



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 EN 473 and 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: Penetrant Inspector, Level 1, 2 and 3

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These syllabi are applicable to candidates seeking certification in accordance with Document CSWIP-ISO-NDT-11/93-R 'Requirements for the Certification of Personnel engaged in Non-Destructive Testing.

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)
- 30 multiple choice questions (general engineering)
- Time allowed 30 minutes (welds)
45 minutes (general engineering)
- 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 two 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)
- 30 multiple choice questions (general engineering)
- Time allowed 30minutes duration (welds)
 45 minutes duration (general engineering)
- 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

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, using three different techniques selected by the examiner from those shown below.

Water washable
Solvent removable
Fluorescent and 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%

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 the appropriate 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 Level 3)

Section A1 Materials Science and Process Technology

- 30 multiple choice questions
- Time allowed 45 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 B level 2 knowledge of other NDT methods

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

N.B. Exemptions may apply, for Level 2 holders in the main NDT methods, for this examination section.

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 - Level 3 Knowledge of Method General Theory

- 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 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 renewal 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

The candidate is required to test and report on two 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.

4.1.2 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.

4.2 Level 2 Liquid Penetrant Inspector

4.2.1 Welds

The candidate is required to test and report on two specimens, selected by the examiner: butt weld in plate, butt weld in pipe and a T joint, using two different techniques selected by the examiner from those shown below.

Water washable
Solvent removable
Fluorescent and contrast penetrants.

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

4.2.2 General engineering

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) using the appropriate 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.

5 Level 1 - Liquid Penetrant Inspection Syllabus

5.1 General theory

a. Principles of Penetrant Testing Methods

General principles, capillary action, applications, fluorescence.

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.

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.

5.2 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.

5.3 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.

6 Level 2 Liquid Penetrant Syllabus

6.1 General theory

The syllabus is the same as that for Level 1 but the questions will be more complex.

6.2 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.

6.3 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.

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

Stress relieving. Why stress relieving is and why it is carried out.

7 Level 3 Liquid Penetrant Syllabus

7.1 General theory

7.2 Basic examination

7.2.1 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, inclusions, 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

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. Why 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

7.2.2 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.

Thermography

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.

7.2.3 Standards and documentation relating to the certification of NDT operators

ISO 9712, EN 473, SNT-TC-1A

7.3 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.

7.3.1 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.

8 Reference Literature

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