

WORK INSTRUCTION

QC MPI/2015/01

MAGNETIC PARTICLE INSPECTION PROCEDURE

Record of Amendments

The following is a brief summary of the most recent revisions to this document.

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QUALITY CONTROL – IRAQ

Revision: 01
Effective: 20.July.2020

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1.0 Introduction

- 1.1 The objective of this procedure is to provide the Customer and Verifying Bodies with a documented procedure for the execution of Magnetic Particle Inspection and provide NDT personnel with a general but non-specific procedure which addresses the activities associated with the Inspection of ferromagnetic materials.
- 1.2 Prior to commencement of any inspection, (Quality Control- Iraq) shall inform NDT personnel of the scope of work ahead. Inspectors shall ensure that they are familiar with the instruction and procedural requirements of work to be undertaken and that all relevant information documented or otherwise is made available to facilitate job completion.

2.0 Scope

- 2.1 The scope of this procedure covers the use of Electromagnetic A.C. Yokes for the detection of surface discontinuities and is based on BS EN ISO 9934, Part 1, 2, and 3 – Standard Practice for Non-Destructive Testing, Magnetic Particle Testing, BS EN ISO 1290 – Magnetic Particle Testing of Welds and ASTM E1444 – Standard Practice for Magnetic Particle Examination.
- 2.2 The mode of magnetisation shall be the continuous method for all applications using A.C. and for visible and fluorescent techniques where applicable.
- 2.3 Unless otherwise agreed by (Quality Control - Iraq), this procedure shall be used when performing duties or activities involving magnetic particle inspection.
- 2.4 This procedure is intended to reveal flaws from the test, which may or may not be detrimental to the integrity of the structure. It will, at all times be the objective of the technician to find and report all significant flaws.
- 2.5 Clients may request that the work-scope be carried out in accordance with BS 6072:1981 and its associated documents for reference for Magnetic Particle Flaw Detection. To accommodate this requirement, reference should be made to the technique sheets within the appendices of this procedure in order to withdraw the need to further amend the test of this main procedure.

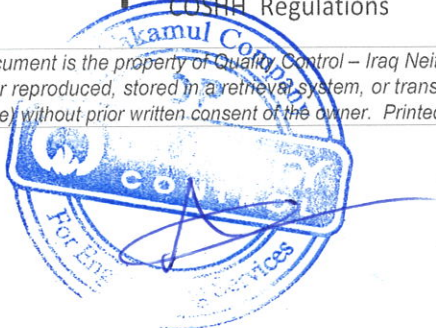
3.0 Standards and References

- 3.1 The following documents are applicable to meet the general or specific industry requirements:

- BS EN ISO 9934-1 – Magnetic Particle Testing, Part 1 – General
- ASTM E1444 - Magnetic Particle Examination
- Company Safety Procedures
- Company Operating procedures
- Health & Safety Law
- COSHH Regulations



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- SNT TC 1A Recommended Practice – Qualification and Certification in NDT 2016 Edition
- PCN Certification Scheme Documentation – Personal Qualification and Certification in NDT
- Company Written Practice
- Client Specification – Acceptance Standards (Attached Separately)
- BS EN ISO 1330-1 – Non Destructive Testing, Terminology Part 1 and General Terms
- BS EN ISO 1290 – Magnetic Particle Testing of Welds
- BS EN ISO 9934-2 – Non Destructive Testing Part 2 – Definition
- BS EN ISO 9934-3 – Non Destructive Testing Part 1 – Equipment
- BS EN ISO 3059 – Non Destructive Testing – Viewing Conditions
- BS EN 473 – General Criteria for Certification and Qualification of NDT Personnel

(All above documents shall be based on the latest revision)

Note – Other standards which may be required, as part of customers' requirements shall be detailed on the technique sheet without further amendments to the text of the main procedure.

4.0 Terminology

4.1 Standard terms and abbreviations used within this procedure are defined within the glossary terms and definitions BS EN 1330-1 Non Destructive Testing Terminology Part 1 – Glossary Terms and ASTM E1316.

