ROSATOM TECHNICAL ACADEMY EXPERIENCE IN THE FIELD OF ADVANCED TRAINING OF OPERATIONAL PERSONNEL FOR SMALL MODULAR REACTORS

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Abstract

The commissioning of Small Modular Reactors (SMR) is an attractive option for most countries embarking on nuclear power programmes. At the same time, one of the key conditions for the safe operation of SMRs is the availability of qualified personnel with appropriate specialized training. This also includes receiving qualification confirmations obtained by national supervisory authorities. Taking into account the need to provide personnel with various qualifications required at the stages of the deployment of nuclear power facilities, Rosatom Technical Academy (Rosatom Tech) plays a key role in training personnel for both nuclear infrastructure and nuclear power plant operations. This article presents Rosatom Tech's experience in training SMR personnel in relation to the basic approach of the IAEA in terms of ensuring national nuclear energy programs.

Introduction

The commissioning of Small Modular Reactors is an attractive option for most countries embarking on nuclear power programmes. Such reactor installations are capable of solving a number of tasks to provide regions with underdeveloped infrastructure with electricity and industrial heat; replace existing hydrocarbon-based generating capacities in order to reduce carbon emissions; provide the population and industry with fresh water. According to the IAEA publications, about 80 different SMR projects are under development and implementation [1,2].

At the same time, one of the key conditions for the safe operation of the SMR is the availability of qualified personnel with appropriate specialized training and qualification confirmations obtained from national supervisory authorities. This statement is relevant not only for the timely provision of facilities by operating personnel, but also by personnel of national organizations involved in the implementation of nuclear energy programs, and personnel of the regulatory authority.

Since 2011, specialized training in the field of SMR has been conducted by the Rosatom Technical Academy, an organization specializing in additional professional education, professional retraining of managers and specialists in nuclear energy and industry, and personnel certification. These training events are aimed at training SMR operational personnel as well as senior and middle managers of foreign countries. These works are carried out in cooperation with representatives of leading scientific institutes of the Rosatom State Atomic Energy Corporation, power engineering enterprises, the regulatory body, as

well as the International Atomic Energy Agency (IAEA).

This article presents the Rosatom Technical Academy experience in training SMR personnel in accordance with the IAEA Milestones Approach for the provision of national nuclear power programmes.

Training of nuclear infrastructure personnel

In 2011, within the framework of the 55th IAEA General Conference in Vienna, practical arrangements were signed between the IAEA, the Rosatom Technical Academy (former CICE&T) and Rosenergoatom JSC on cooperation in training specialists in the field of nuclear infrastructure and NPP operation. In order to expand the use of the innovative potential of Russian nuclear technologies, in 2017, Rosatom State Atomic Energy Corporation and the IAEA signed an agreement concerning an extrabudgetary contribution of the Russian Federation towards the implementation of the IAEA's Technical Cooperation Projects on Nuclear Infrastructure Development [1].

In the same year, in order to form a base for training personnel in the field of SMR, Rosatom Tech hosted a technical workshop on the development of training programmes for foreign specialists based on SMR technologies of Russian design. Within the framework of this workshop, the IAEA announced its approach to the development of the SMR direction and presented information on the development of various SMR projects around the world.

IAEA's representatives, together with the leading experts from Rosatom State Atomic Energy Corporation enterprises, such as. I. Leypunsky Institute of Physics and Power Engineering, OKBM Afrikantov JSC, and TVEL JSC, took part in the workshop. The key outcome of this event was the development of preliminary training programmes that were focused on the end users of such technologies. Subsequently, the results of this workshop were implemented in a series of specialized trainings for foreign specialists and managers of nuclear energy programs:

- Introduction to the Low Power Liquid Metal Cooled Reactors, 2013;
- Assessment of Prospective Use of PWR in Newcomer Countries, 2015;
- Scientific visit on Floating NPP and the Fast-Neutron Reactor Technology, 2016;
- Training courses on the HTGR/SMR technology, 2017;
- Scientific visit on SNPPs, 2017.

It should be noted that specialized training courses in the field of SMR with pressurized water reactor installations focus more on the technologies of the KLT-40 installed at the world's first floating nuclear power plant. At the

same time, in addition to the theoretical training itself, the programmes of these courses included a visit to the NPP construction site. That gave students the opportunity to get acquainted with the features of the facility and the progress of the station construction.

Since 2019, the Rosatom Technical Academy has had the status of an IAEA Collaborating Center. Rosatom Tech became the first center to cooperate with the IAEA in four different programme areas at the same time: nuclear science and applications, nuclear security, nuclear energy, and safeguards.

Within the IAEA Technical Cooperation projects, the Rosatom Technical Academy conducts workshops, training courses, group scientific visits, as well as joint schools. One of the projects is INT2023 « Supporting Member States' Capacity Building on Small Modular Reactors and Micro-reactors and their Technology and Applications as a Contribution of Nuclear Power to the Mitigation of Climate Change».

Within this project, Rosatom Tech's Center for International Cooperation conducted 5 training courses, which were attended by more than 100 people from 32 countries [FIG.1]. The events covered the most relevant topics in the field of SMR, for example:

- Closed fuel cycle for SMR;
- Using IAEA tools for modeling electric power systems for SMR;
- Cogeneration projects using SMR.

