Modern trends of training of specialists in metrology

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Abstract. Effective implementation of metrological activities is impossible without qualified specialists. Nowadays, we are moving to a new generation of Federal state educational standards for institutions of higher education. That standards are focused on «competence-based approach» that means that graduates ought to be ready for real-life situations. The transition to professional standards has been implemented to determine the competence of employees. Standards include a description of necessary qualifications for an employee to perform a certain type of professional activity, including specific service function. Therefore, in modern conditions educational programs should be based on the requirements of professional standards and reflect the interaction of education and specific segment of the labor market.

1. Introduction
Measurements have been the basis of people's relationships throughout time. Nowadays, the importance of metrological activity has increased. Responsible decisions are based on the results of measurements. It applies to all areas where it is necessary to obtain and use measurement information to ensure the quality of products.

Despite the fact that it is impossible to ensure any production activity without Metrology, the specialty «Standardization and Metrology» was introduced in Russian universities only in 1987. The specialty was introduced into the educational structure on the initiative of professors V. N. Azarov and B. V. Boytsov with the support of the state standard and the Ministry of education and science of the Russian Federation. At the moment, 96 Russian Universities are training specialists in the field of study 27.03.01 «Standardization and Metrology» [1].

According to the website «Professions and professionals» in the top three ranking of training specialists in the field of «Standardization and Metrology» are: MSTU named after N. Bauman – Moscow state technical University, UrFU named after B. Yeltsin – Ural Federal University and RUDN – Peoples' Friendship University of Russia.

2. Main part
In that way, «Standardization and Metrology» is a relatively young specialty of modern higher education but approaches to training have been repeatedly revised. Currently, the transition to a new generation of Federal state educational standards (FSES 3++) for higher education institutions is underway. It is focused on the «competence approach», that is, the ability of graduates to work with information and readiness for real life situations [2-4].

Russia has created a national qualification system (NQS) to determine the competence of employees and assist employers in ensuring this process when hiring staff. The NQS is based on the professional standards that has been mandatory for use in Russian organizations since July 2016. The professional...
standards describe the requirements for the quality and content of employees’ work in a certain area of professional activity, i.e. the competence of specialists in certain professions. Employers must apply that in all aspects of work with the personnel: when recruiting, selecting and hiring staff, in organizing training and certification of employees, development of job descriptions, billing work, assigning wage categories of employees and establishing the wage system, taking into account features of the organization of production, labor and management. In addition, educational programs of higher education institutions should be based on their requirements in the conditions of mandatory transition to professional standards [5, 6].

The Central concepts of professional standards are employee qualification and labor function. Employee qualification is the level of knowledge, professional skills and work experience of the employee. Labor function (LF) is work according to the position in accordance with the schedule, specialty, with the indication of qualification; specific type of work assigned to the employee. Professional standards are developed according to the scheme of sequential decomposition of professional activity through generalized labor functions (GLF) and labor functions to direct labor actions related to the necessary knowledge and skills [7].

In 2017, the professional standard «Metrology Specialist» with the code 40.012 was approved by the Order of the Ministry of labor and social protection of the Russian Federation (replacing the first version of the standard designed in 2014). Its professional activity is designated as «metrological support of production activities», which is relevant in organizations of any field of activity. Therefore, the field of professional activity of the «Metrology Specialist» refers to interdisciplinary types of professional activity. In the professional standard of the «Metrology specialist», the main goal of professional activity is designated as «product quality assurance», which is implemented through 4 generalized labor functions (figure 1). Figure 1 also shows the possible names of positions and requirements for the education of specialists in Metrology in the framework of a specific generalized labor function.

![Diagram](image)

**Figure 1.** Names of positions and requirements for the education of specialists in Metrology in the framework of a specific generalized labor function.

3. Discussion and conclusion

Bachelors who have received higher education in the field of Standardization and Metrology should now be ready to perform two generalized work functions: «Metrological support of product

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development, production and testing» and «Organization of work on metrological support of divisions». The description of the labor functions that make up these generalized functions is presented in table 1.

| Code | Generalized labor function                                                                 | Labour Function                                                                 |
|------|-------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------|
| B    | Metrological support for product development, production and testing                      | B/01 - Performing particularly accurate measurements to determine the actual values of the monitored indicators |
|      |                                                                                           | B/02 - Metrological supervision of compliance with the rules and standards for ensuring the unity of measurements, the state and use of measuring instruments |
|      |                                                                                           | B/03 - Monitoring and updating of the reference base for calibration of equipment and measuring instruments |
|      |                                                                                           | B/04 - Verification (calibration) of complex measuring instruments                |
|      |                                                                                           | B/05 - Development of calendar plans and schedules for verification of measuring instruments |
|      |                                                                                           | B/06 - Metrological examination of technical documentation                        |
|      |                                                                                           | B/07 - Development of measurement and test methods                                 |
|      |                                                                                           | B/08 - Certification of test equipment and special measuring instruments          |
|      |                                                                                           | B/09 - Development and implementation of special measuring instruments            |
|      |                                                                                           | B/10 - Development and implementation of normative documents of the organization in the field of metrological support |
|      |                                                                                           | B/11 - Certification, testing and approval of measuring instruments               |
|      |                                                                                           | B/12 - Preparation of local verification schemes by type of measurement           |
| C    | Organization of work on metrological support of divisions                                 | C/01 - Organization of works on verification (calibration) of measuring instruments in the division |
|      |                                                                                           | C/02 - Organization of works on updating of the reference base for calibration of equipment and measuring instruments |
|      |                                                                                           | C/03 - Analysis of the state of metrological support in the metrological service division of the organization |
|      |                                                                                           | C/04 - Preparation of the metrological service division of the organization for accreditation in the field of ensuring the unity of measurements |
|      |                                                                                           | C/05 - Organization of employment in the metrological service division of the organization |
|      |                                                                                           | C/06 - Organization of work on metrological examination of technical documentation |

To perform these functions, within the professional standard «Metrology Specialist» has been formulated requirements for the necessary knowledge and skills of employees as you can see in figure 2.
The same requirements in the higher education system should be transformed into requirements for training programs and for the results of the development of educational programs. Therefore, the new generation of educational standards (FSES 3++) have significantly changed the requirements to the structure of the bachelor’s program, to the results of the program development. For example, the following significant changes can be identified in the FSES 3++ project in the training area 27.03.01 «Standardization and Metrology»:

- expanded types of professional activities;
- new types of training and production practices were introduced;
- universal competences (UK) were established instead of general cultural competences (GCC);
- the scope of general professional competences (GPC) has been expanded;
- professional competencies are formed on the basis of professional standards, as well as on the basis of analysis of market requirements and generalization of domestic and foreign experience;
- two professional standards were approved as professional standards corresponding to the professional activity in the field of training 27.03.01 «Standardization and Metrology»: 40.010 «Technical control specialist» and 40.012 «Metrology Specialist».

Due to the fact that professional competencies are not fixed in the FSES, they can be updated for new technological tasks, updated versions of professional standards, avoiding lengthy formal procedures for reviewing the FSES. This approach provides for greater variability of programs, and the expansion of the scope of practices will allow taking into account the specific needs of regional and industry employers.

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