



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 1a: Ultrasonic Inspector (Conventional), Level 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-R 4th Edition, 'Requirements for the Certification of Personnel engaged in Non-Destructive Testing.

ULTRASONIC INSPECTOR

1 Level 1 - Butt Welds in Plate and Pipe

1.1 General theory examination

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

1.2 Specific theory examination

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

1.3 General practical examination

In the general practical part, the candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution. Written instruction are provided.

The candidate will also determine areas of lamination in a plate.

- Time allowed: 1 hour
- Pass mark 70%

1.4 Specific practical examination

In the specific practical part the candidate is required to test and report on a plate butt weld and a pipe butt weld as selected by the examiner and in accordance with provided instructions.

- Time allowed 5 hours
- Pass mark 70%

2 Level 1 - Thickness Measurement

2.1 General theory examination

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

2.2 Specific theory examination

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

2.3 General practical examination

The candidate is expected to calibrate equipment in a range of different materials commonly found in process and treatment plant. Written instructions are provided.

- Time allowed 1 hour

2.4 Specific practical examination

The candidate is required to test and report on three samples selected by the examiner which demonstrate mechanisms of corrosion and/or erosion commonly found in process and treatment plant. Written instructions are provided.

- Time allowed 2 hours
- Pass mark 70%

3 Level 1 – Wrought Products

3.1 General theory examination

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

3.2 Specific theory examination

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

3.3 General practical examination

In the general practical part, the candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution. Written instructions are provided.

- Time allowed 1 hour

3.4 Specific practical examination

The candidate is required to test and report on four samples selected by the examiner which contain discontinuities representative of those found in bar, billet, plate and forgings of simple shape. Written instructions are provided.

- Time allowed 4 hours
- Pass mark 70%

4 Level 1 – Castings

4.1 General theory examination

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

4.2 Specific theory examination

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

4.3 General practical examination

In the general practical part, the candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution. Written instructions are provided.

- Time allowed 1 hour

4.4 Specific practical examination

The candidate is required to test and report on four samples selected by the examiner which contain discontinuities representative of those found in castings of simple shape; of differing heat treatment condition and requiring thickness measurement. Written instructions are provided.

- Time allowed 4 hours
- Pass mark 70%

5 Level 2 - Welds

5.1 General theory examination

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

5.2 Specific theory examination

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

5.3 General practical examination

The candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution; the candidate will also determine areas of lamination in a plate.

- Time allowed 1 hour

5.3.1 Specific practical examination

The candidate is required to test and report on a number of welded specimens dependant on the category of certification sought.

Weld samples are available in 11 different categories of weld joint geometry subdivided into five groups.

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|-----------|--|
| Group 3.1 | Butt welds in plate (two samples selected from three categories) |
| Group 3.2 | Butt welds in pipe (three samples selected from three categories) |
| Group 3.7 | Constructional T joints (two samples selected from two categories) |

- Group 3.8 Nozzles and variable configuration welds (two samples selected from two categories)
- Group 3.9 Nodes (one sample from one category)

Group 3.1 Butt welds in plate (two samples to be attempted):

Category	Thickness	Type of Weld
3.1.2	6 – 15mm	Deposited from one side of plate
3.1.3	Over 15mm	Deposited from both sides of plate
3.1.4	Over 15mm	deposited from one side of plate

Group 3.1 plate also covers pipe welds of 500mm outside diameter and above.

To obtain certification for butt welds in plate, success must be achieved in two categories. The selection of specific categories in this group will be by the examiner.

Group 3.2 Circumferential butt welds in pipe and tube (three samples to be attempted):

This group is subdivided according to wall thickness and outside diameter into the following categories:

Category	O.D. (mm)	Wall thickness (mm)
3.2.1	50-105	6 – 15
3.2.5	Over 105	6 – 15
3.2.7	Over 105	Over 15

Note 1: All welds are deposited from outside the pipe without backing strips. Certification on such welds covers welds deposited from both outside and inside of the pipe.

Note 2: Candidates for certification in pipe 3.2 will be required to complete examinations on three categories of sample, 3.2.1, 3.2.5 and 3.2.7. To gain certification all three categories must be successfully examined.

Group 3.7 Constructional T joints (two samples to be attempted):

This group is subdivided into two categories: 3.3.2 full penetration T joints and 3.4.2 partial penetration T joints.

