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PCN/GEN Appendix C3.1B Issue 4 Rev C

Further information concerning the content of PCN documents is available from the PCN Scheme Manager at the above address.

SPECIFIC REQUIREMENTS FOR THE CERTIFICATION OF PERSONNEL IN ALTERNATING CURRENT FIELD MEASUREMENT (ACFM) TESTING OF FERRITIC WELDS

ASSOCIATED DOCUMENTS:

Appendix C3.2B to PCN/GEN

Examination Syllabus for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

Appendix C3.3B to PCN/GEN

Specimen Examination Questions for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

CONTENTS

1. SCOPE 2
2. EXAMINATION CONTENT 2
3. CERTIFICATION AVAILABLE 3
4. RENEWAL AND RECERTIFICATION.....3
6. GRADING 3
PCN/GEN Appendix C3.2B Issue 2 4
REFERENCE LITERATURE 9
LEVEL 1.....2
LEVEL 2.....3
LEVEL 3.....5

1. SCOPE

1.1 This document prescribes the specific requirements and procedures by which personnel may be examined and, if successful, certificated for the Electromagnetic Testing of Ferritic Welds using Alternating Current Field Measurement (ACFM) techniques. Requirements contained in this document are supplementary to those contained in the current edition of PCN General Requirements for the Certification of Personnel engaged in Non-Destructive Testing.

1.2 Candidates for ACFM examinations are encouraged to bring their own equipment, including probes but test centre equipment may be hired subject to availability. Where candidates elect to use their own equipment the test centre will provide a substitute lap top computer and software. Candidates will not be allowed to use computers other than those provided by the test centre for the examination. Candidates who elect to use test centre equipment will be allowed extra time prior to the examination to familiarise themselves with the equipment.

1.3 Additional periods of training, over and above those specified by PCN, may be required for personnel engaged in two person operation.

2. EXAMINATION CONTENT

General information on examination content and time allowed for each written part is described in PCN General Requirements for Certification of Personnel engaged in Non-Destructive Testing. This Appendix amplifies the provisions of that document only where necessary.

2.1 Level 1

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprising the following:

2.1.1 General Theory of the ACFM technique.

2.1.2 Sector Specific Theory of the application of the ACFM electromagnetic testing technique to the testing of Welds including basic weld production processes and associated defects.

2.1.3 Sector Specific Practical examination utilizing remote probe operator and comprising of:

(i) setting up and checking of equipment function and probe sensitivity; (ii) examination of one steel block containing machined defects, and of two steel welds selected from plate, pipe and tee, the welds to be uncoated or to have a non- metallic coating.

(iii) reporting the results in a prescribed manner in accordance with the NDT instructions provided.

(iv) briefing remote probe operator

The total time allowed for the practical examination is 90 minutes. The minimum pass mark for the practical part is 70% in each sample tested.

NOTE: *Typical defects which candidates will be expected to locate and size will include a selection from but may not be limited to:*

(i) surface breaking defects;

(ii) plane and curved surface defects;

(iii) longitudinal defects in the weld or parent material, originating from the welding process or in service fatigue.

2.2 Level 2

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprising the following:

2.2.1 General Theory of ACFM.

2.2.2 Sector Specific Theory of the application of the ACFM electromagnetic testing technique to the testing of welds.

2.2.3 Sector Specific Practical examination comprising:

(i) setting up and checking equipment function and probe sensitivity.

(ii) examination of 3 welds selected from various configurations including plate, pipe, "T", "Y" and gusset plate (one or more of which will be coated).

(iii) interpreting and reporting the results in accordance with the NDT instructions provided.

(iv) sizing and reporting of 3 defects from pre-recorded inspection data on computer disks;

(v) production of probe configurations.

(vi) preparation of a detailed NDT Instruction, suitable for a level 1 certificated individual to follow, involving the testing of one of the above samples to a provided procedure, standard or specification.

(vii) set up probe configuration for detection and depth sizing

The total time allowed is 4 hours.. The minimum pass mark for the practical part is 70% in each sample tested

NOTE: *Typical defects which candidates will be expected to locate and size will include a selection from but may not be limited to:*

(i) surface breaking defects;

(ii) plane and curved surface defects;

(iii) parent material and weld defects, both longitudinal and transverse, originating from the weld or adjacent parent material;

(iv) in-service defects in the weld or adjacent parent material.

