



**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 Syllabuses for the Certification of Personnel Engaged in Non-Destructive Testing**

**PART 12: Asset Management Inspector, Level 2 and 3 of In Service Tubular Products**

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## SCOPE

These requirements and syllabi are applicable to candidates seeking certification in accordance with Document CSWIP-ISO-NDT-11/93R 'Requirements for the Certification of Personnel Engaged in Non-Destructive Testing. The methods and techniques are principally directed towards providing data for the assessment of remanant life in heat transfer units. They may also be used to provide base data for new equipment being placed in service.

Candidates must be in possession of a current EN 473/ISO 9712 Level 2 or Level 3 certificate in eddy current testing of wrought products and/or a current EN 473/ISO 9712 Level 2 or Level 3 certificate in the ultrasonic testing of welds or wrought products to be eligible for the examination.

Holders of relevant employer based Level II certification which complies with the standards in terms of training and examination content may also be considered for eligibility on an individual case basis.

## ASSET MANAGEMENT INSPECTOR – EXAMINATION FORMAT

### 1 Level 2 - Applicable to Eddy Current, Remote Field Eddy Current and Ultrasonic IRIS inspections

#### 1.1 Product technology examination

- 15 multiple choice questions relating to tubular wrought products
- Time allowed 20 minutes
- Pass mark 70%.

#### 1.2 Specific theory examination

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

#### 1.3 General practical examination

In this practical part, the candidate is required to select the necessary probes and equipment to conduct the test; conduct operational and function checks on equipment and probes and record the results in the method for which certification is required.

- Time allowed 30 minutes
- Pass mark 70%.

#### 1.4 Instruction writing

To write an NDT instruction suitable for guidance of trainees or Level 1 personnel.

- Time allowed 1.5 hours
- Pass mark 70%

#### 1.5 Specific practical examination

Candidates for certification in asset management inspection can seek certification in:

Eddy current inspection of non-ferritic tubing,  
Remote field eddy current inspection of ferritic tubing  
Ultrasonic IRIS inspection of ferritic or non-ferritic tubing.

The specific practical examinations are shown below.

### **1.5.1 Eddy current inspection of non-ferritic tubing**

To test one tube bundle specimen of 12 - 16 non-ferritic tubes having a minimum length of one metre as selected by the examiner, collect and digitally store the data and analyze the collected data.

Additionally the candidate shall analyze data on a further 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

The tests shall be conducted in accordance with procedures and/or instructions.

Reports shall be produced for each sample on supplied report formats

- Time allowed 6 hours
- Pass mark 70%.

### **1.5.2 Remote field eddy current inspection of ferritic tubing**

To test one tube bundle specimen of 12 - 16 non-ferritic tubes having a minimum length of one metre as selected by the examiner, collect and digitally store the data and analyze the collected data.

Additionally the candidate shall analyze data on a further 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

The tests shall be conducted in accordance with procedures and/or instructions.

Reports shall be produced for each sample on supplied report formats

- Time allowed 6 hours
- Pass mark 70%.

### **1.5.3 Ultrasonic IRIS inspection of Ferritic or Non-ferritic Tubing**

To test one tube bundle specimen of 12 - 16 non-ferritic tubes having a minimum length of one metre as selected by the examiner, collect and digitally store the data and analyze the collected data.

Additionally the candidate shall analyze data on a further 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

The tests shall be conducted in accordance with procedures and/or instructions.

Reports shall be produced for each sample on supplied report formats

- Time allowed 6 hours
- Pass mark 70%.

## **ASSET MANAGEMENT DATA ANALYZER – EXAMINATION FORMAT**

## **2 Level 2 - Applicable to Eddy Current, Remote Field Eddy Current and Ultrasonic IRIS inspections**

### **2.1 General theory examination**

- 40 multiple choice questions relating to the general principles of the method concerned
- Time allowed 60 minutes
- Pass mark 70%.

Candidates holding the certification stated in the scope of this document are exempted from this section of the examination.

## **2.2 Specific theory examination**

- 30 multiple choice questions on the application of the method concerned
- Time allowed 45 minutes
- Pass mark 70 %.

## **2.3 Specific practical examination**

Candidates for certification in asset management data analysis can seek certification in:

- Eddy current inspection of non-ferritic tubing,
- Remote field eddy current inspection of ferritic tubing
- Ultrasonic IRIS inspection of ferritic or non-ferritic tubing.

The specific practical examinations are shown below.

