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OCCUPATIONAL EDUCATION OF SPECIALISTS IN FIELD OF METROLOGY AND INSTRUMENTATIONS IN UKRAINE

Tetyana Gordiyenko, *Antonina Gaber*

Odessa State Academia of Technical Regulation and Quality, Odessa, Ukraine, t_gord@hotmail.com

Abstract – The new legislation of Ukraine in the field of metrology and higher education from one side provides harmonization of national legislation with European standards and principles. From other – requires certain changes and adaptation for organization of education and competency evaluation of metrologists. The analysis of degree of adaptation of the existent system of occupational education in field of metrology is conducted taking into account a new legislation.

Keywords: metrology, occupational education, competency evaluation.

1. INTRODUCTION

Making of quality products of especially hi-tech and the scientifically capacious is needed by providing of measuring precision. Engineer metrologist has official duties to control rigging of technological processes facilities of measuring technique (MT), to watch after accordance of measuring devices to the requirements of legislation.

The representatives of this profession organize repair, check and calibration of MT, conduct metrology expertize of documentations and technique, develop methodologies, instructions, graphic of verification, repair documentation, co-operate with producers on questions development and introduction on the enterprise of new MT, with the further studies of personnel to work with new devices.

Therefore quality of education of metrologists has a no less important, than increase of their qualification and competency. Knowingly the different countries of the world pay attention to the questions of studies of metrologists [1]. Certainly, that at the market of labor is valued specialists-metrologist that is able to develop methodologies of realization of metrology researches, have an experience participating in the certification of MT, and also know international standards on Quality Management System (QMS).

2. EDUCATION IN FIELD OF METROLOGY AND INSTRUMENTATIONS

On 5 June 2014 the Parliament of Ukraine adopted new important legal act: "Law on Metrology and Metrological Activity" (2014). The Metrology System of Ukraine according new law in particular included educational institutions, research and development institutions, organizations that disseminate knowledge and experience in the area of metrology and metrological activity.

New "Law on Higher Education" (2014) provided five Levels higher education (LHE) and ten levels National Qualifications Framework (NQF) what provided harmonization of legislation in the field of education with european standards and principles. National System of Education show in Figure 1.

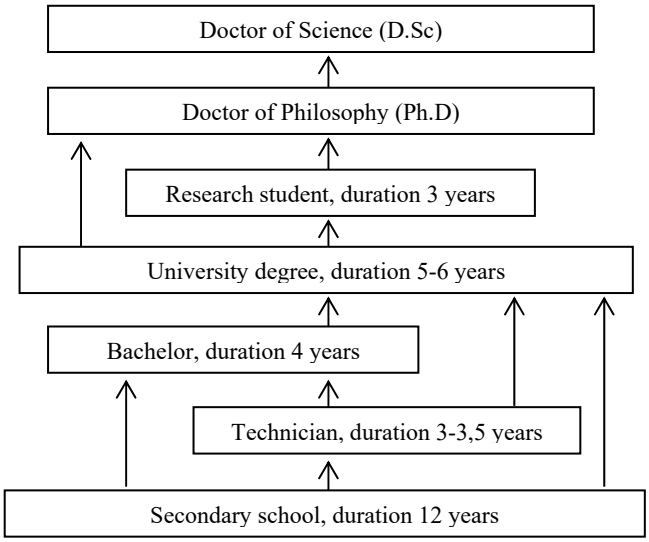

Figure 1. National System of Education in Ukraine.

Now in Ukraine are four types of training for metrologist:

• engineer metrologist education;

• engineer-specialist of different specialties in field of metrology general preparation;

• specialist-metrologist post-diploma education (postgraduate education, advanced training, re-educational, re-grant, retraining or internship);

• metrologists higher qualification preparation [2].

State makes registration, licensing and accreditation of higher educational institutions, determines single requirements to maintenance of educational activity, and sets the state standards of education.