2.3 Level 3

Except where exemptions apply (refer to PCN General Requirements), all candidates will be required to attempt an examination comprising a Basic examination and a Main Method examination. Information on the content and grading of PCN level 3 examinations is provided in PCN General Requirements for Certification of Personnel engaged in Non-Destructive Testing.

Level 3 candidates not holding a valid PCN level 2 ACFM testing of welds certificate will be required to be successful in the practical examination detailed in Clause 2.2.3 except clause (iv).

3. CERTIFICATION AVAILABLE

3.1 Level 1

3.1.1 ACFM Testing of Welds including the direction of remote probe operators.

3.2 Level 2

3.2.1 ACFM Testing of Welds.

3.3 Level 3 ACFM Testing of Welds.

Candidates who achieve an overall score of 80% or more for Level 1, 2 and 3 examinations shall be awarded with the distinction level ‘D’ (refer to PCN GEN – Grading of Examinations).

4. RENEWAL AND RECERTIFICATION

4.1 The general rules for level 1 and level 2 renewal and recertification are fully described in the current edition of PCN document CP16, and level 3 recertification is described in CP17.

4.2 Level 1 certificate holders seeking recertification will be required to undertake the practical examination detailed in clause 2.1.3 above. 4.3 Level 2 certificate holders seeking recertification will be required to undertake the practical examination detailed in clause 2.2.3 above, except they will test only two weld samples. The maximum time allowed is 3 hours and the minimum pass mark is 70%.

6. GRADING

General information on the grading of examinations will be as specified in the current edition of PCN General Requirements, and information on the grading of practical examinations is provided in PCN document CP22.

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EXAMINATION SYLLABUS FOR THE CERTIFICATION OF PERSONNEL IN ALTERNATING CURRENT FIELD MEASUREMENT (ACFM) TESTING OF FERRITIC WELDS

ASSOCIATED DOCUMENTS:

Appendix C3.1B to PCN/GEN

Specific Requirements for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

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Specimen Examination Questions for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

CONTENTS

LEVEL 1 SYLLABUS……5
LEVEL 2 SYLLABUS……6
LEVEL 3 SYLLABUS……7
REFERENCE LITERATURE……9

LEVEL 1 SYLLABUS

1. General Theory of the ACFM Technique

1.1 History of Electromagnetic Testing

1.1.1 Terms and definitions used in electromagnetic testing. Electrical Theory: Basic AC theory, electromagnetics. Magnetic fields generated by alternating electric currents in conductive materials. Effect of material geometry on magnetic fields.

1.1.2 General principles of the ACFM technique. Field measurements, both surface and perpendicular: surface magnetic fields from defects and factors affecting penetration. Uniform fields. Effect of field curvature. ACFM equipment design and construction. ACFM signal displays and presentation of signals. Storage of data. Retrieval of data.

2. Specific Theory of the ACFM Technique

2.1 Introduction

Range of available ACFM techniques, when and where they may be used, and their capabilities and limitations. Defect detection limits. Defect sizing limits.

2.2 Equipment Selection and Preparation

Types of equipment. Correct use of equipment. Particular applications of each equipment type. Construction of probes. Selection of probes for various applications. Equipment setting up and checking.

2.3 The effect upon the ACFM Test of the Material to be Tested

The effect of geometry and the proximity of materials having different conductivity and permeability to the test material. The effect of surface finish (including grinding), preparation and coating on the conduct of ACFM techniques. Effect of crack shape and orientation on ACFM signals. Effects of geometry.

2.4 Preparation for Testing

2.4.1 Surface preparation, methods used for surface preparation; importance of correct surface preparation.

2.4.2 Pre-test visual inspection and reporting.

2.4.3 NDT procedures and Instructions - reasons for NDT procedures and instructions and general contents.

2.5 Carrying out the Test

2.5.1 Probe handling and signal observation. Inherent difficulties and solutions.

2.5.2 Typical responses to the effects of variation in geometry of test materials, different types of discontinuity and the effect of surface coatings.

