



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 BS EN ISO 9712**

APPENDIX 1

Examination Format and Syllabuses for the Certification of Personnel Engaged in Non-Destructive Testing of Welded Joints and General Engineering Components

PART 8: Eddy Current Inspector, Level 1, 2 and 3

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These syllabi are applicable to candidates seeking certification in accordance with the current version of Document CSWIP-ISO-NDT-11/93R 'Requirements for the Certification of Personnel Engaged in Non-Destructive Testing in accordance with the requirements of BS EN ISO 9712'.

EDDY CURRENT INSPECTOR – EXAMINATION FORMAT

1 Level 1

1.1 General theory examination

- 40 multiple choice questions
- Time allowed 60 minutes
- Pass mark 70%.

1.2 Specific theory examination

- 20 multiple choice questions
- Time allowed 30 minutes
- Pass mark 70%.

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 and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

1.4 Specific practical

Candidates for certification in eddy current inspection can seek qualification in either the welding or general engineering sectors. The latter of these encompasses welds, castings and wrought products. The specific practical examinations in these two sectors are as shown below.

1.4.1 Welds

The candidate is required to carry out inspections, following written instructions, on three specimens selected by the examiner and report his findings on pro-forma report sheets.

- Time allowed 2 hours
- Pass mark 70%

1.4.2 General engineering (Wrought products including forgings & tubular wrought)

The candidate is required to carry out inspections, following written instructions, on three specimens selected by the examiner and report his findings on pro-forma report sheets.

- Time allowed 2 hours
- Pass mark 70%

2 Level 2

2.1 General theory examination

- 40 multiple choice questions
- Time allowed 60 minutes
- Pass mark 70%.

2.2 Specific theory examination

- 20 multiple choice questions
- Time allowed 30 minutes
- Pass mark 70 %.

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 and record the results.

- Time allowed 30 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.

- Time allowed 1 hour
- Pass mark 70%

2.5 Specific practical examination-

Candidates can seek certification in welds, wrought products including forgings or tubular wrought products. The specific practical examinations are shown below.

2.5.1 Welds

To test three specimens selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each sample on supplied report formats.

- Time allowed 6 hours
- Pass mark 70%.

2.5.2 Wrought products including forgings

To test three specimens selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each sample on supplied report formats.

- Time allowed 6 hours
- Pass mark 70%.

2.5.3 Tubular wrought products

To test three bundles of tubes selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each bundle of tubes on supplied report formats.

- Time allowed 6 hours
- Pass mark 70%.

2.6 Eddy Current Array Endorsement

These additional endorsement examinations are available to Level 2 Eddy Current Inspection holders who hold valid certification in compliance with ISO 9712 or equivalent.

2.6.1 Specific theory examination

- 20 multiple choice questions
- Time allowed 30 minutes
- Pass mark 70%.

2.6.2 General practical examination

In the practical examination, the candidate is required to choose the necessary probes and equipment to conduct the test; conduct operational and function checks on equipment and problems and record the results.

- Time allowed 30 minutes
- Pass mark 70%.

2.6.3 Instruction writing

The candidate shall draft an NDT instruction suitable for Level 2 personnel, on a sample detailed by the examiner.

- Time allowed 120 minutes
- Pass mark 70%.

2.6.4 Specific practical examination

Candidates for certification in Eddy Current Array inspection can seek certification in welds; wrought product including forgings; or tubular wrought products. The specific practical examinations are detailed below.

2.6.4.1 Welds

The candidate is required to test three specimens selected by the examiner, the tests shall be conducted in accordance with a written procedure and/or written instruction. Reports shall be produced for each sample on a supplied report format.

- Time allowed 6 hours
- Pass mark 70%

2.6.4.2 Wrought products including forgings

The candidate is required to test three specimens selected by the examiner, the tests shall be conducted in accordance with a written procedure and/or written instruction. Reports shall be produced for each sample on a supplied report format.

- Time allowed 6 hours
- Pass mark 70%

2.6.4.3 Tubular wrought products

The candidate is required to test three specimens selected by the examiner, the tests shall be conducted in accordance with a written procedure and/or written instruction. Reports shall be produced for each bundle of tubes on a supplied report format.

- Time allowed 6 hours
- Pass mark 70%

3 Level 3 –

3.1 Basic examination (exempt if already holding Level 3 ISO 9712 Certification)

Section A1 Material Science and Processes

- 25 multiple choice questions
- Time allowed 40 minutes
- Pass mark 70%.

