# NUCLEAR EDUCATION AND TRAINING IN LITHUANIA IN THE CONTEXT OF EU ACCESSION

S. Ziedelis, J. Gylys
Kaunas University of Technology (KTU), Lithuania

V. Gediminskas
Ignalina NPP, Lithuania

D. Brandisauskas
State Nuclear Power Safety Inspectorate (VATESI), Lithuania

*Email address of main author:* Stanislovas.Ziedelis@ktu.lt

Abstract. During accession and integration of Lithuania into the EU new problems have arisen in the energy, economical, ecological, social, and educational sectors. Some of them are caused by planned premature closure of Ignalina NPP. The existing national system of education and training of highly qualified specialists for the nuclear industry as well as the process of its reorganisation to meet forthcoming challenges, are analyzed in the paper. It is shown that the essential condition for preventing complete destruction of Lithuania's nuclear engineering education, training and research system, and for future maintenance and development of nuclear knowledge in Lithuania, is the survival of Lithuania as a nuclear state.

## INTRODUCTION

Lithuania is a relatively small country with the population of 3.5 million, disproportionately powerful energy industry and low energy consumption. Installed electricity generating capacities are more than 6 GW, but total power demand is less than 2 GW. Lithuania with average electricity consumption of about 2900 kWh per person occupies one of the last places in Europe. It is not a secret that we can't boast of high living standards of population: the gross domestic product per capita in 2003 was only 4673 euros. However, rate of growth of the gross domestic product is very high: in 2003 it was 9.4 % per year.

Ignalina NPP with its two RBMK-1500 type reactors is the main source of electric energy in Lithuania: it covers 60 - 86% of total electricity production. Nuclear energy in Lithuania has relatively short history: at the end of 2003 the 20$^{th}$ anniversary of commissioning of 1$^{st}$ unit of Ignalina NPP was commemorated. During this period, both reactors produced more than 200 billion kWh of electrical energy, which is the cheapest in Lithuania. Nowadays both Lithuanian and foreign experts agree that the safety level of Ignalina NPP is very similar to the western type NPP's of the same age. Among other factors, the safe, reliable and successful operation of Ignalina NPP during these 20 years was conditioned by well-organized system of personnel training and education.

During accession process, one of the main EU requirements to energy sector of Lithuania was to close both reactors of Ignalina NPP, which were decided to be unsafe in principle. This decision and subsequent requirement of EU authorities has not changed despite all explanations made by Lithuanian and foreign specialists about differences between Ignalina and Chernobyl reactors, numerous safety improvement measures implemented, positive results of safety studies and assessments. Negative economic and social consequences to population of Lithuania were also not taken into account. The accession negotiations were finished in 2003, and Lithuanian parliament approved a new version of the National Energy Strategy, in which the shutdown of the 1$^{st}$ reactor of INPP is foreseen at the end of 2004 and shutdown of the 2$^{nd}$ reactor is foreseen at the end of 2009.

This unadvised and questionable political decision may have crucial impact on all nuclear knowledge system of Lithuania in the future, but its first consequences are already observable. Recent discussions about feasibility of Lithuania remaining a nuclear energy state and building a new nuclear power plant with safe, modern reactors instead of the RBMK reactors have raised some hopes for the future. However, neither final decision nor even clearly defined opinion of Lithuanian government concerning this problem has not yet been formulated.

## 2 STRUCTURE OF NUCLEAR KNOWLEDGE SYSTEM

The structure of Lithuanian nuclear knowledge system is not complicated (*FIG.1*). Its only peculiarity is small number of organisations, participating in various activities in nuclear area. This peculiarity determines limited human resources, insular market of jobs and specialists, and big expenses for preparation of qualified specialists.

