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 2: Magnetic Particle Inspector Inspectors Levels 1, 2 and 3

6th Edition, January 2026

Issued under the authority of the Governing Board for Certification
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1 EXAMINATION CONTENT

1.1.0 CSWIP Magnetic Particle 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

In the practical part of the examination the candidate is required to conduct and report on a Function or control test on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner

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

1.1.4 Specific practical examination

Candidates for certification in magnetic particle 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 below.

1.1.4.1 Welds

The candidate is required to test and report on two specimens selected by the examiner from butt welds in plate, pipe or T-joint according to written instructions provided. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks.

Permanent magnets
Electromagnets
Flexible coils
Prods

- Time allowed 2 hours
- Pass mark 70%

1.1.4.2 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), casting and wrought products according to written instructions provided. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks.
Permanent magnets
Electromagnets

Flexible coils
Prods
Bench unit: Current flow, Magnetic Flow, Rigid Coil, Threading Bar

- Time allowed 3 hours
- Pass mark 70%

1.2.0 CSWIP Magnetic Particle Inspector Level 2:

1.2.1 General theory examination

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

1.2.2.1 Specific theory examination

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

1.2.2.2 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 on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner.

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

1.2.4 Specific practical examination

Candidates for certification in magnetic particle 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 below.

1.2.4.1 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 black inks and using the most appropriate magnetisation techniques as selected from the list below for the component type:

Permanent magnets
Electromagnets
Flexible coils
Prods

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

1.2.4.2 Instruction writing

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

- Time allowed: 60 minutes

- Pass mark: 70%

1.2.4.3 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. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks.

Permanent magnets

Electromagnets

Flexible coils

Prods

Bench unit: Current flow, Magnetic Flow, Rigid Coil, Threader Bar

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

1.2.4.4 Instruction writing

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

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

1.3.0 CSWIP Magnetic Particle 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 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 or Level 2 certificate holders in the main NDT methods.

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 Magnetic Particle Inspector

2.1.1 Welds

2.1.1.1 General practical examination

In the practical part the candidate is required to conduct and report on a function or control test on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner.

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

2.1.1.2 Specific practical

The candidate is required to test and report on two specimens selected by the examiner from butt welds in plate, pipe or T joint according to written instructions provided. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks. Permanent magnets Electromagnets Flexible coils Prods

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

2.1.2 General engineering

2.1.2.1 General practical examination

In the practical part the candidate is required to conduct and report on a function or control test on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner.

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

2.1.2.2 Specific practical

The candidate is required to test and report on three specimens selected by the examiner from welds (in plate, pipe or T joint), casting and wrought products according to written instructions provided. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks. Permanent magnets Electromagnets Flexible coils Prods Bench unit: Current flow, Magnetic Flow, Rigid Coil, Threading Bar

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

2.2 Level 2 Magnetic Particle Inspector

2.2.1 Welds

2.2.1.1 General practical examination

In the practical part the candidate is required to conduct and report on a function or control test on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner.

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

2.2.1.2 Specific practical

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 black inks and using the most appropriate magnetisation techniques as selected from the list below for the component type: Permanent magnets Electromagnets Flexible coils Prods

- Time allowed: 3 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

In the practical part the candidate is required to conduct and report on a function or control test on magnetic inks, permanent magnets, electromagnets, bench units and/or UV light intensity as selected by the examiner.

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

2.2.2.2 Specific practical

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. The techniques used will be selected by the examiner from those shown below and may include both fluorescent and black inks. Permanent magnets Electromagnets Flexible coils Prods Bench unit: Current flow, Magnetic Flow, Rigid Coil, Threader Bar

- 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 Magnetic Particle

3.1.1 General theory

a. Principles of Magnetism

General principles, magnetic poles, magnetic field, lines of force, longitudinal magnetisation, horse-shoe magnet, vector field, consequent poles, distorted field, leakage field. Curie Point to EN ISO 9934-1.

b. Magnetic Materials

Ferromagnetic, paramagnetic and diamagnetic materials. Simple definitions of permeability and reluctance.

c. Electrically induced Magnetic Fields

Generation of circumferential flux and longitudinal flux. Flux density and residual magnetism.

d. Hysteresis Loops

e. Magnetisation Methods

Permanent magnet, electro-magnet, contact current flow (includes prod testing), threading bar, coils, induced current flow.

f. Equipment

Fixed, transportable and portable installations. DC battery, AC mains, DC rectified half wave, DC rectified full wave. Ancillary equipment. Inspection lighting (including white and black light). Viewing aids. Marking devices. Demagnetisers. Contrast aids. Calibration of equipment and the use of meters. Performance checks. Test pieces and 'portable cracks.

g. Magnetic Detection

Inks, Concentrates and Powders Inks and concentrates: fluorescent and non-fluorescent. Water, hydrocarbon and quick drying based colours. Wetting agents and inhibitors. Dry powders: puffs, cabinets. Preparation and testing of materials: determination of solid content.

3.1.2 Specific theory - welds

a. Testing Procedures

Magnetising operation to be used, current or flux values, jigs or fixtures. Geometric shape of components. Methods of assessing sensitivity of techniques. Remanence technique.

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

c. Demagnetisation and Post Test Procedures
Reasons for demagnetisation, AC and DC methods. Testing for demagnetisation. Cleaning.

d. 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.

e. Welding technology
Terminology for welds, welded joints, welding procedures. Types of defect in welds and parent metals detectable by magnetic particle 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 magnetic particle.

b. Wrought Production Processes
Definition of rolling and knowledge of process overviews.
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 magnetic particle.

3.2.0 Level 2 Magnetic Particle

3.2.1 General theory

The syllabus is the same as that for Level 1 but the questions will be more complex, and will include rectilinear conductors, long magnetic coils, flux passing in non-magnetic media, continuity of HT and BN, flux of a magnetic discontinuity, remarkable points, curve of first magnetisation, acceptance criteria and radiometers, influence of manufacture and material and document traceability.

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 magnetic particle inspection. Defect parameters which influence detectability.

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.

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 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 it is carried out and the results obtained.
Stress relieving. What stress relieving is and why it is carried out.

3.3.0 Level 3 Magnetic Particle

3.3.1 Basic examination

3.3.1.1 Materials, Processes and Product Technology

Material Technology

Properties of materials, origin of discontinuities and failure modes, statistical process control, probability of detection, ferrimagnetism, influence of temperature, effect of interface between magnetic medium and non-magnetic medium, behaviour of particle on flux, effects of work hardening, alloys (Invar, Inconel, permalloys), format of working procedures.

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.

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.

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.

Heat Treatment Processes
Annealing. How annealing is carried out and the results obtained, full anneal and definitions, sub-critical annealing 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

3.3.1.2 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 and 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.

3.3.1.3 Standards and documentation relating to the certification of NDT operators

BS EN ISO 9712, SNT-TC-1A 5.3.2

3.3.1.4 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.