### **2.3.1 Eddy current inspection of non-ferritic tubing**

The candidate shall analyze data on 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

Reports shall be produced for each sample on supplied report formats

- Time allowed 1 hour
- Pass mark 70%.

### **2.3.2 Remote Field Eddy Current Inspection of Ferritic Tubing**

The candidate shall analyze data on 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

Reports shall be produced for each sample on supplied report formats

- Time allowed 1 hour
- Pass mark 70%.

### **2.3.3 Ultrasonic IRIS inspection of ferritic or non-ferritic tubing**

The candidate shall analyze data on 10 data sets from tubes displaying typical conditions which may be encountered during inspections.

Reports shall be produced for each sample on supplied report formats

- Time allowed 1 hour
- Pass mark 70%.

## **3 Level 3 – Asset Management Inspector**

The basic examination is applicable to all candidates not already holding either an exemption from or a current Level 3 certification acceptable to CSWIP

### **3.1 Basic examination (exempt if already holding Level 3)**

#### **Section A1 Material Science and Processes**

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

#### **Section A2 Knowledge of the Certification Scheme**

- 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%

Exemptions for holders of Level 2 certification in the main NDT methods may be available for this section of the examination.

### **3.2 Main method examination**

Candidates for certification in asset management inspection can seek certification in:

- Eddy current inspection of non-ferritic tubing,
- Remote field eddy current inspection of ferritic tubing
- Ultrasonic IRIS inspection of ferritic or non-ferritic tubing.

#### **Section C1 - Level 3 Theory of the NDT Method**

- 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 may be open book with respect to Codes, standards and specifications

#### **Section C3 - NDT Procedure Writing**

- Time allowed 4 hours
- Pass mark 70%

This section of the examination may be open book with respect to Codes, standards and specifications

## **4 Ten Year Renewal**

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 2**

#### **4.1.1 Each category of certification**

To test one tube bundle specimen of 12 - 16 non-ferritic tubes having a minimum length of one metre as selected by the examiner, collect and digitally store the data and analyze the collected data.

The tests shall be conducted in accordance with procedures and/or instructions.

Reports shall be produced for each sample on supplied report formats

- Time allowed 4 hours
- Pass mark 70%.

## **5 Level 2 Asset Management NDT - Eddy Current Syllabus**

### **5.1 General theory**

Not detailed as candidates will be Level 2 certificated.

### **5.2 Specific Theory**

#### **5.2.1 Product technology theory**

- a) General heat exchanger tube design and construction.
- b) The purpose of a heat exchanger.
- c) Heat exchanger types:
  - i) tube plate designs;
  - ii) tube fixing designs
- d) Plant materials:
  - i) manufacture of tubing and sheet alloys;
  - ii) tube and alloy materials;
  - iii) uses of the various tube materials including the advantages and disadvantages.
- e) Defect formation:
  - i) manufacturing tube defects;
  - ii) in-service tube defects, causes and remedies e.g. corrosion, erosion, fretting, cracking and fatigue;
  - iii) internal and external tube damage

#### **5.2.2 Review of Electromagnetic Theory**

- a) Review of Eddy Current Theory
- b) Types of Eddy Current Probe (Probe configuration)
- c) Standard Depth of Penetration
- d) Probe considerations
- e) Differential v Absolute

#### **5.2.3 Calibration Curves**

- a) Calibration Considerations
- b) Minimum Requirements
- c) Calibration Curves (phase shift)

#### **5.2.4 Selection of test Frequency**

- a) Test frequency Calculation (f90)
- b) Multi Frequency Inspection
- c) Frequency Mixing

#### **5.2.5 Equipment Set Up & Operation**

- a) Parameter Selections
- b) Screen Configuration
- c) Channel Selection
- d) Calibration Setup
- e) Defect Codes
- f) File Management
- g) Optimizing Depth Curves
- h) Advanced Settings
  - i) Gain
  - ii) Filters
  - iii) Frequency Changes
  - iv) Driver Voltage

#### **5.2.6 Data Acquisition & Analysis**

- a) Defining the Inspection
- b) Recording Data
- c) Recalling Data
- d) Defect Evaluation
- e) Automatic Measurement
- f) Manual Measurement
- g) Adding Report Entry
- h) Creating a Report

### **5.3 Level 2 Asset Management NDT Specific Theory – Remote Field Eddy Current Testing**

#### **5.4 General**

Differences between remote field and standard eddy current testing. Need for generating and detection separation.

