



BSI Standards Publication

Non-destructive testing – NDT training syllabuses (ISO/TS 25107:2019)

National foreword

This British Standard is the UK implementation of CEN ISO/TS 25107:2019. It supersedes PD CEN ISO/TR 25107:2006, which is withdrawn.

The UK participation in its preparation was entrusted to Technical Committee WEE/46/7, Personnel.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Non-destructive testing - NDT training syllabuses (ISO/TS 25107:2019)

Essais non destructifs - Programmes de formation en
END (ISO/TS 25107:2019)

Zerstörungsfreie Prüfung - Leitfaden für Ausbildungs-
Syllabus der zerstörungsfreien Prüfung (ISO/TS
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European foreword

This document (CEN ISO/TS 25107:2019) has been prepared by Technical Committee ISO/TC 135 "Non-destructive testing" in collaboration with Technical Committee CEN/TC 138 "Non-destructive testing" the secretariat of which is held by AFNOR.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN shall not be held responsible for identifying any or all such patent rights.

This document supersedes CEN ISO/TR 25107:2006.

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Endorsement notice

The text of ISO/TS 25107:2019 has been approved by CEN as CEN ISO/TS 25107:2019 without any modification.

Non-destructive testing — NDT training syllabuses

Essais non destructifs — Programmes de formation en END



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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 135, *Non-destructive testing*, Subcommittee SC 7, *Personnel qualification*.

This first edition cancels and replaces ISO/TR 25107:2006.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

The body of technical knowledge required of non-destructive testing (NDT) personnel is essential for the development of deliverables concerning NDT methods. No deliverables can be developed appropriately for NDT methods, without sufficient information on the technical background knowledge of the personnel who utilize the methods.

Role of NDT

Non-destructive testing makes an important contribution to the safety, economic and ecological welfare of our society.

NDT is the only choice for the testing of an object which cannot be destroyed, modified or degraded by the testing process. This is generally required for objects which are to 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 are combined or verified by other test methods.

NDT personnel and professional ethics

NDT personnel have a great responsibility, not only with respect to their employers or contractors but also under the rules of good workmanship. The NDT personnel is independent and free from economic influences with regard to his/her test results, otherwise the results are compromised. The NDT personnel is aware of the importance of his/her signature and the consequences of incorrect test results for safety, health and environment.

Finally, the NDT personnel is responsible for all interpretations of test results carrying his/her signature and he/she never signs test reports beyond his/her certification.

[Annex B](#) provides standards numbers that can be of interest for the application of the provisions laid out in this document.

Non-destructive testing — NDT training syllabuses

1 Scope

This document gives requirements and recommendations for non-destructive testing (NDT) training syllabuses, with the intention of harmonizing and maintaining the general standard of training of NDT personnel for industrial needs.

It also establishes 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. In addition to non-destructive testing in general, its guidelines for syllabuses cover acoustic emission testing, eddy current testing, leak testing, magnetic testing, penetrant testing, radiographic testing, ultrasonic testing, visual testing, thermographic testing, and strain gauge testing.

ISO/TS 25108 gives requirements and recommendations for NDT training organizations.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9712, *Non-destructive testing — Qualification and certification of NDT personnel*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

ISO and IEC maintain terminological databases for use in standardization at the following addresses:

- ISO Online browsing platform: available at <https://www.iso.org/obp>
- IEC Electropedia: available at <http://www.electropedia.org/>

3.1

adjustment

set of operations carried out on a measuring system so that it provides prescribed indications corresponding to given values of a quantity to be measured

Note 1 to entry: Types of adjustment of a measuring system include zero adjustment, offset adjustment, and span adjustment (sometimes called gain adjustment).

4 General

4.1 NDT training

Training syllabuses by themselves cannot guarantee competence of the trainees to provide adequate technical knowledge, since it is quite common that some students achieve excellent results whereas others fail in the same class. ISO 9712 provides the minimum training requirements for candidates who possess adequate skills and prior knowledge. If it is not the case, consideration for additional training should include:

- a) level 1, 2 and 3 — mathematics;

- b) level 1, 2 and 3 — materials and process;
- c) level 3 — general knowledge common course applicable to all NDT methods.

As specified in ISO 9712, direct access to the level 2 examination requires the total training time for level 1, level 2 and direct access to level 3 requires the total training time shown for level 1, level 2 and level 3.

ISO 9712 also provides the opportunity for reductions in training duration for candidates seeking certification in more than one method or who have a certain educational degree in an NDT relevant subject. Thus, the training organizations should use discretion when implementing the syllabuses respective of their training environment taking into consideration product/industrial sectors and development or use of common focused courses which pertain to all NDT methods in developing their training curriculum.

