CERTIFICATION SCHEME FOR PERSONNEL

DOCUMENT No. CSWIP-ISO-NDT-11/93-R

Requirements for the Certification of Personnel Engaged in Non-Destructive Testing in accordance with the requirements of ISO 9712

APPENDIX 1

Examination Content and Syllabus details for CSWIP-ISO-NDT-11/93-R scheme

PART 7: ACFM Inspector, Level 1, 2 and 3

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Issued under the authority of the Governing Board for Certification
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1.1.0 CSWIP ACFM Inspector Level 1:

1.1.1 General theory examination

- 40 multiple-choice questions
- Time allowed: 80 minutes
- Pass mark: 70%

1.1.2 Specific theory examination

- 20 multiple-choice questions
- Time allowed: 60 minutes
- Pass mark: 70%

1.1.3 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes; record function check data and print out a hard copy.

- Time allowed: 60 minutes
- Pass mark: 70%

1.1.4 Specific practical examination

Candidates for certification in ACFM inspection can seek qualification in general engineering, rails or welds. General engineering encompasses welds, castings and wrought products (including forgings). The specific practical examinations in these two sectors are as shown below.

1.1.5 General engineering

The candidate is required to carry out inspections following written procedures as specified by an NDT Level 2 operator. The candidate is required to test and report on two specimens selected by the examiner; carry out sizing for length and depth; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 1 hour
- Pass mark: 70%

1.1.6 Rails

The candidate is required to carry out inspections following written procedures as specified by an NDT Level 2 operator. The candidate is required to test and report on two specimens selected by the examiner; carry out sizing for length and depth; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 1 hour
- Pass mark: 70%

1.1.7 Welds

The candidate is required to carry out inspections following written procedures as specified by an NDT Level 2 operator. The candidate is required to test and report on two specimens selected by the examiner; carry out sizing for length and depth; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 1 hour
- Pass mark: 70%

1.2.0 CSWIP ACFM Inspector Level 2:

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1.2.1 General theory examination

- 40 multiple-choice questions
- Time allowed: 80 minutes
- Pass mark: 70%

1.2.2 Specific theory examination

- 20 multiple-choice questions
- Time allowed: 60 minutes
- Pass mark: 70%

1.2.3 General practical examination

In the practical part, the candidate is required to choose the necessary probes and equipment to conduct the test; conduct operational and function checks on equipment and probes; record function check. Data and print out hard copy.

- Time allowed: 60 minutes
- Pass mark: 70%

1.2.4 Specific practical examination

Candidates for certification in ACFM inspection can seek qualification in general engineering, rail or welds. General Engineering encompasses welds, castings and wrought products (including forgings). The specific practical examinations are as shown below:

1.2.5 General engineering

To test and report on three specimens selected by the examiner; carry out sizing for length and depth on a fatigue crack specified by the examiner; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 90 minutes
- Pass mark: 70%

1.2.6 Instruction writing

The candidate shall draft an NDT instruction suitable for Level 1 personnel as selected by the examiner.

- Time allowed: 1 hour
- Pass mark: 70%

1.2.7 Rails

To test and report on three specimens selected by the examiner; carry out sizing for length and depth on a fatigue crack specified by the examiner; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 90 minutes
- Pass mark: 70%

1.2.8 Instruction writing

The candidate shall draft an NDT instruction suitable for Level 1 personnel as selected by the examiner.

- Time allowed: 60 minutes
- Pass mark: 70%

1.2.9 Welds

To test and report on three specimens selected by the examiner; carry out sizing for length and depth on a fatigue crack specified by the examiner; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 90 minutes

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- Pass mark: 70%

1.2.10 Instruction writing

The candidate shall draft an NDT instruction suitable for Level 1 personnel as selected by the examiner.

- Time allowed: 60 minutes
- Pass mark: 70%

1.3.0 CSWIP ACFM Inspector – Welds, Plates, Castings, Forgings, Bars and Rails made of Ferritic Steel (or Electromagnetically Similar Material) Level 3

1.3.1 Basic examination (exempt if already a holding Level 3 ISO 9712 certification)

Candidates successful in Sections A, B and C will be not required to re-sit this section when attempting additional Level 3 examinations in other methods.