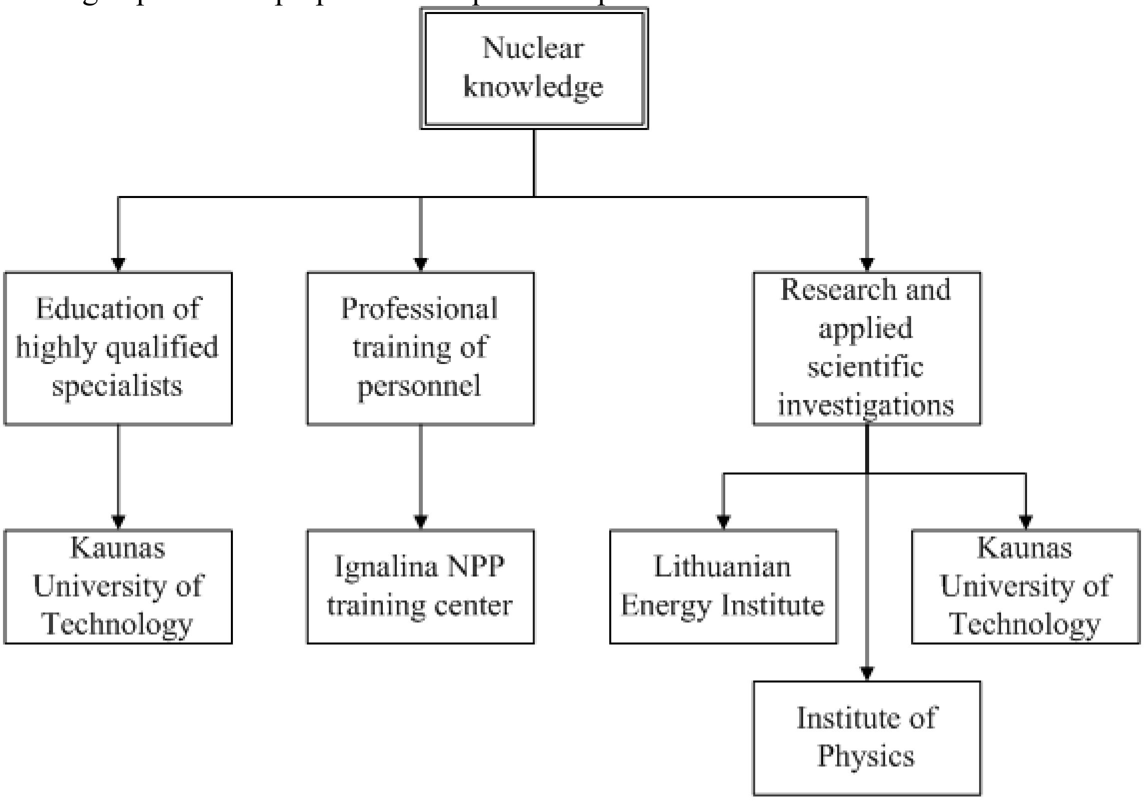



*FIG. 1 Main activities and organisations, participating in nuclear knowledge development in Lithuania*

## *3 EDUCATIONAL SYSTEM IN NUCLEAR ENGINEERING*

### 3.0. Period up to 1991

During this period Lithuania was a part of former Soviet Union, and all main planning decisions for economy, industry and education were being made not in Lithuania. Education of engineers for Ignalina nuclear power plant and for Lithuanian nuclear energy infrastructure as well was begun at Kaunas University of Technology (Department of Thermal and Nuclear Energy) in 1978. Professors, lecturers and teachers of KTU had very little experience in nuclear at that time and for that reason we had to ask for help from our colleagues in other universities and nuclear power plants of the former Soviet Union. The main support in preparation of our teachers came from the Moscow Energy Institute (Department of Nuclear Power Plants, Department of Heat Transfer Processes and others). The Kursk NPP, Chernobyl NPP, Kola NPP were ready to take our students for the four-eight weeks practice after graduating the third and the fourth courses.

Nuclear study programs and curriculum were the same as at the other higher schools of the former Soviet Union. Unlike other specialities in Lithuanian universities, our students were forced to use only Russian textbooks and manuals, as there was practically no nuclear literature in Lithuanian or other foreign languages in this period. During the years 1980-1986 56 nuclear energy engineers were prepared (*FIG. 2*). Unfortunately, due to some political and other reasons only a few of them are working at Ignalina NPP at present. In 1986, just after the Chernobyl NPP accident, the training of nuclear energy specialists at KTU was suspended.

