

Specifics of MS training in the area of nuclear materials safe management for new-comers in nuclear power

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Abstract. The issues of specialists training in the field of nuclear materials safe management for the countries, who have taken a way of nuclear power development are analyzed. Arguments in justification of a need of these specialists training for the new-comers are adduced. The general characteristic of the reference MS program "Nuclear materials safe management" is considered. The peculiar features of the program, which is important for graduates from the new-comers have been analyzed. The best practices got as a result of implementation of the program in recent years for the students from Kazakhstan, Belarus, Azerbaijan, Tajikistan, Iran, Turkey and other countries are presented. Finally, the directions of international cooperation in further improvement and development of the program are considered.

1. Introduction

Nuclear materials are the integral component of any nuclear power system. One of very important aspects for development of these systems is providing the conditions of nuclear materials safe management. It relates especially to the countries, who have taken a way of nuclear power development (new-comers) and where the staff deficit in nuclear area is often observed. For these countries it is important to have their own staff, which capable to make professional solutions on safety assessment of the existing conditions and steps taken in development of nuclear power. Therefore the new-comers are strongly interested in training of national personnel in the field of nuclear materials safe management.

The notion of the nuclear materials (NM) safe management is many-sided and includes nuclear, radiation, technical, fire safety, etc. Among the sides of NM safe management the safe keeping and also full and reliable knowledge about NM play an important role.

All these sides of NM safe management include one common component – personnel. The extensive operational experience shows that a permanent attention and purposeful efforts are required to maintain a high level of reliability of personnel at nuclear sites. This activity is reflected in the notion of nuclear safety culture. At that, the nuclear safety culture is considered as an active mean for increase of the safety level of NM and nuclear installations.

The MS program "Nuclear Materials Safe Management" is devoted to training of masters in all noted above areas of the NM safe management. The program is especially important for the students from new-comers, because it is focused on complex specialists training on NM safe management.



This program is already implemented in NRNU MEPhI (the Moscow site) for a number of years. During this time the students of Kazakhstan, Belarus, Ukraine, Azerbaijan, Tajikistan, Iran, Nigeria and other countries have successfully graduated, and also are training according to this program now.

The program "Nuclear Materials Safe Management" is developed as a reference educational program of a magistracy in the field of NM safe management. The program corresponds to the educational standard of the higher education of NRNU MEPhI in the direction 14.04.01 "Nuclear Power and Thermophysics" [1]. In October, 2015 the program has successfully passed the state accreditation. Thus, it has been recognized that the program conforms to the federal educational standards for a master's degree and it is suitable for the academic training at NRNU MEPhI.

2. Professional activity and competences of the graduates of the program

As a rule, an educational program is developed by universities depending on the required kinds of activity of graduates and a spectrum of the competences allowing the graduates to solve effectively professional tasks.

Taking into account noted specific conditions and needs of the labor market in the new-comers the program "Nuclear materials safe management" is focused on the following kinds of graduates activity: management; design; production and technology, expert, pedagogical work.

The condition of a successful solution of the professional tasks within noted kinds of activity is expressed as a spectrum of the competences of program graduates. Among them there are special competences reflecting specific conditions and needs of labor market in the new-comers. Note some of them here:

- The ability to formulate criteria for an assessment of NM safe management conditions;
- The ability to act in non-standard situations, to be responsible for adopted decisions;
- The ability to creation of theoretical and mathematical models describing the processes of NM management;
- The ability to carrying out physical experiments for the determination of NM characteristics;
- The readiness to analyze and estimate the state of nuclear materials physical protection, control and accountability systems (MPC&A systems);
- The ability to analysis and management of the data, characterizing of NM state, on the basis of modern information technologies;
- The readiness to carry out the organization and technical equipment of workplaces, to develop operational plans of the work of production divisions;
- To have knowledge of the basics of the power installation equipment design;
- To possess test methods for control of the capital equipment of nuclear power plants and other power installations;
- The readiness to carry out technical and economic calculations by production of thermal and electric energy with use of nuclear fuel.

3. Characteristic features of the program "Nuclear materials safe management"

3.1. General structure and training conditions in the program

The training of students of a nuclear profile for the new-comers has to account the existing circumstances in these countries, including: weak traditions (or their absence) of the NM safe management; existence only of some elements of nuclear infrastructure; existence of small experience in nuclear area; lack of the large-scale contingent of experts and specialists in nuclear area, etc. The program "Nuclear materials safe management" takes into account the specifics of nuclear activity in these countries.

The entrants are accepted for training in the program, if they have education at the bachelor level (or above) in the field of technical science and they successfully passed an introductory interview. The term of training in the program is 2 years. The volume of the MS program is 120 credits. At full-time courses the program volume, realized in one academic year, is 60 credits.

Structurally the MS program is constructed according to modular structure recommended by the educational standard 14.04.01 and includes obligatory and variable parts. The disciplines relating to variable part of the program (including the scientific-research work and practice), define its profile. This profile is reflected in the name "Nuclear Materials Safe Management".

Specific filling of structure of the program is presented in the form of working curriculum. The curriculum defines all sequence of two years' training of undergraduates and takes into account the restrictions and recommendations of the educational standard. The curriculum of the program "Nuclear Materials Safe Management" includes more than 30 disciplines. Among them 22 disciplines are included in the variable part of the program. The central place in variable part of the program is taken by the courses having key value for the students from the new-comers: the block of the disciplines devoted to NM safe management, "Nuclear technologies", "Legal and international aspects of NM management", "Materials of nuclear reactors", "Methods and devices for NM measurement" and others.

