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 BS EN 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 11: Guided Wave Testing (GWT) Inspector, Level 1, 2 and 3, of Pipes and Pipelines

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These syllabi are applicable to candidates seeking certification in accordance with the current version of Document CSWIP-ISO-NDT-11/93-R: 'Requirements for the Certification of Personnel Engaged in Non-Destructive Testing in accordance with the requirements of BS EN ISO 9712'.

GUIDED WAVE TESTING (GWT) INSPECTOR

1 Level 1

1.1 General theory examination

- 40 multiple choice questions
- Time allowed 60 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

The candidate is required to verify required settings and operate the test equipment properly in order to obtain satisfactory results and correctly interpret and present these results. The candidate is required therefore to demonstrate to the satisfaction of the invigilator this ability, with comments, using the means available for each test method.

- Time allowed 60 minutes
- Pass mark 70%

1.4 Specific practical examination

Candidates for Level 1 certification are required to test, evaluate and report on data collected from samples relevant to the certification sought containing real or simulated defects. Written instructions are provided for Level 1 candidates.

1.4.1 Pipes and pipelines

The candidate is required to test and evaluate data collected from two locations or specimens selected by the examiner from pipes, a pipeline according to written instructions provided.

- Time allowed 120 minutes
- Pass mark 70%

2 Level 2

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 of:

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

2.3 Specific practical examination

Candidates for Level 2 certification are required to test, interpret and report on data provided by the examiner, which has been previously gathered from samples relevant to the certification sought containing real or simulated defects.

If the candidate is direct entry at Level 2, the Level 1 practical examination must be taken and the candidate must be successful in this examination before Level 2 certification can be awarded.

2.3.1 Pipes and pipelines

The candidate is required to interpret and report on 4 sets of data from sections of pipe or pipeline. The candidate is also required to complete a test paper on flaw classification to standard guided wave UT procedures.

- Time allowed 5 hours
- Pass mark 70%

2.3.2 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%.

3 Level 3

3.1 Basic Examination (Exempt if already holding a Level 3 ISO 9712 Certification)

Section A1 Material Science and Process Technology

- 25 multiple choice questions
- Time allowed 40 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

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 90 minutes
- Pass mark 70%

N.B. Exemptions may apply, for this examination section to valid ISO 9712 Level 2 certificate holders in the main NDT methods.

3.2 Main Method Examination

Section C1 Knowledge of the Method General Theory

The candidate will be tested on Level 3 knowledge relating to the test method for which certification is sought.

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

Section C2 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 30 minutes
- Pass mark 70%

Section C3 Procedure Writing

The candidate is required to draft an NDT procedure for a component selected by the examiner.

- Time allowed 4 hours
- Pass mark 70%

4 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, Section 7.5.3.

4.1 Level 1 Guided Wave Inspector

The candidate is required to test and demonstrate the adequacy of the data collected on one test location selected by the examiner from pipes or pipeline according to written instructions provided.

- Time allowed 120 minutes
- Pass mark 70%

4.2 Level 2 Guided Wave Inspector

The candidate is required to test and demonstrate the adequacy of the data collected on one test location selected by the examiner from pipes or pipelines plus evaluate and report on data collected from two samples relevant to the certification sought containing real and simulated discontinuities. The candidate is also required to complete a test paper on flaw classification to standard guided wave procedures. The candidate is in addition required to produce an NDT instruction for one of the items to be tested.

