

Regulatory Activities in Preparation for the Project of New Slovenian NPP in Krško

Tomaž Nemeč, Benja Režonja Gumpot, Barbara Vokal Nemeč, Tomi Živko
Slovenian Nuclear Safety Administration
Litostrojska 54, SI-1000 Ljubljana, Slovenia
tomaz.nemec@gov.si

ABSTRACT

Some 15 years ago in Slovenia the need arose of a new nuclear power plant (NPP) construction at a site close to existing plant in Krško. A nuclear renaissance started in the World. But in March 2011 the Fukushima accident occurred and had a negative impact on the construction of new NPPs in European Union with some countries abandoning nuclear power option while others halted the construction of their plants.

Long-term positive experience with Krško NPP operation as well as significant investment in the plant safety for extreme external events and severe accidents, increased the public confidence in use of nuclear energy in Slovenia. After completion of Krško safety upgrade project at the end of 2021, the time was right to start the new project of JEK2. The first permit obtained was the energy permit already in July 2021 and in March 2022 the initiative for the national spatial plan was prepared.

The Slovenian Nuclear Safety Administration (SNSA) as the regulatory body responsible for licensing new nuclear facilities actively responded to these activities. A project team was formed that shall prepare the SNSA for such extensive task of licensing the new NPP and will already participate in the process of the national spatial plan preparation as the first stage of licensing process. The cooperation started between the investor GEN Energija and the SNSA as the regulator. The SNSA is active in international cooperation with the aim to gather experience of other new build projects.

The regulatory activities are aimed at increasing the capabilities of the SNSA by employing new personnel and preparing the qualifications criteria as well as training program for the newcomers as well as for the existing staff. The Slovenian legislative framework was also upgraded with new revisions of acts on spatial planning, environmental protection and construction. The SNSA prepares amended regulations with nuclear safety requirements based on WENRA Safety Reference Levels and the IAEA requirements.

Keywords: SNSA, JEK2, new builds, legislation, siting

1 INTRODUCTION

Slovenia is the smallest nuclear country in the World and the Krško NPP, owned by Slovenian and Croatian utilities, is approaching its 40 years of operation and is looking at transition to long-term operation of additional 20 years. However, extended operation of existing plant is not sufficient for predicted future use of electric power. Economic progress in Slovenia results in ever growing demand for supply of electricity. This shall be supplied by carbon neutral technologies, among those the major contribution is expected from nuclear power. A new NPP is part of the solution for carbon-free electric energy production.

The utility GEN Energija d.o.o. (GEN), a 50% part-owner of the existing Krško NPP, planned already some 15 years ago to build a new NPP close to the existing NPP in Krško. This process was accompanied also by the regulatory body Slovenian Nuclear Safety Administration (SNSA) which started preparations for the JEK2 project from 2008 onwards. By 2010 the situation was almost ready to begin the process of new NPP siting but this was abruptly stopped by the Fukushima accident in March 2011. All the resources of the SNSA turned towards the EU stress tests and in parallel the preparation of National Action Plan as well as licensing of the Krško NPP Safety Upgrade Program.

After completion of the post-Fukushima safety improvements implementation in the Krško NPP, which is well on the way to transition to long-term operation for additional 20 years, the SNSA restarted with preparation for new build. The GEN also started with the licensing processes by obtaining the Energy permit in 2021. We expect the start of licensing process for site approval in 2022. The paper will present the activities of the SNSA in the period of almost 15 years that were aimed at preparing the SNSA to the task of licencing the new NPP from siting to operating permit.

2 PREPARATION FOR NEW BUILD IN THE EARLY 21ST CENTURY

Idea of a new Slovenian NPP started more than 15 years ago. Krško NPP just completed its first PSR and was preparing the Ageing management program for the purpose of plant lifetime extension. In Finland, the construction of new EPR began in 2005 at the Olkiluoto site. The Westinghouse AP1000 design was developed with novel passive safety systems providing solution for increased safety. The utility GEN started interest in new NPP and publicly presented its activity for a new NPP in 2008 [1] for the first time.

