



The World Organisation for NDT

The 2015 ICNDT Guide on

Education and Training in NDT

March 2015



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Section 1

Foreword by Chairman of ICNDT

Non-Destructive Testing (NDT) is of great importance, ensuring the safety of the public. The knowledge and competence of those who specify NDT is an essential pre-requisite for the achievement of quality and reliability as well as the competence of those who execute NDT and handle and respond to the results.

The ICNDT, with a track record of almost 60 years in international cooperation, has prepared this Guide to help disseminate best practice in NDT education and training.

In accordance with its 2012 Strategic Plan, ICNDT, through its Working Group (WG2) on NDT Education and Research, will promote regular workshops at major conferences. The first two of these, at the 20th QNDE meeting in Baltimore (July 2013) and at the 14th Asia Pacific Conference in Mumbai (November 2013), have provided valuable input to this issue of the Guide. We are grateful to the presenters at these workshops for allowing us to use and reference their material.

Mike Farley
Chairman, ICNDT

ICNDT will update this document periodically and will provide the latest version online via its website, www.icndt.org. Users are strongly advised to check that they have the latest version of this document, any references, comments and suggestions are welcome and should be sent to the ICNDT Secretariat.

Douglas Marshall
Chairman PGP

Section 2

Background

The prime purpose of this Guide – which has been prepared under the auspices of the International Committee for Non-Destructive Testing (ICNDT) – is to promote best practice in the education and training of technicians and engineers in NDT and essential related disciplines – both those who may be considered NDT specialists and other engineers who should know about NDT. NDT specialists may be involved in the execution of NDT but also, increasingly and importantly, in “NDT engineering” – upstream (before) and downstream (after) NDT operations (see Appendix 1).

The ICNDT Guide is of importance to all the tiers in the specification and implementation NDT operations – regulators, inspection bodies, certification bodies, industry, NDT service companies, engineers and supervisors of NDT personnel.

Section 3

Classification of NDT education and training by level and scope

The following “classifications” are used in this Guide.

- A: NDT training (theory and practical) at Level 1, 2 and 3, prior to certification of NDT specialists, often in accordance with the ISO syllabus TR25107 and or the similar ANSI/ASNT syllabus CP105
- B: NDT awareness for practising Engineers (including Continuing Professional Development)
- C: NDT awareness as part of Foundation/Associate/Bachelor degree level courses in Engineering, including NDT Minor
- D: NDT Foundation/Associate/Bachelor level degree courses in NDT
- E: NDT Postgraduate Certificate/Diploma level and Masters level courses in NDT
- F: NDT courses taught as part of a PhD or Engineering Doctorate in NDT

Information on the wide variety of courses that are offered at classifications B to F was collected through two workshops, organised by ICNDT at the 20th QNDE meeting in Baltimore (July 2013) and at the 14th Asia Pacific Conference in Mumbai (November 2013). The programmes for the two workshops are given below in Tables 1 and 2. The aim of the workshops was to share best practice around the world in NDT education, including undergraduate, postgraduate, masters and doctoral levels and this was achieved. Links between graduate NDT education and pre-certification NDT training were also explored.

Table 1: Workshop organised by ICNDT at the 20th QNDE meeting in Baltimore (July 2013)

	Speaker	Subject	Ref.
1	Mike Farley, Chairman ICNDT + Manfred Johannes WG2	Scene-setting	1
2	Matthew E. Gallagher and David J. Gilbert, The British Institute of NDT	An Integrated Education Programme for NDT Professionals	2
3	Peter Cawley, Imperial College, UK	The Engineering Doctorate in NDE	3

4	B. Boro Djordjevic, Materials and Sensors Technologies, Inc., USA	NDE Education in the USA	4
5	K. Balasubramanian pp B. Venkatraman, Indira Gandhi Centre for Atomic Research, Kalpakkam, India	INDE Education – Requirements, Status, and Gaps Indian Scenario	5
6	Bernd Koehler/Christian Boller, Fraunhofer Institute of Nondestructive Testing (IZFP), Germany	Double Degree Master Studies in Non-Destructive Testing	6
7	Manfred Johannes, SAINT South Africa	The Need for “Non-Destructive Testing (NDT) for Engineers” as a Stepping Stone to PostGraduate Studies in NDT in South Africa	7
8	Nicola Bowler, Iowa State University, Center for NDE, USA	Iowa State University’s Undergraduate Minor and Online Graduate Certificate in NDE	8
9	Mike Farley	Wrap-up and close	