Section A2 Knowledge of the Certification Scheme

- 10 multiple choice questions
- Time allowed 15 minutes
- Pass mark 70%

This section of the examination shall be open book.

Section B - 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 method.

- 60 multiple choice questions
- Time allowed 90 minutes
- Pass mark 70%

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

3.2 Main method examination

The candidate shall select the category of certification required from:

- Welds
- Wrought Products including forgings
- Tubular Products

Section C1- Knowledge of the General Method Theory

The candidate will be testing on Level 3 knowledge relating to the test method for which certification is sought.

- 30 multiple choice questions
- Time allowed 45 minutes
- Pass mark 70%.

Section C2 – Application of the NDT Method

This section of the examination may be open book with respect to codes, standards and specifications

- 20 multiple choice questions
- Time allowed 30 minutes
- Pass mark 70%.

Section C3 - NDT Procedure Writing

The candidate is required to draft an NDT procedure for a component selected by the examiner.

- Time allowed 4 hours
- Pass mark 70%

4 Ten Year Recertification

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, Section 7.5.3.

4.1 Level 1 Welds

4.1.1 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

4.1.2 Specific practical examination

The candidate is required to carry out inspections, following written instructions on three specimens selected by the examiner and report their findings on pro-forma sheets.

- Time allowed 2 hours
- Pass mark 70%

4.2 Level 1 General engineering

4.2.1 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

4.2.2 Specific practical examination

The candidate is required to carry out inspections, following written instructions on three specimens selected by the examiner and report their findings on pro-forma sheets.

- Time allowed 2 hours
- Pass mark 70%

4.3 Level 2 - Welds

4.3.1 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

4.3.2 Specific practical examination

The candidate is required to test three specimens selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each sample on supplied report formats.

- Time allowed 4 hours
- Pass mark 70%.

4.3.3 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%

4.4 Level 2 - Wrought products including forgings

4.4.1 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

4.4.2 Specific practical examination

The candidate is required to test three specimens selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each sample on supplied report formats.

- Time allowed 4 hours
- Pass mark 70%

4.4.3 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%

4.5 Level 2 Tubular wrought products

4.5.1 General practical examination

In the practical part, the candidate is required to set up and conduct operational and function checks on equipment and probes and record function check data as required by the examiner.

- Time allowed 30 minutes
- Pass mark 70%.

4.5.2 Specific practical examination

The candidate is required to test three bundles of tubes selected by the examiner, the tests shall be conducted in accordance with procedures and/or instructions. Reports shall be produced for each bundle of tubes on supplied report formats.

- Time allowed 4 hours
- Pass mark 70%.

4.5.3 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%

5 Examination Syllabus

5.1 Level 1 Eddy Current Inspector

5.1.1 General Theory

a. Overview of NDT techniques.

History of electromagnetic testing
Visual inspection; MPI.

b. Electricity

Formation of AC and DC electrical current; voltage; resistance and Ohm's law; alternating current and skin effects.

c. Eddy current Principles

Impedance; eddy current fields; electromagnetism, coils and coil constructions; simple circuitry for absolute and differential eddy current fields; geometrical effects and eddy currents; resonance.

d. Signal Display and Analysis

Amplitude display and analysis; phase display and analysis; impedance diagrams; effects of high and low frequency.

e. Eddy Current Applications

Eddy current induced in ferromagnetic and non – ferromagnetic materials; conductivity testing; tube testing; corrosion detection; weld testing and automated systems.

5.1.2 Specific Eddy Current Theory

a. Equipment Type and Operation

Selection of equipment; special purpose equipment; method of analysis; frequency selection; probe selection and construction; advantages and disadvantages of probe types.

b. Pre – Inspection Requirements

Surface preparation and methods; effects of surface condition on lift-off and detection; preparation of probes for scanning, product information, grade, condition, shape, type of discontinuities and test conditions.

c. Testing Procedures

Use of test instructions; non-compliance; scanning, probe handling and its effects on testing; false indications; fault finding and rectification; reporting; methods of presentation and storing of results, reference blocks, design, production and storage and calibration curves.

d. Standards

The standards and specifications used in eddy current testing include EN 1330 parts 1,2 and 5, EN 12084 and EN 13860 parts 1 and 2.

5.1.3 Specific Theory – General Engineering

a. Welding technology

Terminology for welds, types of defects in welds and parent metals detectable by eddy current inspection methods.

b. Wrought Product Processes

Definition of rolling and how it works; types of defects in rolled material; definition of forging and how it works; types of defect in forged products; tube manufacture and the types of defect encountered when eddy current testing.