The examination consists of: an on full penetration T joint and a partial penetration T joint. Success must be achieved in both samples and in 3.1 butt welds in plate to obtain certification in this group. Candidates successful in Group 3.8 need not attempt 3.7

Group 3.8 Nozzles and variable configuration welds (two samples to be attempted)

This group comprises two categories: 3.3.1 full penetration nozzles and 3.4.1 partial penetration nozzles, and covers welds in branches and stubs as well as nozzles. Successful completion of this group provides exemption from Group 3.7 constructional T joints.

Candidates will be examined on one full penetration 3.3.1 and one partial penetration joint 3.4.1, both of which will be of variable geometry. Success must be achieved in both samples and in Group 3.1 and/or Group 3.2 to obtain certification for this group.

Group 3.9 Nodes (one sample to be attempted)

This group covers full penetration node joints. Success must be achieve in one sample and in 3.1. and/or 3.2 to obtain certification for this group.

The candidate is required to write and apply one NDT instruction on a plate butt or pipe butt weld.

- Time allowed 2.5 hours per specimen
- Pass mark 70%.

6 Level 2 – Thickness Measurement

6.1 General Theory examination

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

6.2 Specific theory examination

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

6.3 General practical examination

The candidate is expected to calibrate equipment in a range of different materials commonly found in process and treatment plant.

- Time allowed 1 hour

6.4 Specific practical examination

The candidate is required to test and report on six samples selected by the examiner which demonstrate mechanisms of corrosion and/or erosion commonly found in process and treatment plant.

A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

- Time allowed 5 hours (including 1 hour for the written instruction)
- Pass mark 70%

7 Level 2 – Wrought Products Including Forgings

7.1 General theory examination

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

7.2 Specific theory examination

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

7.3 General practical examination

The candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution.

- Time allowed 1 hour

7.4 Specific practical examination

The candidate is required to test and report on three samples selected by the examiner which contain discontinuities typical of those found in bar, billet, plate and general forgings.

A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

- Time allowed 7 hours (including 1 hour for the written instruction)
- Pass mark 70%

8 Level 2 – Castings

8.1 General theory examination

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

8.2 Specific theory examination

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

8.3 General practical examination

The candidate is required to complete system or function checks as selected by the examiner from: check linearity of amplifier and time base; check probe index point, angle, squint, beam spread, resolution.

Attenuation measurement and signal to noise ratio may also be included.

- Time allowed 1 hour

8.4 Specific Practical Examination

The candidate is required to test and report on three samples selected by the examiner which contain discontinuities typical of those found in cast steel products.

A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

- Time allowed 7 hours (including 1 hour for the written instruction)
- Pass mark 70%

9 Level 3 – Basic Examination

Candidates successful in Section A will be not required to re-sit this section when attempting additional Level 3 examinations in other methods.

9.1 Section A1

Materials Science and Process Technology

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

Section A2

Knowledge of the certification body system based on relevant standards. This part of the examination may be open book.

- 10 multiple choice questions
- Time allowed 15 minutes
- Pass mark 70%

9.2 Section B

Knowledge of 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%

9.3 Main method examination

This written examination shall assess the candidate's knowledge of the main method subjects using the examination sections detailed below. Sector examinations available in the ultrasonic main method are:

- Welds
- Castings
- Wrought Products (including forgings)

9.4 Section C1

Level 3 knowledge relating to the test method for which certification is sought.

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

9.5 Section C2

Application of the NDT method in the sector concerned using the applicable codes and standards. Relevant sections of the codes and standards may be provided as reference material.

- 20 multiple choice questions
- Time allowed 30 minutes

- Pass mark 70%

9.6 Section C3

Drafting of an NDT procedure in the relevant method and sector. The applicable codes standards and specifications shall be available during this part of the examination.

- Time allowed 4 hours
- Pass mark 70%

10 Ten Year Renewal Examination

Level 1 and Level 2 candidates whose certificate 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.

10.1 Level 1 – Ultrasonic Inspection

10.1.1 Butt Welds in Plate and Pipe

The candidate is required to test and report on a plate butt weld and a pipe butt welds as selected by the examiner and in accordance with provided instructions.

10.1.2 Level 1 Thickness Measurement

The candidate is required to test and report on three samples selected by the examiners. Written instructions are provided.

10.1.3 Level 1 – Wrought Products

The candidate is required to test and report on two samples selected by the examiner which contain discontinuities representative of those found in bar, billet, plate and forgings of simple shape. Written instructions are provided.

10.1.4 Level 1 – Castings

The candidate is required to test and report on two samples selected by the examiner which contain discontinuities representative of those found in castings of simple shape; of differing heat treatment condition and requiring thickness measurement. Written instructions are provided.