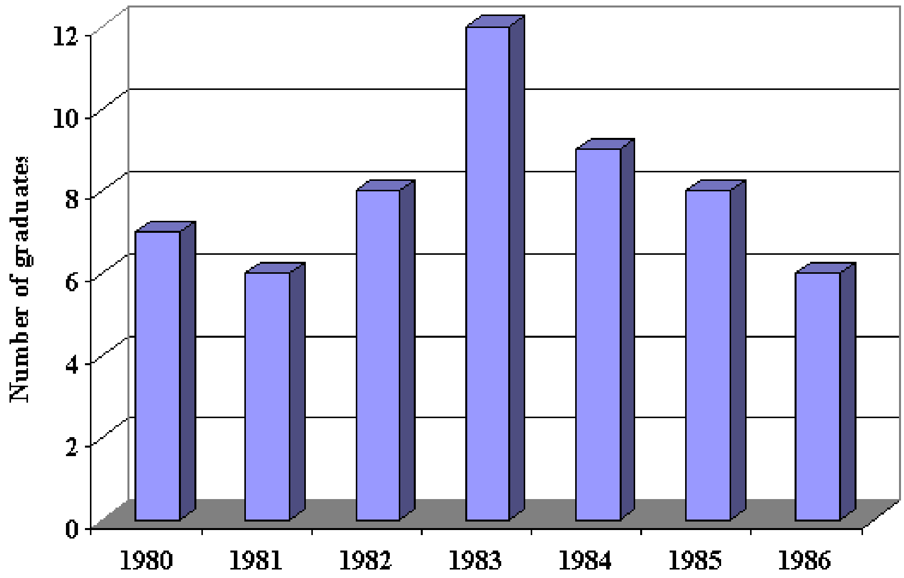



*FIG. 2. Number of nuclear energy engineers, prepared at Kaunas University of Technology in period 1978-1986*

3.1. Period 1991 – 2004

In 1991, when Lithuania became an independent state, Government of Republic of Lithuania passed resolutions, in which Kaunas University of Technology was obliged to renew the preparation of nuclear energy specialists. Since then, system of studies in nuclear engineering has been substantially modified and modernised, in order to implement the best practice of highly developed western countries.

At present, the system of studies at KTU has four levels (*FIG. 3*): Bachelor (undergraduate studies), Diploma engineer (professional studies), Master (graduate studies), and PhD (post-graduate studies). Duration of studies depends on chosen level and can continue from 4 to 10 years. The first two years of undergraduate studies provide background courses in science, social studies or humanities appropriate to the studies undertaken. During the second two years of study, in addition to compulsory courses, optional study modules are introduced, enabling students to strengthen their knowledge in the area they have selected. Undergraduate studies lead to Bachelor of Science degree (B. Sc.). The Master of Science degree (M. Sc.) is conferred on those with B. Sc. or other higher educational qualification after a minimum of a further two years of study. Proficiency in carrying out independent research must be demonstrated in the theses presented. The Master of Engineering degree (formerly it was Diploma engineer qualification) is conferred after 1.5 years of study, emphasizing professional qualification. The Doctor of Science degree, which corresponds to a PhD or a somewhat higher degree elsewhere, takes a further four years to acquire and is only awarded to those whose research provides a significant and original contribution in the selected field of science.

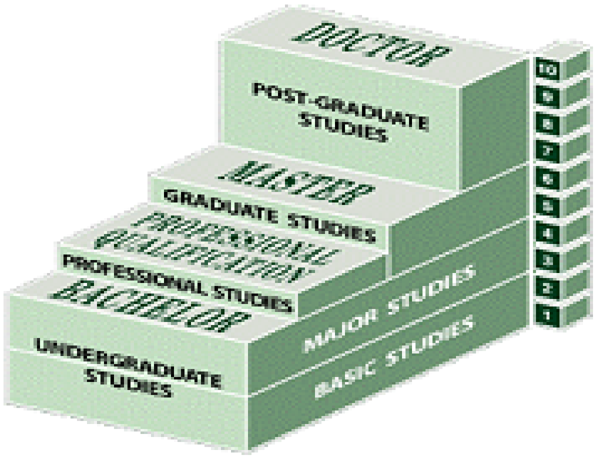



*FIG. 3. Structure of study system at Kaunas University of Technology*

The program of study for Bachelor of Nuclear energy science includes 174 credits (*FIG. 4*), which are divided between: obligatory courses (92 credits), common alternative courses (42 credits), specialized alternative courses (32 credits) and freely chosen courses (8 credits). Obligatory modules include Computer science, Mathematics, Physics, Chemistry, Languages, Mechanics and so on. All those modules are necessary for almost all study programs of the University. At the same time the common alternative modules are used mainly for the Thermal engineering study program. This part of program consists of Fluid mechanics, Thermodynamics, Heat and mass transfer, Thermal engines, Environmental protection and other modules. Specialized alternative courses belong to Nuclear energy alternative only. These are: Nuclear and neutron physics, Nuclear materials, Theory of nuclear reactors, Nuclear reactor design, Nuclear power plants, Nuclear fuel, Dosimetry and ionized radiation protection and many others.