4.2 Levels of competence

A three-level scheme, in accordance with ISO 9712, is used to define levels of competence to indicate the required depth of understanding, knowledge and application of material.

Level 1

- Acquire a general knowledge of topic areas.
- Identify equipment and accessories.
- Identify common reference documents.
- Recognize when material is applicable or why it is relevant.
- Demonstrate understanding by performing instructed inspection tasks.

Level 2

- Attain a sound understanding of concepts and principles.
- Develop a sound conceptual and comprehensive technical knowledge.
- Develop a sound working knowledge of procedures.
- Become familiar with common reference documents.
- Become proficient in the application of knowledge to practice.
- Apply concepts and techniques to inspection situations.
- Analyse information to make preliminary conclusions.

Level 3

- Attain an in-depth understanding of concepts and principles.
- Develop in-depth comprehensive technical knowledge of procedures.
- Be proficient in the application of knowledge to practice.
- Be proficient with the use of reference documents.
- Analyse information to form conclusions.
- Apply concepts and techniques to new inspection situations.

NOTE Where topics/subjects/content are listed across multiples levels in [Tables 1](#) through [21](#), this indicates a more in-depth knowledge is required at the higher level(s).

4.3 General environmental and safety considerations

4.3.1 Non-destructive testing is often applied in conditions where the safety of the operator can be in danger owing to local conditions, or where the application of the particular NDT method or technique itself can compromise the safety of the operator and others in the vicinity.

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

4.3.2 Additional training in radiation safety shall be required prior to radiographic training.

4.3.3 General safety considerations include, but are not necessarily limited to, the following:

- environmental conditions (heat, cold, humidity);
- toxicity (NDT materials, tested products, atmosphere);
- radiation safety (NDT materials, products);
- electrical safety (NDT equipment, lethal voltages, EMC);
- potential for injury to personnel (working at height or in other dangerous environments);
- personal protection equipment (clothing, radiation dosimeters);
- pressure test safety.

5 Radiographic testing (RT) — Levels 1, 2 and 3

The radiographic testing training shall be in accordance with [Tables 1](#) and [2](#).

Table 1 — General content

	Level 1 (% of total duration)	Level 2 (% of total duration)	Level 3 (% of total duration)
5.1 Introduction to terminology and history of radiographic testing (RT)	3	1	1
5.2 Physical principles of the method and associated knowledge	15	10	15
5.3 Product knowledge and capabilities of the method and its derived techniques	15	15	20
5.4 Equipment	25	20	25
5.5 Information prior to testing	5	8	5
5.6 Testing	30	25	2,5
5.7 Evaluation and reporting	5	10	7,5
5.8 Assessment	0	5	10
5.9 Quality aspects	2	5	8
5.10 Developments	0	1	6

NOTE [Annex A](#) provides guidance on the training process for advanced radiographic techniques.

Table 2 — Radiographic testing (RT) — Levels 1, 2 and 3

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
5.1 Introduction to terminology and history of radiographic testing (RT)	History	X	X	X	X	X	X	X	X	X
	Purpose of NDT	X	X	X	X	X	X	X	X	X
	What is testing?	X	X	X	X	X	X	X	X	X
	What is the purpose of NDT?	X	X	X	X	X	X	X	X	X
	At what stage of life is NDT performed on a “product”?	X	X	X	X	X	X	X	X	X
	How does it add value?	X	X	X	X	X	X	X	X	X
	Who may carry out NDT?	X	X	X	X	X	X	X	X	X
	Main NDT methods	X	X	X	X	X	X	X	X	X
	Definition	X	X	X	X	X	X	X	X	X
	Applicability and limitations	X	X	X	X	X	X	X	X	X
	Electromagnetic radiation	X	X	X	X	X	X	X	X	X
	Energy	X	X	X	X	X	X	X	X	X
	Dose	X	X	X	X	X	X	X	X	X
5.2 Physical principles of the method and associated knowledge	Dose rate	X	X	X	X	X	X	X	X	X
	Wavelength	X	X	X	X	X	X	X	X	X
	Intensity	X	X	X	X	X	X	X	X	X
	Dose rate constant	X	X	X	X	X	X	X	X	X
	Activity	X	X	X	X	X	X	X	X	X
	See Annex B	X	X	X	X	X	X	X	X	X
	Structure of the atom	X	X	X	X	X	X	X	X	X
	Electromagnetic spectrum	X	X	X	X	X	X	X	X	X
	Sources of radiation and its properties:									
	— X-rays	X	X	X	X	X	X	X	X	X
	— Gamma rays	X	X	X	X	X	X	X	X	X
	— Neutrons			X			X			X
	X-ray and gamma ray spectrum	X	X	X	X	X	X	X	X	X
	Essential radiographic parameters:									
	— Voltage	X	X	X	X	X	X	X	X	X
	— Current	X	X	X	X	X	X	X	X	X

