



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 10: Leak Detection 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.

LEAK DETECTION INSPECTOR

1 Level 1 – Pressure Testing

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
- Time allowed 30 minutes
- Pass mark 70%

1.3 General practical examination

In the general practical part, the candidate is required to verify required settings and operate the test equipment properly in order to obtain satisfactory results and correctly interpret these results. The candidate is required to demonstrate this ability, with comments, using the means available for the test method.

- Time allowed 60 minutes
- Pass mark 70%

1.4 Specific practical examination

The candidate is required to test and report on two samples in accordance with the instructions provided.

- Time allowed 60 minutes per sample
- Pass mark 70%

2 Level 1 – Tracer Gas Testing

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
- Time allowed 30 minutes
- Pass mark 70%

2.3 General practical examination

In the general practical part, the candidate is required to verify required settings and operate the test equipment properly in order to obtain satisfactory results and correctly interpret these

results. The candidate is required to demonstrate this ability, with comments, using the means available for the test method.

- Time allowed 60 minutes
- Pass mark 70%

2.4 Specific practical examination

The candidate is required to test and report on two samples in accordance with the instructions provided.

- Time allowed 60 minutes per sample
- Pass mark 70%

3 Level 2 – Pressure Testing

3.1 General theory examination

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

3.2 Specific theory examination

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

3.3 General practical examination

In the general practical part, the candidate is required to verify required settings and operate the test equipment properly in order to obtain satisfactory results and correctly interpret these results. The candidate is required to demonstrate this ability, with comments, using the means available for the test method.

- Time allowed 60 minutes
- Pass mark 70%

3.4 Specific practical examination

The candidate is required to inspect two samples to a set procedure and draft a written instruction suitable for use by a Level 1 practitioner.

Time allowed: 90 minutes per sample plus 60 minutes for written instruction
Pass mark 70%

4 Level 2 –Tracer Gas Testing

4.1 General theory examination

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

4.2 Specific theory examination

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

4.3 General practical examination

In the general practical part, the candidate is required to verify required settings and operate the test equipment properly in order to obtain satisfactory results and correctly interpret these results. The candidate is required to demonstrate this ability, with comments, using the means available for the test method.

- Time allowed 60 minutes
- Pass mark 70%

4.4 Specific practical examination

The candidate is required to inspect two samples to a set procedure and draft a written instruction suitable for use by a Level 1 practitioner.

- Time allowed 90 minutes per sample plus 60 minutes for written instruction
- Pass mark 70%

5 Level 3

5.1 Basic Examination

The basic examination consists of three parts as detailed below. It is recommended that this examination is passed first. It will remain valid providing that the first method examination is passed within five years of passing the basic examination.

5.1.1 Section A1

Materials Science and Process Technology

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

Section A2

Knowledge of the certification body system based on relevant standards. This part of the examination may be open book.

- 10 multiple choice questions
- Time allowed 15 minutes
- Pass mark 70%

5.1.2 Section B

Knowledge of at least four methods of NDT at 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%

5.2 Main Method Examination

This written examination shall assess the candidate's knowledge of the main method subjects using the examination sections detailed below. Sector examination is available in:

- Pressure and tracer gas testing

5.3 Section C1

Level 3 knowledge relating to the test method for which certification is sought.

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

5.4 Section C2

Application of the NDT method in the sector concerned using the applicable codes and standards. Relevant sections of the codes and standards may be provided as reference material.

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

5.5 Section C3

Drafting of an NDT procedure in the relevant method and sector. The applicable codes, standards and specifications shall be available during this part of the examination.

- Time allowed 4 hours
- Pass mark 70%

6 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

6.1 Level 1 Pressure Testing

The candidate is required to test and report on two samples in accordance with the instructions provided.

6.2 Level 1 Tracer Gas Testing

The candidate is required to test and report on two samples in accordance with the instructions provided.

6.3 Level 2 Pressure Testing

The candidate is required to inspect two samples to a set procedure and draft a written instruction suitable for use by a Level 1 practitioner.

6.4 Level 2 Tracer Gas Testing

The candidate is required to inspect two samples to a set procedure and draft a written instruction suitable for use by a Level 1 practitioner.

