GE Power Generation Engineering
Materials and Processes Engineering
Schenectady, NY 12345

PROCESS SPECIFICATION

P3A-AG1

MAGNETIC PARTICLE TESTING - GENERAL

DOCUMENT REVISION STATUS: DETERMINED BY THE LAST ENTRY IN THE "REV" AND "DATE" COLUMN

REV.	DESCRIPTION	SIGNATURE	REV. DATE
D	REVISED SPECIFICATION TO MEET ASTM AND ASNT (SNT-TC1A) REQUIREMENTS. (TV TRICOZZI)	C.R. Tricozzi	1994 DEC 19

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ORIG. ISSUE DATE: December 27, 1965

DT-1

MAGNETIC PARTICLE TESTING - GENERAL

1. SCOPE

1.1 This specification establishes the minimum requirements for magnetic particle examination used for the detection of surface or slightly subsurface discontinuities in ferromagnetic materials.

1.2 Wet suspensions or dry particles, either fluorescent or non-fluorescent, may be used.

1.3 Magnetic slurry/paint and magnetic polymers are authorized for use to this process specification.

2. COMMUNICATION

2.1 External Supplier (See Definition)

General Electric Company - Power Systems Sourcing Operation (PSSO) is the authorized interface for all communication between GE and the External Supplier. All questions or requests for additional information shall be submitted to PSSO for clarification. Conflicts between applicable Specifications and/or drawings shall be submitted to PSSO for resolution by Engineering.

2.2 Internal Supplier (See Definition)

All communication, including questions or requests for additional information shall be submitted to Materials and Processes Engineering - Nondestructive Test Engineering (MPE-NDTE).

2.3 Requests For Deviations

Requests for deviations to the requirements of this specification shall be submitted as follows:

2.3.1 External Supplier - To PSSO by SDR.

2.3.2 Internal Supplier - To the appropriate Engineering personnel by QCR.

3. APPLICABLE DOCUMENTS

3.1 The following documents shall form an integral part of this specification to the extent specified herein. Unless otherwise indicated, the latest issue shall apply.

3.1.1 American Society for Nondestructive Testing

SNT-TC-1A Personnel Qualification and Certification in Nondestructive Testing

3.1.2 American Society for Testing and Materials

ASTM A 275/A 275M	Standard Test Method for Magnetic Particle Examination of Steel Forgings
ASTM E709	Standard Guide for Magnetic Particle Examination
ASTM E1316	Standard Terminology for Nondestructive Examinations
ASTM E1444	Standard Practice for Magnetic Particle Examination

4. DEFINITIONS

4.1 Personnel

4.1.1 Purchaser - The GE Power Generation Operation (PGO), or its Business Associate.

4.1.2 External Supplier - The corporation, company, partnership, sole proprietorship or individual engaged to perform the process covered by this Specification.

4.1.3 Internal Supplier - Any GE Power Generation Manufacturing Department.

4.1.4 Supplier - As used herein, unless specifically designated, refers to either an External or an Internal Supplier.

4.2 Specification Deviation Documents

4.2.1 Applicable to External Supplier

4.2.1.1 Supplier Deviation Request (SDR) - A method for the documentation, approval and control of a waiver for materials, processes, or dimensions which deviate from the Purchase Order documents (drawings, specifications, engineering instructions, etc.).

4.2.2 Applicable to Internal Supplier

4.2.2.1 Quality Control Report (QCR) - GE Manufacturing Department non-conformance report initiated during processing through the factory. Used by Manufacturing to document non-conformance to governing documents and request corrective action.

4.3 Technical Terms

None

5. ENGINEERING REQUIREMENTS

5.1 Acceptance Requirements

5.1.1 The acceptance requirements applicable to the part or group of parts shall be incorporated as part of the written procedure either specifically or by reference to other applicable documents containing the necessary information.

5.1.2 Applicable drawings and/or specifications, etc., must specify the acceptance size and concentration of discontinuities for the component, with zoning of unique areas as required by design requirements, and as determined by Design Engineering.

5.2 Personnel Qualification

5.2.1 The tests shall be performed by personnel qualified and certified through an established program that reflects the intent of the recommended guidelines provided in ASNT document SNT-TC-1A.