Table 2 (continued)

Content	RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Attenuation of radiation	— Activity	X	X	X	X	X	X	X	X
	Radiation filters		X		X	X		X	X
	Focal spot	X	X	X	X	X	X	X	X
	Dose	X	X	X	X	X	X	X	X
	Dose rate	X	X	X	X	X	X	X	X
	Dose rate constant	X	X	X	X	X		X	X
	General mechanism of interaction:								
	— Photoelectric effect	X	X	X	X	X	X	X	X
	— Compton effect	X	X	X	X	X	X	X	X
	— Pair production	X	X	X		X		X	X
Radiation contrast, noise	HVL, TVL and attenuation law	X	X	X	X	X	X	X	X
	Hardening of radiation,	X	X	X	X	X	X	X	X
	Scattered radiation and build up factor	X	X	X	X	X	X	X	X
	Filtering and collimation	X	X	X	X	X	X	X	X
	X-ray fluorescence	X	X	X	X	X		X	X
	Attenuation of neutrons and electrons			X		X			X
	Contrast, noise, granularity	X	X	X	X	X	X	X	X
	Specific contrast		X	X		X		X	X
	Scatter influence	X	X	X	X	X	X	X	X
	Signal-to-noise ratio (SNR)				X	X	X	X	X
Optimization of image quality	Contrast-to-noise ratio					X		X	X
	Unsharpness	X	X	X	X	X	X	X	X
	Basic spatial resolution				X	X	X	X	X
	Pixel size				X	X	X	X	X
	Normalized SNR (SNR _N)				X	X		X	X
	Compensation principles:								
	— Contrast vs SNR					X		X	X
	— Basic spatial resolution vs SNR					X		X	X
	— Local unsharpness vs SNR					X		X	X

Table 2 (continued)

Content	RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Geometrical projection conditions	Scatter protection	X	X	X	X	X	X	X	X
	Maximum/optimum X-ray voltage		X		X	X		X	X
	Geometrical and inherent unsharpness	X	X	X	X	X	X	X	X
	Geometrical magnification		X		X	X	X	X	X
	Effect of magnification		X	X	X	X	X	X	X
	Optimum magnification		X		X	X		X	X
	Difference between radiography and radioscopy		X		X	X		X	X
Image quality indicators	Law of the squared distance	X	X	X	X	X	X	X	X
	Wire type	X	X	X	X	X	X	X	X
	Step hole type	X	X	X	X	X	X	X	X
	Plate hole type	X	X	X	X	X	X	X	X
	Duplex wire type	X	X	X	X	X	X	X	X
	Measurement of basic spatial resolution		X	X	X	X		X	X
	Converging line pairs			X	X	X		X	X
5.3 Product knowledge and capabilities of the method and its derived techniques	Line pair gauges (MTF)		X			X			X
	Processes overview:								
	— Casting		X		X	X		X	X
	— Forging		X		X	X			X
	— Welding		X		X	X		X	X
	— Tubes and pipes		X		X	X			X
	— Wrought products		X		X	X			X
	— Composite material		X		X	X		X	X
	Types of discontinuities	X	X	X	X	X	X	X	X
	Fracture mechanics			X		X			X
	Working load					X			X
	Material properties		X		X	X		X	X
	Origin of defects		X		X	X		X	X
	Evaluation		X		X	X		X	X