3.2. Support and collaboration

Preparation of highly qualified nuclear energy specialists in Lithuania would be much more difficult without the substantial support of foreign countries. Sweden, Finland, Germany, Russia, France, USA, Japan, UK and others allow for our students to become familiar with different stages of nuclear fuel cycle, including processing of fuel elements, nuclear power plant operation, spent fuel and radioactive waste management and laboratory works in nuclear research centres. Those countries help in modernization of curricula and preparation of new study programs as well. E.g., Swedish International Projects provided considerable financial support in publishing the first original Lithuanian textbooks: “Introduction to Nuclear Engineering”, “Nuclear Fuel Cycle”, “Materials of Nuclear Energy Systems” and others. Training of teachers is also a very important issue. Stockholm Royal Institute and Studsvik Research Centre in Sweden, Helsinki Technological University in Finland, Argonne National Laboratory in USA, IPSN and Cadarache Nuclear Research Centre in France, GRS in Germany, JAPIC in Japan, KAERI in South Korea and many other institutions have invited staff of the Department of Thermal and Nuclear Energy to participate in different training courses, seminars and workshops.

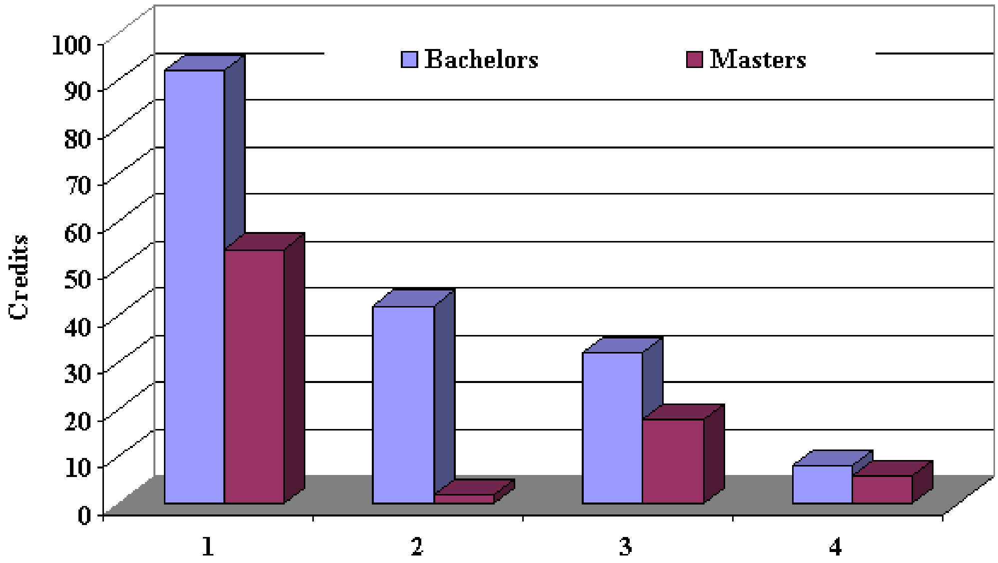



*FIG. 4. Structure of Bachelor's and Master's study programs: 1 - obligatory courses; 2 - common alternative courses; 3 - specialised alternative courses; 4 - freely chosen courses*

Internal collaboration between Lithuanian organizations is also very useful for preparation of nuclear energy specialists. Ministry of Economy, Lithuanian Energy Institute, Institute of Physics, and State Nuclear Power Safety Inspectorate have supported KTU by providing highly qualified lecturers, laboratory equipment, and financial investments.

The most important collaboration partner of KTU is Ignalina NPP, which has a direct interest in quality of nuclear energy specialists. For that reason a tripartite agreement is signed between Ignalina NPP, KTU, and each student in the third year of nuclear engineering education. Power plant is under contract to pay scholarship to students with sufficient average marks and to accept them for work in the plant after graduation. Kaunas University of Technology obliges itself to prepare highly qualified nuclear energy specialists for the Ignalina NPP needs. Students oblige themselves to study hard and to work at Ignalina NPP for at least five years after they graduate.

To ensure relevant qualification of young specialists, governing bodies of Ignalina NPP and VATESI raised a strict additional condition for KTU. Only the KTU graduates who after basic education at KTU receive further education at Obninsk Institute of Atomic Energy (OIAE) in Russia will be hired to work in technological service of Ignalina NPP. This condition was raised because highly qualified specialists (professors and experienced professionals) in RBMK type reactor are working at OIAE, and their knowledge is very useful for our graduates. To fulfil this requirement, another tripartite agreement on nuclear energy specialists' preparation was signed between Ignalina NPP, Kaunas University of Technology and Obninsk Institute of Atomic Energy in 1994. According to this agreement, all three parties are committed to collaborate in education process of qualified specialists for Lithuanian nuclear energy infrastructure. The agreement has to be renewed and extended every five years. At present this scheme of teaching students in nuclear energy specialization has changed a little. Between 50 and 70 percent of KTU graduates are usually sent to Obninsk, and the rest of them stay at KTU to continue their education in Masters studies and sometimes in PhD studies.

