



## Experience in the Organization of Non-Destructive Testing Formal Education in Ukraine

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### Abstract

The paper contains the analysis of the experience of NDT formal education organizing in Ukraine. In particular, differences in educational syllabuses development at educational institutions and training syllabuses development at training centers is analyzed. The paper provides recommendations on the harmonization of NDT educational and training syllabuses.

**Keywords:** non-destructive testing, formal education, training, syllabuses requirements.

## 1. Introduction

It is well-known that Non-DT processes and techniques are heavily used today - in USA, Europe, India, Africa and others, covering and serving the engineering and metalworking, energetics, fuel industry, etc. Non-destructive testing methods are widely used to evaluate the quality of technical objects, determine their characteristics, research their structure and more. Non-destructive testing (NDT) enables the objects’ quality to be assessed without destroying their integrity or without disturbing the properties that affect their intended use. NDT methods are widely used on the railway, to inspect the elements of aircraft design, to monitor the condition of bridges, cableways, cars’ units, etc. The widespread use of non-destructive methods is associated with the ability to use them to test the quality of products, the continued use of which affects the lives and safety of people. The NDT education is a responsible type of human activity that has certain standardized requirements. In Ukraine these requirements are formulated both by the educational standards and by the product and industry sectors international and European regulatory and technical documentation.

## 2. Problem Overview

In Ukraine formal education in non-destructive testing is currently provided through two types of organizations - educational institutions (higher education institutions, colleges, etc.) and training centers (NDT personnel training organizations). Completion of study at an educational institution implies the achievement of the educational outcomes, specific to a certain educational level, determined by the learning outcomes, and the confirmation of qualification by a diploma of education or other document. The educational document indicates the credit modules studied by the applicant, their duration and the results of the exams. NDT education in high school is conducted according to approved educational syllabuses. Syllabuses requirements are determined by the educational standards, based on the defined learning objectives and competencies of the graduate [1], [2] and others. The educational outcomes are

described by a complex system of competencies that a graduate must possess, including practical skills in non-destructive testing.

NDT formal education in the training centers in Ukraine is usually conducted in form of preparing candidates for certification at the appropriate qualification levels, in NDT-methods, relevant product and industrial sectors. Requirements for the preparation process are regulated by European, international and national normative documents [3], [4], [5], and also by the quality management systems of training centers - in accordance with ISO 9001 ‘Quality management systems - Requirements’. After completing the study of NDT courses at the training center, the candidate is provided with a document that confirming the successful completion of the courses, which usually contains information about the course title (according to NDT methods), its duration, product and industrial sectors, etc. Requirements for certification training syllabuses in non-destructive testing are governed by international and regional standards, the most widely used being ISO/TR 25107 ‘Non-destructive testing - Guidelines for NDT training syllabuses’ [6]. Candidates training outcomes are evaluated in the attestation process, which includes exams: theoretical (theoretical knowledge of methods), special (NDT standards knowledge check) and practical (ability to carry out NDT method’s operations and report on results).

Practical experience shows, that most graduates of higher education institutions, who have completed higher education in non-destructive testing and works in NDT, additionally receive certification at the relevant qualification levels from separate groups of NDT methods. This trajectory of specialists’ professional development has proved to be effective nowadays. Thus, there is a need to harmonize the educational syllabuses for studying NDT engineers with the training syllabuses for certification NDT personnel preparing.

The solution of this problem may be to include certain provisions of the ISO/TR 25107 standard to educational syllabuses. This will allow, first, to bring closer the educational outcomes with the current employers requirements; second, simplify the process of preparation for certification for university graduates (figure 1).