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Influence on detectability	Type of defect	X	X	X	X	X	X	X	X	X
	Size	X	X	X	X	X	X	X	X	X
	Orientation	X	X	X	X	X	X	X	X	X
	Number of exposures		X	X		X	X		X	X
	Beam direction	X	X	X	X	X	X	X	X	X
	Geometric distortion								X	X
	Increase in wall thickness		X	X		X	X		X	X
	Thickness ranges for X- and gamma rays		X	X		X	X		X	X
	Number of exposures vs distortion angle (tubes and pipes)		X	X		X	X		X	X
	Standard sources:									
5.4 Equipment	Radiation sources — X-ray sources	X	X	X	X	X	X	X	X	X
	— Stationary vs mobile	X	X	X	X	X	X			
	— Construction and function of X-ray tubes	X	X	X	X	X	X	X	X	X
	— Unipolar vs bipolar		X	X		X	X		X	X
	Special sources		X	X		X	X		X	X
	Generation of high voltage		X	X		X	X		X	X
	Cooling	X	X	X	X	X	X	X	X	X
	Handling	X	X	X	X	X	X	X	X	X
	Parameters:									
	— kV	X	X	X	X	X	X	X	X	X
	— mA	X	X	X	X	X	X	X	X	X
	— Spot size	X	X	X	X	X	X	X	X	X
	Measurement of parameters		X	X		X	X		X	X
	Container:									
	— Shielding	X	X	X	X	X	X			
Radiation sources — Gamma sources	— Classes of containers			X			X			
	Transportation	X	X	X	X	X	X			
	Source holder and capsula:									

Table 2 (continued)

Content	RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
— Handling and projection — Special design — Collimation Parameters: — Isotope type — Spectrum — Energy — Activity — Source size — Half-life	X	X	X	X	X	X			
		X	X		X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
	X	X	X	X	X	X			
Film Construction: — Latent image information origin — Base, emulsion, silver bromide, grain size, grain form — Photo process Processing: — Properties of film systems — Characteristic curve — Film gradient, film contrast, speed — Influence of film processing — Sensitivity — Granularity — Detail perceptibility Classification of film systems Quality assurance with film test strips Film screens: — Type of screens — Inherent unsharpness	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						
	X	X	X						

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
	— Intensifying effect	X	X	X						
	— Effect of filtering	X	X	X						
	— Screens for cobalt 60 and Linac	X	X	X						
	Working with exposure charts	X	X	X						
	Darkroom design	X	X	X						
	Manual vs machine development	X	X	X						
	Baths:									
	— Different baths	X	X	X						
	— Quality assurance in the dark room	X	X	X						
	Developing process:									
	— Principles	X	X	X						
	— Processing equipment, adjustment	X	X	X						
	— Checking	X	X	X						
	— Storage of unexposed films	X	X	X						
	— Darkroom light test	X	X	X						
	— Fog test	X	X	X						
	— Clearing time	X	X	X						
	— Tally sheet	X	X	X						
	Use of test film strips		X	X						
	Phosphor imaging plates:									
Computer-radiography (CR), Imaging plates	— Introduction				X	X	X			
	— Design				X	X	X			
	Imaging plate and CR-scanner				X	X	X			
	CR system and classification					X	X			
	Quality assurance (phantom)					X	X			
	Exposure conditions				X	X	X			
	Working with exposure charts				X	X	X			
	Handling				X	X	X			

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
DDA's	System selection					X	X			
	Digital Detector Arrays (DDA):									
	— Introduction				X	X	X	X	X	X
	— Design				X	X	X	X	X	X
	Indirect converting					X	X		X	X
	Direct converting					X	X		X	X
	CCD, amorph. Si, CMOS					X	X		X	X
	Detector adjustment					X	X		X	X
	Quality assurance					X	X		X	X
	Exposure conditions					X	X		X	X
LDA's	Handling				X	X	X	X	X	X
	System selection						X			X
	Line Detector Arrays (LDA):									
	— Introduction				X	X	X	X	X	X
	— Design					X	X		X	X
	Application areas					X	X		X	X
	Comparison to DDA's					X	X		X	X
	Quality assurance (phantom)					X	X		X	X
	Exposure conditions and Diagrams					X	X		X	X
	Handling					X	X		X	X
Intensifiers, fluoroscope	System selection						X			X
	Introduction						X	X	X	X
	Design							X	X	X
	Application areas							X	X	X
	Quality assurance (phantom)								X	X
	Exposure conditions and diagrams								X	X
	Handling							X	X	X
	System selection									X
	Comparison to DDA's								X	X

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
Film digitization	Scanner design:									
	— Camera based		X	X						
	— Line scanners		X	X						
	— Laser scanners		X	X			X			
	Quality assurance (phantom)		X	X			X			
	Handling, archiving		X	X			X			
	System selection			X			X			
Accessories	Classification		X	X		X	X			
	Equipment:									
	— Lead letters and tape	X	X	X	X	X	X	X	X	X
	— Holding magnets	X	X	X	X	X	X			
	— Lead shielding, collimation, masking	X	X	X	X	X	X	X	X	X
	— Rubber bands	X	X	X	X	X	X			
	— Radiation protection equipment	X	X	X	X	X	X	X	X	X
Data acquisition, detector adjustment	A/D interface				X	X	X	X	X	X
	Computer structure:									
	— Processor, memory, bus, disk				X	X	X	X	X	X
	— Load and save of digital images				X	X	X	X	X	X
	— Image formats				X	X	X	X	X	X
	Image integration:									
	— On chip integration / frame time				X	X	X	X	X	X
	— In memory integration / frame number				X	X	X	X	X	X
	— Optimum gain and latitude settings					X	X		X	X
	— Accumulation vs integration					X	X		X	X