- Time allowed 5 hours
- Pass mark 70%

5 Examination Syllabus

5.1 Level 1 Guided Wave Testing

5.1.1 Introduction, terminology and history of guided wave testing

- purpose of guided wave tests and screening
- relationship to other NDT methods
- personnel requirements
- history of guided wave testing
- terminology for guided wave testing
- general terminology according to EN 1330
- roles and responsibilities of Level 1 technicians

5.1.2 Physical principles of the method and associated knowledge

a) General Theory

- Physical definitions and parameters
- Nature of sound, basic wave equation
- Bulk wave modes
- Acoustic impedance
- Reflection and transmission coefficients
- Attenuation
- Reflection and refraction
- Snell's Law
- Acoustic pressure
- Transducer characteristics
- Ultrasound beam characteristics
- Near and far fields
- DAC curves

b) Specific theory

- Guided wave modes
- Introduction to guided wave concepts
- Plate wave modes
- Propagation characteristics
- Frequency x thickness product
- Dispersion and dispersion curves
- Guided waves in pipes
- Generation and reception of guided waves
- Transducer types
- Transducer configurations
- Mode control

- Directionality
- Sensitivity achievable
- Basis of flaw detection
- Detection performance
- Factors influencing test performance
- Pipe diameter and thickness
- Pipe contents
- External coatings and surrounding material
- Geometry (bends etc.) and attachments

5.1.3 Product knowledge and related capability of the method and derived techniques

- In-service degradation of pipes and pipelines
- Corrosion
- Other types (mechanical damage, erosion etc.)

5.1.4 Equipment

- Type of equipment available
- General characteristics
- Operation
- Hardware
  - characteristics
  - set-up
  - checks and calibration
- Software
  - test set-up
  - test control
  - data display and analysis
- Care of equipment
- troubleshooting

5.1.5 Information required prior to test

- Scope of the test
- Component details
  - size
  - contents
  - access
  - coatings and other physical details (eg buried)
  - geometry and attachments
- Preparation permitted for tool attachment
- Written test instructions for carrying out the test

5.1.6 Testing

- Setting up equipment
  - operational condition
  - physical and electrical checks
  - selection of tool location in accordance with instructions
  - datum points

- Selection of test parameters
  - input of relevant job and component details
  - Input of tool parameters and location

- Performing the test
  - preparation of the pipe surface and mounting of the sensors

- ancillary operations, thickness measurement, visual examinations
- calibration and coupling checks
- automated & manual
- controlling the test sequence
- monitoring the test operation
- use of focussing
- assessment of collected data
- data security, organisation and storage
- storage of data (staged storage, new files and over-write)
- naming of files
- back-up

5.1.7 Reporting and evaluation

- Level 1 responsibilities and requirements
- Assessment of data quality
- Setting of DAC curves and diagnostic length
- Identification of indications for further tests
- Gathering additional data
- Software reporting functions

5.1.8 Assessment

- Basic assessment of data quality

5.1.9 Quality

- Personnel qualification to BS EN ISO 9712
- Data quality assessment
- Equipment checks and calibration

5.2 Level 2 Guided Wave Testing

5.2.1 Introduction, terminology and history of guided wave testing

The syllabus is the same as that for Level 1 plus roles and responsibilities of Level 2 technicians.

5.2.2 Physical principles of the method and associated knowledge

a) Revision of Level 1 specific theory

b) Level 2 specific theory.

- Properties of guided waves in plates and pipes
- Dispersion and its effects
- Detailed description of dispersion curves
- Factors influencing wave propagation
- Attenuation
- Mode conversion
- Interaction with defects and mechanisms of detection
- Methods of enhancing test performance
- Selection of test parameters
- Focusing
- Post-processing and display of signals
- Requirements for test systems
- Physical basis for system characteristics and performance

5.2.3 Product knowledge and related capability of the method and derived techniques

Same as for Level 1 competency plus:

- mechanisms of generation of in-service flaws
- form, size and location of flaws
- bends, supports and coatings

5.2.4 Equipment

Same as for the Level 1 competency plus:

- Hardware
- -knowledge of equipment performance requirements
- -assessment of equipment condition
- Software
- -advanced software functions
- -manual set-up options
- Advanced troubleshooting

5.2.5 Information required prior to test

Same as for Level 1 competency plus:

- Appreciation of client requirements
- Sufficient information to allow a specific work instruction to be written