5.2 Level 2 Eddy Current Inspector

5.2.1 General Theory

As for Level 1 but will be more complex, including vectors, reluctance, force, diamagnetism, paramagnetism, ferromagnetism, typical flaws (manufacturing and service induced), material properties, product influences on EC testing, types of products tested,..

5.2.2 Specific Theory

As for Level 1, plus:

a. Pre – Test procedures

Surface preparation; characteristics of coatings and their effects. Minimum levels of tube cleaning, product information, grade, condition, shape, type of discontinuities and test conditions.

b. Safety Precautions

Risk assessment; fire hazards; electrical safety and confined space entry.

c. Conduct of tests

Test procedures and reasons for NDT instructions; briefing of the remote probe operator and the supervision of Level 1 personnel; probe selection; chart recording and computer file handling; selection of manual equipment and probes; coating types and methods of compensation.

d. Defect Detection

Probability of detection; defect characteristics; lift off and probe movement; effects of heat treatment and metallurgical changes on detection.

e. Signal Interpretation

Types of defects and their identification; relevant and non-relevant indications and their causes; capabilities and limitations of other NDT methods in terms of detection; characterisation and confirmation of defect.

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 and computer generated reports; maintenance and retention of records, document traceability.

5.2.3 Specific Theory – General Engineering

As for Level 1 plus:

a. Welding and Wrought Product Technology

Basic principles of fusion welding processes; methods of producing welds including, MMA, TIG, MAG and Submerged Arc.

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

Terminology for wrought products including, forging, hammer forging and press forging, closed die and drop forging. Extrusion and tube making processes.

Influence on techniques of non-conductive and conductive coatings and weld repairs.

b. Equipment maintenance

Probe care; trouble shooting; instrument and battery care.

5.3 Eddy Current Array

5.3.1 General theory

General theory is the same as for the Eddy Current Inspector Level 2.

5.3.2 Specific Eddy Current Array Theory

Equipment type and operation

Selection of equipment; special purpose equipment; method of analysis; frequency selection; probe types and construction; advantages and disadvantages of various probes and scan types.

Pre-Inspection Requirements

Surface preparation: the effects of surface condition and lift-off with regards to inspection sensitivity. Preparation and calibration of probes prior to scanning

Testing Procedures

Use of written procedures/instructions; non-compliance; scanning, probe handling and its effects on testing; false indications; fault identification and quantification; reporting; methods of presentation and storing of results.

Standards

Knowledge of standards and specifications pertinent to eddy current testing, and more specifically eddy current array testing.

5.4 Level 3 Eddy Current Inspector

5.4.1 General theory

Same as for Level 2 but more complex, including array probes, pulsed EC, imaging, modelling, non-inductive techniques (eg SQUID) magneto-optical imaging, Giant magneto-resistance.

5.4.1.1 Section A1

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.

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, 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 how it works, why extrusion is used instead of rolling or forging and methods of tube manufacture.

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

5.4.2 Other NDT Methods:

Acoustic Emission

Principles, sources of acoustic emissions, equipment and materials, proper selection of technique.

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.

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.

5.4.3 Standards and Documentation Relating to the Certification of NDT Operators

BS EN ISO 9712, SNT-TC-1A

5.5 Section B

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.

5.6 Section C3 – Procedure Writing

Candidates are expected to produce a procedure for a component, selected by the examiner and relevant to the category of certification sought.

6 Reference Literature

- Product Technology Classroom Training Handbook – The British Institute of NDT 1995.
- ‘Basic Metallurgy for Non – Destructive Testing’ edited by J L Taylor. British Institute of NDT.
- ‘Principles and practice of non-destructive testing’ edited by Dr J H Lambie. Heywood and Company, London, 1962.
- Non-Destructive Testing (second edition, 1991) by R Halmshaw. Edward Arnold, London 1991 ISBN 0340545216.
- ASNT Question and Answer Supplement to SNT-TC-1A – Electromagnetic Testing.
- ASNT Level III Study Guide.
- NDT Handbook, volume 4 Electromagnetic Testing ASNT 1991, Columbus, Ohio ISBN 0931403049.
- Classroom Training Handbook CT-6-5 ASNT.
- Programmed Instruction Handbook PI-4-5 ASNT.
- Materials and Processes for NDT Technology ASNT.