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
5.5 Information prior to testing	Information about the test object									
	Identification or designation material:									
	— Object to be tested	X	X	X	X	X	X	X	X	X
	— Kind of manufacture	X	X	X	X	X	X	X	X	X
	— Catalogue of defects		X	X		X	X		X	X
	— Extent of test coverage	X	X	X	X	X	X	X	X	X
	Accessibility		X	X		X	X		X	X
	Infrastructure		X	X		X	X		X	X
	Particular test conditions		X	X		X	X		X	X
	Application standard		X	X		X	X		X	X
	Stage of manufacture or service life when testing is to be carried out		X	X		X	X		X	X
	Standards assigned to the test object		X	X		X	X		X	X
	Requirements of test personnel		X	X		X	X		X	X
	Acceptance criteria		X	X		X	X		X	X
	Surface condition		X	X		X	X		X	X
	Surface preparation		X	X		X	X		X	X
	Post-test documentation		X	X		X	X		X	X
	Preparation of written procedure			X			X			X
	Preparation of written instruction		X	X		X	X		X	X
	Performing inspection in accordance with written instruction	X			X			X		
5.6 Testing	Presentation of the standards, codes and procedures			X			X			X
	Selection of technique:									
	— Different exposure geometries		X	X		X	X		X	X
	— Interpretation of images		X	X		X	X		X	X
	— Evaluation of flaws		X	X		X	X		X	X
	— Use of catalogues		X	X		X	X		X	X

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
5.7 Evaluation and reporting	— Measurement of flaw dimensions		X	X		X	X		X	X
	Viewing conditions:									
	— Room condition	X	X	X	X	X	X	X	X	X
	— Viewing time	X	X	X	X	X	X	X	X	X
	— Lapsed time after dazzling	X	X	X						
	— Luminance		X	X		X	X		X	X
	— Density measurement	X	X	X						
	— Mach effect		X	X						
	Film illuminator:									
	— Introduction	X	X	X						
	— Minimum luminance		X	X						
	— Homogeneity factor		X	X						
	Eye sight		X	X		X	X		X	X
Physical factors	Adaption prior viewing		X	X						
	Verification of the image quality	X	X	X	X	X	X	X	X	X
	Report of imperfections		X	X		X	X		X	X
	Complies with examination standard		X	X		X	X		X	X
Test report	Conformed to test quality		X	X		X	X		X	X
	Achieved test class	X	X	X	X	X	X	X	X	X
	Achieved diagnostic coverage of test object	X	X	X	X	X	X		X	X
	Image structure, quantization (bits and Bytes)				X	X	X	X	X	X
Digital image processing	Basic operation:									
	— Picture element (pixel)				X	X	X	X	X	X
	— Grey value				X	X	X	X	X	X
	Point operations:									
	— Contrast				X	X	X	X	X	X
	— Brightness				X	X	X	X	X	X

Table 2 (continued)

Content	RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
— Gamma correction — Histogram — Look up table (LUT) Matrix operations, filters: — Smoothing, improvement of SNR — High pass, gradient — Edge enhancement, line extraction — median Measurement tools: — Adjustment — Line profile — Measurement of flaw length — Measurement of areas — Measurement of depth Correction of raw data: — Introduction — Linearization, LUT — Bad pixel interpolation				X	X	X	X	X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
					X	X		X	X
Automated image interpretation					X	X		X	X
						X			X
						X			X
5.8 Assessment		X	X		X	X		X	X
		X	X		X	X		X	X
		X	X		X	X		X	X
		X	X		X	X		X	X
		X	X		X	X		X	X
		X	X		X	X		X	X

Table 2 (continued)