4.2 Non standard definitions / abbreviations are as follows:

- SNT – Society of Non-Destructive Testing
- PCN – Personnel Certification in NDT
- NDT – Non Destructive Testing

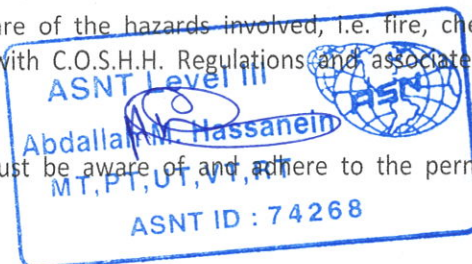
5.0 Safety

Where deemed necessary, all technicians performing magnetic particle inspection shall wear, prior to and during inspection, safety glasses, safety boots, safety coveralls and gloves as a minimum.

All operators shall be familiar with the Health and Safety Law and be cognisant with the Company Safety Procedure.

Operators carrying out Magnetic Particle Inspection shall be aware of the hazards involved, i.e. fire, chemical reaction, toxic, UV-A radiations etc and this would be cognizant with C.O.S.H.H. Regulations and associated risk assessments.

All inspection work carried out on clients' installations or sites must be aware of and adhere to the permit to work systems, where applicable.



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No inspection tasks will be performed without the operators being in possession of a valid permit entitling them to carry out inspections as specified within the correct permit.

In compliance with the installation / work site permit requirements, any materials / consumables used during the inspection must be disposed of safely using the receptacles provided.

6.0 Personnel Qualifications

- 6.1 All operators performing magnetic particle inspection shall be trained, experienced and currently certified in that method to SNT or PCN Level II, or equivalent in weld sector, as a minimum.

All training records shall be kept within personnel files. All operators shall hold current valid certification in accordance with the Company Written Practice and in line with SNT-TC-1A 2016 Edition.

Operators' qualification certificates shall be available for review by the client at any time.

All personnel shall meet, in addition to the above; the qualification requirements stated by the client and shall demonstrate their experience and competence in any given aspect of the technique, if required.

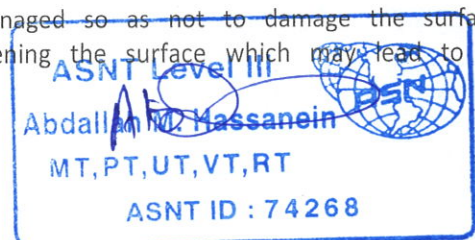
7.0 Identification and Datum Points

- 7.1 All material inspected shall have evidence of a unique number for traceability as determined by client.
- 7.2 A datum point shall be clearly marked by means of paint, marker pen, tape or other means acceptable by the client in order to identify the areas where indications or discontinuities may be present and to ensure the repeatability of test results or the future location of defects.
- 7.3 In the event of any material being found defective a detailed drawing will be provided. The item shall be identified as rejected and marked clearly on the component using a marking pen or similar that will not affect the use of the component or prejudice any subsequent testing.

8.0 Surface Preparation

- 8.1 All area(s) under inspection shall be clean and dry and free from all contaminants such as oil, grease, debris, rust, scale, paint, water and or any foreign matter that may affect or hinder the sensitivity of the test.

- 8.2 Mechanical cleaning operations must be carefully managed so as not to damage the surfaces of inspection leading to mechanical damage or by peening the surface which may lead to closing discontinuities open to the surface.



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9.0 Extent of Inspection

- 9.1 All areas to be inspected should be identified on a request for inspection as required or provided by the client / issuing authority.
- 9.2 Where sections or part sections require inspection, at least 25mm either side of those areas shall be tested unless otherwise agreed by contracting parties.

10.0 Equipment Specification

- 10.1 The equipment used will be maintained in proper working order in accordance with the requirements and applicable reference specifications (BS EN ISO 9934 – Part 3).

Each magnet will be identified by a unique serial number and will be function checked using a calibrated 4.5kg test weight before use.

- 10.2 The type of equipment normally used in the activities associated with the material under test, but not limited to, are as follows:

- Pulsed DC Electromagnet (if required)
- Y6 Electromagnet, 110V A.C.
- Penetrometer, Foil Strip Type I or Equivalent
- UV-A Lamps Portable 110V A.C.
- Radiometer / Photometer
- Crowe Receiver or Equivalent
- Test Weight 10Lbs (4.5Kg)
- White Contrast Paint – J&A Neopaint or Equivalent
- Medium – J&A Neocol or Equivalent / J&A Neoastra or Equivalent

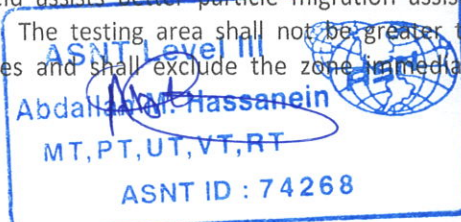
10.3 Magnetising Techniques

The magnetic field is induced into the workplace by application of an AC or Pulsed Electromagnet by placing on to the material surface.

