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 Content and Syllabus details for CSWIP-ISO-NDT-11/93-R scheme

PART 1c: Time of Flight Diffraction (TOFD) Ultrasonic Inspector of Welds in Ferritic and Non-Ferritic Materials, Levels 1, 2 and 3.

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

1.1.0 CSWIP TOFD Ultrasonic Inspector Level 1: Welds

Set up, calibration and data gathering of plate and pipe welds using TOFD ultrasonic equipment for the material selected.

1.1.1 General theory examination

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

1.1.2 Specific theory examination

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

1.1.3 General practical examination

The candidate is required to optimise a calibration of TOFD ultrasonic equipment to the requirements of ISO 10863.

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

1.1.4 Specific practical examination

The candidate is required to complete an examination of two welds from the categories required selected by the examiner and produce complete and accurate data files.

Calibrate the TOFD sensitivity

Calibrate the motor drive unit (where appropriate)

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

1.2.0 CSWIP TOFD Ultrasonic Inspection Level 2: Welds

1.2.1 General theory examination

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

1.2.2 Specific theory examination

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

1.2.3 General practical examination

The candidate is required to optimise a calibration of TOFD ultrasonic equipment to the Requirements of BS EN ISO 10863.

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

1.2.4 Specific practical examination

The candidate is required to complete an examination, collect and store test data of two linear welds from the categories required selected by the examiner and produce complete and accurate data files. Weld preparation should include double-V and single-V configurations.

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

Interpret the results of four recorded weld scan data files selected by the examiner and report the results of the inspections in an indicated format, showing the size and location of flaws in the welds.

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

The candidate is in addition required to draft an NDT instruction suitable for a Level 1 operator for a testing of one linear butt weld selected by the examiner, to a provided code, standard or specification, and to prove the instruction by testing.

- Time allowed: 1.5 hours
- Pass mark: 70%

Note: The samples shall be selected by the examiner. The samples shall be in the thickness range of 6 to 15mm and above 15mm.

Candidates who hold Level 1 TOFD certification in compliance with ISO 9712 will be have the following allowances/exemptions from the following parts of the Level 2 examination:

- Level 2 General Practical Examination
- Production of two data file as required in the Level 2 Specific Practical examination

1.3.0 CSWIP TOFD Ultrasonic Inspection Level 2: Data Analysis

1.3.1 General theory examination

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

1.3.2 Specific theory examination

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

1.3.3 Specific practical examination

The candidate is required to assess and evaluate four data files from the categories required, selected by the examiner, and report the results therein.

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

1.3.4 Instruction writing examination

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

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

1.4.0 CSWIP TOFD Ultrasonic Inspection Level 3

1.4.1 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 test method.

- 60 multiple-choice questions
- Time allowed: 120 minutes
- Pass mark: 70%

1.4.2 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 – TOFD Ultrasonic Operator (Welds)

The candidate is required to calibrate the TOFD sensitivity and calibre the motor drive unit (where appropriate). A full inspection is performed on two given weld samples and accurate and complete data files produced.

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

Note: The samples shall be selected by the examiner. The samples shall be in the thickness range of 6 to 15mm and above 15mm.

2.2. Level 2 – TOFD Ultrasonic Operator (Welds)

The candidate is required to complete an examination of two welds from the categories required selected by the examiner and produce complete and accurate data files.

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

Interpret the results of four data files selected by the examiner and report the results of the inspections.

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

The candidate is in addition required to draft an NDT instruction for a weld selected by the examiner.

- Time allowed: 1.5 hours
- Pass mark: 70%

2.3. Level 2 – TOFD Ultrasonic Data Analyst

The candidate is required to assess and evaluate four data files from the categories required, selected by the examiner, and report the results therein.

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

3. Examination Syllabus

3.1.0 Level 1 – TOFD Ultrasonic Testing

3.1.1 General Theory

a) Brief history of development of ultrasonic testing theory

b) Ultrasonic capabilities in relation to other NDT methods

c) Physical principles of sound
Nature of sound, relationship between wavelength, frequency and velocity. Wave motions and particle vibrations, velocities of sound in common materials.

d) Behaviour of ultrasonic waves
Reflection, refraction, diffraction. Snell's laws, attenuation, acoustic impedance, mode conversion, resonance, scattering from defects.

e) Production of ultrasonic waves
Piezo-electric effect. Types and properties of transducers pulse width, near and far fields, effect of frequency and sound velocity on near field, far field and beam divergence. Dead zone, production of compression, shear and surface waves, critical angles, construction of single and twin crystal probes. Couplants.

f) Ultrasonic equipment
Block diagrams of flaw detector, functions of controls, amplifier and equipment performance characteristics. A-scan, B-scan and C-scan displays.

g) Calibration and equipment checks
Calibration and reference blocks, check for dead zone, penetrative power, resolution, sensitivity, probe index, angle of refraction, linearity of time base and amplifier. Plotting beam spread diagrams. Calibration of time base ranges. Comparison of probe sensitivities. Setting sensitivity levels for scanning.

h) Practical applications - parent material and weld examination
Information required prior to examination. Parent material examination, attenuation measurements, methods of flaw sizing 20dB, 6dB, DGS, maximum amplitude, use of flaw location slide, reporting methods. Brief knowledge of component surface finish and its measurement.

3.1.2. Specific Theory

a) TOFD instrumentation
Set up and function of instrument controls Basic software details internal circuitry processing.

b) TOFD transducers/probes
Principles of design and performance typical arrays.

c) Scan types
Radial Linear Offset Scan limitations

d) Sensitivity
Reference reflectors and blocks for sensitivity settings

e) Calibration and checks
Probe spacing Exit points Scans in thick material

f) Data collection software
File structures and naming Data acquisition control Encoder parameter sand set-up Storage Real time scans.

g) Data analysis

Data transfer protocols Analysis tools A, B scan formats saving files Report generation Flaw verification procedures.

3.2.0 Level 2 – TOFD Ultrasonic Testing

3.2.1 General Theory

As for Level 1 Inspector.

3.2.2 Specific Theory

As for Level 1 Inspector, with in addition

a) Introduction to data analysis
b) Defect length determination
c) Defect height determination
d) Near surface defect parameter determination
e) Practical defect determination
f) Reporting
g) Data analysis and acceptance criteria
h) Effects of different materials on defect sizing

3.3.0 Level 3 – TOFD

3.3.1 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.

3.3.2 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 question on:

a) Alternative probe arrangements

The purpose and performance of twin crystal probes, special arrays for the detection of near surface defects, focused probes, probes with wide band frequency, phased array probes.

b) Immersion testing, gap scanning

c) Phased array, guided waves

d) Methods of digital processing

e) Flaw sizing systems

3.3.3 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 examination.
The ultrasonic 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.