

Training Staff for the Proryv Project in the Seversk Technological Institute of NRNU MEPhI

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Abstract. In Seversk on the base of Siberian Group of Chemical Enterprises (SGCE) the pilot project "PRORYV" on creation of nuclear power technologies of new generation based on the closed nuclear fuel cycle with the use of the fast neutron reactors is being implemented. It is planned to create a research and demonstration power complex (RDPC) including the BREST-OD-300 reactor, and modules of fabrication and refabrication of nuclear fuel. Implementation of such large-scale project at SGCE means the necessity of creating an effective system of the staff training and retraining. At Seversk technological institute of National Research Nuclear University MEPhI (NRNU MEPhI) the complex personnel training system for the "PRORYV" project is going ahead of the construction and start-up of RDPC. The system includes various educational levels: middle school, higher education (bachelor and specialist programmes, magistracy, postgraduate course) and advanced training and retraining of the staff. In these educational activities highly-qualified scientific and pedagogical employees of NRNU MEPhI and employees of the Russian Federation national nuclear corporation ROSATOM with wide experience in the solution of innovative and technological tasks of nuclear industry are being involved. The educational process is organized on the basis of the modern interactive and multimedia training technologies using the modelling of key technological procedures of the closed fuel cycle. Joint research and educational center on the fast energetics is being created for effective interaction providing of NRNU MEPhI and the SGCE, integration of education, science and production.

Key Words: nuclear power, training staff, national research nuclear university.

1. Introduction

The *Proryv* project has been realized in Seversk on the base of the Siberian Group of Chemical Enterprises (JSC SGChE) within the federal target program named "New Generation Nuclear Technology for the period from 2010 to 2015 to 2020" [1]. This project has the task of creating an continuous multi-level practice-oriented program for training staff who could be able to ensure technology development and improvement, constructing and opening a pilot demonstration power complex (PDPC) consisting of a lead-cooled fast reactor BREST-OD-300, as well as modules for fabricating and re-fabricating nuclear fuel.

To ensure the effective participating in solving the staff task given, the leaders of NRNU MEPhI agreed to the STI's offer about the opening Fast Power Industry Centre for integrating the advanced research and educational programs. This offer naturally continues the whole activity of STI that is located in Seversk and for nearly 60 years has been solving staff and research problems for JSC SGChE, the largest nuclear industry enterprise in Russia [2-4].

2. Fast Power Centre

The main aim of creating the Fast Power Centre (Centre) is to ensure the staff, scientific and information realization of the Proryv project on the base of JSC SGChE and also to form a

scientific technological school on new generation nuclear technology. The Centre is supposed to organize research on creating and working out nuclear industry technologies, to train highly-qualified specialists for the Proryv project, and to improve the production process. The continuous training system includes several levels: secondary, higher (bachelors, specialists, masters, post-graduates) and subsequent (qualification improvement and re-training).

In training the staff for the Proryv project, up-to-date informatization methods are used in educational process [5]. Implementing multi-media and interactive information technologies into the training process makes it more effective. Involving students in the training process, as well as information visualization results in improving the students' motivation and their research activities. Another promising trend is using mathematical simulation of the key technology processes of the closed fuel cycle. The problem-oriented software has been made for studying fast neutron reactor operation, recycling irradiated mixed uranium-plutonium (nitride) fuel, nuclear fuel fabrication and re-fabrication, radioactive waste disposal, etc. Detailed mathematical simulations of physical and chemical processes are used for better understanding the operation of installations and individual production units. The closed fuel cycle as a whole and operation of individual production PDPC modules is studied with the help of simpler balance simulations. Multiple-variant calculation of the operation of installations and individual production units, sites and whole production schemes enables optimization of technological process modes, decisions on design, predicting performance during an accident and its consequences. It should be noted that informatization and forming modern educational resources requires not only developing, improving and adapting the appropriate software, but also preparing innovating study guides, improving teachers' qualification, and developing infrastructure inside the institute.

