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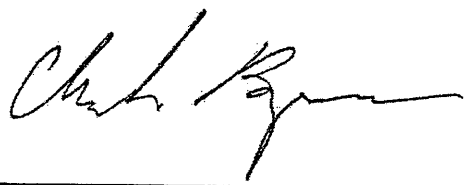
PROCEDURE NO. I

**ALL MATERIAL IN PROCEDURE I
HAS BEEN REVIEWED &
APPROVED BY**



Charles Brignac / President

ACCURATE NDE & INSPECTION, LLC

MAGNETIC PARTICLE EXAMINATION AWS GENERAL PROCEDURES

ACC-MT-02-GEN

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1.0 Scope:

This document shall govern the procedures used by Accurate NDE & Inspection, LLC personnel to perform magnetic particle testing of ferromagnetic materials, including welds, of all shapes or sizes in accordance with AWS codes, including B31.3, and in accordance with other codes, specifications, or contract requirements that specify ASTM E-709 for magnetic particle examination procedures.

2.0 General:

2.1 These are general procedures for factors common to most magnetic particle testing. Accurate NDE & Inspection, LLC supplemental procedures shall address the specific variables. **The general and supplemental procedures are intended for use in conjunction with each other.** Specific requirements in these general procedures may be superseded by the supplemental procedures.

2.2 Acceptance criteria shall be specified by customer.

2.3 Variations in testing procedures and equipment may be used upon agreement between Accurate NDE & Inspection, LLC and the customer.

3.0 Reference Documents:

The following documents are referenced and form a part of these procedures as applicable:

1. American Welding Society (AWS) Structural Welding Code AWS D1.1.
2. American Society for Testing and Material (ASTM) ASTM E-709
3. Accurate NDE & Inspection, LLC WRITTEN PRACTICE (ACC-WP-O1)
4. Accurate NDE & Inspection, LLC NONDESTRUCTIVE EXAMINATION LABORATORY PROCEDURES (ACC-LP-01)
5. Accurate NDE & Inspection, LLC SUPPLEMENTAL PROCEDURES
6. ASNT Recommended Practice for Nondestructive Testing Personnel Qualification and Certification SNT-TC-1A

4.0 Personnel:

Magnetic particle testing personnel shall be qualified and certified in accordance with the Accurate NDE & Inspection, LLC WRITTEN PRACTICE ACC-WP-O1, which complies with ASNT Recommended Practice SNT-TC-1A. The duties and responsibilities of personnel shall be as listed in WRITTEN PRACTICE ACC-WP-01. Duties shall be performed in accordance with all applicable safety requirements.

5.0 Extent of Testing:

Extent of testing shall be as required by customer specifications.

6.0 Magnetization Techniques:

6.1 Magnetization techniques applicable to this procedure include the prod technique, longitudinal magnetization technique, circular magnetization technique, yoke technique, multidirectional magnetization technique.

6.2 All examinations shall be performed by the continuous method whereby the magnetizing current shall be sustained during application and removal of excessive ferromagnetic particles.

7.0 Magnetization and Illumination Equipment:

7.1 Magnetization equipment for the prod technique shall be Parker Model P-90 units or customer approved equal producing circular half-waved rectified alternating magnetization current. To prevent arcing, a remote control switch shall be provided to permit proper positioning of prods prior to activating current.

7.2 Magnaflux Model Y-6 units or customer approved equal.

7.2.1 Longitudinal Magnetization Technique

7.2.1.1 Magnetizing Procedure- For this technique, magnetization is accomplished by passing current through a multi-turn fixed coil (or cables) that is wrapped around the part or section of the part to be examined. This produces a longitudinal magnetic field parallel to the axis of the coil. If a fixed, pre-wound coil is used, the part shall be placed near the side of the coil during inspection. This is of special importance when the coil opening is more than 10 times the Cross-sectional area of the part.

7.2.2 Circular Magnetization Technique

7.2.2.1 Direct Contact Technique

7.2.2.2 Magnetizing Procedure- For this technique, magnetization is accomplished by passing current through the part to be examined. This produces a circular magnetic field that is approximately perpendicular to the direction of current flow in the part.

7.2.3 Central Conductor Technique

7.2.3.1 Magnetizing Procedure- For this technique, a central conductor is used to examine the internal surfaces of ring or cylindrically shaped parts. The central conductor technique may also be used for examining the outside surfaces of these shapes. Where large diameter cylinders are to be examined, the conductor shall be positioned close to the internal surface of the cylinder. When the conductor is not centered, the circumference of the cylinder shall be examined in increments and magnetic field strength indicator, applied in accordance with T- 755, shall be used to determine the extent of the arc that may be examined For each conductor position. Bars, or cables passed through the bore of a Cylinder, may be used to induce circular magnetization.