2.5.3 False indications, their identification and cause.

2.5.4 Off scale readings on instrument, reasons and corrective actions. Potential equipment faults, causes and corrective actions.

2.5.5 Recording and retrieval of information (on computer and using written report sheets).

2.5.6 Factors affecting the sensitivity of the ACFM technique. Correct use of instruments for crack detection and sizing, and for presentation of and recording information. Methods for accurate measurement of defect length and depth.

2.6 Post Test Procedures

Reporting. Presentation of inspection results. Off-line data analysis procedures

2.7 Codes and Standards and Specifications

Current and developing national, European and international standards relating to electromagnetic testing techniques in general. Industrial codes and specifications, and typical ACFM inspection procedures.

2.8 Briefing of remote probe operator

Briefing of remote probe operator; minimum qualification for remote probe operators;

LEVEL 2 SYLLABUS

As for Level 1 and, in addition:

3. General Theory

3.1 Electrical Theory

Further principles of AC theory. Further principles of magnetisation; magnetic effect of current flow, magnetic flux density. Magnetic fields from electric currents. Induced currents and fields. Directions of currents and fields. Generation and measurement of magnetic and electric fields.

3.2 Equipment

ACFM equipment design and construction. The range of available ACFM instruments. ACFM displays. Probe arrangements specific to weld inspection. Configuration of probe files. Probe selection. Array probe technology.

4. Sector Specific Theory

4.1 Preparation for Testing

4.1.1 Surface preparation, methods used for surface preparation; importance of correct surface preparation. Pre-test visual inspection and reporting.

4.1.2 ACFM techniques: probe characteristics and selection; factors affecting sensitivity; selection of equipment; lift-off compensation; design and application of test reference standards; limitations of the various methods and types of test equipment; examples of when to use various methods; selection of the appropriate technique to ensure complete coverage. Methods of assessing sensitivity of technique.

4.2 Safety Precautions

Fire hazards, electrical safety.

4.3 Conduct of Test

4.3.1 Test Procedure - reasons for NDT instructions and specific contents required. Supervision of level 1 personnel.

4.3.2 Factors affecting the sensitivity of the ACFM technique. Correct use of instruments for crack detection and sizing, and for presentation of and recording information. Methods for accurate measurement of defect length and depth.

4.3.3 Probe and instrument set-up; selection of probes for specific inspection; production of probe configurations; equipment function and operation checks.

4.3.4 Computer file handling.

4.4 Detectability of Defects

General advantages and limitations of the test method with regard to defect detection. Characteristics of indications. Probe handling factors which can affect indications. Basic metallurgical factors that can affect ACFM readings. Effect of coatings, grinding and geometry.

4.5 Characterisation of Defects

Difficulties and limitations. Values measured.

4.6 Interpretation and Reporting

4.6.1 Types of discontinuity and their identification. Relevant, non-relevant and false indications and their cause. Identification of crack features and their effect. Capabilities and limitations of other NDT methods in terms of detection, characterisation and confirmation of defects.

4.6.2 Responsibilities for reporting. Origination and authentication of NDT reports. Content and layout of report. Presentation of the inspection results on an NDT report. Hard copy and computer reports. Maintenance and retention of records.

5. Welding Product Technology

5.1 Basic Welding Processes

5.1.1 Terminology for welds. Basic principles of fusion welding processes. Schematic lay out and general method of producing welds: MMA, TIG, MIG/MAG, submerged arc

5.1.2 Basic types of welds: fillet welds, butt welds. Variable configuration welds: 'T's, nozzles and nodes

5.2 Fabrication Defects

5.2.1 Types of defect associated with particular parent metal/welding process combinations including: lack of fusion (all types), porosity; worm holes, gas pores, cracks; centre line, HAZ.

5.2.2 Visual defects including weld mismatch etc., lack of penetration, grinding cracks, slag.

5.2 3 How defects are formed.

5.3 In-service Defects

Fatigue cracks, stress corrosion cracks.

5.4 Stress Relieving

What stress relieving is and why it is carried out.

