

The role of Lithuanian TSO in view of changing nuclear situation in Lithuania

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Abstract. At present, the Technical and scientific Support Organisations (TSOs) are gaining increased importance by providing the technical and scientific basis for decisions and activities regarding nuclear and radiation safety. In Lithuania, after Lithuania declared its independence, the technical support organisations in Lithuania grows and develops into institution, capable to perform all necessary safety analyses for Ignalina NPP. However, the preparation for the construction of new nuclear power plant showed that Lithuania lacks the nuclear energy specialists. This paper presents information about the creation and growing up of Lithuanian TSOs, the works performed at present days and the needs for nearest future.

1. Introduction

Ignalina NPP is the only nuclear power plant in Lithuania consisting of two units, commissioned in 1983 and 1987. Both units are equipped with channel-type graphite-moderated boiling water reactors RBMK-1500. Since 1984 Ignalina NPP produced up to 82% of electric energy for Lithuania. Unit 1 of Ignalina NPP was shutdown for decommissioning at the end of 2004 and Unit 2 – at the end of 2009. Before of shutdown of Unit 2, in June 2007, Lithuanian Parliament endorsed a decree about construction of a new NPP in Lithuania in cooperation with Latvia, Estonia and Poland.

After 1990 Lithuania declared its independence, Ignalina NPP with two largest in the world RBMK-1500 reactors came under authority of the Lithuania Republic. The primary national institution, responsible for the regulation of nuclear energy, VATESI was established by Government resolution in October 1991. VATESI approves nuclear safety rules and guides, issues licences for the activities related to nuclear safety and controls adherence to the requirements set out in licences and safety rules. At the same time the creation of Lithuanian TSOs starts. In March 1992 at the Lithuanian Energy Institute in Kaunas the Ignalina Safety Analysis Group (ISAG) was established. The goals of ISAG were to gain a thorough understanding of the basic processes of RBMK-1500 reactors; to gather and analyze design and operational data; to record and rank safety issues at Ignalina; to analyze the consequences of simulated accidents at the plant; and to provide professional technical and scientific consultation to the VATESI, the government and the international community. Later this group overgrows into Laboratory of Nuclear Installation Safety. The other organizations also took income into creation of TSOs - Kaunas University of Technology (KTU), Vytautas Magnus University, Faculty of Physics of Vilnius University (VU) and the Institute of Physics (IP).

2. Technical support, provided by Lithuanian TSOs during Ignalina NPP operation in 1994 – 2009

The first Safety Justification of Ignalina NPP has been prepared by Russian experts of Research and Design Institute for Power Engineering (RDIPE), organization - designer and developer of RBMK

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reactors, after Chernobyl NPP accident. In this document the analysis of all design basis accidents was performed using at that time existing tool – quasistationary derivative approximation method, being based on conservative assumptions and existing experimental data. Therefore, after 1990 Lithuania declared its independence there were reasonable doubts how such safety justification of Ignalina NPP, presented in the first safety justification, corresponded to the real situation. In 1994 Lithuania signed the agreement with the European Bank for Reconstruction and Development (EBRD) Account of Nuclear Safety. According this Account, in 1995 – 1996 was prepared In-depth Ignalina NPP Unit 1 Safety Analysis Report, using USA and Western Europe methodology and computer codes. This study has been performed by specialists from the Ignalina NPP, Russia (RDIPE), Canada and Sweden. The created group of Lithuanian TSO (ISAG) has been participated in preparation of independent Review of the Ignalina Nuclear Power Plant Safety Analysis Report. This Review was performed in parallel with the Ignalina NPP Unit 1 safety analysis report (in 1995–1997) together by the experts from USA, Great Britain, France, Germany, Italy and Russia. Such first very significant international project was the good school for the young Lithuanian TSO.

