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EDUCATION IN NUCLEAR SCIENCE AND ENGINEERING IN BULGARIA: NATIONAL STANDARDS AND REGULATIONS AND PRESENT STATUS

Abstract: A concise review of the general and specific requirements set by the national legislation and the Nuclear Regulatory Agency to the education in Nuclear Engineering in Bulgaria is presented. A brief description of the existing curricula in Nuclear Engineering, Nuclear and Particle Physics and Nuclear Chemistry education at university level is also given.

1. BACKGROUND/HISTORY

According to the Convention on Nuclear Safety, “Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety related activities in or for each nuclear installation, throughout its life”.

General regulation of the education in Bulgaria is provided by the national legislation on higher education. It prescribes a state control on the quality assurance and accreditation of the universities and their Bachelor and Master programmes, which is a responsibility of the National Evaluation and Accreditation Agency of Bulgaria.

Specific regulatory requirements are stated by the Bulgarian Nuclear Regulatory Agency (NRA) in a “Regulation on the Terms and Procedure for obtaining of Vocational Qualification and on the Procedure for Issuing of Licenses for Specialised Training and of Individual Licenses for Use of Nuclear Power”.

(<http://www.bnra.bg/en/documents-en/legislation/regulations/reg-kvalifikacia-en.pdf>)

For a list of positions which involve activities in nuclear facilities with effects on nuclear safety and radiation protection, this regulation demands a Master de-

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gree in “nuclear power engineering (technical sciences – mechanical engineering)” or in “nuclear power engineering (natural sciences – physics)”. For each position in the list, one or either of these two types of university degree is explicitly required.

Education in Nuclear Science at university level exists in Bulgaria since 1939, when Prof. Elisaveta Karamihailova was the first to offer a lecture course on Experimental Atomic Physics and Radioactivity at the University of Sofia. A few years later (in 1945) she founded there the Department of Atomic Physics. Later, in 1962, Prof. Kostadin Kostadinov (presently retired) began to give the first lectures in radiochemistry as an optional course at the Faculty of Chemistry.

2. STRUCTURE

Specialized education at MS level started in 1972: in Nuclear Engineering at the Faculty of Physics and in Radiochemistry at the Faculty of Chemistry, both of the University of Sofia. The technical aspects of nuclear power plants are studied at the Department of Thermal and Nuclear Power Engineering of the Technical University – Sofia. The Department of Atomic Physics at the Plovdiv University is also involved in the nuclear education process in the country.

At present, there are three departments at the Sofia University (SU) which, along with the Technical University of Sofia (TU), form the national basis of nuclear education in Bulgaria (Table 1):

Table 1. Nuclear Science and Engineering related programmes in Bulgaria

Department	Faculty	Scope
Nuclear Engineering	Physics (SU)	Nuclear Engineering (B. Sc., M. Sc.)
Atomic Physics	Physics (SU)	Nuclear and Particle Physics (M. Sc.), Radioactivity, Health physics (B. Sc., M. Sc.)
General and Inorganic Chemistry, Analytical Chemistry	Chemistry (SU)	Nuclear chemistry (B. Sc., M. Sc.), Radiochemistry and Radioecology (M. Sc.)
Thermal and Nuclear Power	Power Engineering and Power Machines (TU)	Thermal and Nuclear Power (B. Eng.) Nuclear Power (M. Eng.) Thermal Power (M. Eng.)

Research in Nuclear Science and Engineering is performed at the Institute for Nuclear Research and Nuclear Energy of the Bulgarian Academy of Science, as well as within the above mentioned universities.

3. CURRICULA IN NUCLEAR ENGINEERING

A brief description of the curricula in Nuclear Engineering, Nuclear and Particle Physics and Nuclear Chemistry is presented below (Table 2).