Engineer-metrologist learning carries out licensed technical higher educational institutions of Ukraine (university, academy, institute or college). Post-diploma education for specialist-metrologist carries out licensed subdivisions of technical higher educational institutions and other specialized scientific institutions of Ukraine. Formal

studies in the metrology field encompass study programs, which provide a professional qualification of a "Metrologist". A person, who completes the training, is granted a certificate, recognized by the state, confirming professional qualification. The duration of these study programs varies from 1 week to 2 years.

Metrologist higher qualification is specialist that has scientific degrees Doctor of Philosophy (Ph.D) or Doctor of Science (D.Sc). Scientific degrees (Ph.D or D.Sc) may to confer after successful public defence of dissertations through Specialized Scientists Council.

Metrology qualifications levels in Ukrainian higher education show in Table 1.

Table 1. Metrology qualifications levels in Ukrainian higher education.

<table>
<tr><th>LHE (level NQF)</th><th>Level higher education</th><th>Degree higher education</th><th>Terms of achievement</th><th>Description code and name</th></tr>
<tr><td>Initial (5)</td><td>Short cycle</td><td>Low Bachelor</td><td>90-120 credit</td><td>–</td></tr>
<tr><td>First (6)</td><td>Bachelor's</td><td>Bachelor</td><td>180-240 credit</td><td rowspan="2">Field of knowledge: 0510 Metrology, measuring technique and informatively measuring technologies (Specialty: Metrology and measuring technique; Informatively-measuring systems; Metrology ensuring of tests and products quality)</td></tr>
<tr><td>Second (7)</td><td>Master's</td><td>Master</td><td>90-120 credit (Scientific component must be not less 30 %)</td></tr>
<tr><td>Third (8)</td><td>Educational-Scientific</td><td>Doctor of Philosophy</td><td>First Science Degree – Public defense of dissertation is in the Specialized Scientific Council</td><td rowspan="2">Specialty: 05.01.02 Standardization, Certification and Metrology ensuring</td></tr>
<tr><td>Fourth (9)</td><td>Scientific</td><td>Doctor of Science</td><td>Second Science Degree – public defence of dissertation or published monograph or totality of the articles is in the Specialized Scientific Council</td></tr>
</table>

Bachelors and master's degrees higher education is provided on the fields of knowledge teaching certain disciplines in accordance with standards of higher education. Every discipline is taught the determined amount of time (terms, hours). Thus there are mandatory to educating disciplines and those that can be chosen in accordance with the accredited educational program. Certificate accreditation of higher educational institutions is first given out on every accredited educational program for a term of five years, and at the second and next accreditations – for a term of 10 years.

Generals disciplines of educational program for metrologist (for master) in Ukrainian higher education on an example Odessa's State Academy of the Technical Regulation and Quality (OSATRQ) show in Table 2.

Table 2. Generals disciplines of educational program for metrologist (example).

<table>
<tr><th>Disciplines</th><th>Teaching terms</th><th>Terms, hours</th></tr>
<tr><td>Statistical methods of treatment of measuring information in metrology</td><td rowspan="4">mandatory</td><td>20</td></tr>
<tr><td>Bases of metrology and measuring technique</td><td>84</td></tr>
<tr><td>Methods and facilities for measuring</td><td>84</td></tr>
<tr><td>Economy of metrology activity is on a production</td><td>42</td></tr>
<tr><td>Physical bases of advanced metrology</td><td rowspan="5">independent choice</td><td>26</td></tr>
<tr><td>Legal metrology</td><td>30</td></tr>
<tr><td>Informatively-measuring systems</td><td>40</td></tr>
<tr><td>Accreditation of measuring and proof-of-concept laboratories</td><td>30</td></tr>
<tr><td>Technical diagnostics and reliability of facilities of measuring technique</td><td>48</td></tr>
<tr><td>Metrology ensuring of products quality</td><td>free choice</td><td>42</td></tr>
</table>

Higher educational institutions give bases knowledge (competence) that provides the necessary level of qualification. However for the receipt of higher level of qualification and maintenance metrology-practices of the attained level of qualification a necessity are implementations of certain terms – postgraduate education, advanced training, retraining or internship.

