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 4: Radiographic Interpreter Level 2

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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.

1 Radiographic Interpreter (Welds)

1.1 General theory examination

The theory part consists of

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

1.2 Specific theory examination

The theory part consists:

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

1.3 General practical examination

In the practical part the candidate is firstly required to carry out a number of sensitivity calculations using DIN, ASME and BS IQIs and to establish the accuracy of a densitometer using a density strip.

- Time allowed 1 hour
- Pass mark 70%

1.4 Specific practical examination

Certification is awarded in a number of combinations of metal groups:

Group A: Ferritic steels including clad steels: manual metal arc, MIG, TIG and mechanised fusion welding, oxy-acetylene welding.

Group B: Austenitic steels and high nickel alloys (excluding Monel): manual metal arc, MIG, TIG and mechanised fusion welding. Titanium alloys: inert gas welding.

Group C: Aluminium and its alloys: MIG and TIG welding. Magnesium and its alloys: TIG welding.

Group D: Copper and its alloys and Monel: manual metal arc, MIG and TIG welding.

The candidate is required to interpret 6 radiographs for the first group plus three radiographs for each additional group. A minimum of twelve radiographs must be submitted by each candidate. For each radiograph the candidate is required to locate and identify defects and to comment upon radiographic technique and quality of the radiographs. The duration of the second part depends on the number of metal groups attempted:

- One group 1½ hours
- Two groups 2 ¼ hours
- Three groups 3 hours
- Four groups 3 ¾ hours
- Pass mark 70% per group

2 RADIOGRAPHIC INTERPRETER (CASTINGS)

2.1 General theory examination

The theory part consists of

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

2.2 Specific theory examination

The theory part consists:

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

2.2.1 General practical examination

In the practical part the candidate is firstly required to carry out a number of sensitivity calculations using DIN, ASME and BS IQIs and to establish the accuracy of a densitometer using a density strip.

- Time allowed 1 hour
- Pass mark 70%

2.2.2 Specific practical examination

The candidate is required to interpret 12 radiographs to gain certification.

Candidates who wish to gain Dense metal **or** Light Alloy certification only will interpret and report on 12 Dense metal **or** Light Alloy casting radiographs as selected by the examiner.

Candidates who wish to gain Dense metal and Light Alloy certification as a combined group will interpret and report on 12 radiographs from the two groups as selected by the examiner.

For each radiograph the candidate is required to locate and identify defects and to comment upon radiographic technique and quality of the radiographs. The duration of the second part depends on the number of metal groups attempted:

- Time allowed 4 hours
- Pass mark 70% per group

3 TEN YEAR RENEWAL

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.

3.1 Radiographic interpreter (welds)

The candidate is required to interpret two radiographs for the first group plus one radiograph each of any additional group. For each radiograph the candidate is required to locate and identify defects and to comment upon radiographic technique and quality of the radiographs. The duration of the test will be 15 minutes per radiograph interpreted.

3.2 Radiographic interpreter (castings)

The candidate is required to interpret two radiographs per group to gain certification.

For each radiograph the candidate is required to locate and identify defects and to comment upon radiographic technique and quality of the radiographs. The duration of the test will be 15 minutes per radiograph interpreted.

4 Radiographic Interpreter (Welds) Level 2 Syllabus

4.1 General theory

a. Nature and Properties of X and/or Gamma Radiation

Penetration, absorption, scatter, diffraction, transmission. Rectilinear propagation. Photographic properties.

b. Photographic aspects

Dark room procedures: layout, light traps and entrance, wet and dry benches, film-pass hatches, processing units, safe-lights and ancillary equipment. Handling and processing of films, temperature control.

Sensitometry: types of film and paper used in industrial radiography. Characteristic curves, speed, contrast, definition, density. Fog. Graininess. Inherent unsharpness. Latitude. Commercial films and their properties. The use of screens.

c. Fundamental aspects of Radiographic quality

Quality of radiation. Optimum working densities. Radiographic contrast. Objective and subjective contrast. Methods of controlling radiographic contrast. Effects of scattered radiation. Use of filters, screens, masking and blocking media. Influence of processing conditions and viewing conditions on contrast.

Radiographic definition: objective and subjective, unsharpness, geometric unsharpness, inter-relationship of dimensions of focal spot or source, focus (source) - object and focus (source) - film distances. Inherent unsharpness. Movement. Film screen contact. The summation of factors controlling definition.

Control of radiographic sensitivity and its assessment by the use of image quality indicators.

d. X-ray and Gamma ray equipment

A knowledge of the effects on radiographic quality in the event of equipment change.

e. Geometry of Image Formation

Control of focus (source) - object distance, object - film distance, focus (source) - film distance. Selection of beam angle.

4.2 Specific Theory - Welds

a. Exposure Calculations

Effect of distance on exposure. Use of exposure charts and calculators for X and gamma radiography.

b. Application to Welds

Interpretation of Radiographs in steel plate, and circumferential butt joints in steel pipe.

Welds in aluminium.
Welds in copper and its alloys.
Welds in small bore tubes.

The determination of the depth of a flaw from one surface in a specimen by the practical use of the tube or source shift method.

c. Viewing of Radiographs

Optimum viewing conditions. Checking for acceptable density, contrast and freedom from spurious indications. Analyse the loss of sensitivity in order to rectify faulty techniques.

Spurious indications: light (and safe-light) fogging, chemical fog, strains, air bubbles, reticulation, pressure marks, static marks, drying marks, finger marks, defective screens, incomplete fixing, film manufacturing faults.

d. 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 radiography. Defect parameters which influence detectability, eg size, geometry, distance from surface, orientation, reflectivity and opacity.

4.3 Specific theory – castings

Casting Methods;

Sand castings, pressure and gravity die casting, investment casting

Casting Defects:

Voids; porosity, gas and blowholes, airlocks and sponge

Surface defects; sinks, scabs, chisel and other fettling marks fins and fash.

Linear indications; hot tears, cold or stress cracks and cold shuts

Other defects; unfused chill and chaplets, core shifts and mould damage.

Heat treatment

Common heat treatments and their reason for use.

5 Recommended Reading

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

An introduction to Industrial Radiology Techniques by R Halmshaw. Wykeham Publications.

Basic Metallurgy for NDT. British Institute of NDT.

Data Sheets for Industrial Radiography. Kodak Limited, London.

Handbook of Radiographic Apparatus and Techniques, a concise guide to the radiography of welds. The Welding Institute.

Industrial Radiography. Agfa-Gevaert Limited. Brentford, Middlesex.

Industrial Radiography. Kodak Limited, London.

Non-Destructive Testing (second edition, 1991) by R Halmshaw. Edward Arnold.

Radiation Safety for Site Radiography. Kluwer Publishing Limited.

Recent Developments in Non-Destructive Testing. The Welding Institute.

The Physics of Industrial Radiography by R Halmshaw. Heywood.

ASNT Classroom Training Handbook. Originally published by General Dynamics.

ASNT Self Study Handbook. Originally published by General Dynamics.

ASNT Question and Answer Book.

ASNT Student Package.

ASNT Instructor Package (overheads for training).