7 Level 1 Pressure Testing Syllabus

a. Introduction to Pressure Testing

History of leak testing, reasons for leak testing, fundamental terminology, fundamentals of leak and leak detection.

b. Physical Principles

Physical behaviour of gases, pressure, pressure range in vacuum, flow in vacuum, leakage measurement units, degassing, virtual and real leak.

c. Product knowledge

Types of leak testing, object preparation, specification and method capabilities, bubble emission method, pressure change methods, tracer gas method, fundamentals of test method choice.

d. Equipment

Vacuum gauges, mechanical gauges, U-tube manometers and McLeod, Pirani and thermocouple gauges, cold and hot ion gauges, vacuum pumps, rotary and piston pumps, roots pumps, diffusion pump, turbomolecular pump, valve, fittings.

e. Information prior to testing

Written procedures – interpretations, data report module filling.

f. Testing

Bubble testing practice and techniques, immersion technique, Liquid application technique, pressure change techniques and practice, pressure decay technique, pressure rise technique, bell pressure change technique, flow measurements technique, tracer gas practice and techniques, Mass spectrometers, halogen ion diode, thermal conductivity gauges, tracer gas flows, vacuum technique – total and partial, vacuum technique – local (spraying), tracer gas flows out of the objects, chemical detection with ammonia, vacuum box using internal tracer gas, vacuum box applying the tracer gas in the opposite side, pressure technique by accumulation, sniffing test, fundamental on pressurisation – evacuation testing (bombing), vacuum chamber technique.

g. Evaluation and Reporting

Test data report filling

h. Quality

8 Level 1 Tracer Gas Testing

a. Introduction to Pressure Testing

History of leak testing, reasons for leak testing, fundamental terminology, fundamentals of leak and leak detection.

b. Physical Principles

Physical behaviour of gases, pressure, pressure range in vacuum, flow in vacuum, leakage measurement units, degassing, virtual and real leak.

c. Product knowledge

Types of leak testing, object preparation, specification and method capabilities, bubble emission method, pressure change methods, tracer gas method, fundamentals of test method choice.

d. Equipment

Vacuum gauges, mechanical gauges, U-tube manometers and McLeod, Pirani and thermocouple gauges, cold and hot ion gauges, vacuum pumps, rotary and piston pumps, roots pumps, diffusion pump, turbomolecular pump, valve, fittings.

e. Information prior to testing

Written procedures – interpretations, data report module filling.

f. Testing

Bubble testing practice and techniques, immersion technique, Liquid application technique, pressure change techniques and practice, pressure decay technique, pressure rise technique, bell pressure change technique, flow measurements technique, tracer gas practice and techniques, Mass spectrometers, halogen ion diode, thermal conductivity gauges, tracer gas flows, vacuum technique – total and partial, vacuum technique – local (spraying), tracer gas flows out of the objects, chemical detection with ammonia, vacuum box using internal tracer gas, vacuum box applying the tracer gas in the opposite side, pressure technique by accumulation, sniffing test, fundamental on pressurisation – evacuation testing (bombing), vacuum chamber technique.

g. Evaluation and Reporting

Test data report filling.

h. Quality

9 Level 2 Pressure Testing

a. Introduction to Pressure Testing

History of leak testing, reasons for leak testing, terminology, fundamentals of leak and leak detection.

b. Physical Principles

Physical behaviour of matter, pressure, pressure range in vacuum, flow in vacuum, leakage measurement, degassing, pumping speed, virtual and real leak.

c. Product knowledge

Types of leak testing, object preparation, specification and method capabilities, bubble emission method, pressure change methods, tracer gas method, chemical or physical properties of detectors, principles of detection for the tracer gas flow into the object 0 Group A techniques, Principles of detection for tracer gas flow out of the object – Group B techniques, test method choice of criteria.

d. Equipment

Vacuum gauges, mechanical gauges, U-tube manometers and McLeod, Pirani and thermocouple gauges, cold and hot ion gauges, vacuum pumps, rotary and piston pumps, roots pumps, diffusion pump, turbomolecular pump, valve, fittings, materials.

