



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

**PART 3 Liquid Penetrant Inspector, Level 1, 2 and 3**

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# 1 EXAMINATION CONTENT

## 1.1.0 CSWIP Liquid Penetrant Inspector Level 1

### 1.1.1 General theory examination

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

#### 1.1.2.1 Specific theory examination single sector

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

#### 1.1.2.2 Specific theory examination multi sector

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

### 1.1.3 General practical examination

Conduct and report on a function or control test used in penetrant testing as selected by the Examiner.

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

### 1.1.4 Specific practical examination

Candidates for certification in liquid penetrant 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.

#### 1.1.5 Welds

The candidate is required to test and report on three specimens selected from butt welds in plate, pipe or T-joint, according to written instructions provided, by one of the techniques shown.

Water washable

Solvent removable

Fluorescent and colour contrast penetrants.

- Time allowed: 2 hours
- Pass mark 70%

#### 1.1.6 General Engineering

The candidate is required to test and report on three specimens selected by the examiner from welds (in plate, pipe or T-joint), castings and wrought products (including forgings), according to written instructions provided, by one of the techniques shown below:

Water washable

Solvent removable

Post emulsifiable

Fluorescent and colour penetrants.

- Time allowed 3 hours
- Pass mark 70%

## **1.2.0 CSWIP Liquid Penetrant Inspection Level 2:**

### **1.2.1 General theory examination**

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

#### **1.1.2.1 Specific theory examination single sector**

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

#### **1.1.2.2 Specific theory examination multi sector**

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

### **1.2.3 General practical examination**

In the practical part the candidate is required to conduct and report on a function or control test of a penetrant system as selected by the examiner.

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

### **1.2.4 Specific practical examination**

Candidates for certification in liquid penetrant 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.

#### **1.2.5 Welds**

The candidate is required to test and report on three specimens: butt weld in plate, butt weld in pipe and a T-joint, employing both fluorescent and colour contrast penetrants.

Water washable

Solvent removable (Mandatory)

Fluorescent and colour contrast penetrants.(Mandatory)

The candidate is in addition required to produce an NDT instruction for one of the items to be tested.

- Time allowed 3 hours plus 1 hour for instruction writing
- Pass mark: 70%

#### **1.2.6 General engineering**

The candidate is required to test and report on three specimens selected by the examiner from welds (in plate, pipe or T joint), castings and wrought products (including forgings) using three different techniques from those shown below.

Water washable

Solvent removable

Post emulsifiable

Fluorescent and colour contrast penetrants.

The candidate is in addition required to produce an NDT instruction for one of the items to be tested.

- Time allowed 3 hours plus 1 hour for instruction writing
- Pass mark: 70%

### 1.2.7 Instruction writing examination

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

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

### 1.3.0 CSWIP Liquid Penetrant Inspection Level 3

#### 1.3.1 Basic examination

The basic examination includes only multiple-choice questions and consists of three sections. The number of questions and the areas covered are shown below.

Candidates successful in Section A, B and C of the basic examination will not be required to retake 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.

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

- Time allowed: 4 hours
- Pass mark: 70%

#### 1.3.2 Main method examination

This written examination shall assess the candidate's knowledge of the main method subject using the examination sections detailed below.

#### 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 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 Liquid Penetrant Inspector**

#### **2.1.1 Welds**

##### **2.1.1.1 General practical examination**

Conduct and report on a function or control test used in penetrant testing as selected by the examiner.

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

##### **2.1.1.2 Specific practical examination**

The candidate is required to test and report on three specimens selected from butt welds in plate, pipe or T-joint, according to written instructions provided, by one of the techniques shown. Water washable Solvent removable Fluorescent and colour contrast penetrants.

- Time allowed: 2 hour
- Pass mark: 70%

#### **2.1.2 General engineering**

##### **2.1.2.1 General practical examination**

Conduct and report on a function or control test used in penetrant testing as selected by the examiner.

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

##### **2.1.2.2 Specific practical examination**

The candidate is required to test and report on three specimens selected by the examiner from welds (in plate, pipe or T-joint), castings and wrought products (including forgings), according to written instructions provided, by one of the techniques shown below: Water washable Solvent removable Post emulsifiable Fluorescent and colour penetrants.

- Time allowed: 3 hour
- Pass mark: 70%

## **2.2 Level 2 Liquid Penetrant Inspector**

### **2.2.1 Welds**

#### **2.2.1.1 General practical examination**

The candidate is required to conduct and report on a function or control test of a penetrant system as selected by the examiner.

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

#### **2.2.1.2 Specific practical examination**

The candidate is required to test and report on three specimens, selected by the examiner: butt weld in plate, butt weld in pipe and a T-joint, employing both fluorescent and colour contrast penetrants Water washable Solvent removable (Mandatory) Fluorescent and contrast penetrants. (Mandatory)

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

#### **2.2.1.3 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%

### **2.2.2 General engineering**

#### **2.2.2.1 General practical examination**

The candidate is required to conduct and report on a function or control test of a penetrant system as selected by the examiner.

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

#### **2.2.2.2 Specific practical examination**

The candidates is required to test and report on three specimens selected by the examiner from welds (in plate, pipe or T-joint), castings and wrought products (including forgings) employing both fluorescent and colour contrast penetrants using the appropriate techniques from those shown below. Water washable Solvent removable Post emulsifiable

- Time allowed: 3 hour
- Pass mark: 70%

#### **2.2.2.3 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 - Liquid Penetrant Inspection**

#### **3.1.1 General theory**

##### **a. Principles of Penetrant Testing Methods**

General principles, capillary action, applications, fluorescence, history of NDT and liquid penetrant terminology.