5.5 Normalising

Definition of normalising and the differences to annealing.

LEVEL 3 SYLLABUS

Level 3 personnel are expected to be competent to assume the responsibilities of management of an industrial NDT facility. The PCN level 3 examination will therefore evaluate the candidate's knowledge of the following:

Allocation of staff with appropriate certification according to customer's requirements. Supervision and maintenance of subordinate's certification and recertification documents and records.

Compilation of records of equipment performance, repairs and maintenance of subordinate's certification and recertification documents and records.

Compilation of records of equipment performance, repairs and maintenance; the work done and results achieved by supervised staff. The review of reports of work done by subordinates, its periodic validation, and the endorsement of routine reports. Review of current practices, equipment, techniques and instructions. Maintenance of standards and text book libraries. Safe working practices and current legislation.

The level 3 examination syllabus is as follows:

6. General Theory

Candidates will be required to be familiar with all the content of the theoretical and practical syllabi for level 2 in ACFM.

7. General Theory of Other NDT Methods at Level 2

7.1 General theory at level 2, including limitations and applications, of four NDT methods. The examination syllabi are detailed in appendices to PCN General Requirements and are obtainable from PCN or any of its test centres.

7.2 In detail, the level 3 candidate will be required to demonstrate a knowledge of the level 2 general theory syllabus covering the NDT method in which level 3 certification is sought and, in addition, three others selected by the candidate from RT, UT, PT, MT, ET and VT.

8. General Theory - Knowledge of PCN Requirements

A thorough understanding of the PCN criteria for certification of all levels of personnel as applied in the current edition of the PCN General Requirements for the certification of personnel engaged in NDT.

9. Sector Specific Theory

The syllabus for PCN ACFM Testing of Welds at level 2, and in addition:

9.1 Codes for Testing and Flaw Acceptance Limits. Familiarity with the criteria in codes and standards covering the application of Electromagnetic Testing in the Welds sector. An understanding of the way in which these are applied in practice.

10. Materials Technology Theory

This examination part will cover the product technology syllabus given earlier under level 2, but the level 3 candidate will also require an understanding of castings and forging processes and associated defects.

11. Procedure Writing

11.1 Candidates will be required to produce a written procedure for the inspection of a specified component to a provided code or standard. PCN publishes a document, reference CP25, for information and for use by candidates in this open book examination.

NOTE: *Codes and standards of other national (or international) origins may be proposed by candidates, if appropriate to their job responsibilities, for use in this examination module. Candidates should notify the test centre of their choice on the enrolment form and will be permitted to bring a copy of the chosen code or standard to the test centre for use in this open book examination.*

11.2 The procedure must include safety requirements appropriate to the test situation, acceptance levels to specified application standards, NDT personnel approvals, reference documentation, the use of complementary NDT methods, the timing of inspection in relation to manufacture and overhaul, special contractual requirements, action to be taken in case of non-compliance and reporting instructions (implementation of the procedure).

REFERENCE LITERATURE

Essential Reading

- BS EN 1300-1: Non-destructive testing-Terminology – Part 1 List of general terms
- BS EN 1330-2: Non-destructive testing-Terminology – Part 2 Terms common to the non-destructive testing methods
- BS EN 1330-5: Non-Destructive Testing - Terminology - Part 5 Terms used in eddy current testing.
- BS EN 10246-1 Automatic electromagnetic testing of seamless and welded (except submerged arc welded) ferromagnetic steel tubes for verification of leak tightness
- BS EN 1711 Non-destructive examination of welds – Eddy current examination of welds by complex plane analysis.
- PCN Classroom Training Handbook (when available) - Electromagnetic testing of welds. Certification Services Division, The British Institute of Non-Destructive Testing, Midsummer House, Riverside Way, Bedford Road, Northampton, NN1 5NX.
- PCN Classroom Training Handbook - Product Technology. Certification Services Division, The British Institute of Non-Destructive Testing, Midsummer House, Riverside Way, Bedford Road, Northampton, NN1 5NX.
- Training Course Notes. PCN requires candidates to have attended an approved course of training. Accredited Training Establishments are required to provide trainees with an up to date set of training course notes. These are considered essential reading.