### 3.3. Current realities and forthcoming challenges

61 Bachelor and 51 Master or Diploma engineer of Nuclear energy sciences were prepared at KTU in the period from 1995 to 2004 (*FIG.5*). During the last few years the number of applicants and graduates has been gradually decreasing. This trend is particularly clear from

dynamics of popularity of nuclear engineering studies (*FIG. 6*). The main reasons for such crucial changes in popularity can be explained taking into account the public opinion, formed by mass media, and the bills passed by Lithuanian government.

Due to the Chernobyl NPP accident syndrome it was initially quite difficult to persuade young graduates of secondary schools to choose the Nuclear energy profession. Public opinion was strictly against nuclear energy in Lithuania. However, with time the predisposition has changed and the numbers of students choosing the nuclear engineering study program started growing. In 1998-2000 more than 10 applicants competed for one place. Popularity of nuclear engineering sciences dropped sharply (*FIG.6*) after the decision to shut down the first unit until 2005 and second unit until 2010. It is unlikely that many students would want to see a nuclear power plant in process of decommissioning as their future workplace.

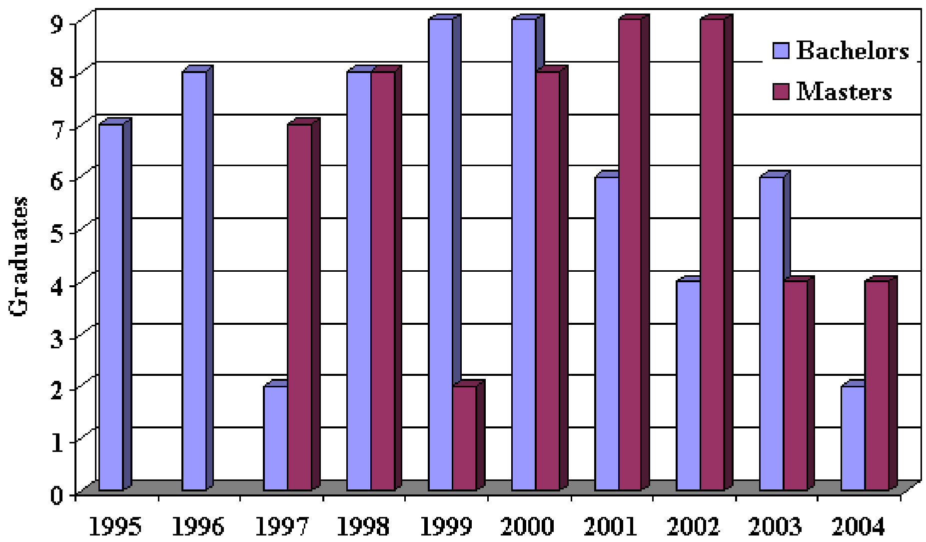



*FIG. 5. Numbers of prepared Bachelors and Masters of nuclear engineering*

Admitting students for nuclear engineering studies is becoming a very important and very difficult problem. On the one hand, the situation at Ignalina NPP requires continuing preparation of specialists for operational needs and for reserve also, because part of plant's staff is searching for new jobs in other plants (mainly in Russia) or is about to retire. Nobody wants to close the power plant before the set time due to lack of qualified personnel. On the other hand, it is quite difficult to persuade young people to study nuclear engineering in order to work at the power plant, which has to be shut down very soon.

KTU is trying to adapt its study system to new circumstances. First of all, our curricula and nuclear engineering study program are being modified so that the main task of education would be the preparation of specialists for plant decommissioning needs instead of its operation. New study modules, e.g. Decommissioning of NPP's, Spent fuel and Radioactive waste management, Equipment aging and others are already implemented or are under preparation. Numerous measures of professional orientation and propagation of nuclear sciences are also undertaken.

