PCN ISI/ Appendix Z1 Issue 1 – dated 1st June 2015 Implementation 01/07/2015

Syllabus document for qualification and PCN certification of NDT personnel for In-Service Inspection

1 Scope
This document defines guidelines with the intention to harmonise and maintain the general standard of training of non-destructive testing (NDT) personnel for industrial needs. Associated guidelines for NDT training organisations have been produced for the general part of training courses. The guidelines also establish the minimum requirements for effective structured training of NDT personnel to ensure eligibility for qualification examinations leading to third party certification according to recognized standards. This document enclose a clause about NDT in general and a clause specific to each of the following NDT method: acoustic emission testing, eddy current testing, leak testing, magnetic particle testing, penetrant testing, radiographic testing, ultrasonic testing and visual testing.

2 Introduction, Terminology, Purpose and History of NDT
2.1 The Task of NDT
Non-destructive testing (NDT) gives an important contribution to the safety and the economic and ecological welfare of our society. NDT is the only choice for the test of an object which must not be destroyed, modified or degraded by the testing process. This is generally required for objects which will be used after testing, for example safety parts, pipelines, power plants and also constructions under in-service inspection, but even for unique parts in archaeology and culture. NDT is based on physical effects at the surface or the inner structure of the object under test. Often the outcome of the test needs to be interpreted to give a useful result; sometimes different NDT methods must be combined, or verified by other test methods.

2.2 The Task of NDT personnel
NDT personnel have a high responsibility not only with respect to their employers or contractors but also under the rules of good workmanship. The tester shall be independent and free from economic influences with regard to his test results, otherwise the results are compromised. The tester should be aware of the importance of his signature and the consequences of incorrect test results for safety, health and environment. Under legal aspects, the falsification of certificates is an offence and judged according to the national legal regulations. A tester may find himself in a conflicting situation about his findings with his employer, the responsible authorities or legal requirements. Finally the tester is responsible for all interpretations of test results carrying his signature. NDT personnel should never sign test reports beyond their certification.

2.3 The History of NDT
NDT started with visual checks in prehistoric times. In medieval centuries, test methods like simple leakage tests and hardness checks were introduced. The breakthrough for NDT came with industrialisation in the 19th and 20th century: X-ray and Ultrasonic Testing for inner defects, Penetrant and Magnetic Particle Testing for surface cracks. During the last few decades sophisticated, mostly electronically linked methods like Eddy Current Testing, RADAR, Computer...
Tomography and Thermography were developed. NDT methods found application in a wide range of industry from civil engineering and industrial plants to space and defence technology.

The history of NDT is linked to many famous researchers and inventors like Röntgen, Becquerel, Curie, Oersted, Faraday and even Leonardo da Vinci. They discovered the physical principles and demonstrated early applications. All together, approximately 5000 scientists worldwide made contributions to the present state of NDT.

NDT is a global technology. Since NDT tasks and related technical problems are similar in all developed countries, improved solutions and new equipment are spread around the world within a few months. Many international conferences and standard committees contribute to a steady and consensual development of NDT for the benefit of safety, economy and the environment.

2.4 Terminology of NDT
Correct Terminology is a necessary demand for a worldwide-applied technology. It is needed for communication between contracting parties, testers and certifying bodies. Terms like “Indication”, “Imperfection”, “flaw” and “defect” need a precise and unequivocal definition to avoid any confusion and misinterpretation of results. The European Standards EN 1330–1 and –2 (for different NDT methods) and the synonymous International Standards (partly drafts) give the agreed denominations and short definitions of terms.

2.5 General safety considerations
2.5.1 Non-destructive testing is often applied in conditions where safety of the operator may be in danger due to local conditions, or where the application of the particular NDT method or techniques may in itself compromise the safety of operator and others in the vicinity.

An essential element of any course training for NDT personnel must therefore be safety and the duration of the training for this subject should be adequate and provided addition to the technical training associated with the particular NDT method.

2.5.2 General safety considerations may include but are not necessarily limited to:
- Environmental conditions: heat, cold, humidity;
- Toxicity: of NDT materials, tested products, atmosphere;
- Radiation safety: NDT materials, products, local regulations;
- Electrical safety: NDT equipment, lethal voltages, EMC;
- Potential of personnel injury: working at height or in other dangerous environments;
- Personnel protection equipment: closing, radiation dosimeters.
Note: "Direct access to Level 2 examination requires the total hours shown for Level 1 and Level 2."

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Ultrasonic testing - MUT, corrosion mapping, phased array, ToFD, long range Eddy Current  
Tube testing - MFL, ET, IRIS  
Hardness testing  
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### Module 2 Specific Theory
Review of typical Oil & Gas systems and components including Offshore Installations & Mobile Offshore Drilling Units (MODUs).
Relevant Standards – Pressure Systems - PSSR, PUWER etc – Overview

### Theory Part E
- Properties of materials.
- Classes of properties and significance of properties on design.
- Loading systems and available destructive tests and how to use the given data.
- Material properties and solid state changes.
- Energy effects on atoms.
- Metallic structure, solidification and grain size.
- Solid state changes in metals including work hardening, plastic deformation and cold working.
- Recrystallization, recovery and grain growth.
- Age hardening.
- Allotropic changes.
- Austenitisation, annealing, normalising, spheroidising, hardening, tempering.
- Corrosion, direct chemical action, electrolytic/electrochemical reaction, rate of corrosion and associated factors, types of corrosion and degradation, corrosion protection.
- Ferrous metals.