5.2.6 Testing

Same as for Level 1 competency plus:

- Variation of operating parameters within system limits to optimise tests for the prevailing conditions

5.2.7 Report and evaluation

- Review, analysis and reporting of indications
- Data reduction and display of results
- A-map and other displays
- Reporting of results
- Software reporting functions and report manager utility

5.2.8 Assessment

- Evaluation of indications and reporting to established procedures
- Review of data reported by Level 1 technicians
- Assessment of category of response based on amplitude and directionality/orientation

5.2.9 Quality

- Personnel qualification in accordance with ISO 9712
- Equipment verification
- Written instructions
- Traceability of documents

5.2.10 Developments

- Summary of development paths being followed

5.3 Level 3 Guided Wave Testing

5.3.1 Basic examination

5.3.1.1 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.

- **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**

5.3.2 Other NDT methods

- **Acoustic Emission**

  Principles, sources of acoustic emissions, equipment and materials, proper selection of technique.

- **Electromagnetic Testing (Eddy Current Inspection)**

  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 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.

5.3.2.1 Standards and documentation relating to the certification of NDT operators

BS EN ISO 9712 and SNT-TC-1A

5.3.3 Main Method Examination

5.3.3.1 Introduction, terminology and history of guided wave testing

The syllabus is the same as for the Level 1 competency plus:

- Review of relevant literature and underlying concepts
- Roles and responsibilities of Level 3 personnel

5.3.3.2 Physical principles of the method and associated knowledge

a) Revision of Level 2 specific theory
b) Level 3 specific theory

- Propagation characteristics of different modes in plates and pipes
- Influence of geometry, coatings etc. on propagation

- Detection mechanisms
- Documentary evidence for performance of guided wave tests
- Guided wave propagation in prismatic structures (wires, tubes, rail ‘I’ sections etc.)

5.3.3.3 Product knowledge and related capability of the method and derived techniques

Same as for the Level 2 competency plus

- Significance of flaws generated in-service on pipes, pipelines and structural tubulars
- Codes and standards for the assessment of flaws in pipes, pipelines and structural tubulars
- Influence of materials other than ferritic steel

5.3.3.4 Equipment

Same as for the Level 2 competency plus:

- Hardware characteristics and their effects on the test
- Transducer systems and factors influencing their performance

5.3.3.5 Information required prior to test

Same as for the Level 2 competency plus:

- Understanding of clients goals for the inspection
- Sufficient information for a comprehensive test procedure to be developed

5.3.3.6 Testing

Same as for the Level 2 competency plus:

- Derivation of optimum operating parameters based on the known test circumstances
- Procedure development

5.3.3.7 Reporting and evaluation

- Review and assessment of test results
- Critical review of results and reports from Level 1 and 2 personnel

5.3.3.8 Assessment

- Evaluation of responses in relation to applicable codes to assess appropriate follow up actions.

5.3.3.9 Quality

- Personnel qualification and responsibility in accordance with ISO 9712
- Equipment verification
- Format of procedures
- Traceability of documents
- Other NDT qualification and certification schemes
- A review of relevant NDT application and product standards

5.3.3.10 Developments

- Latest developments from the literature

6 Reference Literature

6.1 General literature

- Product Technology Classroom Training Handbook – The British Institute of Non-Destructive Testing.
- Electrical, Magnetic and Visual Methods of Testing Materials. J Blitz, W G King and D G Rogers, Butterworth 1969.
- Non-Destructive Testing Handbook, edited by Robert G McMaster, The Ronald Press, New York.
- Basic Metallurgy for Non-Destructive Testing, Edited by J L Taylor. The British Institute of Non-destructive Testing, 1 Spencer Parade, Northampton NN1 5AA.
- 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.
- NDT Handbook, second edition, volume 7 (1991).
- ASNT Student Package.
- ASNT Instructor Package (overheads for training).