Table 2: Workshop organised by ICNDT at the 14th Asia Pacific Conference in Mumbai (November 2013)

	Speaker	Subject	Ref.
11.00 -11.20	Mike Farley, Chairman ICNDT	Scene-setting	9
11.20 -11.40	David Gilbert, BINDT and Prof Phil Picton, The University of Northampton	Foundation degree in NDT linked to pre-certification training	10
11.40 -12.00	Prof Krishnan Balasubramanian <balas@iitm.ac.in>	NDE Education in India	11
12.00 -12.20	Ray Morasse and Roger Engelbart, ASNT	NDE education in the USA – overview	12
12.20 -12.30	Prof Nicola Bowler/Prof. Vinay Dayal, Iowa State University, Center for NDE	Iowa State University’s Undergraduate Minor and Online Graduate Certificate in NDE	13
12.30 -12.40	Dr Marc Kreuzbruck, pp Prof Christian Boller, IZfP	Double Degree Master Studies in Non-Destructive Testing	14
14.00 -14.20	Manfred Johannes, SAINT, South Africa	The Need for “Non-Destructive Testing (NDT) for Engineers” as a Stepping Stone to PostGraduate Studies in NDT in South Africa	15
14.20 -14.40	Patrick Brisset, IAEA	IAEA programmes on NDT education and future needs	16
14.40 -15.00	Sajeesh Babu, ICNDT WG1	Comparison of training syllabuses TR25107, CP105 and TECDOC 628	17
15.00 -15.20	Alexander Mullin, ICNDT WG1	Russian initiative on distance learning	18
15.20 -15.30	Dr. Nassir Ibrahim, Malaysia	Malaysian NDT Certification Scheme: Issues and Challenges	19
15.30 -15.40	Dr B Venkataraman, IGGAR, India	NDE Education in India – Requirements, Status and Gaps	20

Examples of courses at these various classifications A to F are given below in Table 3, cross referenced to the presenter, from whom further information can be obtained.

Table 3: Examples of NDT courses at classifications A to F

Speaker/Title	Classifications	Detail extracted from the full presentation
Baltimore Workshop		
NDE Education – Requirements, Status, and Gaps Indian Scenario – K. Balasubramaniam and B. Venkatraman, India	C	<p>IIT Madras (two Graduate level courses and one Lab).</p> <p>NITT (five/six Graduate level courses and four labs).</p> <p>Anna University (NDT as elective in UG programme) in engineering branches (Mechanical, Metallurgy, Aeronautical, Civil).</p>
	E	<p>NITT – MTech in NDT –15 students per year.</p> <p>Postgraduate students in ME production engineering with one year internship at industries like BHEL in NDT followed by Level 2 certification.</p> <p>New NDE course initiated at SASTRA University at postgraduate level – such as Masters in Welding and NDE. Focus on theory in first year and six months internship in industries and institutes, leading to welding inspection certificate and Level 2 in select methods. Entry Level qualification BE and Masters in Physics.</p> <p>Postgraduate Diploma in NDE being planned by universities and educational institutions in association with ISNT. One year six months course leading to degree and Level 2 certification in four methods (RT, UT, PT and MT). Six months theory and one year internship in industries.</p> <p>#Entry level qualification – B.Sc</p>
	F	<p>IIT Madras – MS and PHD in Engineering with NDE topic – 12 students per year on an average.</p> <p>IISc, IIT Delhi, IIT Kanpur, IIT Bombay, IIT Kharagpur, IIT Roper – PHD in Engineering with NDE topic.</p>
The Engineering Doctorate in NDE – Peter Cawley, Imperial College, UK	F	<p>Four-year postgraduate award for UK's leading research engineers who aspire to senior positions in industry. Linked to UK RCNDE – the UK industry/University collaborative research centre.</p> <p>Programme combines research, industrial experience, relevant taught courses. Alternative to traditional PhD that is better suited to needs of industry.</p> <p>EngD highly effective means of technology transfer from RCNDE research programmes into industry.</p> <p>Taught Training Programme – Developed in consultation with industry who requested combination of technical training (60-70%) and professional development (30-40%).</p>