5.2.2 Where requirements of SNT-TC-1A have been modified to meet the needs of the inspection company, they shall be specifically detailed in the company's written practice for qualification and certification of personnel.

5.3 Written Procedure/Method

5.3.1 Magnetic particle inspection shall be performed in accordance with a written procedure/method applicable to the parts or group of parts under test.

5.3.2 The procedure/method shall be capable of detecting the smallest rejectable discontinuities specified in the acceptance requirements.

5.3.3 All written procedures shall be approved by a Level III individual. This person shall be qualified and certified in accordance with the local written practice.

5.3.4 External suppliers' procedures shall be submitted to the purchaser for approval prior to use.

5.4 Elements of the Written Procedure/Method

5.4.1 The written procedure/method shall include at least the following elements, either directly or by reference to the applicable document:

5.4.1.1 Procedure identification and date written

5.4.1.2 Identification of the part(s) to which the procedure applies

5.4.1.3 Identification of system performance verification devices/test parts

5.4.1.4 Areas of the part to be examined

5.4.1.5 Part preparation required before testing

5.4.1.6 Directions for positioning the item with respect to the magnetizing equipment, for each surface inspected.

5.4.1.7 The type of magnetizing current and the equipment to be used, when work is done with portable or mobile equipment.

5.4.1.8 Method of establishing the magnetization (head shot, coil, prods, yoke, cable wrap, electromagnets, permanent magnet, etc.), for each surface inspected.

5.4.1.9 Directions of magnetization to be used, the order in which they are applied, and any demagnetization procedures to be used between shots.

5.4.1.10 Estimated current level required.

5.4.1.11 Type of magnetic particle material (dry or wet, visible or fluorescent, color of visible particles, etc.) to be used and the method and equipment to be used for its application, and for the case of wet particles, the particle concentration limits.

5.4.1.12 Acceptance requirements to be used for evaluating indications and disposition of parts after evaluation.

5.4.1.13 Post-inspection demagnetization and cleaning requirements.

5.5 Examination Sequence

5.5.1 Magnetic particle inspection shall be performed after the completion of operations that could cause surface or near-surface discontinuities. These operations include, but are not limited to, forging, heat treating, plating, passivation, cold forming, welding, grinding, straightening, machining, proof loading, etc.

5.5.2 Parts shall be magnetic particle inspected without coatings unless otherwise approved by the contracting agency or unless they meet the requirements of Paras. 6.1.5 or 6.1.6.

5.6 Equipment

5.6.1 The types of current used for magnetic particle examination are full-wave rectified alternating current (3 or 1 phase), half-wave rectified alternating current, and alternating current.

5.6.2 The equipment used shall fulfill the magnetizing and demagnetizing requirements adequately without damaging the part, and shall include the necessary features required for safe operation.

5.6.3 Visible light shall be used when testing with non-fluorescent particles. The intensity of the visible light at the surface being inspected shall be 100 foot candles, (1000 lux) minimum. For some field inspections using non-fluorescent particles, visible light intensities as low as 50 foot candles (500 lux) may be used when agreed upon by the purchaser.

5.6.4 Unless otherwise specified, fluorescent magnetic particle examinations shall be performed in a darkened area with a maximum ambient visible light level of 2 foot candles (20 lux) measured at the part surface.

5.6.5 Minimum acceptable black light intensity is 1000 microwatts/cm2 at the part surface. Black lights shall be checked at the interval specified herein and after bulb replacement, for output intensity. Black light reflectors and filters shall be checked daily for cleanliness and integrity. Damaged or dirty reflectors or filters shall be replaced or otherwise corrected as appropriate.

5.6.6 Black Light Intensity Procedure

5.6.6.1 An intensity check is required for each black light used for evaluation.

5.6.6.2 Intensity check shall be accomplished with the black light in a fixed position pointing down toward to a flat surface.

5.6.6.3 The face of the black light filter should be 15" (+/- 1/4 inch) from the sensing element of the light intensity meter.

5.6.6.4 The sensor should be moved around on the flat surface until the maximum reading on the meter is obtained. DO NOT move the black light.

5.6.6.5 A Black Light Intensity Log/Record shall be kept and should include as a minimum the date, identification of person taking reading, black light intensity, identification of black light meter/sensor, and the date the meter and sensor were last calibrated/certified.