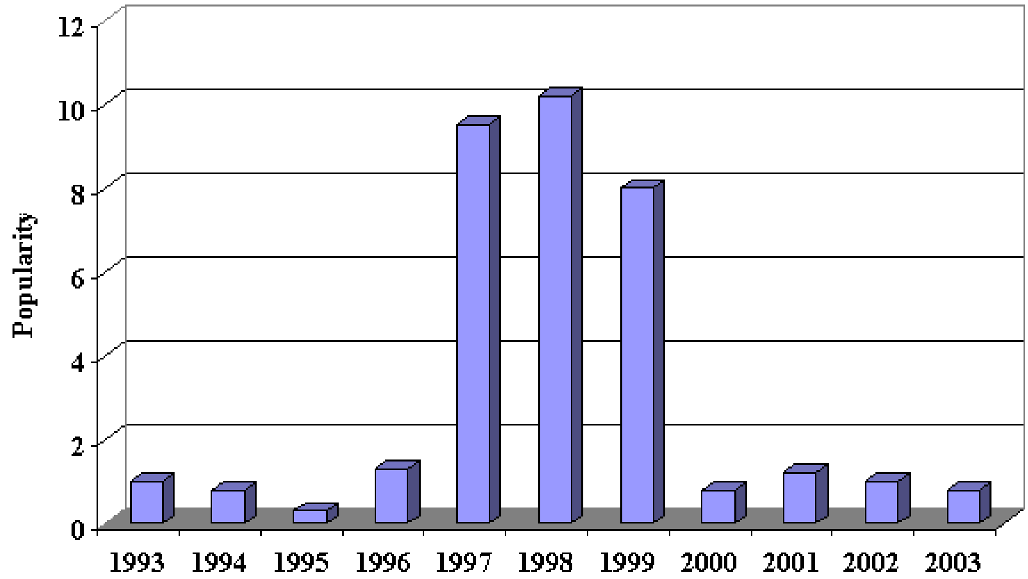



*FIG. 6. Dynamics of popularity of nuclear engineering studies. Popularity = number of applicants/number of places*

## 4 PROFESSIONAL TRAINING AT IGNALINA NPP

Ignalina NPP as operating organization determines system of preparation of the personnel in order to ensure safe and reliable exploitation of nuclear object. The system of preparation of the personnel provides knowledge, practical skills and the responsible attitude to work, which are necessary for realization of duties and the functions determined for each worker by the duty regulations. The system must guarantee, that Ignalina NPP is maintained by sufficient number of qualified employees.

The majority of activities related to professional training of INPP personnel are organized at the Training centre, which is an independent structural department of the plant. It is responsible for organization and performance of initial, continuous and refresher training, certification and licensing of plant's staff and newcomers. The Training centre of INPP is well equipped with modern technical training aids and appliances, including full-scale simulator (FSS) – one of the most advanced models for NPPs with RBMK type reactors. Highly qualified instructors, prepared using support of IAEA experts, staff the Training centre.

The training system of INPP is based on the principle of systematic approach to training. The core of training system is in the following sequence of well coordinated and planned activities: selection of candidates – initial check of knowledge – initial individual theoretical and practical training – certification for the position – working in double – additional specific training – authorization for independent work – continuous in-service or refresher training – periodic certification. An example of typical flowchart of this process is presented in *FIG.7*.

