



**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 5b: Digitised Radiographic Inspector/Interpreter Levels 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- Requirements for the Certification of Personnel engaged in Non-Destructive Testing.

## **1 LEVEL 1 DIGITISED RADIOGRAPHIC INSPECTOR**

### **1.1 General theory examination**

Not required for candidates who hold EN473/ISO 9712 or equivalent radiographic inspection certification at this level

- 40 multiple choice questions on general theory
- 20 multiple choice questions on basic radiation safety
- Time allowed 90 minutes
- Pass mark 70%

### **1.2 Specific theory examination**

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

### **1.3 General practical examination**

Not required for candidates who hold EN 473/ISO 9712 or equivalent radiographic inspection certification at this level

The candidate is required to conduct a test selected by the examiner from:

Check fix for clearing  
Check safelight.

- Time allowed 30 minutes
- Pass mark 70%

### **1.4 Specific practical examination**

#### **1.4.1 Welds and Castings**

In the practical part of the specific examination, the candidate is required to test a butt weld and a casting - as selected by the examiner and to evaluate the quality of the radiographs produced.

- Time allowed 5 hours
- Pass mark 70%

#### **1.4.2 Profile Radiography**

In the practical part of the specific examination, the candidate is required to test a minimum of two samples as selected by the examiner and to evaluate the quality of the radiographs produced.

- Time allowed 5 hours
- Pass mark 70%

**Note:** Both written examinations and practical tests will be selected according to the category of certification being sought with particular reference to the material group(s) and type of radiation.

## **2 LEVEL 2 DIGITISED RADIOGRAPHIC INSPECTOR**

### **2.1 General theory examination**

Not required for candidates who hold Level 2 EN 473/ISO 9712 or equivalent certification in the method.

- 40 multiple choice questions on general theory
- 20 multiple choice questions on basic radiation safety
- Time allowed 90 minutes
- Pass mark 70%

### **2.2 Specific theory examination**

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

### **2.3 General practical examination**

Not required for candidates who hold Level 2 EN 473/ISO 9712 certification in the method.

The candidate is required to conduct a test selected by the examiner from:

Film fog level  
Fixer for clearing  
Safe light.

- Time allowed 30 minutes
- Pass mark 70%

### **2.4 Specific practical examination**

#### **2.4.1 Welds and castings**

In the practical part of the specific examination, the candidate is required to:

Radiograph one weld and one casting, and to evaluate the images produced for suitability for interpretation.

Produce a detailed NDT instruction, suitable for a Level 1 to follow, for one of the samples selected by the examiner.

Process a system evaluation device and report the results

View, interpret and report on a total of four images, chosen by the examiner to represent the category of certification.

- Time allowed 8 hours
- Pass mark 70% for each sample examined, image interpreted and the NDT Instruction

#### **2.4.2 Profile radiography**

In the practical part of the specific examination, the candidate is required to:

Radiograph two samples and to evaluate the images produced for suitability for interpretation.

Produce a detailed NDT instruction, suitable for a Level 1 to follow, for one of the samples selected by the examiner.

Process a system evaluation device and report the results

View, interpret and report on a total of four images, chosen by the examiner to represent the category of certification.

- Time allowed 8 hours
- Pass mark 70%

**Notes:** (i) Both written examinations and practical tests will be selected according to the sector and categories of certification being sought.  
(ii) Candidates requiring certification in the welds, castings and profile radiography sectors shall radiograph one sample from each sector and interpret a total of two images of welds, castings and profile radiography. The time allowed shall be 12 hours in such cases. All other parts of the examination shall be attempted.

### **3 LEVEL 2 DIGITISED RADIOGRAPHIC INTERPRETER**

#### **3.1 Specific theory examination**

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

#### **3.2 Specific practical**

##### **3.2.1 Welds and castings**

View, interpret and report on a total of four images, chosen by the examiner to represent the categories of certification.

- Time allowed 75 minutes
- Pass mark 70% per image assessed and reported

##### **3.2.2 Profile radiography**

View, interpret and report on a total of four images, chosen by the examiner to represent the categories of certification.

- Time allowed 75 minutes
- Pass mark 70% per image assessed and reported

##### **3.2.3 Welds, castings and profile radiography**

View, interpret and report on a total of six images, chosen by the examiner to represent the categories of certification.

- Time allowed 110 minutes
- Pass mark 70% per image assessed and reported

### **4 LEVEL 3 RADIOGRAPHIC INSPECTION EXAMINATION PARTS**

This format may be used for both standard and digitised radiography. Holders of Level 3 in Radiography of welds and/or castings in compliance with EN 473/ISO 9712 standards are exempt from Section A Parts 1 and 2 but must attempt Section A part 3.