STI has the resources required for organizing the Centre's work. The Centre comprises 34 institute and research laboratories with up-to-date equipment. Highly-qualified science-workers and teachers of STI, as well as Rosatom (the Russian Federation national nuclear corporation) production workers, each having a large experience in solving nuclear industry innovative technologies problems, take part in the work of the Centre. The main feature of the Centre's work is forming the special algorithm of interaction between the STI and member-enterprises. This interaction is based on the mobility of students, teachers and specialists of nuclear industry and promotes learning and practical skills in the field of the closed fuel cycle process. The integration of science and education based on high-technology knowledge-intensive production will contribute to improving the efficiency of education and research. In its turn, this will help the graduates transfer the knowledge acquired to the production and take root at nuclear industry enterprises.

3. Training staff according to higher education programs

The staff for the Proryv project are trained at STI according to the educational programs for bachelors, specialists and post-graduates. In 2016 the STI developed and got a license for a new educational program of training masters in speciality 14.04.02 "Nuclear Physics and Technology" which completes a multi-level cycle (specialist – post-graduate; bachelor – master – post-graduate) and further Learning-Through-Life principle.

The key component of the Master educational program is forming a competence-based graduate model that includes the following expertise:

- a notion of today's situation and problems of nuclear Physics and technology, the history of their development;
- ability to arrange the research results in the form of articles, reports, scientific reports and presentations using desktop publishing systems and office software suite;

- ability to use the basic laws of physics of nucleus and particles, nuclear reactors, condensed matter, ecology well enough to independently combine and synthesize real ideas and for creativity;
- ability to estimate the prospects of nuclear industry and use its advanced technologies in their research work;
- ability to estimate risks and determine safety measures for new installations and technologies, to make and analyze scripts of probable accidents, to work out methods for reducing risks of accidents;
- ability to fair assessment of a suggested solution or project in relation to the modern world level, to make an expert conclusion;
- ability to operate, test and repair modern physical installations;
- ability to work out plans and programs of organizing innovative activity at an enterprise; to give technical-and-economic grounds of innovation projects, to control the programs of mastering new production and technology;
- ability to design, create and introduce new products and systems and to put theory into real engineering practice.

Competence-based approach implies wide using both active and interactive lessons. Making funds of assessment means in various disciplines enables knowledge ranking by groups of competences corresponding to the specialization of experts assessing the graduates' qualification theses [6].

Training staff on higher education curricula is carried out both at the STI and the Moscow site of NRNU MEPhI and JSC SGChE and other Rosatom enterprises. Besides, there are institute's base chairs at JSC SGChE. They are the Chair of Radiochemistry and the Chair of Fast Power Installation Control. These chairs' main goal is purposive training young people for specialties "Fuel Fabrication", "Fast Power Plant Operation", "Fuel Refabricating", and also improving qualification of Rosatom leaders and specialists.

These base chairs' main tasks are:

- training students in class combined with observation excursions around production plants and express-laboratories departments;
- participating in students' tutorials on physical-and-chemical principles of sublimate, radiochemical and chemical-and-metallurgical production, as well as on the new Proryv speciality for JSC SGChE's leaders and specialists;
- learning students skills in practical work by studying basic technological processes of the Proryv project, technological apparatus circuits, equipment arrangement principles, automated control systems, and also up-to-date production control and attestation means and analytical examination of the production;
- forming knowledge and skills by involving students into design, rationalization and inventing activity;
- supervising research and design works on the Proryv project themes;
- selection of real-life themes for course and diploma projects considering production urgency of the Proryv project;
- organizing all kinds of practice training at JSC SGChE's plants.

4. Supplementary education

Innovative high-technology enterprises of nuclear industry need specialists having general and specific competences taking into account the potential risks in this field. STI provides re-training and improving qualification for the specialists considering challenges of making nuclear technologies of a new generation. Perspective development plans are constantly being worked out and students are trained in new specialties according to the Proryv project needs.