Table 2. Nuclear related education in Bulgaria

Programme, Level	Duration semesters	Total hours	Exams	ECTS	Students per year
Nuclear Engineering, BS (SU)	8	2835	42	240	15
Nuclear Engineering, MS (SU)	3	685	11	90	5
Nuclear and Particle Physics, MS (SU)	3	900	>10	90	4
Nuclear Chemistry, BS (SU)	8	2985	42	240	12
Thermal and Nuclear Power, BE (TU)	8	2507	49	240	52
Nuclear Power, ME (TU)	3				14

3.1. Sofia University

The average number of students admitted to the two BS programmes is 15 per year for each of them. About half of them complete successfully these programmes.

A typical distribution of the subjects in the BS Curriculum in Nuclear Engineering by topics includes: 20% Mathematics; 29% General (non-nuclear) Physics; 11% General Engineering, 40% specialized nuclear subjects. The essential nuclear-related courses in the BS and MS curricula in Nuclear Engineering are listed below (Table 3 and Table 4).

Table 3. Nuclear-related courses in the BS “Nuclear Engineering” programme

BS Curriculum in Nuclear Engineering Nuclear-related courses	ECTS	Total academic hours
Atomic Physics and Interaction of the Ionizing Radiation with Matter	9.0	105
Nuclear and Particle Physics	9.0	105
Neutron Physics	5.5	75
Nuclear Reactor Physics	3.0	45
Nuclear Fuel Cycle	3.0	45
Computational Methods in Nuclear Technology	6.0	75
Nuclear Electronics	7.0	105
Dosimetry and Radiation Protection	8.5	105
Introduction to Nuclear Technology	9.0	120
Experimental Nuclear Physics	8.0	105
Nuclear Theory	3.0	45
Practical Training at a NPP (2 weeks)	3.0	60

Table 4. Required courses in the MS “Nuclear Engineering” programme

MS Curriculum in Nuclear Engineering Required courses	ECTS	Total academic hours
Operational Reactor Physics and Nuclear Safety - 1	6.0	60
Heat Transfer	4.5	45
Technical Hydromechanics	6.0	60
Reliability in NPPs	6.0	60
Radiochemistry	7.5	75
Operational Reactor Physics and Nuclear Safety - 2	6.0	60
Reactor Analysis	9.0	90
Metrology of Ionizing Radiation	6.0	60
Nuclear Reactors Materials	3.0	45

3.2. Technical University of Sofia

Tables 5 and 6 illustrate the main nuclear-related courses in the BS and MS curricula in the Technical University of Sofia.

Table 5. Nuclear-related courses in the BE “Thermal and Nuclear Power Engineering”

BS Curriculum in Thermal and Nuclear Power Engineering Nuclear-related courses	ECTS	Total academic hours
Nuclear Technology	5.0	53
Nuclear Power Reactors	6.0	68
Technological Installations in Thermal and Nuclear Power Plants	5.0	53
Thermal and Nuclear Power Plants	6.0	68
Radiation Protection	4.0	45
Process Control in TPP and NPP	6.0	68
Water Conditioning in TPP and NPP	6.0	53
TPP and NPP design	4.0	30
Electrical Installations in TPP and NPP	4.0	60
Nuclear Safety	5.0	75

Table 6. Main required courses in the ME “Nuclear Power Engineering”

MS Curriculum in Nuclear Engineering Required courses	ECTS	Total academic hours
Heat Transfer in NPP	6.0	60
Nuclear Fuels and Materials in Nuclear Reactors	6.0	60
Fluid Mechanics in NPP	4.0	53
Neutron-Physical Processes in NPP	6.0	60
Nuclear Reactors Design	3.0	30
Reliability and Risk Analysis in NPP	6.0	60
Design, Operation and Decommissioning of NPP	6.0	60
Regulatory Control in Nuclear Energy	5.0	53
Simulation Modeling in NPP	4.0	60

4. PERSPECTIVE

The university education in Nuclear Science and Engineering in Bulgaria has accumulated a fairly long historical record and has achieved a satisfactory level of quality. The graduates in these fields find good professional acceptance both within the country and abroad. Nevertheless, the future of the related university programmes will continue to be strongly dependent on the commitment of both the nuclear industry and the government to the preservation of nuclear knowledge. The international support to nuclear-related university programmes in Bulgaria is also of vital importance.