## **4.1 Materials and Process Technology**

### **4.1.1 Section A**

#### **1. Materials, Processes and Product Technology**

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

#### **2. Other NDT Methods**

15 multiple choice questions from each of four methods chosen by the candidate. One of the methods shall be the principal method for which certification is sought.

- Time allowed 90 minutes
- Pass mark 70%

#### **3. Standards and Documentation Relating to the Certification of NDT Operators**

- 10 multiple choice questions (open book)
- Time allowed 15 minutes
- Pass mark 70%

Typical documents are ISO 9712, EN 473, SNT-TC-1A

### **4.1.2 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.

- 30 multiple choice questions on the test method
- Time allowed 45 minutes
- Pass mark 70%

## **4.2 Specific Theory**

- 20 multiple choice questions on the application of test method
- Time allowed 30 minutes
- Pass mark 70%

## **5 Procedure Writing**

Candidates are required to produce a comprehensive procedure for the radiography of a weld type selected by the examiner and utilising either standard or digitised radiographic techniques. This examination part is open book, in that applicable codes and standards are to be made available to the candidate.

- 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.

### **6.1 Level 1 Radiographic Inspector**

Candidates for Level 1 recertification examinations shall be provided with written instructions for the samples to be tested.

### **6.1.1 Welds and Castings**

The candidate is required to test two samples selected by the examiner and to evaluate the images produced for suitability for interpretation.

- Time allowed 4 hours
- Pass mark 70% per sample.

### **6.1.2 Profile Radiography**

The candidate is required to test a minimum of two samples selected by the examiner and to evaluate the images produced for suitability for interpretation.

- Time allowed 4 hours
- Pass mark 70% per sample.

### **6.1.3 Welds, Castings and Profile Radiography**

The candidate is required to test three samples selected by the examiner and to evaluate the images produced for suitability for interpretation.

- Time allowed 4 hours
- Pass mark 70% per sample.

## **6.2 Level 2 Radiographic Inspector**

### **6.2.1 Welds and Castings**

The candidate is required to radiograph one weld and one casting sample and to evaluate the images produced for suitability for interpretation.

Produce a detailed NDT instruction, suitable for a Level 1 to follow, for one of the samples selected by the examiner.

View, interpret and report on two images, chosen by the examiner to represent the categories of certification sought.

- Time allowed 6 hours
- Pass mark 70% for each sample, image viewed and the NDT instruction. .

### **6.2.2 Profile Radiography**

The candidate is required to radiograph two samples and to evaluate the images produced for suitability for interpretation.

Produce a detailed NDT instruction, suitable a Level 1 to follow, for one of the samples selected by the examiner.

View, interpret and report on two images, chosen by the examiner to represent the categories of certification sought.

- Time allowed 4 hours
- Pass mark 70%.

### **6.2.3 Welds, Castings and Profile Radiography**

The candidate is required to test three samples selected by the examiner and to evaluate the images produced for suitability for interpretation.

Produce a detailed NDT instruction, suitable a Level 1 to follow, for one of the samples selected by the examiner.

View, interpret and report on three images chosen by the examiner to represent the categories of certification sought.

- Time allowed 6 hours
- Pass Mark 70% per sample, image interpreted and the NDT Instruction

**Note:** Tests will be selected according to the category of certification being renewed.

## **6.3 Level 2 Digitised Radiographic Interpreter**

### **6.3.1 Welds and Castings**

View, interpret and report on a total of four images, chosen by the examiner to represent the category(s) of certification.

- Time allowed 75 minutes
- Pass mark 70% per image assessed and reported

### **6.3.2 Profile Radiography**

View, interpret and report on a total of four images, chosen by the examiner to represent the category(s) of certification.

- Time allowed 75 minutes
- Pass mark 70% per image assessed and reported

### **6.3.3 Welds, Castings and Profile Radiography**

View, interpret and report on a total of six images, chosen by the examiner to represent the category(s) of certification.

- Time allowed 110 minutes
- Pass mark 70% per image assessed and reported

## **7 Level 1 Digitised Radiographic Inspector (Welds) Syllabus**

### **7.1 General theory**

#### **a. Nature and properties of X and/or Gamma Radiation**

Penetration, absorption, scatter, diffraction, transmission. Rectilinear propagation. Photographic, fluorescent and ionising effects. Physiological properties. Descriptions of film, CR and RTR image collection systems

#### **b. Image production aspects**

Dark room procedures: layout, , processing units, safe-lights and ancillary equipment. Handling and processing of films, temperature control. Handling of imaging plates, scanning and erasure procedures,

Sensitometry: types of film, paper, and imaging plates used in industrial radiography.

