

Education in nuclear engineering in Slovakia

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Abstract: Slovak University of Technology is the largest and also the oldest university of technology in Slovakia. Surely more than 50% of high-educated technicians who work nowadays in nuclear industry have graduated from this university. The Department of Nuclear Physics and Technology of the Faculty of Electrical Engineering and Information Technology as a one of seven faculties of this University feels responsibility for proper engineering education and training for Slovak NPP operating staff. The education process is realised via undergraduate (Bc.), graduate (MSc.) and postgraduate (PhD.) study as well as via specialised training courses in a frame of continuous education system.

1. Introduction

Preparation of operating staff for nuclear industry is and also has to be one of the most serious education processes mainly in the Central-European countries where about 40-50 % of electricity is produced in nuclear power plants (NPP). This requires a high level of education and knowledge in nuclear physics and technology supported by wide spectrum of academic as well as research institutions on national and international level.

For Slovak students who would like to work as a NPP operating staff it is recommended to enrol into the study branch of Power Plant Engineering and Power Electronics at the Faculty of Electrical Engineering and Information Technology, Slovak University of Technology in Bratislava. There is a possibility (besides obligatory subjects) to choose some suitable optional subjects from 14 groups listed below in Table I, which were defined by the Working Package 1 of the former ENEN EU 5FP project [1].

In this paper, we focus our attention on our current activities within the “Eugene Wigner Training Course on Reactor Physics Experiments” [2, 3] as well as on the formation of the Slovak Nuclear Education Network (SNEN). More detail information concerning the undergraduate, graduate, and post-graduate studies at the Faculty of Electrical Engineering and Information Technology can be found elsewhere [4, 5].

2. Eugene Wigner Courses

In the Central-European region, there exists a very extensive and also effective international collaboration in nuclear industry and education. Similarly good situation is also among universities and technical high schools in this area. Slovak University of Technology in Bratislava has established contacts with many universities abroad in the area of utilization of research and training reactors. One of good examples of international collaboration is ENEN – European Nuclear Education Network Association, which resulted in a formation of “Eugene Wigner Training Courses on Reactor Physics Experiments” [2, 3] running in the last 2 years as a mutual effort of the Budapest University of Technology and Economics

(Budapest, Hungary), Czech Technical University (Prague, Czech Republic), University of Technology (Vienna, Austria), and Slovak University of Technology in Bratislava (Bratislava, Slovakia). In total 38 participants from different European countries as Austria, Belgium, Bulgaria, Czech Republic, Finland, Italy, Romania, Slovakia, Slovenia, Sweden, and Switzerland took part at these international training courses so far.

In the frame of these courses, students of nuclear engineering visited three different experimental facilities located at the course organisers' institutes and carried out experimental laboratory practices. In the Central-European region, there is a long-lasting tradition of co-operation between Austria, Czech Republic, Hungary, and Slovakia based on short-term students' visits.

3. Slovak Nuclear Education Network

According to international experiences obtained during the last 3 years in the frame of ENEN activities, the Slovak Nuclear Education Network (SNEN) was established. Our department supervises this network. Coordination of nuclear education is essentially important on the regional level.

SNEN has raised and tries to answer the following important questions related to nuclear education in Slovakia:

- WHY is it necessary to have SNEN? To balance and effectively utilize the available capacities and real possibilities of the educational institutions.
- WHO has the main responsibility? Teachers as well as students (trainees).
- WHAT is the ultimate goal? To develop and introduce programs for effective study.
- HOW is the goal to be reached? Through new, effective and attractive forms of study by the help of national and/or international accreditation/ recognition.
- WHERE will be the practical work done? At universities with a broad involvement of industrial partners by arranging for example technical tours and excursions.

SNEN relays on a common approach to nuclear education of academic, research, governmental, industrial, and other domestic as well as international institutions. In the recently created network following institutions take part: **Universities:** Slovak University of Technology in Bratislava, Comenius University in Bratislava, **Governmental organizations:** Slovak Regulatory Authority, St. Elizabeth Institute of Oncology, State Faculty Health Institute, Cyclotron Centrum of the Slovak Republic, **Industrial organizations:** Slovenské elektrárne, a.s., VÚJE Trnava, a.s., VÚEZ Tlmače, DECOM Slovakia, RELKO, s.r.o., **International organization located in Slovakia:** CENS – Centre for Nuclear Safety.