The students from different countries are trained within the program. And as the educational program is realized in Russian, the students, who are not knowing Russian, learn it previously. It should be noted, nevertheless, that teaching of the courses in English is planned in the nearest future.

Often it turns out that students from the different countries and universities have the different level of initial knowledge, but they study together. The practice of adaptive training is provided in these circumstances. It is expressed in a form of the education according to individual working curricula. The similar flexible system of training allows to master successfully the program to the students with different initial professional knowledge.

3.2. Complex consideration of the issues of NM safe management

Specifics of the issues of NM safe management are that all sides of the NM safe management should be considered equally: nuclear, radiation, information, technical, fire safety, NM safe keeping, full and reliable knowledge about NM, the issues of non-proliferation and reliability of personnel. It means that the program "Nuclear materials safe management" has to give to students a complex of knowledge, abilities and skills on all these components of the NM safe management.

In fact, the curriculum of first year of training included the following disciplines:

- basics of nuclear and radiation safety;
- Regulation of nuclear and radiation safety;
- Basics of information security of critical technologies;
- Legal and international aspects of NM management (nuclear non-proliferation);
- Influence of radiations;
- Introduction to the systems of NM physical protection, control and accountability for;
- Methods and procedures for NM control and accountability for;
- Computerized systems for NM control and accountability for;
- Methods of the vulnerability analysis and optimization of physical protection subsystem;
- Safety criteria and risk assessment in the tasks NM physical protection, control and accountability for.

On the second year of training within the cycle "NM safe management" students study:

- Technical means of physical protection of nuclear objects;
- Basics of radioactive waste management;
- Active methods of NM control.

The subject "Nuclear Safety Culture " is common for the courses of the cycle "NM safe management". Much attention is paid to this subject in the program. Different versions of this subject are included in several courses of the cycle of NM safe management.

3.3. Practical trend in teaching

As it is noted in the standard 14.04.01 "The nuclear power and thermophysics", the area of professional activity of the program graduates includes development, creation and operation of the devices and installations, where thermal and nuclear energy are used. In this regard the program "NM Safe Management" is focused, first of all, on practical tasks in nuclear power, including its safe development.

Therefore the considerable part of courses of the program is followed by laboratory and practical training. The last allow students to acquire, in the mode of active work, the knowledge and skills required for further successful professional work. We will note here that a special attention to the practical side of education plays a crucial role for formation of an self-sufficiency in the work of students. This quality is of great importance, first of all, for the students from the new-comers, owing to deficiency of skilled experts in nuclear area there.

The exit classes at the enterprises of nuclear power branch are given for students of the program. There, they get acquainted with the modern technologies of a nuclear fuel cycle, talk to experts, can gain deeper impression about specifics of NM safe management at the sites of various profiles. Besides studying of purely technical issues, the students can feel attention of the management to staff of nuclear enterprise and estimate the significance of a human factor in its safety.

3.4. Using of advanced technologies for distance training of foreign students

The educational standard 14.04.01 "The nuclear power and thermophysics" provides a possibility of the network form of education. Within this educational form, the technology of remote training is allowed. Since fall of 2015 NRNU MEPhI, within the program "NM safe management", realizes the network form of education for the staff of Kazatomprom (the Republic of Kazakhstan).

Besides NRNU MEPhI, the Universities of Kazakhstan participate in training in the program: Al-Farabi Kazakh National University (Almaty); Euroasian national university of name L.N. Gumilev (Astana) and East Kazakhstan state university of S. Amanzholov.

Training courses of the program: "Basics of nuclear technologies"; "Basics of nuclear non-proliferation and NM safe management"; "Basics of information security of critical technologies"; "Special chapters of higher mathematics"; "Methodology of scientific cognition"; "English language" are assigned to NRNU MEPhI. These courses are delivered to listeners in Kazakhstan by teachers of NRNU MEPhI with application of remote technology of training.

4. International cooperation for further development and implementation of the program

Training of specialists according to the program "NM safe management" is carried out with active support from the Department of Energy (DOE) of the USA. Collaboration is carried out within the Basic Agreement between Memorial Institute Battelle and NRNU MEPhI. The cooperation between NRNU MEPhI and DOE is expressed in a definition and further solution of the specific tasks, which arise during development and implementation of this program. These tasks correspond to certain directions of cooperation, allowing to realize effectively the possibilities of both organizations in achievement of common goals.

Below some of these directions are briefly noted.

- Strengthening of educational potential of the program by development and modernization of laboratory base;
- Formation and improvement of methodical provision of the program. Development of working curricula;
- Further improvement and development of the program by contacts, survey, collection of opinions, estimates of disciplines of the program from students, its graduates and employers;
- Transfer of experience of the Moscow site in NRNU MEPhI branches and other nuclear universities.

Being reference, the program includes extensive international experience in the field of nuclear power. A number of courses of the program "NM safe management" has been created and is realized now thanks to joint efforts of the teachers of NRNU MEPhI and the specialists of IAEA.

One of such courses is "Nuclear knowledge management". The course consists not only of lectures, but contains also practical tasks, and also research projects with their subsequent defense.

The course "International Nuclear Cooperation" considers the international system of nuclear cooperation and activity of the IAEA in this area. The course shows the ways, how the results of international cooperation can be used in the practical activities of organizations and experts, especially young specialists.

The courses "Nuclear Knowledge Management" and "International Nuclear Cooperation" are given by the experts of IAEA in the Russian and English languages. These courses are delivered by means of videoconference technology on the Internet. For lecturing support the computer CLP4NET platform developed by IAEA for nuclear education is used.

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