



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 Syllabus for the Certification of Personnel engaged in Non-Destructive Testing of Welded Joints and General Engineering Components

PART 3: Liquid Penetrant 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-11/93-R 'Requirements for the Certification of Personnel engaged in Non-Destructive Testing in accordance with the requirements of BS EN ISO 9712'.

LIQUID PENETRANT INSPECTOR

1 Level 1

1.1 General theory examination

The theory part of the specific examination consists:

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

1.2 Specific theory examination

The theory part consists of

- 20 multiple choice questions (welds), time allowed 30 minutes
- 30 multiple choice questions (general engineering), time allowed 45 minutes
- Pass mark 70%

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 1 hour
- Pass mark 70%

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.

1.4.1 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%

1.4.2 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%

2 Level 2

2.1 General theory examination

The theory part consists of:

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

2.2 Specific theory examination

The theory part consists:

- 20 multiple choice questions (welds), time allowed 30 minutes
- 30 multiple choice questions (general engineering), time allowed 45 minutes
- Pass mark 70%

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 1 hour
- Pass mark 70%

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.

2.4.1 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 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%

2.4.2 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 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%

3 Level 3

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

Section A1 Materials Science and Process Technology

- 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.

3.2 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 method.

- 60 multiple choice questions
- Time allowed 90 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%

3.3 Main method examination

Section C1 - Knowledge of Method General Theory

The candidate will be tested 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 – 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 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, Section 7.5.3.

4.1 Level 1 Liquid Penetrant Inspector

4.1.1 Welds

4.1.1.1 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%

4.1.1.2 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 hours
- Pass mark 70%

4.1.2 General engineering

4.1.2.1 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%

4.1.2.2 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 hours
- Pass mark 70%

4.2 Level 2 Liquid Penetrant Inspector

4.2.1 Welds

4.2.1.1 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%

4.2.1.2 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 3 hours
- Pass mark 70%

4.2.1.3 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%

4.2.2 General engineering

4.2.2.1 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%

4.2.2.2 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 hours
- Pass mark 70%

4.2.2.3 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%

5 Examination Syllabus

5.1 Level 1 - Liquid Penetrant Inspection

5.1.1 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.

5.1.2 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.

5.1.3 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 how it works. Types of defect in castings detectable by liquid penetrant inspection.

b. Wrought Production Processes

Definition of rolling and how it works. Types of defect in rolled material detectable by magnetic particle. Definition of forging and how it works. Types of defect in forged products detectable by liquid penetrant inspection.

5.2 Level 2 Liquid Penetrant

5.2.1 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.

5.2.2 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.

5.2.3 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, 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 how it works, 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.

5.3 Level 3 Liquid Penetrant Syllabus

5.3.1 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.

5.4 Basic examination

5.4.1.1 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.

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 extrusion and how it works, 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 normalisation is carried out and the results obtained.

Stress relieving. What is stress relieving 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

5.4.1.2 Other NDT methods

Acoustic Emission

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

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.

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.

5.4.1.3 Standards and documentation relating to the certification of NDT operators

BS EN ISO 9712, SNT-TC-1A

5.4.2 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.

5.4.2.1 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.

6 Reference Literature

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