5.7 Materials

5.7.1 Dry and wet particles selected for use must be capable of demonstrating the sensitivity required by the acceptance requirements.

5.7.2 Aerosol can suspensions of magnetic particles are approved for use, providing they meet the requirements of Para. 5.7.1.

5.7.3 The suspension vehicle for the wet method shall be a light petroleum distillate or a suitably conditioned water.

5.7.3.1 Petroleum distillates must have a known/certified flash point, viscosity, and background fluorescence that meet ASTM-E-1444 requirements.

5.7.3.2 When water is used as a suspension vehicle, it shall be conditioned suitably to provide for proper wetting, particle dispersion, and corrosion protection. Proper wetting shall be determined by a water break test as described in ASTM-E-1444.

5.7.3.3 Particle Concentration

5.7.3.3.1 For fluorescent particles, the particle concentration shall be in the range of 0.1 to 0.4 mL in a 100 mL bath sample.

5.7.3.3.2 For non-fluorescent particles, the particle concentration shall be in the range of 1.2 to 2.4 mL per 100 mL bath sample.

5.7.3.3.3 Fluorescent and non-fluorescent particles shall not be used together.

5.7.3.4 Bath Concentration Check Procedure

5.7.3.4.1 The bath shall be adequately agitated prior to taking a sample.

5.7.3.4.2 The centrifuge tube shall be filled from the applicator used to apply the suspension to the part being inspected.

5.7.3.4.3 The filled centrifuge tube should be demagnetized if clumping of particles is noticed. Particles shall not be pulled to the bottom of the tube by magnetization.

5.7.3.4.4 Allow a minimum settling time of 60 minutes for petroleum distillates or a minimum of 30 minutes for conditioned water suspensions before taking the reading. It is permissible to begin work while the settling test is being accomplished. If, at the time that the concentration is recorded it is found to be outside of the acceptable concentration limits, correct the concentration and re-inspect any hardware inspected prior to the correction.

5.7.3.4.5 As a minimum, the particle concentration record (using the centrifuge tube) shall include the date and time of the reading, the identification of the person taking the reading, the concentration noted, a record of bath additions or replacement, and any contaminant conditions noted.

6. PRACTICE

6.1 Preparation of Parts for Examination

6.1.1 The part shall be demagnetized before examination if prior operations have produced a residual magnetic field that may interfere with the examination.

6.1.2 The surface of the part shall be essentially smooth, clean, dry, and free of oil, scale, machining marks, or other contaminants or conditions that might interfere with the efficiency of the inspection. Where possible, the wet method of testing shall be used on machined surfaces with a surface finish of 250AA (Arithmetic Average) or smoother.

6.1.3 Cleaning of finished machined components may be accomplished using detergents, organic cleaners, solvents, aqueous cleaners, or fine abrasive mechanical means. Cleaning solvents shall not have more than 100 ppm of chlorine, 5000 ppm of sulfur and no free caustic alkalinity.

6.1.4 As-welded surfaces, following the removal of slag, shall be considered suitable without grinding, providing this does not interfere with interpretation of test results, and provided the weld contour blends into the base metal without excessive undercutting. However, unless otherwise specified, the weld shall be inspected in the final surface condition and final heat-treated condition.

6.1.5 Non-Conductive Coatings

6.1.5.1 Thin non conductive coatings such as paint in the order of 1 or 2 mils (0.02 to 0.05 mm) will not normally interfere with the formation of indications, but they must be removed at all points where electrical contact is to be made for direct magnetization.

6.1.5.2 If a non-conductive coating/plating having a thickness greater than 2 mils (0.05mm) is left on the area to be examined, it must be demonstrated that discontinuities can be detected through the maximum thickness applied.

6.1.5.3 If the smallest rejectable discontinuities specified in the applicable acceptance standards cannot be detected through the non-conductive coating/plating, the coating/plating must be removed prior to the magnetic particle inspection.

6.1.6 Conductive Coatings

6.1.6.1 A conductive coating such as chrome plating and heavy mill scale on wrought products can mask discontinuities. As with non-conductive coatings, it must be demonstrated that the discontinuities can be detected through the coating.

