation

- 6.1 Satisfactory results are usually obtained when the surfaces are in the as-welded, as-rolled, as-cast, or as-forged condition. Surface preparation by grinding or machining may be necessary where surface irregularities could mask indications due to discontinuities.
 - 6.1.1. Prior to magnetic particle examination, the surface to be examined and all adjacent areas within at least 1 inch shall be dry and free of all dirt, grease, lint, scale, welding flux, weld spatter, oil or other extraneous matter that could interfere with the examination. Longitudinal wave calibration blocks shall be used to establish sweep range and distance amplitude correction.
 - 6.1.2. Cleaning may be accomplished using vapor degreasing, solvent flushing, sand or grit blasting, paint removers, detergents, organic solvents or de-scaling solutions.
 - 6.1.3. Prior to magnetic particle inspection the parts to be tested shall be visually examined to locate any surface anomalies that will not be detected by magnetic particle testing. Any such anomalies shall be noted on the inspection report.

7.0 Application of Particles

- 7.1. Wet Method
 - 7.1.1. After surface is prepared per Paragraph 6.0, pre-clean inspection area by spraying with cleaner and wiping off with a cloth. A longitudinal wave search unit may be used on any calibration block,

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which will provide amplitude differences, with sufficient signal separation to prevent overlapping of the two signals.

- 7.1.2. Place unit [AC or DC Yoke] on test piece perpendicular to the direction to suspect discontinuities.
 - 7.1.3. Energize unit creating the magnetic field. Maintain good contact.
 - 7.1.4. Apply the wet particles using the aerosol can after the mixture has been properly agitated. Continuous magnetization shall be applied throughout this spray process. The color of the particles shall provide adequate contrast with the examination surface.
 - 7.1.5. The wet particles can be applied during or just prior to energizing the unit. Care shall be taken to prevent high velocity flow over critical surfaces and to cease application of the wet suspensions prior to removing the magnetizing force. The application and evaluation of fluorescent particles shall be performed under a black light.
 - 7.1.6. Repeat steps 7.1.2 through 7.1.5 in different direction to initial area inspected.
 - 7.1.7. All rejectable indications must be marked for repair with a suitable marking pencil/marker.
 - 7.1.8. The inspector shall complete a Nondestructive Test Report form (see Appendix 1).
- 7.2. Dry Method
- 7.2.1. After surface is prepared per Paragraph 6.0, pre-clean inspection area by spraying with cleaner and wiping off with a cloth.
 - 7.2.2. Place unit on test piece perpendicular to the direction to suspected discontinuities.
 - 7.2.3. Energize unit creating the magnetic field. Maintain good contact.
 - 7.2.4. Apply the dry magnetic particles with a bulb applicator or powder blower in such a manner that a light uniform dust-like coating settles on the examination surface. The particles shall be suspended in air in such manner that they reach the examination surface in a uniform cloud with a minimum of force.
 - 7.2.5. While unit is energized remove excessive dry particles without disturbing the particles which are attracted by a flux leakage field that is indicative of discontinuities. This may be done by directing a light stream of air from a squeeze bulb approximately two (2") inches away and at an angle to the direction in which discontinuities are expected. Note that excess particles must be removed while the current is on.
 - 7.2.6. Position the unit 90 degrees to the initial area inspected and repeat steps 7.2.2 through 7.2.5.
 - 7.2.7. All rejectable indications must be marked for repair with a suitable marking pencil/marker.
 - 7.2.8. The inspector shall complete a Nondestructive Test Report form (see Appendix 1).

8.0 Magnetizing Technique

The Yoke technique using AC or HWDC [rectified alternating current] shall be used as specified below:

8.1. Yoke Method

8.1.1. This method should only be used to detect discontinuities which actually come to the surface. When using direct current, the yoke shall have a lifting power of at least 40 lbs at the maximum pole spacing at which it will be used. When using alternating current, the yoke shall have a lifting power of at least 10 lbs at the maximum pole spacing at which it will be used and shall be used for materials over 1/4" in thickness. 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 need only be verified again if damaged in a manner that could have caused potential loss of material.

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9.0 Direction of Magnetization

- 9.1. At least two separate examinations shall be performed on each area. During this second examination, the lines of magnetic flux shall be approximately perpendicular to those used during the first examination. A different technique for magnetization may be used for the second examination. Each examination shall be conducted with sufficient overlap to assure 100% coverage. Calibration shall be performed at the start of the examination. Re-calibration or verification calibration shall be performed if any of the following occur.

10.0 Magnetizing Field Adequacy

- 10.1. When it is necessary to verify the adequacy or direction of the magnetizing field, the magnetic particle field indicator shall be used by positioning the indicator on the surface to be examined. A suitable flux or field 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 with the magnetizing force turned on. 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. The contact surface must be free from weld spatter, roughness, or other condition, which interfere with free movement of the search unit or impair the transmission of ultrasound.