Recommended Reading

- Basic Metallurgy for Non-Destructive Testing, Edited by J L Taylor: The British Institute of Non-Destructive Testing, Midsummer House, Riverside Way, Bedford Road, Northampton, NN1 5NX.
- Metals handbook (volume 17, ninth edition) : Non-destructive evaluation and quality control (published by the American Society of Metals, available through ASNT).
- Materials and Processes for NDT Technology. ASNT.

ACFM Specific Technical Literature

- The following selected papers are available from Certification Services Division, The British Institute of Non-Destructive Testing, Midsummer House, Riverside Way, Bedford Road, Northampton, NN1 5NX.
- The list of available papers may be extended by the addition of later publications. This document will not be revised to show the extended list in every case.
- An Introduction to ACFM. M Lugg. Technical Software Consultants Limited.
- The use of AC Field Measurements for Non-Destructive Testing. R Collins and M C Lugg. Fatigue Crack Measurement: Techniques and Applications. EMAS 1991.
- An Alternative Method for Offshore Inspection. A Raine. CSNDT Annual Conference 1995 (Insight Vol 36 No. 9 September 1994).
- A Beginners Guide to Eddy Current Testing. J Rudlin. (Insight Vol 31 No. 6 June 1989).
- The ACFM Technique and its Application to the Inspection of Oil and Gas Installations. D Topp. 32nd Annual British Institute of NDT Conference (Insight Vol 36 No. 6 June 1994).
- Operational Experience with the ACFM Inspection Technique for Sub-Sea Weld Inspection. D Topp, B Jones. British Gas Environmental Engineering March 1994.
- The Use of Manual and Automated ACFM Techniques for Sub-Sea and Topside Crack Detection and Sizing. D Topp. Offshore S E Asia December 1994 OSEA 94.137.
- ROV Inspection of Welds - A Reality. A Raine. The British Institute of NDT Conference 1995.
- .ACFM Inspection Procedure for AMIGO and ASSIST Family Software, TSC/MCS/1449, Issue 1.5 4th June 2008 (check with TSC for later issue).

- ACFM Inspection Procedure for U31 and ASSISTu Software, TSC/MCS/1699, Issue 1.1 11th January 2007 (check with TSC for later issue).
- Additional applications with the ACFM technique. C Laenen, APAVE and A Raine, TSC. (Insight Vol 40 No. 12 December 1998).
- Defect evaluation using the alternating current field measurement technique. C K Low and B S Wong, NTU, Singapore (Insight Vol 46 No. 10. October 2004)
- Application of the ACFM inspection method to rail and rail vehicles. D Topp and M Smith, TSC (Insight Vol 47 No. 6. June 2005.
- The detection of pipeline SCC flaws using the ACFM technique. M Smith, TSC and R Sutherby, TransCanada Pipelines. (Insight Vol 47 No. 12. December 2005).
- PCN gratefully acknowledges the contributions made by the authors of the above papers, and thanks them for their permission to distribute the papers as training material.

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PCN/GEN Appendix C3.3B Issue 4 Rev A

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SPECIMEN EXAMINATION QUESTIONS FOR THE CERTIFICATION OF PERSONNEL IN ALTERNATING CURRENT FIELD MEASUREMENT (ACFM) TESTING OF FERRITIC WELDS

ASSOCIATED DOCUMENTS:

Appendix C3.1B to PCN/GEN

Specific Requirements for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

Appendix C3.2B to PCN/GEN

Examination Syllabus for the Certification of Personnel in Alternating Current Field Measurement (ACFM) Testing of Ferritic Welds.