Section A: Materials Science and Process Technology

- 25 multiple-choice questions
- Time allowed: 50 minutes
- Pass mark: 70%

Section B: Knowledge of the Certification Scheme

This part of the examination may be open book.

- 10 multiple-choice questions
- Time allowed: 30 minutes
- Pass mark: 70%

Section C: Level 2 Knowledge of Other NDT Methods

This section tests the knowledge of the candidate in at least four methods of NDT at a Level 2 standard. The methods shall be chosen by the candidate and shall include at least one volumetric test method.

- 60 multiple-choice questions
- Time allowed: 120 minutes
- Pass mark: 70%

N.B. Exemptions may apply, for this examination section to valid ISO 9712 Level 2 certificate holders in the main NDT methods.

1.3.2 Main method examination

Section D: Level 3 Knowledge of the Test Method

- 30 multiple-choice questions
- Time allowed: 60 minutes
- Pass mark: 70%

Section E: Application of the NDT Method

This section of the examination may be open book in relation to codes, standards and specifications.

- 20 multiple-choice questions
- Time allowed: 60 minutes
- Pass mark: 70%

Section F: Procedure Writing

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The drafting of an NDT procedure for a component selected by the Examiner. The use of applicable codes, standards and specifications by the candidate shall be allowed.

- Time allowed: 5 hours
- Pass mark: 70%

2 Ten Year Recertification Examination

Level 1 and Level 2 candidates whose certificates expire at the end of the maximum ten year period of validity will be required to undertake a recertification examination comprising practical tests only as detailed below.
Level 3 candidates should refer to CSWIP-ISO-NDT-11/93R.

2.1 Level 1 ACFM Inspector

2.1.1 General Practical Examination

In the practical part, the candidate is required to choose the necessary probes and equipment to conduct the test; conduct operational and function checks on equipment and probes; record function check. Data and print out a hard copy.

- Time allowed: 30 minutes
- Pass mark: 70%

The candidate is required to carry out inspections following written procedures as specified by NDT Level 2 operator. The candidate is required to test and report on two specimens selected by the examiner; carry out sizing for length and depth; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 60 minutes
- Pass mark: 70%

2.2 Level 2 ACFM Inspector

2.2.1 General Practical Examination

In the practical part, the candidate is required to choose the necessary probes and equipment to conduct the test; conduct operational and function checks on equipment and probes; record function check. Data and print out hard copy.

- Time allowed: 30 minutes
- Pass mark: 70%

2.3 Specific practical

The candidate is required to test and report on three specimens selected by the examiner; carry out sizing for length and depth on a fatigue crack specified by the examiner; record inspection data in accordance with accepted conventions; transfer inspection data files to long term storage.

- Time allowed: 90 minutes
- Pass mark: 70%

2.4 Instruction writing

The candidate shall draft an NDT instruction suitable for Level 1 personnel as selected by the examiner.

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- Time allowed: 60 minutes
- Pass mark: 70%

3 Examination - Syllabus

3.1.0 Level 1 ACFM Inspector

3.1.1 General theory

a) Overview of NDT techniques
Visual inspection; MPI; History of electromagnetic testing.

b) Electricity
Formation of electrical current; current and voltage; resistance and Ohm's law; alternating current.

c) Magnetism
Line of force and force fields; residual magnetism; effect of material geometry on magnetic fields.

d) Electromagnetism
Induction and magnetic fields; magnetic permeability; induced magnetic flux; magnetic field produced by a current.

e) Eddy Currents
Eddy current induced by a magnetic field; fields created by eddy currents; eddy current distribution; standard depth of penetration; factors affecting penetration; theory of deflection of currents by defects.