#### **5.5 Specific Theory**

##### **a. Wrought Product Processes**

Definition of rolling and how it works; types of defects in rolled material; definition of forging and how it works; types of defect in forged products; tube manufacture and the types of defect encountered when eddy current testing.

##### **b. Pre – Test procedures**

Surface preparation; characteristics of coatings and their effects. Minimum levels of tube cleaning.

##### **c. Safety Precautions**

Risk assessment; fire hazards; electrical safety and confined space entry.

##### **d. Conduct of tests**

Test procedures and reasons for NDT instructions; briefing of the remote probe operator and the supervision of level 1 personnel; probe selection; chart recording and computer file handling;

digital data collection and storage; selection of manual equipment; probes and frequency selection; coating types and methods of compensation.

**e. Defect Detection**

Probability of detection; defect characteristics; lift off and probe movement; effects of heat treatment and metallurgical changes on detection.

**f. Signal Interpretation**

Types of defects and their identification; relevant and non-relevant indications and their causes; capabilities and limitations of other NDT methods in terms of detection; characterisation and confirmation of defect, digital data collection and storage

**g. Reporting**

Responsibilities for reporting; origination and authentication of NDT reports; content and layout of report; presentation of the inspection results of an NDT report; hard copy and computer generated reports; maintenance and retention of records

**5.6 Level 2 Asset Management NDT Specific Theory – Ultrasonic IRIS Tube Inspection**

**5.6.1 Product technology theory**

- a) General heat exchanger tube design and construction.
- b) The purpose of a heat exchanger.
- c) Heat exchanger types:
  - i) tube plate designs;
  - ii) tube fixing designs.
- d) Plant materials:
  - i) manufacture of tubing and sheet alloys;
  - ii) tube and alloy materials;
  - iii) uses of the various tube materials including the advantages and disadvantages.
- e) Defect formation:
  - i) manufacturing tube defects;
  - ii) in-service tube defects, causes and remedies e.g. corrosion, erosion,
  - iii) internal and external tube damage

**5.6.2 IRIS Theory of Operation**

- a) General Concept
- b) Path in Tube
- c) Echo Detection
- d) System Components
- e) Selection of test Frequency & Turbine

**5.6.3 Equipment Set Up & Operation**

- a) Parameter Selections
- b) Screen Configuration
- c) Defect Codes
- d) File Management
- e) Real Time Settings
- f) Advanced Settings
  - i) Pulser Receiver
  - ii) Trigger
  - iii) Echo Finder
  - iv) Pulse Width



#### **5.6.4 Data Acquisition & Analysis**

- a) Defining the Inspection
- b) Recording Data
- c) Recalling Data
- d) Defect Evaluation
- e) Adding Report Entry
- f) Creating a Report

### **6 Level 3 Asset Management NDT Inspector Syllabus**

#### **6.1 Basic Examination Theory**

##### **6.1.1 Section A1**

#### **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 and methods of tube manufacture.

##### **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.

### **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**

#### **6.1.2 Section A2 - Standards and Documentation Relating to the Certification of NDT Operators**

ISO 9712, EN 473, EN 4179 & SNT-TC-1A

#### **6.1.3 Section B - Other NDT Methods:**

##### **Electromagnetic Testing**

Principles, properties of ACFM testing, effect of varying frequency, 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.

#### **6.1.4 Section C1 - General theory for the Method**

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

#### **6.2 Section C2 - Specific Theory for the Method**

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

#### **6.3 Section C3 – Procedure Writing**

Candidates are expected to produce a procedure for inspection of tubing using the selected method relevant to the category of certification sought.

## **7 Reference Literature**

Product Technology Classroom Training Handbook – The British Institute of NDT 1995

'Basic Metallurgy for Non – Destructive Testing' edited by J L Taylor. British Institute of NDT

'Principles and practice of non-destructive testing' edited by Dr J H Lambie. Heywood and Company, London, 1962.

Non-Destructive Testing (second edition, 1991) by R Halmshaw. Edward Arnold, London 1991 ISBN 0340545216.

ASNT Question and Answer Supplement to SNT-TC-1A – Electromagnetic Testing

ASNT Level III Study Guide.

NDT Handbook, volume 4 Electromagnetic Testing ASNT 1991, Columbus, Ohio ISBN 0931403049.

Classroom Training Handbook CT-6-5 ASNT

Programmed Instruction Handbook PI-4-5 ASNT

Materials and Processes for NDT Technology ASNT