Higher educational institutions are under an obligation to have the internal System of providing of Quality for Educational Activity (QEA) and Quality of Higher Education (QHE) according to new "Law on Higher Education" (2014). Quality of education in Bologna of process is a basic condition for a trust, compatibility and mutual confession of higher educational establishments in European space.

The system of providing of quality of higher education in Ukraine consists of:

1) systems of of providing of QEA and QHE (system of the internal providing of quality) higher educational institutions;

2) systems of the external providing of QEA of higher educational institutions and QHE;

3) systems of providing of quality of activity of the National Agency for providing of quality of higher education and independent establishments of evaluation and providing of QHE.

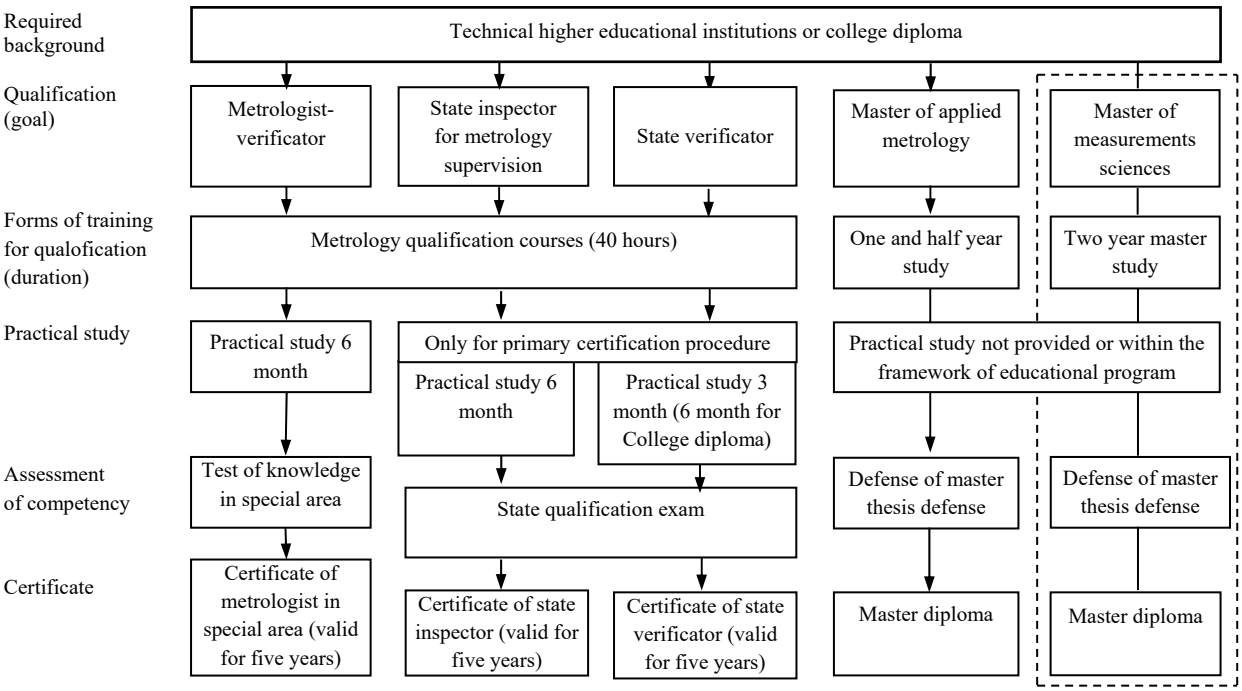

Figure 2. National Model of education, postgraduate education, re-educational and competency evaluation system for metrologist-practice.

The system of providing of QHE for the purpose her conforming to the set requirements is estimated by the National Agency for providing of quality of higher education.

Also one of ways of achievement of high level of preparation of specialists is development and introduction of QMS corresponding to ISO 9001 (show on Figure 3).