**b. Testing Techniques**

Method selection. Method of application, spraying, brushing, immersion. Penetrant contact time. Application of Emulsifier, contact time, removal, drying. Application of developer, immersion, brushing, spraying, powder storm. Development time. Viewing conditions, white and black light and their assessment, physical principles, viscosity, bleed-out, flash point.

**c. Stages of a Penetrant Inspection**

Surface dressing, cleaning methods.

**d. Equipment and Materials**

Static installations, portable kits, auxiliary equipment. Dye (solvent removable), fluorescent (water washable) and fluorescent (post-emulsifiable) penetrants. Emulsifiers. Developers, dry powder, water suspended, solvent suspended.

**3.1.2 Specific examination - welds**

**a. Methods of Assessing Sensitivity**

Chromium plated, aluminium test blocks. Defective components.

**b. Interpretation and Reporting of Indications**

Types of discontinuity and their identification. Non-relevant indications. Recording: transparent tape transfer, lacquer transfer, photographic (fluorescent and non-fluorescent). Reporting.

**c. Standards and Specifications**

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.

**d. Welding technology**

Terminology for welds, welded joints, welding procedures. Types of defect in welds and parent metals detectable by liquid penetrant inspection.

**3.1.3 Specific theory – general engineering**

As for Level 1 welds but in addition candidates for General Engineering certification will be required to have a knowledge of:

**a. Basic Casting Production Methods – Finished Products**

Definition of casting and knowledge of process overview. Types of defect in castings detectable by liquid penetrant inspection.

**b. Wrought Production Processes**

Definition of rolling and knowledge of process overview. Types of defect in rolled material detectable by magnetic particle. Definition of forging and knowledge of process overview. Types of defect in forged products detectable by liquid penetrant inspection.

**3.2.0 Level 2 Liquid Penetrant**

**3.2.1 General theory**

The syllabus is the same as that for Level 1 but more complex, including dual purpose penetrant, background and post emulsifiable, plus electrostatic equipment systems and fluidised bed. Also cover information prior to testing with relevant standards (see Level 1). Testing written instructions and document traceability. Environmental and safety conditions for disposing of chemicals plus active carbon method, ultrafiltration method, UV radiation and electrical hazard according to national regulations. Developments in liquid penetrant inspection with special installations, including automotive installations.

### **3.2.2 Specific theory – welds**

As for Level 1 but in addition:

#### **a. Welding technology**

Influence on techniques of geometry, size, surface condition, parent metal composition, weld metal structure. Influence of surface cladding, heat treatments and weld repairs. Basic principles of fusion welding processes. Types of defect associated with particular parent metal/welding process combinations. Types of defect in welds and parent metals detectable by liquid penetrant inspection. Defect parameters which influence detectability. Basics of evaluation plus calibration of test units and reports.

### **3.2.3 Specific theory – general engineering**

As for Level 1 but in addition:

#### **a. Welding technology**

Influence on techniques of geometry, size, surface condition, parent metal composition, weld metal structure. Influence of surface cladding, heat treatments and weld repairs. Basic principles of fusion welding processes. Types of defect associated with particular parent metal/welding process combinations. Types of defect in welds and parent metals detectable by magnetic particle inspection. Defect parameters which influence detectability. Basics of evaluation plus calibration of test units and reports.

#### **b. 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. Basics of evaluation plus calibration of test units and reports.

#### **c. 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, inclusions, cold shuts, porosity, laps, hot tears and cracks. Basics of evaluation plus calibration of test units and reports.

#### **d. 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. Basics of evaluation plus calibration of test units and reports.

#### **e. 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. Basics of evaluation plus calibration of test units and reports.

### **3.3.0 Level 3 Liquid Penetrant Syllabus**

#### **3.3.1 General theory**

Same as for Level 2 but more complex, including superficial tension, contact angles and vapour pressure, catalogue of defects. All assessments to include aspects of depth, width, shape, position and orientation.

#### **3.4.0 Basic examination**

##### **3.4.1.1 Materials, processes and product technology**

###### **a. Material Technology**

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

###### **b. 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.

###### **c. 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.

###### **d. 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 extrusion and knowledge of process overview, why extrusion is used instead of rolling or forging.

###### **e. Heat Treatment Processes**

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

###### **f. Machining and material removal**

Turning, boring, milling, grinding and electrochemical. Surface finishing and corrosion protection. Shot peening, grit blasting, painting, plating, chemical conversion coatings.

###### **g. Non-metals and composite materials processing**

###### **h. Dimensional Metrology**

##### **3.4.1.2 Other NDT methods**

###### **a. Acoustic Emission**

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

**b. Electromagnetic Testing**

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

**c. Infrared Thermographic Testing**

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

**d. Magnetic Particle Inspection**

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

**e. Radiographic Inspection**

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

**f. Visual and Optical Inspection**

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

**3.4.1.3 Standards and documentation relating to the certification of NDT operators**

BS EN ISO 9712, SNT-TC-1A 11

**3.4.2 Main Method Examination**

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.

**3.4.2.1 Specific Theory**

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.