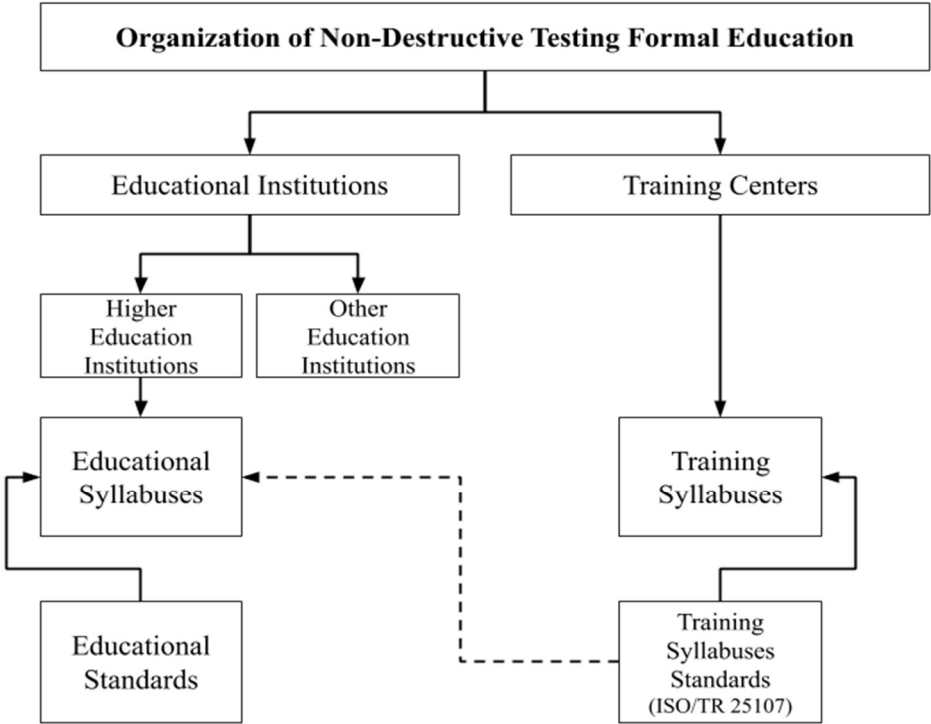


Figure 1. Scheme of NDT formal education organization in Ukraine

The following are separate provisions of ISO/TR 25107 standard that may be included to the educational syllabuses.

### 3. Certain Aspects of Educational Syllabuses Development

International Standard ISO/TR 25107 ‘Non-destructive testing - Guidelines for NDT training syllabuses’ provides guidance on the content of training syllabuses and on the training courses duration for Levels 1, 2, 3 certification applicants in Radiographic testing (RT), Ultrasonic testing (UT), Eddy current testing (ET), Penetrant testing (PT), Magnetic particle testing (MT), Visual testing (VT), Infrared thermographic testing (TT), Leak testing (LT), Acoustic emission testing (AT), Strain gauge testing (ST) and by techniques of Ultrasonic time-of-flight diffraction (UT-TOFD), Ultrasonic phased array testing (UT-PA), Magnetic flux leakage testing (MFL) - in accordance with EN ISO 9712 ‘Non-destructive testing - Qualification and certification of NDT personnel’. The document contains a list of topics that are recommended for study during the candidates training courses, and recommendations on the duration of certain topics study, depending on the level of qualification the candidate is seeking. In addition, the standard provides references to major non-destructive testing standards recommended for study.

For each group of NDT methods, the ISO/TR 25107 standard provides a general structure of the training course, indicating the issues to be considered. This structure includes ten basic provisions, which are listed below [6, p. 9-102]:

- *Introduction to the methods terminology and history*: for each methods group, are considered inspection tasks, general terms and historical information. This section also provides a brief overview of methods’ standards under study. For the study of terminology, it is advisable to use standards of the EN 1330 series and similar, which include the general terms of non-destructive testing and the terminology of separate groups of methods.
- *Physical principles of the method and associated knowledge*: the section includes issues about the mathematical and physical foundations of a particular methods’ group, basic physical phenomena and the processes on which they are based, and related theoretical background.
- *Product knowledge and capabilities of the method and its derived techniques*: the issues in this section are based on the product sectors (castings (c), forgings (f), welds (w), tube and pipe (t), wrought products), and also industrial sectors. The study of this section of the syllabuses provides an overview of basic standards in NDT by product type, NDT methods and techniques, etc. In the same section, it is recommended to analyze possible product defects and their causes.
- *Equipment*: the section covers issues related to equipment and instruments used for a specific group of NDT methods. If appropriate, issues of testing metrological and protection systems are considered.
- *Information prior to testing*: this section includes issues on preparation for the non-destructive testing: defining the material and taking into account the geometry and surface condition of the object to be inspected, determining the conditions of the inspection, determining techniques and sequence of operations - and also drawing written procedures and instructions.
- *Testing*: practical implementation of testing procedures by selected methods and techniques.

- *Evaluation and reporting*: the section deals with the interpretation of testing results, such as defects detection, defects positioning and geometric dimensions, and also testing protocol drawing.
- *Assessment*: the issues of assessment of compliance of the testing object with the requirements set by the regulatory documentation (acceptance levels).
- *Quality aspects*: this section discusses requirements for non-destructive testing personnel in accordance with EN ISO 9712 and other certification systems. The section also includes issues of equipment verification and document traceability.
- *Developments*: the purpose of the study of this section is to familiarize the candidate with the latest industrial and scientific developments of a particular group of NDT methods.

In addition, in accordance with ISO/TR 25107, Penetrant testing and Magnetic particle testing syllabuses should include an ‘Environmental and Safety Conditions’ issue, which is associated with the use of chemically active substances that may be hazardous to human health and environment. Radiation safety issues, according to [3] and [6], are not included in NDT training syllabuses and usually studies additionally. But, it is recommended to include the radiation safety requirement issue in educational syllabuses. A detailed list of issues for each section for NDT methods groups is presented in the ISO/TR 25107 standard [6].

The following table lists the codes of international (ISO) and European (EN) standards, recommended for inclusion to NDT educational syllabuses in higher education institutions. This list is based on the recommendations of ISO/TR 25107 standard, taking into account the experience of its practical application in the preparation of candidates for certification in our NDT training center.