6.2 Magnetization Methods

6.2.1 Permanent magnets shall not be used unless specifically authorized by the purchaser.

6.2.2 Yokes shall not be used unless specifically authorized by the purchaser.

6.2.3 Electromagnets energized by application of magnetizing current, either alone or in aiding pairs, may be used.

6.2.4 Central conductors, cable wraps, direct contact head shots are authorized for use.

6.2.5 Prods shall not be used unless specifically authorized by the purchaser.

6.2.6 To ensure detection of discontinuities in any direction, each part surface must be magnetized in at least two directions at right angles to each other. Surfaces or features which have no acceptance requirement for magnetization in two directions shall only require magnetization in the orientation needed to meet the specified requirement.

6.2.7 Multi-directional Magnetization may be used to fulfill the requirements for magnetization in two directions if it is demonstrated that it is effective in all required areas.

6.2.8 Induced Current Magnetization (toroidal or circumferential field) is authorized for use.

6.3 Magnetic Field Strength

6.3.1 The applied magnetic field shall have sufficient strength to produce satisfactory indications, but it must not be so strong that it causes the masking of relevant indications. Adequate magnetic field strength may be determined by one or both of the following methods:

6.3.1.1 By testing parts having known or artificial discontinuities of the type, size, and location specified in the acceptance requirements.

6.3.1.2 By using the formulas given in ASTM-E-1444 or ASTM-E-709.

6.3.2 Direct Circular Magnetization

6.3.2.1 Unless otherwise specified, the current level for head shots should be from 300 to 800 Amperes/inch of part diameter. The diameter of the part shall be taken as the greatest distance between any two points on the outside circumference of the part.

6.3.2.2 Higher current levels may be used for low-permeability alloys.

6.3.3 Central Conductor Circular Magnetization

6.3.3.1 Centrally located central conductors are preferred. See ASTM-E-1444 and/or ASTM-E-709 for recommended current levels.

6.3.3.2 Offset Central Conductors

6.3.3.2.1 When the central conductor passing through the inside of the part is placed against an inside wall, see ASTM-E-1444 or ASTM-E-709 for recommended current levels.

6.3.3.2.2 The distance along the part inside circumference that is effectively magnetized should be taken as four times the diameter of the central conductor, unless it can be shown that the magnetic field extends further.

6.3.3.2.3 The entire circumference should be inspected by rotating the part on the conductor, allowing for approximately a 10% overlap of the magnetic field.

6.3.3.3 Central conductors shall be used to produce circular magnetic fields for detection of axially-oriented discontinuities on inside diameters such as thru-bores, blind bores, etc.

6.3.4 Longitudinal Magnetization Using Air-Core Coils

6.3.4.1 Low Fill Factor Coils are situations when the cross-sectional area of the coil is ten or more times the cross-sectional area of the part being inspected. Current levels recommended in ASTM-E-1444 or ASTM-E-709 may be used.

6.3.4.2 Intermediate Fill Factor Coils are situations when the cross-sectional area of the coil is between two and ten times the cross-sectional area of the part being inspected. Current levels recommended in ASTM-E-1444 or ASTM-E-709 may be used.

6.3.4.3 Cable Wrap or High Fill Factor Coils are situations when the cross-sectional area of the coil is less than twice the cross-sectional area of the part being tested. Current levels recommended in ASTM-E-1444 or ASTM-E-709 may be used.

6.3.4.4 When longitudinal magnetization is accomplished by coils, a high fill factor is preferred.

6.3.4.5 When length-to-diameter (L/D) ratio is too low for adequate longitudinal magnetization, pole pieces (pieces of ferromagnetic material with the same diameter as the part being tested) should be placed on each end of the part to increase the L/D ratio, or another technique should be used.

6.4 Particle Application

6.4.1 Wet Continuous method is required. Dry continuous method may be used with prior approval of the purchaser.

6.4.2 Residual method shall only apply to examination of parts in areas in which, because of geometric constraints, the continuous method cannot be used. The residual method shall be used only when specifically approved by the purchaser or when it has been documented that it can detect actual or artificial discontinuities in test parts having the same material and processing steps, and similar geometry to the actual part.