Content		RT-F (Film)			RT — D (Digital)			RT-S (Radioscopy)		
		Level 1	Level 2	Level 3	Level 1	Level 2	Level 3	Level 1	Level 2	Level 3
5.9 Quality aspects	Personnel qualification	X	X	X	X	X	X	X	X	X
	Other NDT qualification and certification systems			X			X			X
	Documentation			X			X			X
	Format and scope of working procedures			X			X			X
	Qualification of NDT procedures			X			X			X
	Authorizations (NDT instruction, procedures and personnel)			X			X			X
	Developing written instruction		X	X		X	X		X	X
	Working correctly to written instruction	X			X			X		
	Traceability of documents		X	X		X	X		X	X
	Reliability of measurements		X	X		X	X		X	X
5.10 Developments	Knowledge of applicable NDT application and product standards		X	X		X	X		X	X
	Use of correct test parameters		X	X		X	X		X	X
	NDT method selection			X			X			X
	Job specific training		X	X		X	X		X	X
	Equipment verification		X	X		X	X		X	X
	Stereo radiography		X	X		X	X		X	X
	Computed tomography (CT):									
	— Introduction			X		X	X		X	X
	— Inspection geometry					X	X		X	X
	— 2D vs 3D						X			X
	Reconstruction principles						X			X
	Filtered back projections						X			X
	Applications			X		X	X			X
	Requirements, limitations			X			X			X
	RT-F vs RT-D		X	X		X	X		X	X

6 Ultrasonic testing (UT) — Levels 1, 2 and 3

The ultrasonic testing training shall be in accordance with [Tables 3](#) and [4](#).

Table 3 — General content

Content		Level 1 (% of total duration)	Level 2 (% of total duration)	Level 3 (% of total duration)
6.1	Introduction to terminology and history of ultrasonic testing (UT)	1	1	1
6.2	Physical principles of the method and associated knowledge	12	12	22
6.3	Product knowledge and capabilities of the method and its derived techniques	30	24	3
6.4	Equipment	15	8	13
6.5	Information prior to testing	1	11	13
6.6	Testing	30	27	19
6.7	Evaluation and reporting	10	8	11
6.8	Assessment	0	5	6
6.9	Quality aspects	1	4	7
6.10	Developments	0	0	5

Table 4 — Ultrasonic testing (UT) — Levels 1, 2 and 3

Content			Level 1	Level 2	Level 3
6.1 Introduction to terminology and history of ultrasonic testing (UT)	Task of NDT personnel		X	X	
	Overview of general and product standards				X
	Terminology		X	X	X
6.2 Physical principles and associated knowledge Concepts necessary for understanding the physical principles of ultrasonic testing (physics, mathematics) may be the object of a preliminary course	Review of mathematical basics	Algebra	X		
		Trigonometry	X		
		Logarithms	X		
	Physical definitions and typical parameters	Sinusoidal movement	X	X	
		Amplitude	X	X	
		Period	X	X	
		Frequency	X	X	
		Velocity	X	X	
		Acoustic impedance	X	X	
		Acoustic pressure	X	X	X
		Factors of reflection and transmission (normal beam only)		X	
		Isotropic materials	X		X
		Anisotropic materials		X	X
	Waves	Sinusoidal movement	X		
		Amplitude	X		
		Frequency	X		
		Wavelength	X		
		Propagation velocity	X		

Table 4 (continued)

Content			Level 1	Level 2	Level 3	
		Longitudinal	X	X		
		Transverse	X	X		
		Rayleigh waves (surface waves)	X	X	X	
		Creeping waves		X	X	
		Guided waves		X	X	
	Transmission and reflection	Effects at interfaces at normal incidence	X	X		
		— Transmission	X	X		
		— Reflection	X	X		
		— Interference		X		
		— Dispersion	X	X	X	
		Snell's law	X	X		
		Relation between velocity and elastic properties			X	
		Effects at interfaces at oblique incidence	X	X		
		— Transmission	X	X		
		— Reflection	X	X		
		— Refraction	X	X		
		Corner reflectors	X	X		
		— Reflection	X	X		
		— Mode conversion	X	X		
		Electrostriction			X	
		Magnetostriction			X	
		Electrodynamic generation			X	
		Generation by laser			X	
		Piezo-electric effect	X	X		
		Reverse piezo-electric effect	X	X		
		Transducer characteristics	Material	X	X	
			Dimensions	X	X	
			Frequency	X	X	
	Piezo-electric constants		X	X		
	Sound fields of disc shaped transducers	Near field (Fresnel zone)	X	X		
		Far field (Fraunhofer zone)	X	X		
		Beam divergence	X	X		
		Influence of transducer frequency and diameter	X	X		
6.3 Product knowledge and related capability of the method and derived techniques	General defects	Casting	X	X		
		Forging	X	X		
		Welding	X	X		
		Tubes and pipes	X	X		
		Wrought products	X	X		
		Composite material	X	X		

Table 4 (continued)