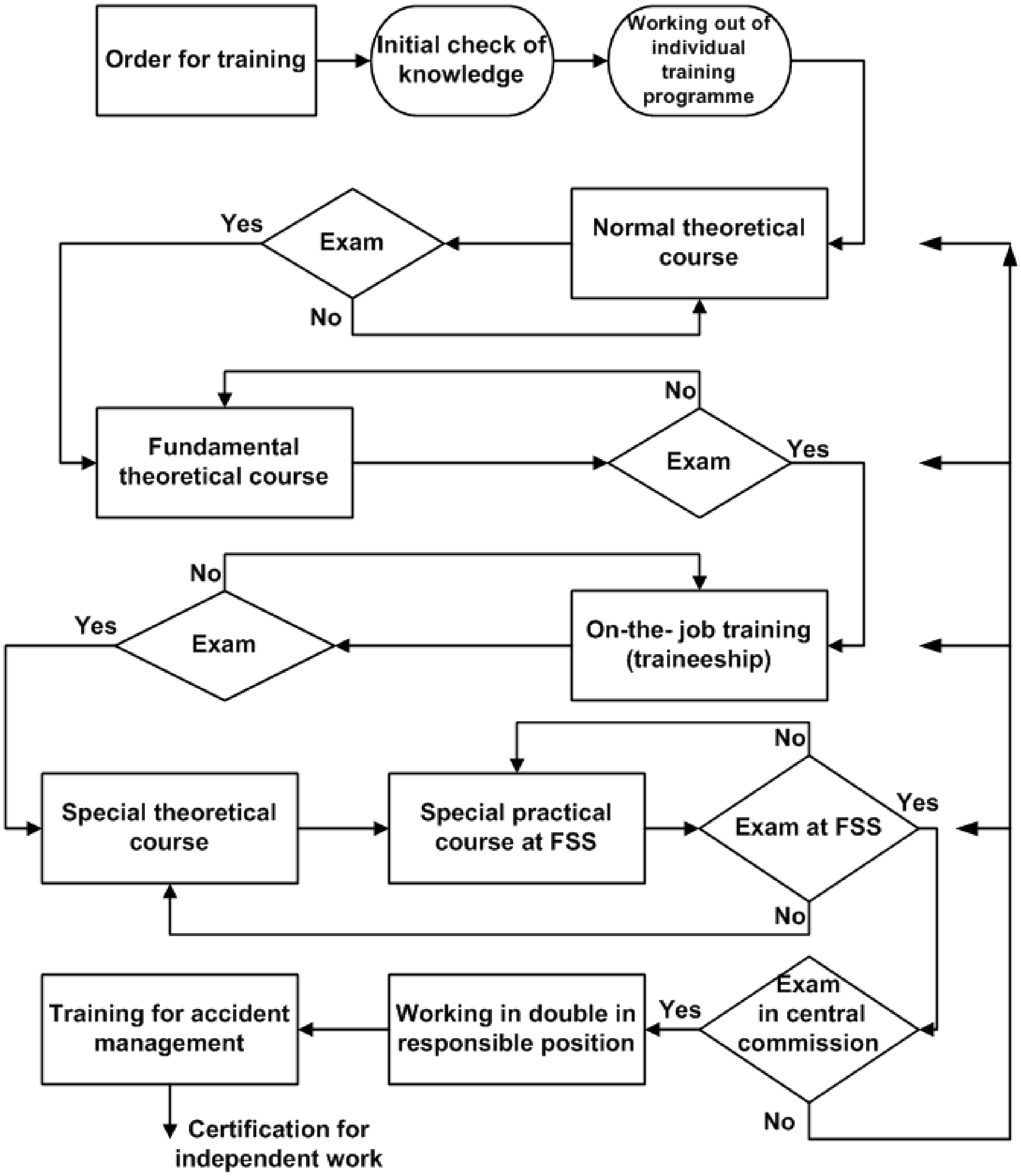
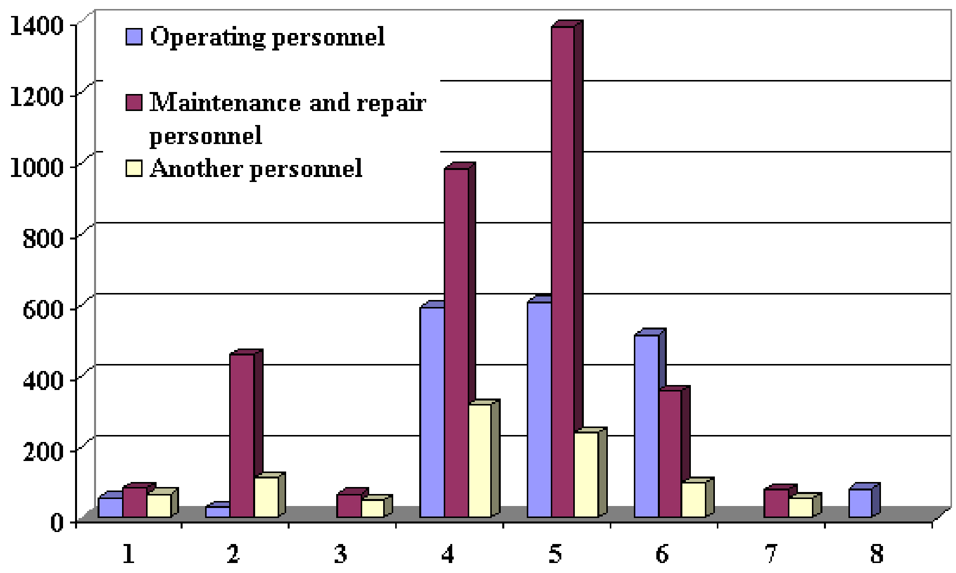



*FIG. 7. Simplified flowchart of senior reactor operator preparation process*

Training of newcomers or candidates to the new position starts after issuing appropriate order by technical director of INPP. The first step of training process is initial check of knowledge. On the basis of check results an individual training program is conducted for each trainee, and all following training process is organized according to this program.