Based on the findings, developed in the Ignalina Nuclear Power Plant Safety Analysis Report and independent Review, the few significant modifications were recommended. At first it is necessary to mentioned the new algorithms for reactor shutdown and activation of Emergency Core Cooling System in the case of low flow through group of fuel channels, connected to single Group Distribution Header and on pressure decrease rate in drum separators. These modifications protected the reactor from flow stagnation and overheating in the group of fuel channels. Safety justifications of these modifications have been performed in Lithuanian Energy Institute (LEI). The modifications of activation algorithms for reactor shutdown and emergency core cooling systems activation were installed in power plant unit 1 in 1999, and unit 2 – 2000 m. It was shown in the prepared In-depth Ignalina NPP Unit 1 Safety Analysis Report that in some anticipated transients without shutdown cases the consequences can be dramatic enough. Therefore the priority recommendation has been formulated: to implement the second, based on other principles of operation, diverse shutdown system for reactors of Ignalina NPP. However development, designing and implementation of such system needed few years, so the compensating means, which were used in transition period while second diverse shutdown system was developed, has been implemented. This temporary system was called according Russian abbreviation „DAZ“ („Dopolnitelnaja avarijnaja zaštita“ – „Additional emergency protection“). This system used the same control rods as well as design reactor shutdown system, however signals for this system control were generated independently in respect of design reactor shutdown system. In Lithuanian Energy Institute for DAZ system has been selected not only set points of activation, but also the safety justification was performed. In Unit 1 DAZ system was installed in 1999, in Unit 2 – in 2000. The Second Diverse Shutdown System (DSS) has been designed and installed in Ignalina NPP Unit 2 in 2004. In the first unit of Ignalina NPP this system has not been installed because reactor has been shutdown in 2004. Specialists from LEI together with experts from the countries of the Western Europe checked and have assessed the design documentation, carried out independent calculations, thus helping Lithuanian regulatory body (VATESI) to make the appropriating decisions concerning implementation of mentioned system at Ignalina NPP.

On 2002 the safety analysis report for Ignalina NPP Unit 2 has been developed. This report contains the description of systems, list of postulated accidents, engineering assessment of reactor cooling system, accident analysis, assessment of fuel channels structural integrity, assessment of reactor safety acceptability and other chapters. The accident analysis in this report was performed using best-estimate approach with uncertainty and sensitivity analysis. According the international practice the best-estimate approach is used mainly for analysis of loss of coolant accidents in reactor cooling system. In Lithuania the best estimate approach was successfully applied not only for loss of coolant accidents but also for reactor transients and accident confinement system response analyses. The uncertainty and sensitivity analysis allows to avoid the unnecessary conservatisms, assess and address the existing safety margins. The safety analysis report and its review were the main documents, required for license for Ignalina NPP Unit 2. LEI performed the accident analysis part in this report. The other Lithuanian TSOs (KTU, IP) performed the independent review of such report.

In parallel to deterministic analyses Lithuanian TSOs performed the Probabilistic Safety Assessment (PSA). The Ignalina NPP first level PSA “BARSELINA” project was initiated in 1991. It was first PSA for nuclear power plants with RBMK type reactors. From the beginning this project was carried out by nuclear energy experts from Lithuanian, Russian and Swedish institutions, and since 1995 it was carried out by efforts of experts from Lithuania (Ignalina NPP, LEI) and Sweden. The performed PSA 1 level analysis has shown that in Ignalina NPP probability of core damage is about $6 \cdot 10^{-6}$. Thus, Ignalina NPP fulfilled the requirements for new NPPs, which are in process of construction.

The performed by LEI and Ignalina NPP specialists PSA studies demonstrated, that the risk of core damage most of all increases transients with loss of long-term core cooling. It is the positive fact meaning that up to consequences of severe accidents there is enough time. Based on these findings, the procedures and means on severe accident management were developed by international team from England, United States of America and Lithuania. LEI bring the significant contribution in development of Severe Accident Management Guidelines for the Unit 2 of Ignalina NPP. These guidelines were implemented two years before final shutdown of plant. The works do not stop even on forthcoming final shutdown of the plant – just before the shutdown, the Severe Accident Management Guidelines were harmonised with the Symptom-Oriented Emergency Operating Procedures at Ignalina NPP. This work, performed by LEI, allowed to provide safe elimination of accident consequences in all range of accidents.

3. Activities of Lithuanian TSOs at present

It was presented in the section below, that after Lithuania declared its independence, the technical support organisations in Lithuania grows and develops into institution, capable to perform all necessary safety analyses for Ignalina NPP. At present Lithuanian TSOs provided the supports to the Lithuanian State nuclear power safety inspectorate (VATESI) in the form of consultations, design, research, expertise and other works requiring high scientific-technical qualification, competence, special knowledge and skills. To achieve the most efficient use of the scientific-technical potential in solving the problems of nuclear safety, the Coordination Council of VATESI Technical Support Organisations was established, which coordinates the TSO expertise assistance to VATESI, promotes the development of nuclear energy research-industrial infrastructure, upbringing of scientific technical potential in the country and training of nuclear energy specialists.