The medium is applied prior to and during magnetic induction (continuous mode) with a shot duration of 3 to 5 seconds. The alternating or pulsed field assists better particle migration assisting detection of leakage fields from discontinuities or defects. The testing area shall not be greater than that defined by a circle inscribed between the pole pieces and shall exclude the zone immediately adjacent to the poles.

10.4 Magnetic Field Directions

Discontinuities are difficult to detect by Magnetic Particle Method when they make an angle less than 45° to the direction of magnetisation. To ensure the detection of discontinuities in any direction,



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each area / part must be magnetised in a minimum of two directions at approximately right angles (90°) to each other.

10.5 A.C. and DC pulsed current Yokes

The strength of the Y6 Electromagnet shall be assessed by its lifting power by magnetic attraction alone and shall be capable of lifting a calibrated weight of at least 4.5Kg, with pole spacing of between 50 – 150mm, where typical pole spacing of 100mm – 150mm are used. The Y6 Electromagnet shall induce a magnetic field between the poles (legs) and use the continuous method of application used for local magnetisation. Portable yokes shall have articulated legs (poles) that allow the legs to be adjusted to contact irregular surfaces or two surfaces that join at an angle. The area to be inspected is considered to be a circle inscribed between the pole pieces. An A.C. Electromagnet produces a longitudinal magnetic field and the pole pieces of the magnet shall abut intimately against the component being tested.

10.6 Penetrameter

Adequate field direction shall be verified by using an appropriate Penetrameter (e.g. foil strip type I), placed across the material perpendicular to the longitudinal magnetic field. Three indications minimum shall be visible on the foil strip during the application of the medium from the continuous method used. Slotted shim foil strips shall be used to verify field direction as a rough guide and shall never be used to distinguish the permeability of the material under test.

Note – Flux indicators (e.g. shim type) placed in contact with the surface under test, provide a guide to the magnitude and direction of the tangential field strength, but should not be used to verify that the tangential field strength is applicable.

Owing to miss-leading results caused by large flux leakage fields, magnetic flux indicators should not be used when magnetising by permanent magnet or DC electromagnet, except to verify the ink is suitable and correctly applied.

10.7 Inks

The date on the aerosol should be checked before using to make sure it is in date. Out of date aerosols should be removed from storage and the technical manager informed. These will then be disposed of in a suitable manner.

The batch number should be recorded in the report.

Purchase of new inks will come with a certificate of conformity which shall be kept / controlled within the Company Quality System

10.7.1 Magnetic Flaw Detection Inks

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Inks should be thoroughly agitated for 2 to 3 minutes minimum prior to use to ensure magnetic particles are dispersed evenly throughout the liquid carrier medium.

10.7.2 Aerosols should be held approximately 200mm from the surface to be examined ensuring even dispersion over the area(s) inspected. Application of the medium shall be directed between the electromagnetic poles prior to and during induction of the magnetic field.

10.7.3 Detecting Media

Care must be taken to ensure that the correct medium is used in conjunction with the applicable equipment and the material under test.

Wet inks shall be used between temperatures 5° to 55°C.

Detecting media shall be in compliance with the manufacturers' specification and that of BS EN ISO 9934 Part 2 and ASTM E1444 recommendations.

10.8 To enhance examination of the material where necessary preparatory contrasting white background paint will be applied prior to the ink solution. Background paints used will be supplied by a recognised supplier and conform to the requirements of BS EN ISO 9934 Part 1, ASTM E1444 and clients recommendations.

The date on the aerosol should be checked before using to make sure it is in date. Out of date aerosols should be removed from storage and the technical manager informed. These will then be disposed of in a suitable manner.

The batch number should be recorded in the report.

Purchase of new background paint will come with a certificate of conformity, which shall be kept / controlled within the Company Quality System.