НАЦІОНАЛЬНИЙ ОРГАН УКРАЇНИ З СЕРТИФІКАЦІЇ
Система сертифікації УкрСЕПРО
СЕРТИФІКАТ
НА СИСТЕМУ УПРАВЛІННЯ ЯКІСТЮ
ЦИМ СЕРТИФІКАТОМ ПОСВІДЧУЄТЬСЯ, ЩО СИСТЕМА УПРАВЛІННЯ ЯКІСТЮ
ВНЗ "Одеська державна академія технічного регулювання та якості" (ВНЗ "ОДАТРЯ")
65020, м. Одеса, вул. Кузнечна, 15
код ЄДРПОУ 35178067
Відповідає вимогам ДСТУ ISO 9001:2009
(ISO 9001:2008)

Figure 3. Certificate of QMS corresponding to ISO 9001 of OSATRQ.

However for today in Ukraine sufficiently had higher educational institutions, that inculcated certificated QMS corresponding to ISO 9001. From data of the State Certification System in higher educational institutions of Ukraine have less than 20 of QMS certificated.

3. POST-DIPLOMA EDUCATION IN FIELD OF METROLOGY

The primary requirement for metrology qualification levels is technical higher educational institutions or college diploma. National Model of education, postgraduate education, re-educational and competency evaluation system for metrologist-practice showed in Figure 2 [3].

As well as in Lithuania in Ukraine persons with technical university or college education can become a metrologist. There is an exception foreseen for those who have practical skills but do not have a diploma in technical sciences. Persons, having technical university education, can acquire a qualification of master‘s degree of applied metrology or measurement sciences with following studies according to the scientific program of higher educational institutions [1].

Metrologist (verificator) is a person who has a technical university or technical college diploma, has finished metrology qualification courses, practical study 6 month and passed the test of knowledge in special area. He/She is able to carry out equipment control, maintenance and calibration of measuring instruments in a factory or a laboratory. Certificate of metrologist (verificator) are valid for five years.

State inspector for metrology supervision is a person who has a technical university or technical college diploma, has completed metrology qualification courses, practical study 6 month and passed the state qualification exam.

State inspector for metrology supervision for completion of certification procedure must know:

• laws of Ukraine and other normatively-legal acts of Ukraine in field of metrology and metrology activity, and also disciplinary, civil, administrative and criminal responsibility for violation;

• organization and order of realization of State metrology supervision;

• fundamental normative documents in field of metrology;

• bases of metrology, basic principles, methods and terms of receipt of results of measuring;

• bases of legislation are about labour, rules of labour, accident, productive sanitation, fire-prevention safety prevention protection.

Certificate of state inspector are valid for five years.

State inspector for metrology supervision has a similar legal status, is responsible for the execution of various tasks defined within the framework of the application of laws and regulations in legal metrology. He/She is able to apply verification and calibration methods to verify or calibrate different measuring instruments; if necessary fold protocols about administrative crimes, to give out binding overs about the removal of violation and others. According new "Law on Metrology and Metrological Activity" (2014) state inspector for metrology supervision – it the authorized public servants of government institution that will realize a public policy in the field of a metrology supervision. State inspector for metrology supervision can work in government institutions while implementing national laws, technical regulations, recommendations, and standards etc. The workers of law enforcement authorities must give help to the state inspector in implementation by them official duties.

State verificator for metrology supervision is a person who has:

• a technical university or technical college diploma;

• has completed metrology qualification courses;

• has completed practical study: for technical university diploma – 3 month; or for college diploma – 6 month and experience of work of over five years is in industry of metrology;

• passed the state qualification exam.

State verificator for completion of certification procedure must know:

• laws of Ukraine and other normatively-legal acts of Ukraine in field of metrology and metrology activity;

• fundamental National Standards in field of metrology;

• bases of metrology, basic principles, methods and terms of receipt of results of measuring;

• methodologies of verification for the kinds (sub kinds) of measuring;

• principle of action and construction of working standards and MT used for verification;

• bases of legislation are about labour, rules of labour, accident, productive sanitation, fire-prevention safety prevention protection.

Certificate of state verificator are valid for five years.

Master is a person who has a technical university diploma and has finished one and a half or two years extended studies concerning modules of measuring instruments and metrology, acquired research skills and was awarded a master's degree in metrology. Masters perform highly specified tasks in science, industry or laboratories for type approval. The possession of this degree is a prerequisite of entry to a doctor's studies (Ph.D or D.Sc.) in field of metrology.