2.1 New NPP designs and licensing processes

Situation in 2006 was promising for the new build. The Westinghouse as the vendor of existing Krško NPP visited the SNSA and presented a novel AP1000 design. There were also presentations of other NPP vendors. New concepts such as passive safety systems and modular construction for GEN III PWR were promising for the new NPP and there was an advantage of simpler and faster construction than for the existing NPP designs. New GEN III PWR offered an increased safety, special solution even for severe accidents, lesser construction costs, shorter construction time and longer operational lifetime. However, later on the experience with construction of EPR in Finland and France or AP1000 in USA showed that long delays with construction can bring up the costs of such projects if investor, vendor and regulator are not well prepared for such projects.

Several years passed since the Chernobyl nuclear accident and in the mean time operational experience without significant events built some confidence in the safety of the existing NPPs. The nuclear renaissance was expected, e.g. in southeast of the USA there were more than 16 new units planned with new novel or evolutionary improved designs, such as AP1000, ESBWR, ABWR and EPR. The regulator US NRC formulated new licensing process for a combined license (COL) that simultaneously performs licensing for early site permit and the design certification. Looking back from 2022 at those plans from 2006 we can see that only Vogtle 3 and 4 NPPs are in construction and shall be completed in next years. New NPPs were constructed mostly in East and South Asia and in Eastern Europe. In recent years some new builds started in new nuclear countries.

In the meantime, the GEN started with preparation for the new NPP in Krško by evaluating site characteristics and the available NPP designs on the market [2].

2.2 The SNSA activities since 2008

The SNSA reacted on the situation with new NPP project announced by GEN and started preparation for the new build. To start with, the SNSA financed a project “Review of the Technical Solutions for the Design of Generation III PWRs” with the aim to prepare the SNSA for its tasks in construction of the new JEK2. The project prepared by the Corporate Risk Associates Ltd [3] consisted of 6 reports that compared the available GEN III technical solutions and safety analyses, as well as the review of standards and licencing procedures worldwide with the aim to prepare a SNSA manual for licencing of new NPP.

Time was available and ideas were flowing at the SNSA and younger generation of SNSA staff cooperated on preparation of several documents relevant to the new plant:

- Preparation of quality management system and SNSA procedure for the project,
- Preparation of guidelines for a special safety analysis for siting,
- Assembling guidelines for national spatial plan for JEK2.

Quickly the SNSA realized that much more resources are needed for the new NPP project. The SNSA prepared an analyses of the licencing procedures and estimated required work in different phases of licencing processes from siting to operation [4]. The following analyses were issued or only prepared as drafts:

- Analysis for new human resources for the SNSA, required competences, recruitment and training [5],
- Analysis of required Technical support organisations (TSOs) for the licencing process,
- Required changes to the Slovenian legislation.

The processes to obtain licenses for the site, the construction, the environmental consent were long and complex (Figure 1, a copy from [4]). The SNSA merged all these processes in one figure and found out that a total of 21 SNSA decisions are needed between the governmental decision on a new NPP project and the final decision on the operating license.