6.4.3 Magnetic Polymers may be used with prior approval of the purchaser.

6.5 Evaluation

6.5.1 Following magnetization and particle application, the part shall be examined for indications. All indications will be identified as relevant or non-relevant. Relevant indications are due to a discontinuity in the material. Non-relevant indications are not due to a discontinuity in the material and thus will not have a detrimental effect on the function of the part. Relevant indications will be compared to accept/reject criteria.

6.5.2 When required, the location of all rejectable indications shall be marked on the part.

6.5.3 Indications which are not acceptable in accordance with the applicable acceptance standards require submittal of the appropriate request for deviation document (SDR or QCR in accordance with Para. 2.3.

6.6 Post-Inspection Demagnetization and Cleaning

6.6.1 Unless otherwise specified, all parts shall be demagnetized, cleaned, and corrosion protected after examination.

6.6.2 Demagnetization

6.6.2.1 When using an ac demagnetizing coil, hold the part approximately 1 foot in front of the coil and then move it slowly and steadily through the coil and at least 3 feet beyond the end of the coil. Repeat as necessary. Rotate and tumble parts of complex configuration while passing through the field of the coil. If the part cannot be moved, move the coil in the same manner described. Operator shall ensure that the part is entirely removed from the influence of the coil before the demagnetizing force is discontinued, otherwise the demagnetizer may have the reverse effect of magnetizing the part.

6.6.2.2 When using dc demagnetization, the initial field shall be higher than, and in nearly the same direction as, the field reached during inspection. The field shall then be reversed, decreased in magnitude, and the process repeated (cycled) until an acceptably low value of residual field is reached.

6.6.2.3 Yokes may be used for local demagnetization by placing the poles on the surface, moving them around the area, and slowly withdrawing the yoke while it is still energized.

6.6.3 Unless otherwise specified, acceptable residual magnetism is ± 3 Gauss, or less, or ± 2 divisions, or less, on the Magnaflux Field Indicator. Residual magnetic field requirements apply only to surfaces specifically noted on part drawings, etc.

6.6.3.1 **WARNING - The sensing element within some pocket field indicators is not located 5/8" from the outside diameter. (Example: square meters)**

6.6.3.2 Gauss/Tesla Meters may be used provided the readings are taken at a distance of 5/8" from the surface being checked for residual field.

6.6.3.3 One of the following procedures for Checking Accuracy of Round Pocket Field Indicators is required:

6.6.3.3.1 Accuracy can be checked by placing in a Calibrated Field Indicator Tester; i.e., a fixture containing a permanent magnet of certified field strength. Reading of pocket field indicator must be within the certified range.

6.6.3.3.2 Accuracy can be checked against a Calibrated Field Indicator of known accuracy.

6.6.3.3.3 At every use of the Pocket Field Indicator, the operator must verify that the indicator has returned to "zero". Field indicators which do not return to "zero" or those with over sensitized elements due to being subjected to a very strong magnetic field should be scrapped.

6.6.4 Post inspection cleaning must be accomplished to remove magnetic particle residue.

7. PROCESS/QUALITY CONTROLS

7.1 System Performance

7.1.1 System Performance Verification

7.1.1.1 The overall performance of the magnetic particle examination system, including equipment, materials, and the lighting environment being used, shall be verified initially and at regular intervals thereafter. The interval for system performance must be approved by the purchaser. The system performance check can be accomplished using one or more of the following:

7.1.1.1.1 Using representative test parts containing known discontinuities of the type, location, and size specified.

7.1.1.1.2 Using fabricated test parts with artificial discontinuities. Artificial defects may be fabricated to meet a particular need or may be commercially available magnetic field indicators (pie gauges, tapered blocks, quantitative quality indicators (QQI's), etc.) When commercial devices are used, their magnetic properties, flaw types, and surface condition should be as close as possible to the production part.