As part of the training programmes, participants were able to visit the Baltic Shipyard, where the nuclear icebreaker project 22220 with two RITM-200 reactors is currently under construction. In addition, within the framework of virtual technical tours, participants visited the sites of JSC OKBM Afrikantov and floating nuclear power plant (FNPP) «Akademik Lomonosov» to get acquainted with Russian technologies in detail.

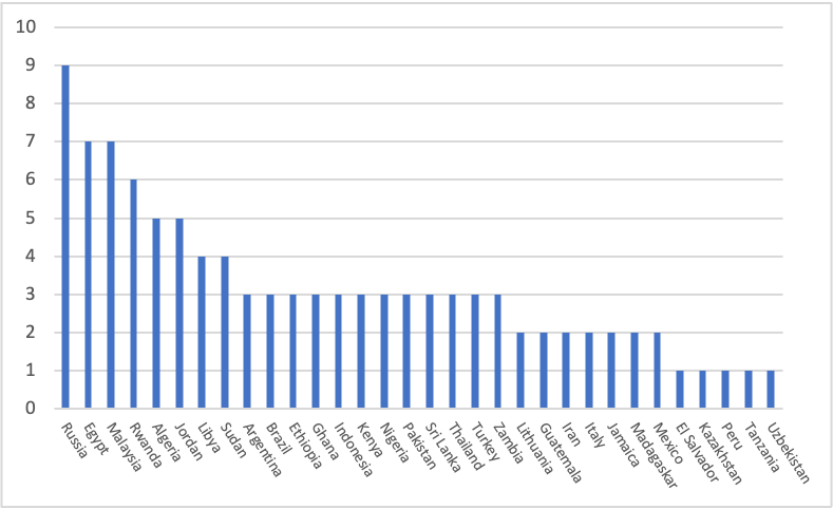

FIG. 1. Number of participants participated in the events within the framework of the extrabudgetary contribution, by country

Moreover, Rosatom Technical Academy hosted the 21st INPRO Dialogue Forum on the Deployment of SMR's Projects and Technologies to Support the Sustainable Development Goals in the St. Petersburg branch for the first time. During the event, more than 80 representatives from 31 countries shared their knowledge about the ways to ensure the sustainability of nuclear energy using SMR technologies.

Features of the training of operational personnel

Like other nuclear power plants, the SMR's operational staff is trained through advanced personnel training, which is based on the widely accepted systematic approach to IAEA personnel training and is closely related to the SMR's construction and commissioning schedule [3]. But unlike the traditional approach, the design, building, and commissioning of new facilities—like the SMR—impose certain requirements on the operating personnel training process.

Currently, Rosatom Technical Academy has implemented an integrated approach to the training of NPP operational personnel, which consists in the development and support of a personnel training system, starting with the development of organizational and administrative documentation and ending with the specialized training of licensed NPP personnel.

For instance, the development of a personnel training system for small modular reactors using a generation IV BREST-OD-300 reactor plant has been

underway at Rosatom Technical Academy since 2021 [4]. This system comprised, in addition to the immediately generated schedule of group training of staff according to the phases of facility building and commissioning:

- Regulations on the personnel management system;
- Standards of the organization in the field of personnel training;
- Qualification requirements and job functions of the staff, etc.

The existence of such a system enables the organization of personnel's advanced training process at the system level and, early in the training process, closes any potential gaps brought about by the object's innovative features and the lack of referents. To guarantee the BREST-OD-300 staff's training, Rosatom Tech is currently developing methodological and instructional documentation.

Moreover, Rosatom Tech has experience training the operational personnel of the SMR. Since 2015, Rosatom Tech has been carrying out advanced training of the operational personnel of the floating nuclear power plant (FNPP) «Akademik Lomonosov» [5]. At the same time, the concept of training the staff of the FNPP included:

- Initial test of knowledge (Floating NPP Training Center);
- Development of individual training programme for specific position (Floating NPP Training Center);
- Theoretical training;
- Simulator training (operating personnel);
- Traineeship on FNPP;
- Final training examination;
- Initial verification of knowledge in the commission of the Floating NPP Directorate;
- Obtaining permission to conduct work in the field of the use of nuclear energy in Rostekhnadzor;
- Qualifying examination;
- Admission to independent work.

Specialized training courses relating to the battle for a barge's survival were arranged to train people, taking into consideration the details of the object's placement on the barge. The following have been designed for the FNPP «Akademik Lomonosov» staff organization and training:

- Operating personnel instructions;
- Typical programme of training for Floating NPP personnel for a specific position;

- Training materials (more than 200 units have been developed including thousands of pages in total);
- Lesson plans;
- Interactive and 3D models for complex nuclear power facility systems;
- Control questions on each topic and test questions for the final certification on each courseГ;
- A complete set of documents is uploaded on a server with open access for trainees.

Conclusion

Currently, Rosatom Technical Academy has a wide experience in training personnel to ensure the deployment of Small Modular Reactors. Since 2011, Rosatom Tech has been hosting training events on a regular basis in cooperation with the IAEA to train foreigners for the national nuclear infrastructure facilities. Moreover, based on many years of experience in training personnel of nuclear power facilities, Rosatom Tech conducted training of personnel of the floating nuclear power plant (FNPP) «Akademik Lomonosov» and is currently working on training personnel of the innovative Generation IV reactor with lead coolant BREST-OD-300.

Taking into account the extensive experience of Rosatom Technical Academy, it can be noted that the organization trains personnel at all stages of the deployment of the SMR, starting from the training of participants who make decisions on the formation of national nuclear energy programmes, to the direct training of the operational personnel of the SMR.

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