As the first step of the SNEN activities, an actual summary of teaching programs in the area of nuclear physics and technology was prepared. Available subjects were arranged into 14 groups as suggested by the Working Package 1 of the ENEN project [1]:

1. Nuclear Power Engineering
2. Nuclear Physics
3. Theory of Nuclear reactors
4. Experimental reactor Physics
5. Thermohydraulics
6. Operation and Control of NPP
7. Nuclear Safety and Reliability
8. Nuclear Fuel Cycle
9. Nuclear Materials
10. Radiochemistry
11. Radiation Protection and Dosimetry
12. Advanced Courses
13. Miscellaneous

14. Decommissioning of NPP and Rad-Waste Management

Table I - Subjects offered by Slovak universities in the field of nuclear engineering classified according to the conclusions of WP1 ENEN

<i>Group</i>	<i>Slovak University of Technology</i>	<i>Comenius University</i>
1	Nuclear Power Facilities	
2	Sources of Radiation Nuclear Physics and Technology	Introductory Atomic and Nuclear Physics Neutron and Reactor Physics Introductory Particle Physics Theory of Atomic Nucleus Interaction of Radiation with Matter Nuclear reactions
3	Theory of Nuclear Reactors Nuclear Reactors	
4	Experimental Reactor Physics Experiments at Research Reactors	
6	Operation of Nuclear Power Plants Control of Nuclear Power Plants Nuclear Power Plant Equipment Power Engineering, Machines and Equipment	
7	Safety and Reliability of Nuclear Power Plants	
8		Nuclear Fuel Cycle
9	Materials of Nuclear Power Plants Materials for Nuclear Power Plants	
10		Determination of Radionuclides Nuclear Chemistry
11	Dosimetry	Radiation Environmental Physics Introduction to Dosimetry
12		Special Laboratory Exercises
13	Accelerators and Their Applications Particle Accelerator Physics and Technology Ion Beams Ion Beams Nuclear Electronics	Radiopharmaceuticals Numerical Methods in Nuclear Science and Technology Nuclear Electronics and its Applications Data Evaluation and Statistics Particle Accelerators Particle Detectors
14	Decommissioning of Nuclear Power Plants	

Even though the subjects listed in Table I are basically offered to Slovak students and are given in Slovak language, for some of them English is proposed to the students and all of them can be modified and lectured in English if required. Future activities of SNEN will be oriented towards an increasing effectiveness of collaboration in nuclear education on regional level.

4. Conclusions

University can contribute not only to the education but also to attract students to nuclear field, which is a base also for the safety culture at NPP as well as essential need for accepting nuclear industry by the public. Readers at the university (professors, assistants, etc.) can stimulate students for nuclear physics or at least they can relieve them of distress from nuclear issues. The first contact is very important. University enables an optimal selection of students. The option for "nuclear education" is completely free and independent. The problem is that the amount of students taking these lectures is low. Proper education at the university is a source of knowledge and attitudes for the whole life. Theoretical and practical experiences, professional approach and consistency are very important also from the safety culture point of view. University lectures and seminars are basically opened for public and this academic field can be made better use of in public relations. It is an investment mainly to young generation. During discussions with students, teachers can form their professional orientation according to their abilities and needs. Good teacher encourages also the growth of student and shapes his personality. Graduated students have to learn to take responsibility for their decisions and their academic level of education.

Several specific features characterize education system in nuclear power engineering in Slovakia. Many of them are a consequence of previous developments. Nevertheless, this system has achieved certain level of quality, which has been confirmed not only through IAEA missions but also via technical activities of institutions working actively in nuclear field. Slovak University of Technology in Bratislava is ready and would like to contribute to this system in the future and by this way also to contribute to international and/or regional effort.

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