<p>Double Degree Master Studies in Non-Destructive Testing – Bernd Koehler and Christian Boller, Fraunhofer Institute of Nondestructive Testing (IZfP), Germany</p>	<p>E</p>	<p>DIU/IZfP; Distance learning NDT master course (started 2011). German/English.</p> <p>DIU/IZfP: Double degree Master Studies in NDT (scheduled for 2014), Includes): NDT Basic Course of DGZfP (a Gateway to Certified Testing); and Research Internship at Fraunhofer IZfP. Master thesis at partner University.</p>
<p>Iowa State University's Undergraduate Minor and Online Graduate Certificate in NDE – Nicola Bowler, Iowa State University, Center for NDE, USA</p>	<p>C</p>	<p>ISU NDE Minor: 16 credits, including a survey course, and independent study with CNDE mentor.</p> <p>Average of nine students/year in Iowa State.</p>
	<p>E</p>	<p>ISU; Graduate Certificate in NDE offered <i>online</i>.</p> <p>Thesis-based MS in NDE and coursework-only MEng in NDE are under development.</p>
<p>The Need for “Non-Destructive Testing (NDT) for Engineers” as a Stepping Stone to PostGraduate Studies in NDT in South Africa – Manfred Johannes, SAINT South Africa</p>	<p>B</p>	<p>University of Pretoria offers Engineering NDT CPD course. (CPD is a requirement for continued registration as a Professional engineer in RSA).</p>
<p>An Integrated Education Programme for NDT Professionals – Matthew E. Gallagher and David J. Gilbert, The British Institute of NDT</p>	<p>A and D</p>	<p>Foundation and Bachelors Degrees at the University of Northampton with syllabus content encompassing ISO 9712 syllabus, fast track entry for existing certificated personnel, link to Engineering registration. There are currently around 200 students in the distance learning degree programme.</p>
<p>NDE Education in the USA – B. Boro Djordjevic, Materials and Sensors Technologies, Inc., USA</p>	<p>B, C, D, E, and F</p>	<p>The author emphasises the importance of NDT education and training for engineers and is concerned at the lack of provision for this training in the USA, except perhaps at Iowa State University.</p>
<p>Mumbai Workshop</p>		
<p>Foundation degree in NDT linked to pre-certification training – Matt Gallagher Director for Education & Professional Development, David Gilbert, Deputy CEO BINDT and Prof Phil Picton, The University of Northampton</p>	<p>A and D</p>	<p>See above.</p>

<p>NDE Education in India – Prof Krishnan Balasubramanian</p>	<p>C</p>	<p>Courses Offered in NDT</p> <ul style="list-style-type: none"> – IIT Madras (two Graduate level courses and one Lab). – NITT (five/six Graduate level courses and four labs). – Anna University (NDT as elective in UG programme) in engineering branches (Mechanical, Metallurgy, Aeronautical, Civil).
	<p>D</p>	<p>Degree/Diploma Programmes</p> <ul style="list-style-type: none"> – NITT – MTech in NDT –15 students per year. – IIT Madras – MS and PHD in Engineering with NDE topic – 12 students per year on an average. – IISc, IIT Delhi, IIT Kanpur, IIT Bombay, IIT Kharagpur, IIT Roper – PHD in Engineering with NDE topic. – Postgraduate students in ME production engineering with one year internship at industries like BHEL in NDT followed by Level 2 certification.
	<p>E</p>	<p>New NDE course initiated at SASTRA University at postgraduate level – such as Masters in Welding and NDE. Focus on theory in first year and six months internship in industries and institutes, leading to welding inspection certificate and Level 2 in select methods.</p> <p># Entry level qualification BE and Masters in Physics.</p>
	<p>F</p>	<p>Postgraduate Diploma in NDE being planned by universities and educational institutions in association with ISNT. One year six months course leading to degree and Level 2 certification in four methods (RT, UT, PT and MT). Six months theory and one year internship in industries.</p> <p>#Entry level qualification – B.Sc</p>
<p>NDE Education in the USA – overview – Ray Morasse and Roger Engelbart, ASNT</p>	<p>A/B</p>	<p>NDT/NDE Educational Options in USA</p> <ul style="list-style-type: none"> ● Vocational/Technical Schools. <ul style="list-style-type: none"> ● Two-year course of study open to young people leaving high school at age 18 leading to diploma or certificate. ● Course work focus on utilisation of methods & techniques. ● 26 such schools in USA offer NDT certificate programmes or NDT courses related to other programmes such as welding.