7.2.4 Multi-Directional Magnetization

7.2.4.1 Magnetizing Procedure- For this technique magnetization is accomplished by high amperage power packs operating as many as three circuits that are energized one at a time in rapid succession. The effect of these rapidly alternating magnetizing currents is to produce overall magnetization of the part in multiple directions. Circular or longitudinal magnetic fields may be generated in any combination using the various techniques described in T-764 and T-765.

7.3 Black lights used with fluorescent particles shall produce a minimum light intensity of 800 uW/cm sq. at 15" from the face of the light lens filter.

7.4 White light, either natural or artificial, used with non-fluorescent particles shall be sufficient intensity to satisfy the magnetic particle technician that lighting is adequate.

7.5 Magnetic Particle testing equipment shall be calibrated upon repair and whenever a malfunction is suspected, but at least once per year.

8.0 Ferromagnetic Particles:

8.1 Ferromagnetic particles applicable to this procedure include wet and dry particles. Wet powders may be either fluorescent or nonfluorescent. Dry powders shall be nonfluorescent. Particles used shall be finely divided ferromagnetic materials colored to contrast with surfaces of materials examined.

8.2 Wet Powders:

8.2.1 Wet fluorescent powders shall be Magnaflux #14AM Magnaglo prepared bath or customer approved equal.

8.2.2 Wet nonfluorescent powders shall be Magnaflux #7C Black, #9C Red, or customer approved equal suspended in a conditioned water bath. Conditioning agent shall be either Magnaflux WA-2B at 1-1/3 oz./gal. of water, WA-4 at 1 part/100 parts water, or customer approved equal. Conditioned water bath alkalinity shall not exceed a pH of 10.5 as determined with litmus paper.

8.2.3 Fluorescent powders settling volume shall be from 0.1 to 0.5 mL in a 100 mL bath sample. Non-fluorescent particles settling volume shall be from 1.2 to 2.4 mL in a 100 mL bath sample.

8.2.4 Ferromagnetic particle used, whether wet fluorescent, wet non-fluorescent, or dry non-fluorescent, shall be as specified by customer.

9.0 Surface Preparation:

9.1 Material surfaces to be examined shall be clean, dry, and free of contaminants such as oil, grease, loose rust, scale, welding flux, weld spatter, or other matter that might interfere with examination. Additionally, surfaces shall be free of excessive roughness that might mask or interfere with interpretation of indications. Unless other arrangements are made prior to examination, surface preparation shall be the responsibility of the fabrication contractor and/or customer.

9.2 A light colored paint contrasting with the magnetic particle color shall be applied to surfaces prior to examination if colors of surfaces to be examined do not supply sufficient contrast to particle color.

10.0 Magnetic Field Strength and System Performance/Sensitivity Evaluation:

10.1 Prod Technique:

10.1.1 For material less than 3/4" thick, the current shall be 90 to 110 amp/in. of prod spacing. For material 3/4" thick and greater, the current shall be 100 to 125 amp/in. of prod spacing.

10.1.2 Prod spacing shall not exceed 8 in.

10.2 Yoke Technique:

10.2.1 The magnetizing force of the alternating current electromagnetic yokes shall be sufficient to lift a 10 lb. block at a pole spacing of 6 in. Magnetizing force shall be checked prior to examination on a minimum daily basis.

10.2.2 Pole spacing shall not exceed 6 in.

10.2.3 Longitudinal Magnetization Technique

10.2.3.1 Magnetic Field Strength- Direct or rectified current shall be used to magnetize parts examined by this technique. The required field strength shall be calculated based on the length (L) and the diameter (D) of the part in accordance with (a), (b) and (c) below. Long parts shall be examined in sections not to exceed 18 inches (460 mm) and 18 inches (460 mm) shall be used for the part (L) in calculating the required field strength. For non-cylindrical parts, D shall be the maximum cross-sectional diagonal.

(a) Parts with L/D Ratios Equal to or Greater Than 4 – the magnetizing current shall be within + 10% of the ampere-turn's value determined as follows:

$$\text{Ampere-turns} = \frac{35{,}000}{L/D+2}$$

(b) Parts with L/D Ratios less than 4 but not less than 2 – The magnetizing ampere-turn shall be within + 10% of the ampere-turn's value determined as follows:

$$\text{Ampere-turns} = \frac{45{,}000}{L/D}$$

(c) Parts with L/D Ratios less than 2 – An alternate form of magnetization shall be used.