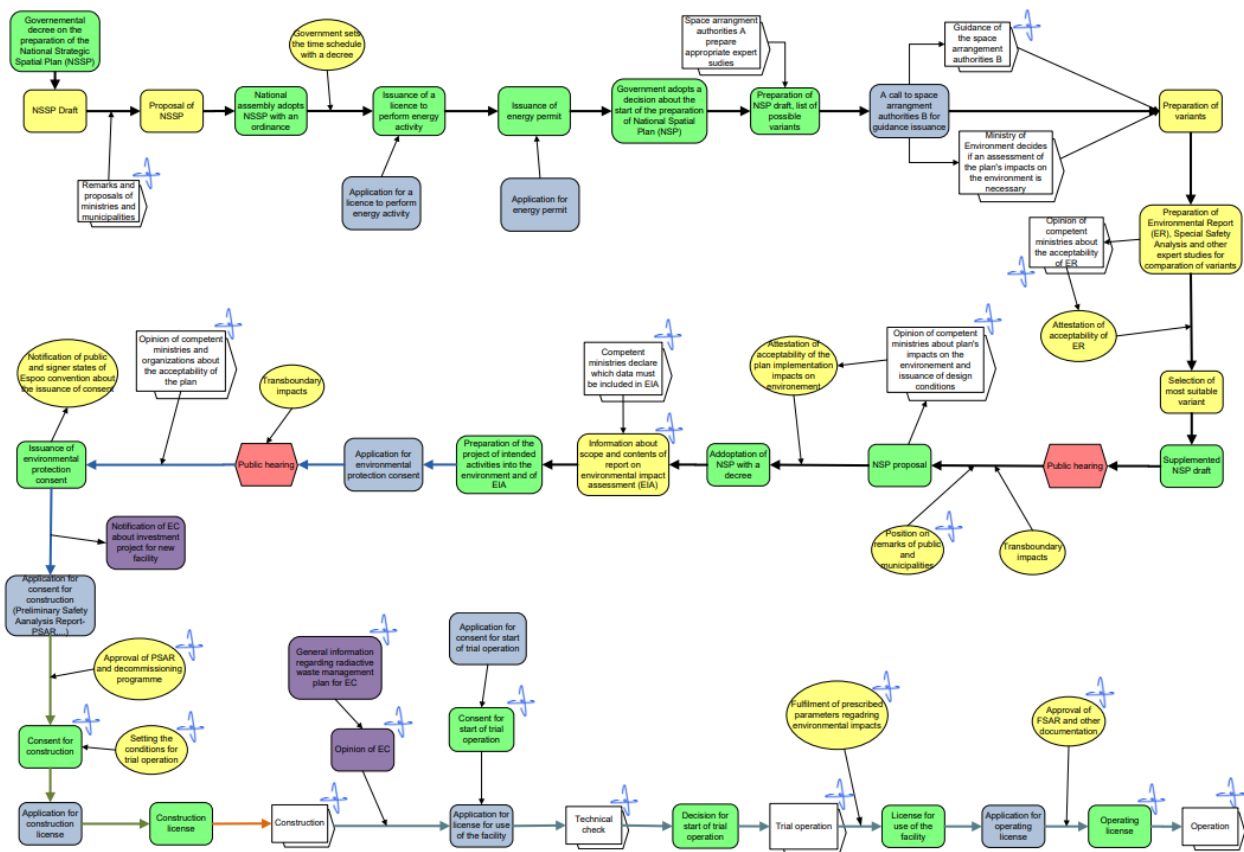


Figure 1: Illustration of extensive licensing process in Slovenia in 2009, from [4].

This process was much more demanding, extensive and time consuming than the US NRC COL licensing. The SNSA estimated the required time for all steps of licensing process from the energy permit to the operating license (Table 1). The time span showed that it is very important to plan licensing activities in advance and to synchronize activities between the investor and the regulator.

The SNSA also followed the progress in international activities related to the new build, such as OECD/NEA MDEP [6].

Table 1: Estimated time for licensing processes [7].

Licensing process assumptions	Process timeline	Years total	Construction license obtained
Optimal	2009-2029	20	2019
Optimistic	2009-2021	12	2014
Conservative	2009-2031	22	2021

However, in Slovenia the licensing of the new NPP did not start as it was expected. The possible national referendum to confirm the nuclear option was not organized. The site licensing process also did not start in 2009 or 2010. But the situation was still optimistic both for the investor and the SNSA.

3 POST-FUKUSHIMA ACTIVITIES

3.1 SNSA activities related to the Fukushima accident

On 11 March 2011 the Fukushima accident occurred, and it changed the whole approach to the licensing of new NPPs. Such extreme natural disasters such as the tsunami of such size were previously not considered in design due to low probability of such events to occur (probability was below the threshold). The combination of different extreme events (e.g. earthquake and flooding) was not acknowledged because these were considered even much less probable. The resulting plant conditions at Fukushima Daiichi were total loss of AC power and total loss of heat sink, two conditions where no successful solution was available to prevent such accident to develop into a severe core damage.