	D	<ul style="list-style-type: none"> ● Junior/Senior Colleges. ● Junior colleges generally offer courses of study leading to associate degree or bachelor's degree (with transfer to senior college) – 22 such colleges in USA offer associate degrees in NDT, or NDT courses as part of another associate degree or certificate programme. ● Senior colleges – 56 – offering bachelor, master and doctoral degrees, or NDT courses in other degree and certificate programmes.
	A	<ul style="list-style-type: none"> ● <u>Some</u> provide hands-on opportunities which may be accepted by many companies as on-the-job training hours. ● Programmes designed to help students understand direct relationships between underlying physics principles & testing techniques. ● Industrial/Corporate Programmes. ● These organisations offer professional training which generally include some form of certificate or diploma (final testing often similar to Level 1/Level 2 exams).
<p>Iowa State University's Undergraduate Minor and Online Graduate Certificate in NDE – Prof Nicola Bowler/Prof. Vinay Dayal Iowa State University, Center for NDE</p> <p>(in absentia)</p>		See above.
<p>Double Degree Master Studies in Non-Destructive Testing – Dr Mark Kreutzbrucke pp Prof Christian Boller</p> <p>IZfP</p>	E (including A)	<p>DIU/IZfP: Double degree Master Studies in NDT (scheduled for 2014), Includes): NDT Basic Course of DGZfP (a Gateway to Certified Testing); and Research Internship at Fraunhofer IZFP. Master thesis at partner University.</p>

<p>The Need for “Non-Destructive Testing (NDT) for Engineers” as a Stepping Stone to PostGraduate Studies in NDT in South Africa – Manfred Johannes, SAINT South Africa</p>	C to E	<p>See above.</p> <p>Post script Jan 2015: University of Pretoria now offer an NDT course for engineers who enrol for the Multi-disciplinary Postgraduate Programme in Physical Asset Management. This postgraduate programme consists of a course-based Honours Degree followed by a research dissertation for a Masters. The Honours Degree can be completed full-time over a one year period, or on a part-time basis, typically over two-to-three years. Completion of the Masters Degree dissertation normally requires one year full-time, or two-to-three years part-time research. The programme is structured to achieve specific objectives. Details can be found at http://www.up.ac.za/caim. This NDT course falls into the classification ‘C’ to ‘E’, as the student is introduced to the theory of NDT and can, on successful completion of the course, opt to do a research dissertation.</p>
<p>IAEA programmes on NDT education and future needs – Patrick Brisset, IAEA</p>	A	<p>Miscellaneous education and training initiatives in developing countries.</p>
<p>Comparison of training syllabuses ISO TR25107, ASNT CP105 and IAEA TECDOC 628 – Sajeesh Babu, member ICNDT WG1</p>	A	<p>These syllabuses exist to define the topical content of pre-certification training in the ISO and ASNT systems at Levels 1, 2 and 3.</p>
<p>Russian initiative on distance learning – Alexander Mullin, Chairman ICNDT WG1</p>	A/B	<p>This is a radical new on-line training system in the Russian language developed by the Russian Society for NDT for use pre-certification across the whole country.</p>
<p>Malaysian NDT Certification Scheme: Issues and Challenges – Dr. Nassir Ibrahim, Malaysia.</p>	A	<p>1. Pre-certification training is offered by training agencies accredited by the Malaysian National Certifying Body by:</p> <ul style="list-style-type: none"> ● Malaysia Nuclear Agency (RT, UT, MT, PT). ● SIRIM (UT and recently RT). ● RUANE-TATI (RT, UT, MT, PT). ● INTESTMAL (MT, PT).
	C E	<p>2. NDT for engineers:</p> <ul style="list-style-type: none"> ● University Technology of MARA(UiTM). ● As major subject for degree in B. Applied Science (School of Applied Science). ● Planning to provide MSc in NDT in 2014 (syllabus completed).