10.2.3.2 Magnetizing Current – The current required to obtain the necessary magnetizing field strength shall be determined by dividing the ampere-turns obtained in steps (a) or (b) above by the number of turns in the coil as follows:

$$\text{Amperes (meter reading)} = \frac{\text{ampere-turns}}{\text{Turns}}$$

For example, if a 5-turn coil is used and Ampere-turns required are 5000, use:

$$\frac{5000}{5} = 1000 \text{ amperes } (+ 10\%)$$

10.2.4 Circular Magnetization Technique

10.2.4.1 Magnetizing Current – Direct or rectified (half-wave rectified or full-wave rectified) magnetizing current shall be used. The required current shall be determined using the following guidelines:

(a) For parts with outer diameters up to five (5) inches (125 mm), 700 to 900 amp/inch of diameter shall be used.

(b) For parts with outer diameters over five (5) inches (125 mm) up to 10 inches (250 mm), 500 to 700 amp/inch of diameter shall be used.

(c) For parts with outer diameter over 10 inches (250 mm) up to 15 inches (380 mm), 300 to 500 amp/inch of diameters shall be used.

(d) For parts with outer diameters over 15 inches (380 mm), 100 to 330 amp/inch of outer diameter shall be used.

(e) For parts with geometric shapes other than round, the greatest cross-sectional diagonal in a plane at right angles to the current flow shall determine the inches to be used in the above computations.

(f) As an alternate, for non-cylindrical parts only, the magnetizing amperage may be established using the Magnetic Particle Field per T-754.

10.2.5 Central Conductor Technique

10.2.5.1 Magnetizing Current – The field strength required shall be equal to that determined in T-765.1(b) for a single turn central conductor. The

magnetic field shall be increased in proportion to the number of times the central conductor cable passes through a hollow part. For example, if 6000 amperes are required to examine a part using a single central conductor, 3000 amps are required when two (2) turns of the through cable are used; and 1200 amps are required if 5 turns are used.

10.2.6 Multi-directional Magnetization

10.2.6.1 Magnetic Field Strength – Only three-phase full-wave rectified current shall be used to magnetize the part. The initial magnetizing current requirements for each circuit shall be established using the previously described guidelines (see T-764 and T-765). The adequacy of the magnetic field shall be demonstrated in accordance with T-754, and a magnetic field indicator shall be used to verify that an adequate field is obtained in at least two (2) nearly perpendicular directions. For areas where adequate field strength cannot be demonstrated, additional magnetic particle techniques shall be used to obtain the required two-directional coverage.

10.3 System performance/sensitivity evaluation shall be performed using a fabricated test part made in accordance with Figure 15 of ASTM E-709. Evaluation shall be performed prior to examination of a minimum daily basis with maximum prod and/or yoke spacing to be in examination.

11.0

11.0 Application of Particles:

11.1 Wet magnetic particles shall be applied during the activation of the magnetizing field current by spraying bath on the surface to be examined. High velocity flows shall be prevented. Bath application shall be completed before discontinuing the magnetic field.

11.2 Dry magnetic particles shall be applied during the activation of the magnetizing field current with a hand powder applicator so that a light, uniform coating settles on the surface to be examined. Excess powder shall be removed by lightly blowing on the surface. Particle application and removal of excess powder shall be completed before discontinuing the magnetic field.

11.3 At least 2 examinations approximately 90 deg. to each other shall be performed on each area.

11.4 Examinations shall overlap a minimum of 50% of prod or yoke spacing.

12.0 Evaluation of Indications:

12.1 Indications shall be maximized by aligning the prods or yoke parallel to the length of each indication with the indication ends approximately centered in the area examined. Particle application described in paragraphs 11.1 or 11.2, as applicable, shall be repeated.

12.2 Indications shall be evaluated as either relevant or nonrelevant.

12.3 Relevant indications are indications caused by discontinuities in the material tested and exceed the limits of the acceptance criteria.

12.4 Nonrelevant indications are indications caused by, among other things, surface irregularities, inherent metallurgical properties, and discontinuities within the limits of the specified acceptance criteria. All indications shall be considered relevant unless proven nonrelevant.

13.0 Reporting:

Written reports completed and signed by the magnetic particle technician shall be submitted to the customer. Information reported shall include, but not be limited to, date of examination, welds or areas or parts examined identified in a unique manner approved by customer, dimensions of discontinuities for each weld or area or part in which relevant indications are found, magnetic particle method, magnetic current strength, and direction of magnetic field. Examinations shall be sufficiently detailed to permit repetition at a later date. Additionally, the location and extent of defects shall be marked on pieces examined unless otherwise specified. Any additional information required by customer shall be reported.

14.0 Demagnetization Techniques:

Demagnetization, if required, shall be addressed in supplemental procedures.

15.0 Post-examination Cleaning:

Post-examination cleaning, if required, shall be addressed in supplemental procedures.