The EU decided to perform safety evaluation of the NPP fleet in EU countries by stress tests, where the methodology was developed by WENRA. The Krško NPP and the SNSA cooperated in preparation of national report [8]. Much pressure was on the Krško NPP, because it is the only EU plant constructed in a seismically significant location. But due to the Krško NPP ambitious plan of safety improvements, first as implementation of mobile equipment already in first half of 2011 and then followed by the Safety upgrade program (SUP), the Krško NPP was estimated as one of the best NPPs. The National action plan [9] included not only hardware solutions but also improvements of regulations, the emergency response, inspection etc. The SUP was a large effort for the NPP and the SNSA alike. All available resources of the regulator had to be used for preparing new legislation, licensing the plant modifications, developing the new operating limits and conditions DECTS and a new USAR Chapter 20, dedicated to design extension conditions (DEC) analyses and systems. The nuclear safety legislation was upgraded according to the WENRA 2014 Safety reference levels for existing plants.

3.2 Restart of JEK2 activities in 2021

The post-Fukushima actions for NEK were mostly completed in 2021 and this allowed for a new start of activities connected with the new build. The implementation of Krško NPP SUP was

completed at the end of 2021. In January 2022 the final action from the second Periodic safety review (PSR) was completed. The next, third PSR started already at the end of 2020 and in the year 2021 the review phase was performed by the Krško NPP contractors. The long-awaited solutions for the spent fuel and radwaste began to be implemented as plant lifetime extension was a process where the radwaste issue has to be resolved. The Krško NPP Spent fuel dry storage construction already started in 2021. The project of repository for low and intermediate radioactive waste in Vrbina (NSRAO) was in preparatory phase with Safety analysis report in finalization and the process of obtaining the construction permit mostly completed. The SNSA in 2021 prepared new amendments to the regulations on nuclear safety that included also new requirements for design of a new NPP. The SNSA resources were relieved from many years of intense activities.

The conditions were favourable for GEN to restart the JEK2 project with support of the ministries of the infrastructure and of the environment and spatial planning. The Energy permit for the JEK2 was issued in July 2021 [10] and defined the new NPP as a PWR with 1100 MWe power single unit that would operate for a period of 60 years. The GEN did not yet choose the vendor of the NPP as this should be selected later on after the completion of siting. The GEN continued with its activities which resulted in issuing of initiative for preparation of national spatial plan for JEK2.

4 SNSA PREPARATION FOR THE NEW NPP

4.1 SNSA team for the new NPP

The situation at the SNSA was not as good as it was more than 10 years ago when most of the SNSA staff was more or less involved in the new built activities. The SNSA staff aged and at the same time no organisation growth occurred in these 10 years of post Fukushima activities. At the end of 2021 the original SNSA leader of the JEK2 team left the SNSA for another job. The SNSA then formed a new team for new build that consisted of 5 members from the Nuclear safety division. The team urgently started to improve its competences related to the process of licensing the new NPP. The plan was to form a new division of the SNSA later on that would be dedicated to the JEK2 project.

Cooperation with GEN started with regular working meetings to exchange information, to discuss licensing requirements for the JEK2 and to prepare guidelines for siting of JEK2 based on IAEA standards such as requirements for siting SSR-1 and guidelines for content of the SAR in new SSG-61. The old analyses from 2009 were reviewed again and updated.

The legislation changed significantly following the Fukushima accident and the licensing process in Figure 1 was not applicable anymore in this form. The Ministry of the Environment and Spatial Planning was very active in 2021 and prepared new revision of the Spatial Management Act, the Environmental Protection Act and the Building Act. The amendments to these important laws governing both licensing and construction affect the process of licensing since a decision making body shall be formed from representatives of different regulatory bodies and decide on a common decision at the end of the licensing process. The new WENRA 2020 SRL, issued in January 2021, introduced important new contents for assessment of internal and external hazards and the management system of operator, all to be included into new revisions of nuclear safety regulations.

4.2 IRRS mission at the SNSA and evaluation of SNSA capabilities for the new build

In April 2022 the IRRS mission review was performed at the SNSA. One of the special topics of the mission was assessing the SNSA capabilities for the new build. The results were not in favour of the SNSA, since the mission conclusion stated as quoted:

“(New build...) project consists of the construction of a second unit on the Krško site. Although this project is not launched yet, the IRRS team considers that SNSA does not have sufficient numbers of competent staff to perform its functions.”

Several other recommendations and suggestions connected with the new build were issued, e.g. Recommendation on NPP design requirements: The SNSA should develop requirements related to human factors engineering and human-machine interface. (JV5). Resolution of some issues requires also changes to the legislation, such as regulation JV5.