11.0 Evaluation of Indications

- 11.1. Lighting
Magnetic indications found using non-fluorescent particles are examined under visible light. Indications found using fluorescent particles must be examined under black (ultraviolet) light. This requires a darkened area with accompanying control of the visible light intensity.
- 11.1.1. Visible Light Intensity
The intensity of the visible light at the surface of the part/work piece undergoing examination shall be a minimum of 100 foot candles (1000 lux). The intensity of ambient visible light in the darkened area where fluorescent magnetic particles examination is performed should not exceed 2 foot candles (20 lux). These two light measurements shall be taken and a record of them shall be kept on file.
- 11.1.2. Black Light Intensity
The black light intensity at the examination surface shall be not less than 1000 micro W/cm² when measured with a suitable black light meter. The black light intensity shall be measured with a black light meter prior to use, whenever the light's power source is interrupted or changed, and at the completion of the examination or series of examinations.
- 11.1.3. Black Light Condition
Black light reflector and filter lenses shall be checked for cracks, light leaks and cleanliness before each application.
- 11.1.4. Black Light Warm-up
Allow the black light to warm up for a minimum of 5 minutes prior to its use or measurement of the intensity of the ultraviolet light emitted.
- 11.2. Dark Area Eye Adaptation
It is recommended that the inspector be in the darkened area for at least 5 minutes prior to examining parts using black light so that his/her eyes will adapt to dark viewing. Caution - Photochromatic or permanently tinted lenses shall not be worn during examination.

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11.3. Housekeeping

The examination area should be kept free of interfering debris. If fluorescent materials are involved, the area should also be kept free of fluorescent objects not related to the part/piece being examined.

11.4. Definition of Indications

- (a) Non-relevant indications are surface imperfections other than true discontinuities and are to be regarded as a defect. Re-examination of these areas, following additional surface conditioning as necessary, shall be performed to determine if there are any actual discontinuities present. Non-relevant indications that could mask true discontinuities are unacceptable.
- (b) Relevant indications are those with major dimensions greater than 1/16 inch.
- (c) Linear indications are those with a length three times greater than the width.
- (d) Rounded or elliptical indications are those with a length equal to or less than three times the width.

12.0 Acceptance Standards

- 12.1. All indications shall be evaluated in terms of the acceptance standards of ASME Section VIII Appendix 6. Only indications with major dimensions greater than 1/16 inch shall be considered relevant. All relevant linear indications are unacceptable.
- 12.2. All surfaces to be examined shall be free of:
 - (a) No relevant linear indications.
 - (b) No relevant rounded indications greater than 3/16".
 - (c) Four or more relevant rounded indications in a line separated by less than 1/16 in. (1.6 mm) (edge to edge) are unacceptable.
 - (d) 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.
 - (e) Any questionable or doubtful indications shall be reexamined to determine whether they are relevant.

13.0 Demagnetization

- 13.1. When residual magnetism in the part could interfere with subsequent processing or usage, the part shall be demagnetized any time after completion of the examination.

Demagnetization is rarely required on test pieces magnetized by the yoke method. [It is rare to have gauss readings above 2 on completion of the inspection.] In event of a need to reduce residual magnetism to zero, set Yoke in an AC mode, active it while in contact with the test piece, and forcibly withdraw the yoke from the surface. Such an action will withdraw small levels of residual magnetism.

14.0 Post Examination Cleaning

- 14.1. After completion of the examination, excess particles remaining on the test piece shall be removed by solvent wiping or flushing the test surface.

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15.0 Defect Removal and Repairs

- 15.1. All unacceptable indications shall be removed and re-examined by the same NDT method used to detect the indication originally. Whenever a defect is removed and repair by welding is not required, the excavated area shall be blended into the surrounding surfaces so as to avoid sharp notches, corners, or crevices.
- 15.2. Where welding is required after removal of a defect, the area shall be cleaned and welding performed in accordance with a qualified welding procedure. Completed repairs shall be re-examined by the method originally used for detection of the defect.

16.0 Reporting

- 16.1. The results of the examination shall be reported on the form in Appendix 1. All indications that are rejectable in accordance with the referencing Code Section are to be so noted on the form. As a minimum, the type of indications (linear or rounded), location and extent (length or diameter or aligned) shall be recorded. The following shall be recorded:
 - (a) Procedure identification and revision
 - (b) magnetic particle equipment and type of current
 - (c) magnetic particles (visible or fluorescent, wet or dry)
 - (d) examination personnel identity and if required by referencing Code Section, qualification level
 - (e) map or record of indications
 - (f) material and thickness
 - (g) lighting equipment
 - (h) date and time examinations were performed

17.0 Documentation

- 17.1. A Nondestructive Test Report (Appendix I) is generated as a result of the tests covered by this procedure. Copies of the report are distributed as required within the MOGAS documentation system.
 - 17.1.1. Non rejectable indications shall be recorded per part 16.0
 - 17.1.2. The Rejectable indications shall be recorded. As a minimum, the type of indications (linear or rounded), location and extent (length of diameter of aligned) shall be recorded.

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APPENDIX I

MT Examination Report



MAGNETIC PARTICLE TEST REPORT

DATE		REPORT NUMBER			
CUSTOMER/PROJECT Job No:		WELD OR PART IDENTIFICATION			
PROCEDURE NO:		ACCEPTANCE STANDARD		TEST TEMP	
MATERIAL:	SURFACE CONDITION		THICKNESS, DIMENSIONS:		
MT EQUIPMENT: YOKE _____ COIL _____					
PARTICLES: FLOURESCENT _____ VISIBLE _____ WET _____ DRY _____					
LIGHTING: WHITE _____ F/C _____ U/V _____ MW/CM ²					
SKETCH					
NOTES					
RESULTS					
IND. NO.	TYPE OF INDICATION	LOCATION	SIZE/EXTENT	EVALUATION	REMARKS

EXAMINED BY:
 PRINT NAME _____
 SIGNATURE _____

WITNESSED BY:
 PRINT NAME _____
 SIGNATURE _____