10.2 Level 2 – Ultrasonic Inspection

10.2.1 Welds

The candidate is required to test and report on welded specimens dependent on the category of certificate sought. Practical weld tests will consist of one joint category from each of the following groups appropriate to the certificate already held.

- 3.1 Butt welds in plate
- 3.2 Circumferential butt welds in pipe
- 3.7 Constructional T joints
- 3.8 Nozzles and variable configuration welds
- 3.9 Nodes.

Candidates who successfully re-certify in category 3.8 are automatically awarded 3.7.

The selection of the specific categories for renewal examinations will be made by the examiner.

10.2.2 Wrought Products Including Forgings

The candidate is required to test and report on two samples selected by the examiner which contain discontinuities typical of those found in bar, billet, plate and general forgings. A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

10.2.3 Castings

The candidate is required to test and report on two samples selected by the examiner which contain discontinuities typical of those found in cast steel products.

A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

10.2.4 Ultrasonic Thickness Measurement

The candidate is required to test and report on three samples selected by the examiner which demonstrate mechanisms of corrosion and/or erosion commonly found in process and treatment plant.

A written instruction of detail suitable for a Level 1 to follow and complete a test shall be produced for one sample.

- Time allowed 3 hours (including 1 hour for the written instruction)
- Pass mark 70%
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11 Level 1 Ultrasonic Inspection Syllabus

11.1 Butt welds in plate and pipe

The syllabus for the general examination and for the theory party of the specific examination is the same for Level 1 - Butt Welds in Plate and Pipe and Level 2 except that:

Level 1- Butt Welds in Plate and Pipe candidates will be expected to have only an awareness of B-scan and C-scan displays, attenuation measurements and of the various methods of flaw sizing. Level 1 candidates will also not be expected to make decisions about sensitivity levels, nor will they be required to know about the application of tandem and transmission techniques.

With regard to welding technology, Level 1 - Butt Welds in Plate and Pipe candidates will only be required to understand terminology for welds, welded joints, weld defects and parent metal defects. They will also need to be aware of the basic principles of the various fusion welding processes and of the defect parameters which affect detectability, e.g. size, geometry, orientation, distance from surface, etc.

11.1.1 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.

11.1.2 Specific theory

a) Weld testing techniques

Scanning procedures for detection of both longitudinal and transverse flaws in welded joints in which certification is sought. Causes of spurious indications and other signals not associated with weld defects, assessment of root condition of welds deposited from one side without backing strips. Types of signal from typical flaws. Errors in defect size measurement.

b) Welding technology

Terminology for welds, welded joints, welding procedures, types of defect in welds and parent metals detectable by ultrasonics. Defect parameters which influence detectability, e.g. size, geometry, distance from surface, orientation, reflectivity and opacity.

c) Standards

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.

11.2 Thickness Measurement

11.2.1 General theory

Candidates will cover sections (a) to (g) of the syllabus (see 11.1.1).

11.2.2 Specific theory

Scanning procedures. Causes of spurious indications.
Errors in measurement.

11.3 Wrought Products Including Forgings

11.3.1 General theory

Candidates will cover sections (a) to (g) of the syllabus (see 11.1.1).

11.3.2 Specific Theory

Scanning procedures. Causes of spurious indications.
Measurement errors. Level 1 personnel will have a knowledge of the terminology used in wrought product technology and the basic knowledge of rolling and forging processes.

11.4 Castings

11.4.1 General theory

Candidates will cover sections (a) to (g) of the syllabus (see 11.1.1).

11.4.2 Specific theory

Scanning procedures. Causes of spurious indications.

Recognition of heat treatment condition. Effects of velocity change.

Measurement errors. Level 1 personnel will have a knowledge of the terminology used in casting technology and the basic knowledge of casting processes

12 Level 2 Ultrasonic Inspection Syllabus

12.1 Welds

12.1.1 General theory

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

12.1.2 Specific theory

As for Level 1, with in addition:

a) Weld testing techniques

Selection of probe type, angle and frequency. Deciding and recording sensitivity levels for parent plate and weld examinations. Tandem techniques, transmission techniques, selection of method for accurate sizing of weld defects.

b) 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, e.g. size, geometry, distance from surface, orientation, reflectivity and opacity.