For instance, a study guide on dense nitride fuel for fast reactors has been developed by STI in cooperation with JSC VNIINM specialists and then agreed with JSC SGChE. This study guide takes into account the specific features of JSC SGChE's working standard which determines technological competences aimed at developing the main production. The educational aim is training JSC SGChE's engineers engaged in the Proryv project for work and making research while producing dense fuel (uranium-plutonium nitride, uranium-plutonium alloys) for fast reactors, including fabricating fuel materials and pellets, and production of fuel elements and fuel assemblies. The participants acquire basic and advanced knowledge and professional competences on developing technologies of fabrication and re-fabrication of dense fuel for fast reactors, and on completing the course they are prepared for technological, research and fabrication activity in the field given.

In addition, STI has developed and agreed with JSC SGChE the program of training personnel for operating the fabrication and re-fabrication module. The aim of this training is to acquire knowledge and develop professional competence of engineers and technicians of the PDPC in relation to increasing production efficiency and modernizing technologies and equipment. The program is made up of modules and includes the following training courses: technology and automatization of Nuclear Fuel Cycle enterprises, securing work at NFC enterprises, information technology, project management in constructing nuclear power objects.

Professional work at hazardous plants has its peculiarities, such as being very stressful. Next, the production cycle control is highly automated when most information about the proceeding process cannot be directly perceived, but instead is given on a screen in a digital and symbol way. Consequently, the specialists must be well-prepared and understand the integrity and interconnection of the production processes, and have strong visual imaginative thinking that allows to recognize the proceeding process behind concise symbolic (virtual) information and to quickly analyze the possible solutions. Therefore, the training is based on up-to-date interactive and multi-media technologies using simulation of the key technological processes.

The educational process is supplied with all the facilities and resources: classrooms and laboratories with modern equipment, computer classrooms, a library. At the same time, there are used facilities and resources of JSC SGChE and of other organizations whose work corresponds to the program given in the frame of scientific and educational partnership and under net educational programs.

5. Pre-university training

What is peculiar about pre-university training is that STI has established Seversk Engineering School (SES) integrated with the system of secondary education in Seversk. This School meets the requirements of the municipal open net educational project of "Seversk Engineering School". The project aims at practical realization of educational career-guidance which form the motivation to master professions in natural sciences, engineering-and-technical and engineering-and-technological spheres. Besides, it considers the labor market needs in connection with the Proryv project realization plans.

The main purpose of establishing the School is to organize a system of early career-guidance by supervising the educational, research and experimental design activities of high-school students on the base of STI's chairs and research laboratories.

The key aims of SES include

- forming basic educational and professional technical competences required for nuclear and other priority industries of ZATO Seversk;

- mastering practical skills for carrying out research, laboratory and design work, both in worker's and engineer's specialities in the field chosen;
- making engineering professions attractive and to motivate choosing jobs in nuclear and other priority industries of ZATO Seversk;
- creating the educational environment for training engineering staff whose qualifications meet today's and future needs of ZATO Seversk;
- adapting university students-to-be to the conditions of studying at a higher school intended for the better survival and successful mastering the specialities chosen;
- making conditions for SES's graduates to get high-quality engineering education and to gain rating points that could contribute to their priority employment in nuclear and other hi-tech industries.

These challenges involve city's school students-members of the net project into the project activities closely connected with the Institute research on the Proryv project subjects.

Thus, through the career-guidance the school students get the opportunity of making a preliminary and deliberate choice of a job, workplace and higher school. The training increases motivation to work and study and consequently the quality level of students who are planning to become engaged in nuclear industry.

6. Conclusion

Thus, the STI of NRNU MEPhI has created all the necessary organizing, teaching and technical conditions for an effective system of training and re-training specialists for the Proryv project. The high training quality is gained by forming competences necessary for the practical realization of the whole cycle, i.e. formulating an idea and giving proof of the operating principle, design, construction, production and operation, de-commissioning with reference to a wide range of hi-tech products, systems and processes.

7. References

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