e. Information prior to testing

Analysis of written procedures, data report modules, tracer gas detector/instruments performance factor.

f. Testing

Bubble testing practice and techniques, immersion technique, Liquid application technique, pressure change techniques and practice, pressure decay technique, pressure rise technique, bell pressure change technique, flow measurements technique, tracer gas practice and techniques, Mass spectrometers (helium), halogen ion diode, thermal conductivity gauges, reactive tracers, gas analysis apparatus (gas chromatography etc), tracer gas flows, vacuum technique – total and partial, vacuum technique – local (spraying), tracer gas flows out of the objects, chemical detection with ammonia, vacuum box using internal tracer gas, vacuum box applying the tracer gas in the opposite side, pressure technique by accumulation, sniffing test, pressurisation – evacuation testing (bombing), vacuum chamber technique.

g. Evaluation and Reporting

Test data report filling

h. Quality

i. Developments

Special industrial installation.

10 Level 2 Tracer Gas Testing

a. Introduction to Pressure Testing

History of leak testing, reasons for leak testing, terminology, fundamentals of leak and leak detection.

b. Physical Principles

Physical behaviour of matter, pressure, pressure range in vacuum, flow in vacuum, leakage measurement, degassing, pumping speed, virtual and real leak.

c. Product knowledge

Types of leak testing, object preparation, specification and method capabilities, bubble emission method, pressure change methods, tracer gas method, chemical or physical properties of detectors, principles of detection for the tracer gas flow into the object 0 Group A techniques, Principles of detection for tracer gas flow out of the object – Group B techniques, test method choice of criteria.

d. Equipment

Vacuum gauges, mechanical gauges, U-tube manometers and McLeod, Pirani and thermocouple gauges, cold and hot ion gauges, vacuum pumps, rotary and piston pumps, roots pumps, diffusion pump, turbomolecular pump, valve, fittings, materials.

e. Information prior to testing

Analysis of written procedures, data report modules, tracer gas detector/instruments performance factor.

f. Testing

Bubble testing practice and techniques, immersion technique, Liquid application technique, pressure change techniques and practice, pressure decay technique, pressure rise technique, bell pressure change technique, flow measurements technique, tracer gas practice and techniques, Mass spectrometers (helium), halogen ion diode, thermal conductivity gauges, reactive tracers, gas analysis apparatus (gas chromatography etc), tracer gas flows, vacuum technique – total and partial, vacuum technique – local (spraying), tracer gas flows out of the objects, chemical detection with ammonia, vacuum box using internal tracer gas, vacuum box applying the tracer gas in the opposite side, pressure technique by accumulation, sniffing test, pressurisation – evacuation testing (bombing), vacuum chamber technique.

g. Evaluation and Reporting

Test data report filling

h. Quality

i. Developments

Special industrial installation.

11 Level 3 Leak Detection Syllabus

11.1 Basic Examination

11.1.1 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, 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

11.1.2 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.

11.1.3 Standards and documentation relating to the certification of NDT operators

ISO 9712, EN 473, SNT_TC-1A

11.2 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.

11.2.1 Section C1 – General Theory

Candidates for Level 3 examinations will be questions on the contents of the syllabus for Levels 1 and 2, the questions will however be of a more complex nature.

11.2.2 Section C2 – 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. In addition they will be questioned on:

Pressure Testing Technology

The influence of leak detection methods and techniques on the size and types of leaks that may be detected.

Defect parameters that influence detectability.

11.2.3 Section C3 – Procedure Writing

Candidates are required to produce a fully detailed NDT procedure for a sample selected by the examiner from the sector in which the candidate is undergoing evaluation.

The leak detection procedure must include the scope of examination, test operator approvals, equipment and calibration, reference documents, acceptance and recording levels, reporting requirements, timings in relation to complementary NDT methods and stages of production/manufacture and actions in the case of procedure non-compliance.

12 Reference Literature

ASNT NDT Handbook - Leak Detection

ASNT Level III Study Guide - Leak Testing

ASTM Standards Section 3 .03.03 Non Destructive Testing

ASM Handbook - NDE and Quality Control

Current EN Standards for Leak detection and Method Selection