



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 6: Visual and Optical Inspector Level 1, 2 and 3

3rd Edition October 2008

Issued under the authority of the Governing Board for Certification
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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.

VISUAL AND OPTICAL INSPECTOR

1 LEVEL 1

1.1 General theory examination

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

1.2 Specific theory examination

- 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

The candidate is required to conduct and report on a control or function test for the practical applications of visual and optical testing as selected by the examiner.

- Time allowed 1 hour
- Pass mark 70%.

1.4 Specific practical examination

Candidates for certification in visual and optical inspection can seek qualification in either the welding or general engineering sectors. The latter of these encompasses welds, castings and wrought products (including forgings). The specific practical examinations in these two sectors are as shown.

1.4.1 Welds

The candidate is required to inspect and report on two specimens selected from butt welds in plate, pipe or T joint, according to written instructions provided.

- 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.

- Time allowed 3 hours
- Pass mark 70%.

2 LEVEL 2

2.1 General theory examination

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

2.2 Specific theory examination

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

2.3 General practical examination

The candidate is required to conduct and report on a control or function test for the practical applications of visual and optical testing as selected by the examiner.

- Time allowed 1 hour
- Pass mark 70%.

2.4 Specific practical examination

Candidates for certification in visual and optical 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.

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).

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 - Material Science and Process Technology

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

Section A2 - Knowledge of the Certification System

- 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

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

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

3.2 Main Method Examination

Section C1 – Level 3 General Theory

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

Section C2 – Application of the NDT Method

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

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

Section C3 – Procedure Production

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 Renewal 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 Welds

The candidate is required to inspect and report on two specimen selected from butt welds in plate, pipe or T joint, according to written instructions provided.

- Time allowed 2 hours
- Pass mark 70%.

4.2 Level 1 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.

- Time allowed 3 hours
- Pass mark 70%.

4.3 Level 2 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 two different techniques selected by the examiner.

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

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

4.4 Level 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).

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%.

5 Level 1 - Visual and Optical Inspection Syllabus

5.1 General theory

a. Introduction

Definition and history of visual testing.

b. Factors Influencing visual Inspection

Vision, lighting, material properties, environmental, visual perception, surface preparation, direct and indirect inspection

c. Equipment

Mirrors, magnifiers, borescopes, fibrescopes, CC TV, gauges, templates, scales, automated systems, computer enhanced.

5.2 Specific theory - Welds

a. Inspection and Testing

Selection of parameters, inspection objectives and test points.

b. Reporting

Test standards/calibration, classification of indications.

c. Welding technology

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

b. Wrought Production Processes

Definition of rolling and how it works. Types of defect in rolled material detectable by visual and optical inspection. Definition of forging and how it works. Types of defect in forged products detectable by visual and optical inspection.

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.

6 Level 2 Visual and Optical Inspection Syllabus

6.1 General theory

As for Level 1 plus:

a. Vision

The eye, limitations, disorders, vision requirements.

b. Light

Fundamental theories, light measurements, required levels, lighting techniques

c. Material Attributes

Cleanliness, colour, condition, shape, size, temperature, texture, type, surface finish

d. Environmental and Physical Factors

Atmosphere, comfort, distance, elevation, fatigue, health, humidity, mental attitude, position, safety, temperature, cleanliness

e. Visual Perception

f. Equipment

Imaging systems, optical systems

6.2 Specific theory - Welds

As for Level 1 Welds plus

a. Welding technology

Terminology for welds, welded joints, welding procedures, weld defects, parent metal defects.

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 visual and optical inspection.

6.3 Specific theory – General Engineering

As for Level 1 General Engineering plus

a. Welding technology

Terminology for welds, welded joints, welding procedures, weld defects, parent metal defects.

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 visual and optical inspection.

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 for 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, inclusions, 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

7.1 General theory

7.1.1 Section A

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 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

7.1.2 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.

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.

7.1.3 Standards and Documentation Relating to the Certification of NDT Operators

ISO 9712, EN 473, SNT_TC-1A.

7.2 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.

7.2.1 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.

8 Recommended Reading

PCN Classroom Training Handbook on the Visual Inspection of Metallic Materials in General Engineering Use. The British Institute of Non-Destructive Testing.

Product Technology Classroom Training Handbook – The British Institute of Non-Destructive Testing.

Visual Examination: Inspection of Metals. RC Anderson, American Society for Metals 1983

Non-Destructive Testing, Vol 8, Visual and Optical Testing, ASNT

ASNT Question and Answer Book.

ASNT Level III Study Guide.

Basic Metallurgy for Non-Destructive Testing, Edited by J L Taylor. The British Institute of Non-destructive Testing