The first block of disciplines is normal theoretical course. It covers such disciplines as industrial safety, radiation safety and protection, fire protection, basics of organization and nuclear regulation. The second block – fundamental theoretical course – includes fundamentals of nuclear physics for RBMK type reactors, equipment and systems of reactor department, equipment and systems of instrumentation and control department. The next stage of training process is on-the-job training and traineeship in the appropriate departments of INPP. At the end of each course trainee must pass examination or testing. After successful passing of on-the-job training, future specialist begins to study special theoretical and practical course using full-scale simulator. The main topics of this block for reactor operators are related to management of reactor in the conditions of normal, abnormal and emergency operation. After finishing this course and full set of practical exercises, the test using the full-scale simulator is organized, and in the case of success, trainee is directed to the final examination in central examination commission. If commission evaluation of gained knowledge is positive, the specialist, after working in double, additional training for accident management and fire drill exercises, is certified for independent work. In the case of negative evaluation, trainee must repeat the course or topics, in which his knowledge is insufficient. For maintaining and further improvement of qualification of each employee, training process is extended by means of continuous in-service or refresher training. Qualification of personnel is periodically certified: for operational personnel - every two years, for other personnel – every three years.

As an example, the results of INPP personnel training in 2003 are presented in *FIG. 8*. They show, that the majority of INPP personnel raised their qualification in radiation protection, fire protection and in works with potentially dangerous equipment. Numbers of trainees in other courses, such as initial training, maintaining qualification, and training in safety culture, were not so big. In general, numerous missions of western and Lithuanian experts have agreed with the conclusion that the training system implemented in INPP is sufficiently effective and complies with all requirements of Lithuanian and international normative documents. The same evaluation of INPP training system was achieved during the preparation and review of safety analysis report for 1st and 2nd Units of INPP **Error! Reference source not found.**.




8. *Training of Ignalina NPP personnel in 2003. On the vertical axis are shown numbers of trainees, who passed: 1-initial training (for new position or for reserve); 2-improvement of qualification; 3-maintaining qualification; 4-radiation protection training; 5-fire protection training; 6- training for works with potentially dangerous equipment; 7- training in safety culture; 8-training at the full-scale simulator*

Despite the success of recent years, both INPP and its training system have also met new problems related to forthcoming closure. Since perspectives of further development of Lithuanian nuclear energy sector are unclear, nuclear specialists already working in this sector don't see their future in nuclear. Due to closure of the 1st unit in 2005, about 500 employees will be transferred to other duties in the 2nd unit or fired. The leakage of specialists to other

NPPs or business areas is already observable. The nuclear workforce is ageing, retiring and one can observe the signs that it becomes more complicated to replace it with appropriately qualified younger personnel.

Since time of closure of the 1st unit is approaching, wide programme of measures to prepare for this event is being implemented at Ignalina NPP. The most important of them are targeted for preparation of specialists for decommissioning and changing qualifications of employees, transferred from the 1st unit to the 2nd unit. The administration of INPP understands the importance of preserving technical competence, experience and knowledge of specialists who have been operating the reactor since its commissioning, and is trying to retain them. However, it is obvious that these measures will be temporary and not very effective, if the 2nd unit is shut down in 2009 and no real plans for building new nuclear plant or reactor are approved.

## 5 Conclusions

(1) Lithuania has established effective and successfully working national system of education and training of highly qualified specialists of nuclear engineering.

(2) Political decision to close both reactors of Ignalina NPP at the end of 2009 has had a negative impact on nuclear knowledge system of Lithuania. Popularity of nuclear engineering sciences and numbers of students studying these sciences are decreasing, and lack of motivation to work in the nuclear energy sector is observable. Current trends lead to gradual degradation of nuclear knowledge system of Lithuania.

(3) Preventive measures being implemented and reorganization of existing system of nuclear education and training can slow down process of degradation, but they cannot change current trends.

(4) Nuclear education and training system of Lithuania can survive, be strengthened and modernized, if Lithuania remains a nuclear state. This way is feasible if real plans to build new nuclear plant or reactor are approved by Lithuanian government in the near future.

## REFERENCES

[1] GYLYS J., Ziedelis S., Adomavicius A. New Challenges in Energy Future of Lithuania. Proceedings of the 5th International Conference on Nuclear Option in Countries with Small and Medium Electricity Grids. Dubrovnik, Croatia, May 16-20, 2004, p. 9.

[2] REVIEW OF SAFETY ANALYSIS REPORT OF IGNALINA NPP unit 2. Summary. Kaunas, 2004, 68 pp.

[3] NUCLEAR ENERGY IN LITHUANIA: Nuclear Safety. Annual Report – 2002.- State Nuclear Power Safety Inspectorate (VATESI), Vilnius, 2003, 48 pp.

[4] LITHUANIAN NATIONAL ENERGY STRATEGY. Lithuanian Energy Institute, 2003, 44 pp.

[5] KAUNAS UNIVERSITY OF TECHNOLOGY. Course offerings 2002-2003.- 2002, 322 pp.