7.1.2 Other Required Verification Intervals

7.1.2.1 Black light intensity shall be checked at least once per day.

7.1.2.2 Ambient white light intensity shall be checked at least once per day.

7.1.2.3 Visible light intensity shall be checked at least once per day.

7.1.2.4 Wet particle concentration shall be checked at least every 8 hours or every shift change.

7.1.2.5 Water break test shall be checked at least once per day.

7.1.2.6 Wet particle contamination shall be checked at least each time the particle concentration is checked.

7.1.2.7 Equipment calibration checks shall be conducted as follows:

7.1.2.7.1 Ammeter accuracy shall be verified at least once every six months.

7.1.2.7.2 Timer controls shall be checked at least once every six months.

7.1.2.7.3 Quick break circuit shall be checked at least once every six months.

7.1.2.7.4 Dead weight check shall be performed at least once every two months.

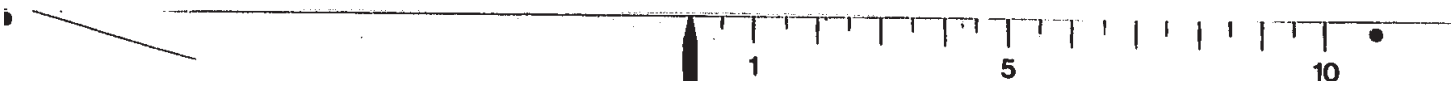
7.1.2.7.5 Black Light/White Light Intensity Meters (Radiometer/Photometer) and sensors calibration shall be performed at least once every six months.

7.1.2.7.6 Pocket Field Indicators must have accuracy checked weekly in accordance with Para. 6.6.2.3.

7.1.2.7.7 Gauss/Tesla Meters shall be calibrated at least once every six months.

7.1.2.7.8 Calibrated Field Indicators shall be certified at least once every six months.

7.1.2.7.9 Calibrated Field Indicator Tester shall be certified at least once per year.



7.1.2.8 A record of all verifications described in Para. 7.1.2 is required. Records shall be maintained for the time period specified in the contract.

7.2 Suspension Vehicle Tests

7.2.1 Suspension concentration check is not required for aerosol can solutions.

7.2.2 Wet Particle Concentration, Contamination, and Water Break Tests shall be performed in accordance with ASTM-E-1444 requirements.

7.3 Equipment Calibration

7.3.1 Calibration requirements for ammeter accuracy, timer control accuracy, quick break, and dead weight checks shall be in accordance with ASTM-E-1444.

7.3.2 Black Light/White Light Intensity Meters, Pocket Field Indicators, Gauss/TeslaMeters, Field Indicator Testers, etc., shall be calibrated to the manufacturer's specifications.

7.4 Eye Glasses

7.4.1 When using fluorescent materials, inspectors shall not wear eye glasses that are photochromic or that have permanently darkened lenses.

7.4.2 Eye glasses with lenses treated to absorb ultraviolet light are permitted.

7.5 Safety

7.5.1 The safe handling of magnetic particles, oil vehicles, water baths, and water conditioner concentrates are governed by the suppliers' Material Safety Data Sheets.

7.5.2 Magnetizing equipment shall be maintained properly to prevent personnel hazards from electrical short circuits.

7.5.3 Cracked or broken ultraviolet filters shall be replaced immediately. Broken bulbs can continue to radiate ultraviolet energy and must be replaced immediately.

7.6 Dark Adaptation

7.6.1 Personnel should wait at least 3 minutes after entering a darkened area for their eyes to adjust to the low-level lighting before performing fluorescent magnetic particle examination.

8. EVALUATION OF INDICATIONS

8.1 All indications in weld craters shall be considered relevant and shall be evaluated in accordance with applicable acceptance standards.

8.2 If indications are believed to be non-relevant, at least 10 percent of each type of indication shall be explored by removing the surface roughness or other condition believed to have caused the type of indication to determine if actual defects are present.

8.3 The absence of indications upon re-testing by magnetic particle inspection after removal of the surface roughness, or other condition, shall be considered to prove that the indications were of non-relevant origin.

8.4 If a re-test again reveals indications, these and all of the original indications shall be considered to be relevant and shall be evaluated in accordance with applicable acceptance standards.

9. RECORD OF TEST

9.1 The following information shall be supplied by the Supplier:

9.1.1 Supplier name

9.1.2 Part identification

9.1.3 Shop order or purchase order number

9.1.4 Part drawing number

9.1.5 Final disposition of part

9.1.6 Date of test and name of person performing the test

9.2 Copies of the magnetic particle test report shall be submitted to the appropriate Engineering group through appropriate channels.

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