CONTENTS

LEVEL 1.....2
LEVEL 2.....3
LEVEL 3.....5

LEVEL 1

General Theory of the ACFM Method

1. The resistance of an electrical conductor is measured in:

a) volts

b) OHMS

c) MHOS

d) Henrys

2. Conductivity of a material is affected by:

a) the air gap between probe and specimen

b) its chemical composition

c) equipment sensitivity settings

d) all of the above

3. The opposition to flow of AC is called:

a) reluctance

b) inductance

c) impedance

d) resistance

4. Which of the following test frequencies would produce eddy currents with the deepest penetration?

a) 200 Hz

b) 1 MHz

c) 10 kHz

d) 50 kHz

Sector Specific Theory of ACFM Testing of Welds

1. Variations in probe speed:

a) have no deleterious effect on results

b) will cause changes in signal amplitude

c) may result in incorrect defect assessment

d) both B and C

2. Which three items of information are required for off-line sizing of a defect?

a) i, ii, vi

b) i, iv, vi

c) ii, iii, v

d) iii, v, vi

Where: i) = measured length between markers
ii) = page number
iii) = probe direction
iv) = probe file
v) = clock position
vi) = coating thickness

3. What is the standard operating frequency of the ACFM equipment?

a) 5 kHz

b) 5 MHz

c) 5 Hz

d) none of the above

LEVEL 2

General Theory of the ACFM Method

1. When the applied voltage and current through a circuit are in phase the:

a) current leads voltage by 90 degrees

b) current and voltage have the same value

c) voltage leads current by 90 degrees

d) none of the above

2. The term used to define the value of H field required to decrease the residual magnetism in a material to zero is:

a) coercive force

b) magnetising force

c) back emf

d) the overlap value

3. When the voltage applied to a circuit and the current through the circuit both reach their maximums at the same time the voltage and current are:

a) additive

b) in phase

c) regenerate

d) out of phase

Specific Theory of the ACFM Testing of Welds

1. Which of the following conditions is the most important when selecting reference standard specimens?

a) the specimen should be the same size and shape as the component under test

b) the surface finish and material specification should conform to the component under test

c) the backwall of the specimen should be at least 50 mm in depth

d) none of the above

2. By using smaller sensing coils you would expect:

a) no measurable difference

b) larger signals

c) improved discrimination of defect features

d) less access capabilities

3. When a semi elliptical crack is in an applied uniform AC magnetic field parallel to its surface length, what is the magnitude of the magnetic field at the crack centre in the same relative to uniform field on the surface?

a) less than the uniform field

b) greater than the uniform field

c) the same as the uniform field

d) zero

4. Which of the following normally has no effect on crack depth sizing when using the ACFM technique?

a) crack angle to the surface

b) multiple cracking

c) geometry signals

d) material changes

5. Which one of the following normally has no effect on crack sizing accuracy using ACFM?

a) coating thickness (non conducting)

b) line contacts (cracking bridging)

c) multiple cracking

d) crack aspect ratio >2:1

6. An upwards movement in the butterfly plot trace will show:

a) no movement in the Bx trace

b) downward movement in the Bx trace

c) movement to the right on the Bx trace

d) upwards movement by the Bx trace

Welding Product Technology Theory

1. Slag inclusions are a common weld defect. Such defects will **not** be found in:

a) MMA welds

b) TIG welds

c) submerged arc welds

d) cored wire MIG/MAG welds

2. A lack of fusion defect orientated perpendicular to the test surface is most likely to occur in which of the following processes?

a) electroslag welding

b) TIG welding

c) MIG/MAG welding

d) oxy-acetylene welding

3. Which of the following is a weld defect?

a) porosity

b) hot tear

c) lamination

d) burst

LEVEL 3

General Theory of the ACFM Method

1. Commercial eddy current equipment may be designed to detect changes in:

a) specific gravity

b) sub-surface cavities

c) grain direction

d) electrical conductivity

2. When a non-ferrous material is passed through two comparative encircling coils a false defect free indication can arise when the defect is:

a) filled with water

b) deep but very narrow

c) long and uniform

d) short and wide

3. Impedance of an AC system used for eddy current testing is a combination of:

a) inductive reactance, resistance and capacitive reactance

b) inductive reactance and capacitive reactance only

c) resistance and capacitive reactance only

d) frequency and phase

4. The effect of lift-off on the impedance of a test coil is used principally when designing:

a) crack detectors

b) coating thickness meters

c) conductivity meters

d) ACPD crack depth instruments

General Theory of Other NDT Methods at Level 2

The examination will test the candidate's understanding of the General Theory at level 2 of four out of the radiographic, ultrasonic, electromagnetic, magnetic particle and liquid penetrant NDT methods to enable him/her to recognise correct application but not necessarily to specify techniques.