3.1.2 Specific ACFM Theory

a) ACFM Theory
Uniform fields; interaction of field with defects; effects of field curvature; Bx and Bz field components; typical displays; Bx and Bz time base; butterfly plot; ACFM defect models.

b) ACFM Equipment
Equipment design and construction; equipment set up and basic operation; basic maintenance; potential equipment faults, causes and corrective actions.

c) ACFM Manual and Array Probes
Simple probes; field generation; Bx and Bz sensors; multiple coil configurations; advantages and limitations of array probes; position encoders; X and Y field direction switching; optical encoder; identity chip; multiple Bz coil pencil probes.

d) ACFM Software
Role of individual package components; task based operation; importance of component identification; software set up; operation of main inspection screen.

e) Defect Sizing
Manual software sizing; automatic sizing and limitations, defect sizing limits defect detection limits; minimum detectable defect size and measurement.

f) Basic Signal Interpretation

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Signals influenced by geometry and material variations; defect shape and orientation; edge effects; influence of attachments; material changes; surface finish; effects of non-conductive coatings; false indications and causes.

g) Basic scanning techniques
Function checks; probe deployment including A / C / T direction; software operation to start and stop scan; operation of markers.

h) Detailed Signal interpretation
Relationship between Bx, Bz and butterfly plot; typical signals from spark eroded slot; general strategies for crack identification; effect on signal from, lift off, plate edges, welds, bolt holes, other general geometry effects, inclined defects, transverse defects.

i) Defect sizing
Use of ACFM model; data required to size using models; sizing problems.

j) Data
Storage of data; retrieval of data.

k) Reporting
Marking the product under test; individual data print outs; creating standard reports; retrieval of information.

l) Standards
The standards and specifications to be used will be relevant to the region in which the examination is to be conducted and to the employment of the candidate.

3.1.3 Specific Theory

3.1.3.1 General Engineering

a) Welding technology
Terminology for welds, welded joints, welding procedures; types of defects in welds and parent metals detectable by ACFM inspection methods.

b) Basic Casting Production Methods – Finished Products
Definition of casting knowledge of process overview; types of defect in castings detectable by ACFM inspection methods.

c) Wrought Production Processes
Definition of rolling and knowledge of process overview; types of defects in rolled material detectable by ACFM inspection methods; definition of forging and knowledge of process overview; types of defect in forged products detectable by ACFM inspection methods.

3.1.3.2 Rails

a) Rails
Stress areas; types of defect and their related signals; sizing different defect types.

b) Wheel sets
Axles; wheels.

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2.1.3.3 Welds

a) Welding technology
Terminology for welds, welded joints, welding procedures; types of defects in welds and parent metals detectable by ACFM inspection methods.

3.2.0 Level 2 ACFM Inspector

3.2.1 General theory
As for Level 1 but the examination questions will be more complex.

3.2.2 Specific theory
As for Level 1, plus:

a) ACFM Specific Theory
Probe characteristics and selection.

b) Defect Sizing
Limitations of ACFM model; advanced manual sizing.

c) Safety Precautions
Fire hazards; electrical safety.

d) Conduct of Test
Test procedures and reasons for NDT instructions; briefing of the remote probe operator; minimum qualifications for remote probe operator; supervision of Level 1 personnel; production of probe files; computer file handling.

e) Detailed Signal Interpretation
Types of discontinuity and their identification; relevant and non-relevant indications and their cause; identification of crack features; capabilities and limitations of other NDT methods in terms of detection; characterisation and confirmation of defects.

f) Reporting
Responsibilities for reporting; origination and authentication of NDT reports; content and layout of report; presentation of the inspection results of an NDT report; hard copy computer generated reports; maintenance and retention of records.

3.2.3 Specific Theory

3.2.3.1 General Engineering
As for Level 1 plus:

a) Welding and Wrought Product Technology
Terminology of welds; basic principles of fusion welding processes; methods of producing welds including, MMA, TIG, MAG, Submerged Arc, and Electro slag; rail weld types.

Basic types of welds including, fillet welds, butt welds. Variable configuration welds including, ‘T’s nozzles and nodes.

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Terminology for wrought products including, forging, hammer forging and press forging. Methods of casting.