	C	<ul style="list-style-type: none"> ● University Technology of Malaysia (UTM). <ul style="list-style-type: none"> ● B.Sc in Industrial Science (Dept. of Physics, Faculty of Science). ● Beng (Mechanical Engineering Department).
	C	<ul style="list-style-type: none"> ● National University of Malaysia (UKM). <ul style="list-style-type: none"> ● As part of B.Sc in Material Science (Faculty Science and Technology).
	E C	<ul style="list-style-type: none"> ● International Islamic University of Malaysia (UIAM). <ul style="list-style-type: none"> ● As main subject in degree of M.Eng (Faculty of Engineering). ● University Malaysia Perlis (UNIMAP). <ul style="list-style-type: none"> ● As part of B.Sc in Material Science .
	C	<ul style="list-style-type: none"> ● University Kuala Lumpur. <ul style="list-style-type: none"> ● As subject taught at MFI and MIAT. ● University Malaysia Pahang. <ul style="list-style-type: none"> ● As part of B.Sc in Industrial Science – good collaboration with industries.
NDE Education in India – Requirements, Status and Gaps – Dr B Venkataraman IGGAR, India		See above – first item in Table 3.

Section 4

Commentary on discussions in the workshops

The Q&A and discussion periods in the workshops highlighted the following:

- We need more awareness of the significance and role of NDT by managers, decision makers and other engineers who specify or use the results of NDT.
- Several countries including India and Malaysia reported that they have secured NDT modules incorporated within other Engineering courses, as well as Masters degrees in NDT.
- In South Africa, (uniquely?) formal CPD training in NDT is available for engineers whose prime interest is asset management.
- Excellent training materials in English are available on-line (for example NDT Resource Centre at www.nde-ed.org).
- It was suggested that “we need on-line educational courses in NDE with examinations by accredited/reputed international universities.” In Russia this type of training is being provided in Russian through a new distance learning scheme for NDT technicians. It would be interesting to know if this could also be structured to provide NDT Awareness courses and CPD courses for engineers. Could similar structured awareness courses be set up using the NDT Resource Centre materials?
- BINDT has established a new integrated programme for NDT professional development which incorporates vocational training, work-based learning, personnel certification, academic awards, professional engineer registration and ongoing learning provision.
- The UK Engineering Doctorate linked to the RCNDE model is seen as highly successful.
- Whilst in many countries pre-certification NDT training is handled largely by specialist courses provided in the private sector, in the USA much of this training is done in technical schools.
- The content of an NDT postgraduate (diploma, certificate or masters) course may provide:
 - Greater depth in the understanding of the physics of NDT, electronics, signal processing, data analysis etc and/or
 - greater knowledge of the disciplines which link to NDT and diagnostic technologies (upstream and downstream) for example design, structural integrity, materials properties, corrosion and topics such as risk-based inspection, asset management, condition-based maintenance and life assessment.
- There was much discussion of NDT Engineering but no accepted definition.
- ASNT offers support for students, educators and instructors via:
 - Mentor Programmes
 - Awards Programmes
 - Conference Participation & Support
 - Student Membership/Student Sections
 - High School Science Teachers’ Workshop
- There are dilemmas for education establishments, industry and students because there is perhaps less career certainty for the academic route than for the certificated route:
 - **Educationist Dilemma?**
 - Lack of any forecast or study on supply-demand.
 - No organised approach to placement/recruitment.
 - No formal involvement in NDE education programmes.

- **Industry Dilemma?**
 - Hire NDT Level 3 or
 - NDT MS/PHD or
 - Hire BS or MS or PHD in Engineering and train as Level 3.
- **Student's Dilemma?**
 - Job Market? Assured Job???
 - Work in research or industry or service job?

Section 5

Possible ICNDT initiatives

The workshops identified a number of possible initiatives which ICNDT might pursue:

1. Web links to available teaching resources for each level, for example

- NDT awareness for practising Engineers
 - Existing videos BINDT, ASNT, JSNDI,
 - NDT Resource Centre Powerpoint.
- NDT awareness as part of Bachelor level courses in Engineering, including NDT Minor
 - Existing videos BINDT, ASNT, JSNDI,
 - NDT Resource Centre Powerpoint
 - NDT Resource Centre course materials.
- NDT courses taught as part of a PhD or Engineering Doctorate
 - Need recommended reading lists for these levels
 - Need these courses to cover the Level 3 syllabus??