Content		Level 1	Level 2	Level 3
	Implementation of the testing techniques	According to products	X	X
		According to expected discontinuities	X	X
		Standards, specifications and codes		X
	Overall properties of the specimen	Influence of surface conditions	X	X
		Geometry (additional echoes due to grazing incidence and radial straight beam incidence)	X	X
		Structure (sound attenuation)	X	X
		Selection of probe		X
		— Inspection-oriented design of specimen		X
		Testing technique based on task		X
		— Simulations		X
6.4 Equipment	Ultrasonic instruments	Digital instruments	X	X
		— Design	X	X
		— Function	X	X
		— Pulse generation	X	X
		— Reception	X	X
		— Amplification	X	X
		— A-scan presentation	X	X
		— RF-signal	X	X
		— Rectification	X	X
		— Peak and flank measurement	X	X
		Analogue vs digital		X
		Ultrasonic thickness gauge	X	X
		Automated and semi-automated systems		X
		Manual		X
		Speed		X
		Incrementation		X
		Repeatability		X
		Sampling rate		X
	Probes	Straight beam	X	X
		— Design	X	X
		— Application	X	X
		Angle beam	X	X
		— Design	X	X
		— Effects at interface wedge/specimen	X	X
		— Critical angles	X	X
		— Typical angles for testing of steel	X	X
		— Sound fields	X	X
		— Probe index	X	X

Table 4 (continued)

Content		Level 1	Level 2	Level 3
		— Beam angle	X	X
		— Change of probe index and beam angle due to abrasion or probe shoes	X	X
		— Half and full skip	X	X
		— Application	X	X
		Dual-element	X	X
		— Design	X	X
		— Deviation error	X	X
		— Sound field	X	X
		— Adjustment	X	X
		— Application	X	X
		Dynamic range		X
		Immersion probes (focused, spherical, cylindrical, Fermat surface)		X
		Measurement of pulse length		X
		Practical measurement of directional characteristics		X
		Shoe (delay, curvature)		X
	Couplant		X	X
	Connecting cables	Length		X
		Impedance		X
	Adjustment reference and transfer blocks	Adjustment block No. 1	X	X
		Adjustment block No. 2	X	X
		Reference blocks	X	X
		Resolution	X	X
		— Near	X	X
		— Far	X	X
6.5 Information prior to testing	Information about the test object	Identification or designation material	X	X
		— Object to be tested	X	X
		— Kind of manufacture	X	X
		— Catalogue of defects		X
		— Extent of test coverage	X	X
	Test conditions and application of standard	Accessibility		X
		Infrastructure		X
		Particular test conditions		X
		Application standard		X
		Stage of manufacture or service life when testing is to be carried out		X
		Standards assigned to the test object		X
		Requirements of test personnel		X
		Acceptance criteria		X

Table 4 (continued)

Content			Level 1	Level 2	Level 3
	Technique and sequence of performing test	Surface condition	X	X	
		Surface preparation	X	X	
		Post-test documentation		X	
	Instructions	Preparation of written procedure			X
		Preparation of written instruction		X	
		Performing inspection in accordance with written instruction	X		
6.6 Testing	Techniques	Pulse echo and transmission	X	X	
		Contact	X	X	
		Tandem technique		X	
		Immersion technique		X	
		TOFD technique		X	
		Phased Array technique		X	
		Techniques for ultrasonic thickness measurement	X	X	
		— Reference reflectors (laws of distance and size)		X	
		Verification of combined equipment	X	X	
		— DGS-techniques		X	
		— Multiple probe arrays			X
		EMAT		X	
		Range setting	X	X	
		— Single point adjustment	X	X	
		— Two point adjustment	X	X	
		Sensitivity setting	X	X	
		— Reference reflectors (BW, SDH, DSR)	X	X	
		— Single reflector technique (reference height)	X	X	
		— Air coupled ultrasonic testing			X
		— Guided waves		X	X
		— Testing at higher temperatures		X	X
		Different sizing techniques		X	
		— Principles		X	
		— Limitations		X	
		— Requirements for reference blocks	X	X	
		— DAC-technique	X	X	
		— Transfer correction	X	X	
		— Recording gain (testing level)	X	X	
		— Errors at echo height evaluation	X	X	
		Laser UT			X
		Verification of procedures and instructions for their efficiency			X

Table 4 (continued)