**Table 1. List of codes of international and European standards recommended for inclusion to NDT educational syllabuses**

Issues	Standards codes
General	EN ISO 9712, EN 4179, ISO 3999, ISO 5579, ISO 5580, ISO 10675-1, ISO 10675-2, ISO 11699-1, ISO 11699-2, ISO 14096-1, ISO 14096-2, ISO 15708-1, ISO 15708-2, ISO 16371-1, ISO 16526-1, ISO 16526-2, ISO 16526-3, ISO 17635, ISO 17636-1, ISO 17636-2, ISO 19232-1, ISO 19232-2, ISO 19232-3, ISO 19232-4, ISO 19232-5, EN 12543-1, EN 12543-2, EN 12543-3, EN 12543-4, EN 12543-5, EN 12679, EN 12681, EN 13068-1, EN 13068-2, EN 13068-3, EN CR 13935, EN 16016-1, EN 16016-2, EN 16016-3, EN 16016-4, EN 13445-5, EN 13480-5
UT	EN 1330-4, ISO 16809, ISO 16810, ISO 16811, ISO 17640, EN ISO 16827, EN 12680-1, EN 10228-3, EN 10228-4, EN ISO 17635, ISO 17640, ISO 23279, ISO 16823, ISO 16826, ISO 16828, EN ISO 13588, EN ISO 22825, EN ISO 10863, EN ISO 11666, ISO 25902, EN 10308, EN 4050, EN 10307, EN 16729, EN 14127, EN ISO 16831, EN 17635, CEN/TR 15135, EN 12668-1, EN 12668-2, EN 12668-3, ISO 10375, EN ISO 15626, EN ISO 18563-1, EN ISO 18563-2, ISO 18563-3, EN 15317, EN ISO 7963, EN ISO 2400, EN 10160, ISO 18175
RT	EN 12543-1, EN 12543-2, EN 12543-2, EN 12543-3, EN 12543-3, EN 12543-4, EN 12543-4, EN 12543-5, EN 12543-5, EN 12679, EN 12681, EN 12681-1, EN 12681-2, EN 13068-1, EN 13068-2, EN 13068-3, EN 13100-2, EN 16016-1, EN 16016-2, EN 16016-3, EN 16016-4, EN 16407-1, EN 16407-2, EN ISO 10893-6, EN ISO 10893-7, EN ISO 17636-1, EN ISO 17636-2, EN ISO 5579, ISO 10675-1, ISO 11699-1, ISO 11699-2, ISO 12721, ISO 14096-1, ISO 14096-2, ISO 15708-1, ISO 15708-2, ISO 16371-1, ISO 16371-2, ISO 16526-1, ISO 16526-2, ISO 16526-3, ISO 17635, ISO 17636-1, ISO 17636-2, ISO 19232-1, ISO 19232-2, ISO 19232-3, ISO 19232-4, ISO 19232-5, ISO 3999, ISO 4993, ISO 5579, ISO 5580, EN 17635, CEN/TR 15135

ET	EN 1330-5, EN 10246-3, EN 12084, EN 13860-1, EN 13860-2, EN ISO 10893-2, EN ISO 12718, ISO 15549, ISO 15548-1, ISO 15548-2, ISO 15548-3, ISO 17643, EN 17635, CEN/TR 15135
PT	EN ISO 12706, EN ISO 3452-1, EN ISO 3452-2, EN ISO 3452-3, EN ISO 3452-4, EN ISO 3452-5, EN ISO 3452-6, EN 1371-1, EN 1371-2, EN ISO 3059, EN 10228-2, ISO 4987, EN ISO 10893-4, EN ISO 23277, ISO 3058, EN 17635, CEN/TR 15135
MT	EN ISO 12707, EN ISO 9934-1, EN ISO 9934-2, EN ISO 9934-3, EN ISO 3059, EN ISO 17638, EN ISO 23278, EN 10228-1, ISO 4986, EN ISO 10893-5, EN ISO 10893-1, EN 1369, ISO 3058, ISO 11960, EN 17635, CEN/TR 15135
VT	EN 1330-10, ISO 6520-1, ISO 5817, EN 13018, EN ISO 17637, EN 1370, ISO 11971, EN 13927, ISO 3057, ISO 3058, ISO 8785, EN 10163-1, EN 10163-2, EN 10163-3, EN 17635, CEN/TR 15135

## 4. Conclusions

Today, there are two main systems of formal education in NDT in Ukraine - educational institutions and training centers. There is a problem of weak correlation between NDT educational syllabuses in educational institutions and NDT training syllabuses at training centers.

Compliance with the provisions of ISO/TR 25107 standard along with educational standards in educational syllabuses development can solve the problem of the inconsistency of NDT educational syllabuses in higher education with training syllabuses in certification preparation. It is proposed to include the ISO/TR 25107 recommendations in the educational syllabuses. It will bring closer the educational outcomes of study in non-destructive testing in higher education institutions to the potential employers' requirements and extend professional development for graduates.

## References

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