1. Thin sheets of lead foil in intimate contact with radiographic film increase film density because they:

a) fluoresce and emit visible light which helps expose the film

b) absorb the scattered radiation

c) prevent back-scattered radiation from fogging the film

d) emit electrons which helps darken the film

2. The fact that gases, when bombarded with radiation, ionise and become electrically conducting make them useful in:

a) X-ray transformers

b) X-ray rubes

c) masks

d) monitoring equipment

3. The most effective method of demagnetisation is:

a) AC aperture coil

b) reversing and decreasing DC

c) stroking with AC yokes

d) hammering along the length of the part

4. For fine, surface breaking cracks the best magnetic particle inspection medium is:

a) dry powder, black

b) dry powder, fluorescent

c) magnetic ink, black

d) magnetic ink, fluorescent

5. Water washable penetrants require longer dwell times than solvent removable versions because of the presence of:

a) emulsifier

b) stabiliser

c) penetrant remover

d) contaminants

6. The property of a liquid which affects the speed of flow is:

a) surface tension

b) edge factor

c) fill factor

d) phase differentiation

7. When the voltage applied to a circuit and the current through the circuit both reach their maximums at the same time the voltage and current are:

a) additive

b) in phase

c) generated

d) out of phase

8. The angle at which the shear component of an incident beam is refracted at 90 degrees to the normal is called the:

a) normal angle of incidence

b) first critical angle

c) angle of maximum reflection

d) second critical angle

9. As frequency increases in ultrasonic testing the angle of beam divergence of a given diameter crystal:

a) decreases

b) remains constant

c) increases

d) varies uniformly through each wavelength

Knowledge of the Requirements for PCN Certification

1. The minimum period of experience required to be eligible for the Level 2 Electromagnetic Tester examination is:

a) 3 months

b) 12 months

c) 9 months

d) 6 months

2. Candidates who fail to achieve 70% in one section of the examination but who achieve a composite grade of 80% or more are eligible for:

a) one retest of the failed part

b) two retests of the failed part

c) one retest of any two parts selected by the test centre

d) one retest of any two parts selected by the candidate

3. PCN candidates shall have near distance acuity, corrected or uncorrected, in a least one eye, such that the candidate is capable of reading:

a) Jaeger number 1 letters at not less than 30 cm

b) Jaeger number 1 letters at not more than 30 cm

c) Jaeger number 1 letters at 300 cm

d) Jaeger number 1 letters at 30 cm

Specific Theory of the Application of the ACFM Method in the Testing of Welds

Multiple choice answer questions will be similar to those for level 2, but generally more complex.

Materials Technology Theory

1. A common cause of solidification cracking in welds made with high deposition rate processes is:

a) hydrogen entrapment

b) contaminated flux or shielding gas

c) weld preparation has an unsatisfactory depth to width ratio

d) operator error

2. A casting discontinuity which is caused by gas release or the evaporation of moisture during solidification is:

a) microshrinkage

b) porosity

c) porous segregation

d) hydrogen induced porosity

3. The heat treatment process which is employed to give a soft ductile product, by recrystallisation of the material, is termed:

a) tempering

b) hardening

c) stress relieving

d) annealing

4. Poor through thickness ductility in rolled plate, often associated with non-metallic inclusions, gives rise to:

a) lamellar tearing

b) reheat cracking

c) uniform porosity

d) hydrogen cracking

5. The welding process which would be chosen for its rapid deposition rates, high welding speeds and deep penetration quality joints is:

a) electroslag

b) manual metal arc

c) submerged arc

d) TIG

6. Hydrogen cracking, due to the break down of water molecules creating hydrogen which dissolves in the weld metal and HAZ, is most likely to occur in which of the following welding processes?

a) TIG

b) MIG

c) sub-arc

d) MMA

7. In open die forging the top and bottom dies are called, respectively, the:

a) tup and anvil

b) cope and drag

c) head and foot

d) hammer and anvil