From 2013 is obligatory presence of publications for awarding of degrees Ph.D and D.Sc in the scientific editions plugged in international database (for example such as Scopus or Web of Science). The basic stages of process of receipt of degrees Ph.D and D.Sc of higher education are showed in Fig. 4.

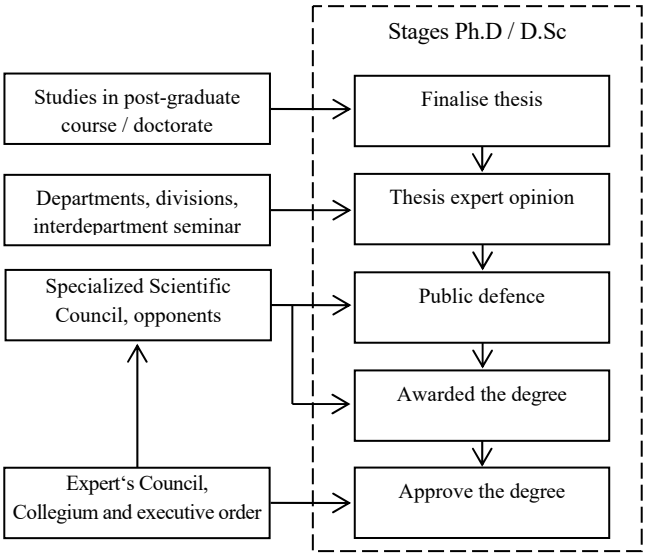

Figure 4. The basic stages of process of receipt of degrees Ph.D and D.Sc of higher education.

Re-grant or advanced training for metrologist-practices is especially important. Only people with a certificate of a state inspector or state verificator may verify measurement means, assigned to legal metrology. In order to obtain this certificate, people have to participate in the metrologist training courses every five years (Fig. 2). Metrologist-practice can choose workshops and conferences, organized in the field of metrology in order to develop their qualification. The proof of participation in such conferences (workshops, training etc.) is a certificate.

A presence of attested state verificator is one of terms of authority in the National Metrology System of metrology institutions (National Metrology Institutes (NMI), Scientific Metrology Centers (SMC), verification laboratories) on realization of check of facilities of measuring technique in accordance with industry of authority. The term of action of testifying to authority presents five years.

Therefore to evaluate and confirm a competency of metrology institutions it is necessary to prepare provision for it. State-administered institution – Ministry of Economic Development and Trade of Ukraine, establishes requirements for competency evaluating bodies and to evaluate competence in metrology. For realization of works from authority the attested auditors in the field of metrology are attracted.

Metrology institute, educational and other institutions arranges seminars, conferences, metrology qualification and training courses. Practical training sessions are carried out in premises of verification or calibration laboratories.

Also Project EU "Complementary Measures to the Sector Policy Support Programme "Promoting mutual trade by removing technical barriers to trade between Ukraine and the European Union" between May 2011 and June 2014:

• in field of metrology conducted seminars and presentations on inter-laboratory comparisons and proficiency testing schemes, and offered assistance to conformity assessment bodies to improve internal quality systems;

• in field of market surveillance conducted 27 training seminars, five coaching sessions, a study visit, and three round table discussions, organized four seminars on risk assessment and RAPEX for 120 staff members of the market surveillance authority.

4. APPLICATION OF THE NEWEST TECHNOLOGIES FOR EDUCATION OF SPECIALISTS IN FIELD OF METROLPGY

Separate structures – corporate universities, the task of that is providing of competense of employees, permanent increase of their qualification and retraining, are created in many domestic companies. One of major tasks of educational institutions – to provide the level of learning in accordance with the queries of employers and organize co-operating of employer with educational establishment with the use of competence approach [4–7]. Presently in the world is absent approach to the model of competenses. It stipulates insufficient transparency and mobility of the professional education system and learning. ISO/IEC JTC 1/SC 36 “Information of technology for learning, education and training” develops standards, decision-oriented, and development, exchange and maintenance of certificates of professional education and learning, and also improvement of their availability and transparency.