In the last years the Lithuanian State nuclear power safety inspectorate continued cooperation with the Institute of Physics; the Laboratory of Nuclear Engineering Problems, the Nuclear Installations Safety Laboratory, the Laboratory of Research and Testing of Materials of the Lithuanian Energy Institute; the Department of Thermal and Nuclear Energy, the Institute of Energy Technologies of Kaunas University of Technology; the Laboratory of Nuclear Hydrophysics, the Materials Strength Department, the Laboratory of Numerical Simulation and the Research Institute of Welding and Materials Science of Vilnius Gediminas Technical University; the State Institute of Information Technologies; UAB ITECHA, Research Centre of Electromagnetic Compatibility and other organisations. The main performed works are in the areas of preparation of working design for decontamination and dismantling of equipment of Ignalina NPP, assessment of environmental impact and safety of interim storage facilities for spent nuclear fuel under construction and radioactive waste processing and storage facilities as well as the Landfill type repository for low and very low activity radioactive waste.

It is necessary to note the participation of Lithuanian TSOs in the international projects. For example, the LEI scientists active participated in the SARNET network of excellence within the framework of the EU FP6-FP7, aimed at integrating research on severe accident phenomenology and management in Europe, in the EU 7FP project SECURE program, the objective of which is to develop the methodology for the assessment of energy security with regard to various problems of security of energy supply and geopolitical changes, in the NULIFE network of excellence, intended for developing the methodology for managing the lifetime of nuclear installations, in one of the biggest international research programs PFEBUS FP intended for safety of water-cooled nuclear reactors and research in severe accidents, in the Ageing Probabilistic Safety Analysis (APSA) study Use of

Probabilistic Safety Assessment (PSA) for Evaluation of Ageing Effects to the Safety of Energy Installations, coordinated by the Energy Centre of the EC Joint Research Centre, in activity of European network for equipment operational control and qualification ENIQ as well as in the new promising thermonuclear energy program FUSION that is the focus of great interest. Also, it should be noted that the LEI scientists continued research in the IRIS project for development of a new-generation nuclear reactors that are important in proceeding with the study for the construction of a new reactor in Lithuania.

4. Needs of Technical Support Organizations in Lithuania in nearest future

The preparation for the construction of new nuclear power plant showed that Lithuania lacks the nuclear energy specialists, and other energy-related professions. During the development of the new Visaginas nuclear power plant project, the need for qualified personnel will only increase. It is estimated that during the construction of the Nuclear Power Plant (NPP), in the most intense period of work, approximately 5000 specialists of different fields - mostly constructors - will be working at the site of the new NPP. As of anticipatory projections, approximately 700 specialists will be needed for preparation and performance of the construction of the power plant, installation, adjustment and other works. Up to 900 additional employees will be needed for operation of the completed power plant.

The Nuclear power law was adopted by the Parliament of Lithuanian Republic in 2007. The main purpose of this law and the objective is to establish a new NPP in the implementation of the project, consisting of legal, financial and organizational preconditions for a new NPP project. Following this law, the national energy-training program should be prepared. The preparation and implementation of such program should be a priority for the Government of Lithuanian Republic. In order to provide the Lithuanian energy infrastructure of highly skilled nuclear specialists, the Lithuanian Parliament and government launched the National Programme for preparation of highly skilled specialists in the nuclear energy field in 2008 – 2015. Objectives of this program are: to provide quality and effective high level of nuclear energy specialists in Visaginas NPP and the entire nuclear infrastructure, and conservation, efficient use and further development of nuclear knowledge, experience and practical, pedagogical and scientific expertise.

From the Lithuanian State nuclear power safety inspectorate side, the primary goals which have to be accomplished in getting ready for the construction of the new nuclear power plant, is to uphold competence and to acquire knowledge in nuclear safety that would comply with the most advanced international practice. In pursuing this goal, by VATESI initiative and in cooperation with the IAEA, in autumn of 2008 and 2009 the regional professional training courses in nuclear safety were arranged in Lithuania. Lithuanian Energy Institute was the host organisation and the main local organizer of these courses. The halves of lectures in these courses were from Lithuanian organisations (KTU, LEI, IP and Ignalina NPP). At present LEI joined to the European TSO Network (ETSON). All these mentioned activities will allowed to Lithuanian TSO to be ready for the construction of the new nuclear power plant.

5. Conclusions

- After Lithuania declared its independence, the technical support organisations in Lithuania grows and develops into institution, capable to perform all necessary safety analyses for Ignalina NPP.
- The preparation for the construction of new (Visaginas) NPP showed that Lithuania lacks the nuclear energy specialists, and other energy-related professions.
- Lithuania is making a training hub for the entire Baltic region: the Regional Basic Professional Training Courses with IAEA support are organising in Lithuanian, Lithuanian Energy Institute joined to the European TSO Network (ETSON).