2. List recommended books for each level on ICNDT website.

3. Promote exemplars; for example University of Pretoria CPD course for Engineers, ISU NDT Minor, BINDT Foundation Degree...

4. Advertise courses being offered on the ICNDT website.

5. Develop model syllabuses for:

- B: NDT awareness for practising Engineers (including CPD).
- C: NDT awareness as part of Foundation/Associate/Bachelor degree level courses in Engineering, including NDT Minor.
- D: NDT Foundation/Associate/Bachelor level degree courses in NDT.
- E: NDT Postgraduate Certificate/Diploma level and Masters level courses in NDT.
- F: NDT courses taught as part of a PhD or Engineering Doctorate in NDT.

6. Develop distance learning tools for each of the above, taking advantage of the resources already available on-line.

Section 6

References

Ref.	Link to Presentation
1	ICNDT QNDE Workshop on NDT Education.pptx
2	QNDE Tuesday\T0830a D.Gilbert.pptx
3	QNDE Tuesday\QNDE EngD Cawley.ppt
4	QNDE Tuesday\T0910c B.Djordjevic.pptx
5	.QNDE Tuesday\930 Venkat.pptx
6	QNDE Tuesday\T0950a C.Boller.pptx
7	QNDE Tuesday\T0910f Johannes.pptx
8	QNDE Tuesday\Nicola Bowler QNDE education presentation 2013.pptx
9	Introduction ICNDT Workshop on NDT Education Farley.pptx
10	Integrated Education Programme D.Gilbert.pptx
11	NDE Education in India – Balasubramaniam.pptx
12	NDT Education Mumbai\Workshop Report\NDT Education in the USA Morasse + Englebart.pptx
13	Iowa State presentation 2013 Nicola Bowler.pptx.
14	DIU IZFP NDT Double Masters Kreutzbruck.pptx
15	Engineering NDT – Manfred Johannes.pptx
16	IAEA NDT Activities APCNDT Brissett.ppt
17	Comparison of syllabuses - S K Babu.ppt
18	Distance Learning System for NDT personnel Mullin.pptx
19	NDT Education and Training in Malaysia Ibrahim.ppt

To locate the above presentations, please visit <http://www.icndt.org/Documents/Document-Store>

Appendix 1

NDT Engineering

“NDT engineering” or “Engineering of NDT” covers all the activities linked to NDT upstream (before) and downstream (after) NDT operations. The following explanation of what constitutes “Engineering of NDT” appears in the 2012 version of ISO 9712 as Annex E. It is important in the context of recertification of NDT personnel who may work in NDT engineering and thereby maintain continuity of experience.

Figure A1.1 Engineering of NDT (from ISO9712)

Annex E (informative)

Engineering of NDT

E.1 Definition

Engineering of NDT covers all the activities linked to NDT, from the design of the equipment to the responsibility of preparation, implementation and verification of NDT (in manufacturing and in service) of the same equipment belonging to industrial or technical installations.

E.2 Non-exhaustive list of activities covered

The activities covered include:

- a) at design stage, definition of requirements to be taken into account and/or verification of inspectability during manufacturing and, where applicable, in service, of equipment;
- b) selection of NDT techniques to be implemented in manufacturing and/or in service;
- c) comparison of specific prescriptions of different codes and standards;
- d) establish or validates the NDT procedures;
- e) technical evaluation of NDT suppliers;
- f) evaluation of NDT techniques, notably in the frame of expertise;
- g) treatment (technical evaluation) of non-conformity;
- h) justification to the customers and where applicable, to the associated safety authorities, of practices implemented;
- i) responsibility for a NDT facility;
- j) co-ordination and supervision of NDT personnel activities;
- k) qualification — validation of NDT techniques:
 - 1) establishment of input information's including the inspection objectives,
 - 2) definition of the necessary mocks-up for open and, where necessary, blind tests,
 - 3) implementation of practical tests,
 - 4) preparation of technical justification including when necessary, modelling,
 - 5) preparation or validation of NDT procedures,
 - 6) preparation or validation of qualification dossiers;
- l) establishment of in-service inspection programmes for industrial installations or definition of rules for the establishment of such programmes.

Notes

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