10.8.1 Where contrast paints are employed, a thin, even adherent coating shall be lightly applied over all inspection areas and allowed to dry, application shall be in compliance with that of the manufacturers' instructions.

10.8.2 Care should be taken not to apply a thick coating as this may mask the indication or greatly reduce the sensitivity of the test.

10.8.3 Painted parts may be tested provided that the paint forms a thin, coherent coating, lightly adhering to the surface and normally not thicker than 50µm.

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In cases where coatings are unavoidably greater than 50µm, the sensitivity shall be verified.

Note – Where any doubt exists, paint coating thickness shall be established using an Elcometer (or other suitable devices) or paint coatings shall be removed prior to testing.

Viewing

10.9 All examinations shall start with a visual examination to ensure removal of all surface contaminants and/or identify discontinuities that may produce indications during inspection.

Note: Any mechanical damage found during visual inspection shall be reported for further evaluation.

10.10 Visual examination(s), shall be performed under evenly illuminated light (artificial or daylight) which shall be at or exceed 500 lux.

10.11 When fluorescent UV-A techniques are used, the operator shall carry out the inspection in a darkened area (≤ 20 lux) and allow at least one minute prior to the inspection to enable their eyes to adapt to the dark viewing conditions. Photo chromatic spectacles shall not be worn when working with UV-A light. For prolonged periods within the UV-A test areas, sodium tinted glasses may be worn.

10.12 UV-A Intensity irradiance shall be $\geq 1000 \mu\text{W}/\text{cm}^2$ ($10 \text{ W}/\text{m}^2$) in accordance with BS EN ISO 3059 and ASTM E1444 at the inspection surface.

Note: A warm up period of 10 minutes may be required when using mercury vapour arc lamps prior to use.

10.13 UV-A lamps shall be fitted with a suitable filter and checked to verify they are free from any damage and be kept clean prior to each use. Damaged filters shall be immediately replaced.

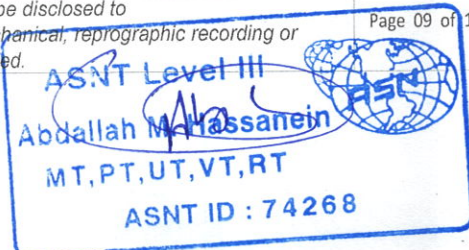
Blacklights (UV-A Lamps) shall be checked periodically for cleanliness and integrity and shall be cleaned, repaired or replaced, as appropriate. Periodic checks of cleanliness / integrity need not be recorded in accordance with BS EN ISO 3059 and ASTM E1444.

10.14 A radiometer shall be used to verify light levels for both the visible & fluorescent techniques used.

11.0 Equipment Calibration

11.1 Only equipment that holds current valid calibration certification to National or International standards shall be used when performing Magnetic Particle Inspection. Calibration information shall be identified on the equipment either by tags, stickers or by any other method approved.

11.2 Records of calibration shall be kept / controlled within the Company Quality System.



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12.0 Equipment Function Tests

12.1 The operator shall carry out a functional test on a daily basis or prior to commencement of work. The test shall be designed to ensure the proper functioning of both the equipment and the magnetic medium in order to reveal discrepancies in either the procedure or the magnetisation technique or the detection media.

12.2 An updated record of all the checks shall be kept on file within the Quality System to include sensitivity checks, and any other function tests that may be required.

Any equipment that fails a function test shall be quarantined and tagged as to the nature of the non-conformance.

After repair of any equipment, a new calibration shall be carried out in accordance with Section 11.0 of this procedure and a record of the equipment history shall be maintained on file.

12.3 Demagnetisation

Demagnetisation may be carried out at the clients request or if specified in drawings, clients' specification or purchase orders, when required on acceptable level of residual magnetisation and the measuring method shall also be specified.

Where demagnetisation is required, an AC Yoke shall be stroked along the surfaced of the material and withdrawn to a distance of $\geq 450\text{mm}$ and the electromagnet switched off. Repeat this process as necessary. After demagnetisation, a magnetic field probe or strength meter shall not detect fields with an absolute value of that specified by the client.

A gauss meter may be used only to determine if it is not intended for accurate measurements of flux leakage should accurate measurements be required a hall effect probe or equivalent shall be employed.

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