



## **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 8: Eddy Current Inspector, Level 1, 2 and 3**

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# 1 EXAMINATION CONTENT

## 1.1.0 CSWIP Eddy Current 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 and record function check data as required by the examiner.

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

### 1.1.4 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.

### 1.1.5 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%

### 1.1.6 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%

## 1.2.0 CSWIP Eddy Current Inspector Level 2:

### 1.2.1 General theory examination

- 40 multiple-choice questions
- Time allowed: 80 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 and record the results.

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

#### **1.2.4 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%

#### **1.2.5 Specific practical examination**

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

#### **1.2.6 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%

#### **1.2.7 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%

#### **1.2.8 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%

#### **1.2.9 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.

##### **1.2.9.1 Specific theory examination**

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

##### **1.2.9.2 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%

##### **1.2.9.3 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%

#### **1.2.9.4 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.

#### **1.2.9.5 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%

#### **1.2.9.6 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%

#### **1.2.9.7 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%

### **1.3.0 CSWIP Eddy Current Inspector Level 3:**

#### **1.3.1 Basic examination (exempt if already 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%

### 1.3.2 Main method examination

The candidate shall select the category of certification required from:

- Welds
- Wrought Products including forgings
- Tubular Products

#### 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

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

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.

### 2.1.0 Level 1 Welds

#### 2.1.1 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%

#### 2.1.2 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%

### 2.2.0 Level 1 General engineering

#### 2.2.1 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%

### **2.2.2 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%

### **2.3.0 Level 2 - Welds**

#### **2.3.1 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%

#### **2.3.2 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%

#### **2.3.3 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%

### **2.4.0 Level 2 - Wrought products including forgings**

#### **2.4.1 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%

#### **2.4.2 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%

#### **2.4.3 Instruction writing**

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

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

### **2.5.0 Level 2 Tubular wrought products**

#### **2.5.1 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%

### **2.5.2 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%

### **2.5.3 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%

## **3 Examination Syllabus**

### **3.1.0 Level 1 Eddy Current Inspector**

#### **3.1.1 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.

#### **3.1.2 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 ISO 12718, EN ISO 15549 and EN ISO 15548 parts 1 and 2.

## **3.1.3 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 knowledge of process overview; types of defects in rolled material; definition of forging and knowledge of process overview; types of defect in forged products; tube manufacture and the types of defect encountered when eddy current testing.

## **3.2.0 Level 2 Eddy Current Inspector**

### **3.2.1 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.

### **3.2.2 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.

### **3.2.3 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.

### **3.3.0 Eddy Current Array**

#### **3.3.1 General theory**

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

#### **3.3.2 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.

### **3.4.0 Level 3 Eddy Current Inspector**

#### **3.4.1 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.

##### **3.4.1.1 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 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 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**

#### **3.4.2 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.

**3.4.3 Standards and Documentation Relating to the Certification of NDT Operators**

BS EN ISO 9712, SNT-TC-1A

**3.5.0 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.

**3.6.0 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.