12.2 Wrought product including forgings

12.2.1 General theory

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

12.2.2 Specific Theory

As for Level 1, with in addition:

a) Testing techniques

Selection of probe type, angle and frequency. Deciding and recording sensitivity levels for wrought product examinations. Area and distance amplitude correction techniques, transmission techniques, selection of method for accurate sizing of defects.

b) Wrought product technology

Influence on techniques of geometry, size, surface condition, material composition and heat treatment.

Principles of wrought product production including; extrusion, drawing, rolling, drop forging and hammer forging

Types of defect associated with particular processes and combinations. Defect parameters, which influence detectability, e.g. size, geometry, distance from surface, orientation, reflectivity and opacity.

12.3 Castings

12.3.1 General theory

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

12.3.2 Specific Theory

As for Level 1, with in addition:

a) Testing techniques

Selection of probe type, angle and frequency. Determination and recording of sensitivity levels for casting examinations. Attenuation measurement, zoning of castings and distance amplitude correction techniques, selection of method for accurate sizing of defects.

b) Casting technology

Influence on techniques of geometry, size, surface condition, material composition and heat treatment.

Principles of casting production including; sand casting, pressure die-casting, investment casting and centrifugal casting. Types of defect associated with particular processes and combinations. Defect parameters, which influence detection, e.g. size, geometry, distance from surface, orientation, reflectivity and opacity. Inspection of casting weld repairs.

12.4 Ultrasonic Thickness Measurement

12.4.1 General theory

As for Level 1 inspector but the examinations question will be more complex.

12.4.2 Specific theory

Time base calibration of A-scan equipment; effects of curved surfaces and probe alignment; thinned wall effects; differing materials and linings.

Surface condition and signal equalisation; attenuation of materials; coupling and acoustic impedance; effects of increasing temperature and the methods of control.

Probe selection – diameter, frequency and damping
Couplant type and selection
Surface type and preparation

Test instruction writing with respect to equipment, application, operation, records and reports.

Interpretation and incorrect analysis of digital thickness reading results. Additional information available from A-scan tests; C-scan testing using automated or semi-automated equipment.

Basic types of corrosion; erosion effects and where to find them; defect types in welds, forgings and castings; non-metallic materials and thickness testing.

13 Level 3 Ultrasonic Inspection Syllabus

13.1 Basic examination

13.1.1 Section A1

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

13.1.2 Section A2 - standards and documentation relating to the certification of NDT operators

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

13.1.3 Section B – level 2 knowledge of 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.

13.2 Main method examination

13.2.1 Section C1 - general 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.

13.2.2 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 questioned on:

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.

Immersion testing, Gap Scanning

TOFD, Phased Array, Guided waves

Methods of digital processing

Flaw sizing systems

13.2.3 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.

14 Reference Literature

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

Procedures and Recommendations for Ultrasonic Testing of Butt Welds', 2nd edition. The Welding Institute.

Guide to the Preparation of a Quality Manual'. The Institute of Quality Assurance.

Ultrasonic Testing of Materials' by J and H Krautkramer. George Allen & Unwin Limited, London. Springer-Verlag Berlin, Heidelberg New York.

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

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

Ultrasonic Flaw Detection for Technicians' by J C Drury. Obtainable from the British Institute of Non-destructive Testing.

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).

Phased Arrays and Mechanised Ultrasonic Testing by E. Ginzel

Automated Ultrasonic Inspection of Welds Obtainable from BINDT

PHASED ARRAY REFERENCE LITERATURE

ASTM Standards

E 1961 – 98 Standard Practice for the Mechanised Ultrasonic Examination of Girth Welds using Zonal Discrimination with Focused Search Units.

(The above practice is under the jurisdiction of ASTM Committee E-7 on Non-destructive Testing)

E 164 Practice for the Ultrasonic Contact Examination of Weldments.

E 317 Practice for Evaluating Performance Characteristics of Pulse-Echo Testing Systems Without the use of Electronic Measurement Instruments.

E 1316 Terminology for Non-destructive Examinations.

(The above obtainable from the Annual Book of ASTM Standards. Vol. 03.03.)

British Standard

BS 7706 (1993) Guide to calibration and setting-up of the ultrasonic time-of-flight diffraction (TOFD) technique for detection, location, and sizing of flaws.

European Standard

EN 583-6 (1995) Non-destructive testing ultrasonic examination – Part 6:
Time-of-flight diffraction technique for defect detection and sizing.

API Standards

API – 1104 Welding of Pipeline and Related Facilities.
Available from American Petroleum Institute.

CSA (Canadian Standards Association) Standard

CSA Z-662 Oil and Gas Pipeline Systems.
Available from Canadian Standards Association.