Content			Level 1	Level 2	Level 3
6.7 Evaluation and reporting	Interpretation	Relevant standards			X
		Relevant specifications			X
		Relevant codes			X
		Evaluation (conventional or computer aided methods e.g. echo tomography, SAFT)			X
		Data storage process (e.g. ALOK)			X
	Detecting, locating and sizing techniques	Detecting	X	X	
		Distinction between defect and geometry echo	X	X	
		Locating (calculation, trigonometrical rules)	X	X	
		Interpretation		X	
		Evaluation		X	
		A-scan presentation	X	X	X
		B-scan presentation		X	X
		C-scan presentation		X	X
		D-scan presentation			X
		E-scan presentation			X
		F-scan presentation			X
		P-scan presentation			X
		S-scan presentation			X
		Recording results	X	X	
		Classifying results	X	X	
		Acceptance levels	X	X	
		Echo height evaluation with DGS-method		X	
		Sizing and half amplitude technique	X		
		Sizing using the fixed amplitude level technique		X	
		Echo height evaluation with single reflector technique and DAC-method	X	X	
		Reporting	X	X	
		Check content and matching of test reports, instructions and procedures			X
6.8 Assessment	Evaluation and confirmation of test reports	Application of the acceptance criteria according to standards, codes and procedures		X	
6.9 Quality aspects	Personnel qualification	ISO 9712	X	X	X
		Other NDT qualification and certification systems		X	X
	Documentation	Traceability of documents		X	X
		Equipment verification		X	X
		Reliability of measurements		X	X
		Format of working procedures			X

Table 4 (continued)

Content			Level 1	Level 2	Level 3
6.10 Developments	Newest develop- ments for industrial and scientific appli- cations of UT	Phased array	X	X	X
		Time of flight diffraction	X	X	X
		Long-range	X	X	X
		Computer modelling			X

7 Eddy current testing (ET) — Levels 1, 2 and 3

The Eddy current testing training shall be in accordance with [Tables 5](#) and [6](#).

Table 5 — General content

Content		Level 1 (% of total duration)	Level 2 (% of total duration)	Level 3 (% of total duration)
7.1	Introduction to terminology and history of eddy current testing (ET)	1	1	2
7.2	Physical principles of the method and associated knowledge	15	16	17
7.3	Product knowledge and capabilities of the method and its derived techniques	10	10	15
7.4	Equipment	24	17	15
7.5	Information prior to testing	4	19	26
7.6	Testing	37	19	4
7.7	Evaluation and reporting	5	8	8
7.8	Assessment	0.0	4	4
7.9	Quality aspects	4	4	4
7.10	Developments	0.0	2	5

Table 6 — Eddy current testing (ET) — Levels 1, 2 and 3

Content			Level 1	Level 2	Level 3
7.1 Introduction to terminology and history of eddy current testing (ET)	History		X	X	X
	Purpose of NDT	What is testing?	X	X	X
		What is the purpose of NDT?	X	X	X
		At what stage of life is NDT performed on a “product”?	X	X	X
		How does it add value?	X	X	X
		Who may carry out NDT?	X	X	X
		Main NDT methods	X	X	X
	Purpose of eddy current testing (ET)	Definition	X		
		Applicability and limitations	X		

Table 6 (continued)

Content			Level 1	Level 2	Level 3
7.2 Physical principles and associated knowledge Concepts necessary for understanding the physical principles of eddy current (physics, mathematics) may be the object of a preliminary course	Electricity	Direct current	X	X	X
		— Current	X	X	X
		— Voltage	X	X	X
		— Resistance	X	X	X
		— Conductance	X	X	X
		— Ohm's law	X	X	X
		— Resistivity	X	X	X
		— Conductivity	X	X	X
		Units	X	X	X
		— Conductivity values for some metals	X	X	X
		Alternating current	X	X	X
		— Sinusoidal current	X	X	X
		— Voltage	X	X	X
		— Amplitude	X	X	X
		— Frequency	X	X	X
		— Period	X	X	X
		— Phase	X	X	X
		— Vector representation		X	X
		Other periodic currents			X
	Magnetism	Magnetic field	X	X	X
		Lines of force		X	X
		Magnetic field strength	X	X	X
		Permeability	X	X	X
		Flux density (induction)	X	X	X
		Flux	X	X	X
		Hysteresis loop	X	X	X
		Units	X	X	X
		Diamagnetism		X	X
		Paramagnetism		X	X
		Ferromagnetism		X	X
		Reluctance		X	X
		Magneto-motive force		X	X
	Electromagnetism	Magnetic field created by a current (wire, coil)	X	X	X
		Electromagnetic induction phenomenon	X	X	X
		Inductance	X	X	X
		Mutual inductance		X	X
		Electromagnetic coupling	X	X	X