One of directions of modernisation of the system of education there is wide introduction of informatively-communication technologies in an educational process, and creation on their basis of the competitive electronic (distance) learning. Some Higher of educational of institutions in Ukraine have a special courses for distance studies in field of metrology and measuring. In particular in the Kyiv National Technical University of “KPI” has course “Uncertainty measuring result”, that allows to pass in short time. General volume of course with independent work – 1,5 credits.

Standards for distance learning not regulate matter of virtual laboratories, but contain the only generalized description of components of learning of objective type. A virtual laboratory must function within the framework of the distance learning system. The use of virtual laboratory works can qualitatively extend possibilities of distance learning, and also effectively support realization of practical works. However, the analysis of experience of implementation of virtual laboratories showed that a task to work out such laboratory as part of distance learning, until now did not have been formulated. Now virtual laboratories used very limit and not in learning system, but only as additional optional tools.

Basic advantages of virtual laboratories:

• absence of necessity to buy the expensive special equipment and reagents;

• possibility to model processes that it is fundamentally impossible to execute in laboratory conditions;

• safety that is the important plus of the use of virtual laboratories in the special cases (for example work with high tension or chemicals and all that);

• an economy of time and resources is for enter of results to the electronic format;

• possibility of the use of virtual laboratory for distance learning, when in principle absent possibility of work in laboratories.

Actuality of creation of virtual laboratory in higher of educational institutions is predefined not only by development of the distance education. There is a row of disciplines which need considerable resource from educational establishments for carrying out laboratory researches.

This software make it possible development in the graphic programming environment of MT , that work with physical signals that come from different sensors in the real mode of time. The modern assortment of virtual MT is big: oscillographs, multimeters, thermometers, cymometers, stop-watches, combined generators of signals et al [8].

Diagram for realization of programmatic-hardware complex for distance learning in sphere of metrology and measuring technique with a virtual measuring laboratory showed in Fig. 5.

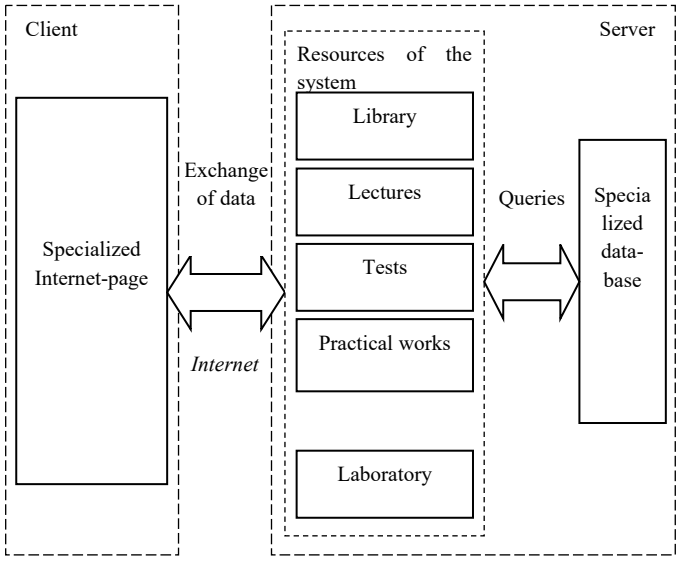

Figure 5. Diagram for realization of programmatic-hardware complex for distance learning in sphere of metrology and measuring technique with a virtual measuring laboratory.

This complex consists of two basic parts: client (the specialized Internet-page is with the flushing player) and server. The exchange of data comes true with application of network the Internet. Server contains the basic resources of system (library, lectures, tests, practical works, laboratory and all that) and specialized database for which sent corresponding queries.

3. CONCLUSIONS

For the offer of suitable labour force in field of metrology is limited, continuous training is becoming an especially important element of work. Such occupational education allows renewing labour force. This system has to be adapted into general national qualification system that is established in Ukraine with new legislations.

The important for education of specialists-metrologists is the use of information technologies as auxiliary events for implementation of QMS of in of higher of educational institutions. For example, virtual facilities of studies and laboratory, by that can to realize distance learning that positively influences on the increase of competitiveness of Higher of educational institutions.

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