Influence on techniques of geometry, size, surface condition, parent metal composition; influence of non – conductive and conductive paint coatings and weld repairs; types of defect in welds and parent metals including lack of fusion, porosity, worm holes and cracks.

b) Equipment maintenance
Probe care; trouble shooting; instrument and battery care.

c) Reporting
Configuring customer's reports; emailing reports; incorporating results into reports; searching for and emailing data records.

3.2.3.2 Rails
As for Level 1 but the examination questions will be more complex.

3.2.3.3 Welds
As for Level 1 plus:
Terminology of welds; basic principles of fusion welding processes; methods of producing welds including, MMA, TIG, MAG, Submerged Arc, and Electro slag; rail weld types.
Basic types of welds including, fillet welds, butt welds. Variable configuration welds including, 'T's nozzles and nodes.
Terminology for wrought products including, rolling, forging, and casting.
Influence on techniques of geometry, size, surface condition, parent metal composition; influence of non – conductive and conductive paint coatings and weld repairs; types of defect in welds and parent metals including lack of fusion, porosity, worm holes and cracks.

b) Equipment maintenance
Probe care; trouble shooting; instrument and battery care.

c) Reporting
Configuring customer's reports; emailing reports; incorporating results into reports; searching for and emailing data records.

3.3.0 Level 3 ACFM Inspector

3.3.1 General theory

3.3.1.1 Section A1

1 Materials, Processes and Product Technology

Material Technology
Properties of materials, origin of discontinuities and failure modes, statistical process control and probability of detection.

Basic Production – Crude and Finished Products
Ingot types narrow end up and wide end up, concast methods (continuous casting process). Definition used in the production of ingots and casting.
Difference between ingot and concast production processes.

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Ingot casting further hot working, rolling, forging and extrusion.

Basic Casting Production Methods – Finished Products
Methods of casting: sand casting, die casting, investment casting.
Basic defects associated with cast products, their appearance and how they are formed: shrinkage, inks, cold shuts, porosity, laps, hot tears, and cracks.

Wrought Production Processes
Rolling process: primary rolling – blooms and slabs, secondary rolling, billets, sections and plates, cold rolling, sheets and strips, basic rolling defects, appearance and how they are formed.
Forging: open die forging and press forging, closed die forging.
Basic forging defects, their appearance and how they are formed: forging bursts, laps, seams, cracks.
Extrusion: definition of and knowledge of process overview, why extrusion is used instead of rolling or forging.

Heat Treatment Processes
Annealing. How annealing is carried out and the results obtained, full anneal and definitions, sub critical anneal and definition.
Normalising: how it is carried out and the results obtained.
Stress relieving. What stress relieving is and why it is carried out.

Machining and material removal
Turning, boring, milling, grinding and electrochemical.

Surface finishing and corrosion protection.
Shot peening, grit blasting, painting, plating, chemical conversion coatings.

Non-metals and composite materials processing

Dimensional Metrology

2 Section A2 - Standards and Documentation Relating to the Certification of NDT Operators

BS EN ISO 9712, SNT-TC-1A

3 Section B - Other NDT Methods:

Electromagnetic Testing
Principles, properties of eddy currents, effect of varying frequency, equipment, application and test results interpretation.

Infrared Thermographic Testing
Principles, temperature measurement, technique selection, equipment, application and test results interpretation.

Magnetic Particle Inspection
Principles, technique selection, equipment, application and test results interpretation.

Liquid Penetrant Inspection
Principles, technique selection, equipment, application and test results interpretation.

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Radiographic Inspection
Principles, technique selection, equipment, application and test results interpretation.

Ultrasonic Inspection
Principles, technique selection, equipment, application and test results interpretation.

Visual and Optical Inspection
Principles, technique selection, equipment, application and test results interpretation.

3.3.2 Sections C1 and C2 – Level 3 General Theory and Application of the Test Method

Candidates for Level 3 examinations will be questioned on the contents of the syllabus for Levels 1 and 2, the questions will however be of a more complex nature.

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