#### 3.0 Product knowledge and capabilities of the method and its derivative Techniques

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Sub arc
Others
A small bit on welding procedures and welder qualifications

Heat Treatment:
Annealing
Normalizing
Stress relieving
Tempering
Problems associated with incorrect HT e.g. sigma phase in stainless

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Heat Treatment:
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Module 2 Specific Theory
Steel production methods, manufacturing processes relative to steel wrought products. Casting and forging of steel components.
Impact of Corrosion, Why metals Corrode
Types of corrosion including,
General/Uniform, Pitting and Microbial pitting, Erosion, Fatigue, Galvanic, Crevice, Inter-granular, Selective leaching, Environmentally assisted cracking, Cavitation and Turbulence.

Corrosion mechanisms including:
CO₂ (Sweet Corrosion), H₂S (Sour Corrosion), Oxygen Corrosion, Electrochemical Corrosion.
Where Corrosion Occurs, Corrosion Control System (Overview).
Material Selection; Metallic materials/Metallurgical principles

Nonferrous metals including the alloys of aluminium, copper, brass, bronze, nickel magnesium, zinc and other specialised alloys. Heat- and corrosion-resistant alloys.
Non-metallic including plastics, the material types and characteristics.
Modern manufacturing methodology covering the casting, forging and wrought processes. Associated defects and flaws. Welding processes including welding metallurgy encompassing composition, grain size, structure effect of heat including stress and distortion.
Weld design.
Weld defects.
Plastic flow including the effects of deformation. Work hardening and recrystallization. Flow rate effects. Influence of flow direction. Temperature and loading systems effects. Grain size. Relative effects of hot and cold working relating to mechanical properties, finish, accuracy and process requirements.
Forging operations including hot and cold working, tube and pipe making. Powder metallurgy, pressing. Sintering and more common manufacturing processes.
Miscellaneous processes for plastic processing. Compression moulding, closed die moulding, casting, extrusion, reinforced plastic moulding, post forming. Adhesive bonding of composites, laminates.
Metal removal processes, electrical discharge machining, electrochemical
| 4.0 Equipment | Module 2 Specific Theory  
Safe Working Practices – Permit to Work – Assessing Risk etc.  
**Module 4 Specific Practical**  
Appropriate instrument and sensitivity settings. | Theory Part E  
Relevant equipment systems for the task. |

| 5.0 Information prior to the Test | **Module 2 Specific Theory**  
Design Considerations  
Visual inspection and characterisation of  
Drawing formats – P & IDs, Isometric drawings – Overview and working understanding. Common anomalies and defects  
Drawing formats – P & IDs, Isometric drawings – Overview and working understanding.  
Relevant Inspection/NDT Standards – Overview (API 570, 572, 574 etc.) | **Module 3 General Practical**  
Instrument settings:  
General initial settings. Differing methods including those for digital thickness instruments and A-scan instruments.  
Instrument checks for settings.  
Factors influencing accuracy including: Operational conditions, surface... |
conditions, surface temperature, metallic
and non-metallic coatings, geometry.
Equipment resolution and range
Evaluation of accuracy:
General and specific influencing factors.
Method of calculation.
Influence of materials:
General factors, inhomogeneity,
anisotropy, attenuation, surface
conditions including contact and reflecting
surfaces, corrosion and erosion.

6.0 Testing

Module 3 General Practical
Parent material and weld heat affected
zone 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.
Calibration of compression wave and 45
degree probes. Appropriate sensitivity
settings.
Surface conditions and surface
preparation
Practical techniques including:
General application, measurements
during manufacturing of product and in-
service measurement of residual wall
thickness.
Probe selection: Limiting parameters
Material differing from the reference
Specific measuring conditions including
measurements at elevated temperatures
and temperatures below 0°C, hazardous
atmospheres.
### Module 4 Specific Practical

**Probe selection and limiting parameters**

### 7.0 Evaluation and Reporting

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**Module 2 Specific Theory**

Reporting formats including Material, Corrosion and Defect Registers.

Reference data.

**Module 3 General Practical**

Test reports.

General information and inspection data.

**Module 4 Specific Practical**

Measurement of general corrosion, corrosion with pitting.
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Notes:

1. It is considered necessary to allocate a period of not less than 80 hours tuition for the above. All practical has to be conducted with both compression and 45 degree probe.

2. It is extremely unlikely that the level of practical described above will be conducted as part of a standard 3.1/3.2 weld inspection course.

3. It is therefore unlikely that a Technician holding a 3.1/3.2 will have the necessary skills required to conduct the corrosion monitoring techniques relative to Oil and Gas Industry.

4. Supplemental training and assessment will be necessary for holders of 3.1/3.2. This shall consist of the Industry Specific theory and the Practical Examination.