The SNSA was aware that the situation is serious, but due to third PSR and other demanding activities in parallel the SNSA team for new NPP was too busy with all the work to dedicate full time to the new build activities. However, the IRRS conclusion may help the SNSA activities for human resources upgrade.

4.3 Build-up of the SNSA resources and competences

The SNSA team for JEK2 updated the human resources analysis from 2010. Based on the analysis of the licensing processes the SNSA estimated the required number of new staff needed to perform the review of plant documentation, issuing licences and oversight of construction of the new plant. To sum up, the needed new employed staff consist of 30 technical experts and 5 administrative workers to support management of extensive documentation. It is a significant upgrade from current SNSA staff of 42. These new employees would not be hired at once, but rather during a period of several years which allows for their training and gathering of on-the-job experience.

The SNSA presented already in December 2021 the updated human resources analysis to the Minister of the Environment and Spatial Planning but with no actual success. The total number of employees at the SNSA is limited by quota set by the Ministry’s human resources department.

The SNSA was not able to hire replacement new staff for positions of experts of mechanical engineering, electrotechnics and physics. The positions are not attractive to potential candidates because of low wages for beginners that are not comparable what the human resources market can offer in these conditions of economic growth. The SNSA will need to provide different approach in attracting new staff to fill-out vacant positions in the organisation and to expand according to the needs for the new NPP project.

The SNSA team for JEK2 tries to build-up competence based on the experience acquired in the last 10 years from the post Fukushima activities and other processes. In this way, the SNSA shall improve the staff competences related to site assessment; to the design and construction of new nuclear facilities; and to the environmental impact assessment of new NPP (Table 2).

Table 2: SNSA experience gained in licensing processes that results in competence upgrades.

Experience category		
Site assessment	Design and construction	Environmental impact assessment
Third PSR of the Krško NPP, safety factors Hazard analysis and Emergency response	Krško NPP Spent fuel dry storage	Report on environmental impact for the NEK lifetime extension
	Repository NSRAO of the ARAO in Vrbina	
Application of decree UV3 conditions in review of projects built in area of limited use of space near the Krško NPP	New buildings OPC and BB1 as part of Krško NPP SUP	Transboundary impacts evaluation
	Impact of the new HPP Brežice and required modifications of Krško NPP cooling systems	

The SNSA plans also to organize the education and training of new hired staff. For the basic knowledge on nuclear technology and nuclear safety the courses of the Educational centre for nuclear technology ICJT of the “Jožef Stefan Institute” are most suitable. For special topics such as design on GEN III reactors with passive safety systems, the international training courses may be

used. The SNSA has good relations with foreign organizations like the IAEA, the OECD and some regulatory bodies, mainly the US NRC, where a number of SNSA staff attended the training courses and workshops to gain knowledge on design and operations of NPPs and other facilities.

5 CONCLUSIONS

The paper presents an overview of the SNSA activities with the new project of JEK2, the second Slovenian NPP that is to be constructed in Krško next to the existing plant. The first period was from 2008-2010 when the SNSA was ready to start the process of licensing the new plant. However, the process abruptly stopped with the accident in Fukushima in 2011. The SNSA activities post-Fukushima did not directly address the new NPP, but they were connected with new designs in many aspects. The Krško NPP SUP was implemented according to the DEC requirements and that means on a level required for new NPPs. Another important aspect is the assessment of extreme external events of low probability as well as combination of events such as seismic and flooding, to determine the design conditions for new buildings and installed equipment.

The SNSA is at the start of the process of preparation for new build and at first it can be seen that the SNSA lacks human and financial resources for such demanding task. The SNSA was for last 15 years limited to only minimal number of staff to perform its regulatory supervision over existing licensees and the SNSA staff aged and is approaching retirement. The challenge will be to attract new people with technical education and knowledge since the starting salaries at the SNSA cannot compete with private employers in industry. Currently, the SNSA is capable to participate in preparation of national spatial plan for the JEK2. For the evaluation of design of new NPP and licensing and supervision of construction, the SNSA must gain significantly more resources in terms of technical experts, practical experience and sufficient financial means.

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