The use of differing types of screens in conventional & CR radiography

**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. Brief reference to grids. 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. The control of CR radiographic quality by the use of, phantoms, duplex & wire IQI's, line pair IQI's, BAM alignment indicators, contrast sensitivity indicators and SN ratios

**d. X-ray equipment**

Generation of X-rays, their characteristics and selection. Handling equipment

**e. Geometry of image formation**

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

**f. Safety**

An understanding of working practices including safety precautions (see recommended reading).

**7.2 Specific Theory**

**a. Exposure calculations**

Effect of distance on exposure. Use of exposure charts and calculators for X and gamma radiography using either film or imaging plates.

**b. Geometric considerations of radiography for welds and castings and profile RT**

Flaw depth determination in a specimen by the tube or source shift method.

Geometric unsharpness and its control.

Principles and practices for profile radiography

Measurement comparators for CR profile radiography.

**c. Viewing of images**

Spurious indications relating to film radiography: light (and safe-light) fogging, chemical fog, strains, air bubbles, reticulation, pressure marks, static marks, drying marks, , defective screens, incomplete fixing, film manufacturing faults.  
Artefacts and fading of CR imaging media

Optimum viewing conditions. Checking for acceptable density, contrast and freedom from spurious indications.

Monitor types and resolutions for viewing of CR images. Optimum viewing conditions for CR images. Measurements using CR images, Image manipulation techniques.

**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 radiographic inspection.

**f. Casting technology**

Types of castings: sand casting, investment castings, pressure die- castings.

Typical defects in cast materials

## **8 Level 2 Digitised Radiographic Inspector (Welds) Syllabus**

### **8.1 General theory**

As for Level 1 but the examination questions will be more complex.

### **8.2 Specific theory**

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. Defect parameters which influence detectability.

## **9 Level 2 Digitised Radiographic Inspector (Castings) Syllabus**

### **9.1 General Theory**

As for Level 1 but the examination questions will be more complex.

### **9.2 Specific Theory**

As for level 1 but in addition:

**a. Casting technology**

Influence on techniques of geometry, size, surface condition, parent metal composition, feeding and cooling effects on defect formation. Influence of heat treatments and weld repairs.

Basic principles of casting processes.

1. Types of defect associated with particular materials and casting process combinations. Defect parameters and their influence on detection.

## **10 Level 2 Digitised Radiographic Inspector (Profile Radiography) Syllabus**

### **10.1 General Theory**

As for Level 2 but the examination questions will be targeted toward image analysis and assessment .

## 10.2 Specific Theory

As for Level 2 but the examination questions will be targeted toward image analysis and assessment.

## 10.3 Specific Practical

The production and assessment of CR images for, corrosion, erosion, pitting and the techniques for measurement of the same

# 11 Level 2 Digitised Radiographic Interpreter Syllabus

## 11.1 General Theory

As for Level 2 but the examination questions will be targeted toward image analysis and assessment.

## 11.2 Specific Theory

As for Level 2 but the examination questions will be targeted toward image analysis and assessment.

## 11.3 Specific Practical

The assessment of CR images for, corrosion, erosion, pitting and the techniques for measurement of the same, defect recognition and assessment of welds and castings

# 10 Level 3 Radiographic Inspection Syllabus

This format may be used for both standard and digitised radiography at Level 3. Holders of Level 3 in Radiography in welds and/or Castings in compliance with EN 473/ISO 9712 standards are exempt from Section A Parts 1 and 2 but must attempt Section A part 3 in addition to the main method examination.

## 10.1 General Theory

### 10.1.1 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, 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**

## **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.

## **3. Standards and Documentation Relating to the Certification of NDT Operators**

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

### **10.1.2 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.

### **10.2 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. Candidates will in addition require a knowledge of the following:

#### **Alternative forms of imaging**

Fluoroscopy, Real time radiography, digital imaging

#### **Alternative Equipment**

Micro focus X-ray equipment, linear accelerators, neutron radiography

## **11 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.

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 Level III Study Guide.

ASNT Student Package.

ASNT Instructor Package (overheads for training).

### **Reference Literature**

BS EN 444 Non-Destructive testing -	General Rules for the radiographic Examination of Metallic Materials using X-Rays and Gamma Rays
BS EN 462-5 Non-Destructive testing -	Part 5, Image Quality Indicators (duplex wire type) for the Determination of Image Quality values.
BS EN 584-1 Non-Destructive testing -	Part 1, Classification of Film Systems for Industrial Radiograph
Pr EN 14784 Non-Destructive testing	Part 1, Industrial Computed Radiography with Phosphor Imaging Plates- Classification of Systems.
ASTM E1647 - 98a	Standard Practice for Determining Contrast Sensitivity in Radioscopy