



International Conference
Nuclear Energy for New Europe 2004

Portorož • Slovenia • September 6-9

port2004@ijs.si
www.drustvo-js.si/port2004
+386 1 588 5247, fax +386 1 561 2276

PORT2004, Nuclear Society of Slovenia, Jamova 39, SI-1000 Ljubljana, Slovenia



Regulatory Review of NPP Krško Periodic Safety Review

Davor Lovinčič, Artur Mühleisen, Andreja Peršič

Slovenian Nuclear Safety Administration,

Železna cesta 16, P.O. Box 5759, SI-1001 Ljubljana, Slovenia

davor.lovincic@gov.si, artur.muehleisen@gov.si, andreja.persic@gov.si

ABSTRACT

At the request of the Slovenian Nuclear Safety Administration (SNSA), Krško NPP prepared a Periodic Safety Review (PSR) program in January 2001. This is the first PSR of NPP Krško, the only nuclear power plant in Slovenia. The program was reviewed by the IAEA mission in May 2001 and approved by SNSA in July 2001. The program is made in accordance with the IAEA Safety Guide »Periodic Safety Review of Operational Nuclear Power Plants« No.-50-SG-012 and with European practice. It contains a systematic review of operation of the NPP Krško, including the review of the changes as a result of the modernization of the facility. The main tasks of PSR are review of plant status for each safety factor, development of aging and life cycle management program, review of seismic design and PSHA analysis and update of regulatory compliance program. The prioritization process of findings and action plan are also important tasks of PSR. The basic safety factors of the PSR review are: Operational Experience, Safety Assessment and Analyses, Equipment Qualification and Ageing Management, Safety Culture, Emergency Planing, Environmental Impact and Radioactive Waste, Compliance with license requirements and Prioritization.

It had been agreed that SNSA will have reviewed all PSR reports generated during the PSR process. At the end of 2003 the PSR Summary Report with selected recommendations for action plan was completed and delivered to SNSA for review. The paper presents regulatory review of NPP Krško PSR with emphasis on the evaluation of the PSR issues ranking process.

1 INTRODUCTION

Until the new Act on Ionizing Radiation Protection and Nuclear Safety (Off. Gaz., RS, No. 67/2002) has been accepted in 2002, there was no direct legal basis for PSR of nuclear installations in the Slovenian nuclear legislation. However, during the plant life NPP Krško regularly, as in U.S. (vendor country of NPP Krško) updates Safety Analysis Report (SAR). The Probabilistic Safety Analysis (PSA) were performed and since then NPP Krško maintains a living PSA that is regularly internally reviewed. The Regulatory Compliance Program (RCP), that reviews NPP Krško compliance with U.S. NRC requests, is a living program at NPP Krško. Additionally, NPP Krško hosted many international missions like OSART in 1984, 1994 and 2003, ASSET in 1986, ICISA (independent international mission) in 1992, IPPARS in 1996, IPERS in 1997, IPSART in 2000 and RAMP in 2001. Having the plant with a such living update program there was a question if the PSR should be required from NPP

Krško or not. There were some facts in favor for NPP Krško PSR: a need for comprehensive and systematic evaluation of nuclear safety, following the European practice and also public awareness.

After the NPP Krško modernization project in 2000 (including steam generators replacement, reactor power increase), the need for conducting a PSR of the Krško NPP has been clearly recognized by both the NPP Krško management and SNSA. The PSR was highly desirable, both in the light of current trends in safety oversight practices and because of many benefits it is capable to provide.

The NPP Krško PSR's objectives encompass three main criteria or goals [1]:

- confirmation that the plant is as safe as originally intended,
- determination of any structures, systems or components that could limit the life of the plant in the foreseeable future and
- plant comparison against modern safety standards to identify where the improvements would be beneficial at justifiable costs.

The secondary goals are as the following:

- verification of standards, best practices and review methods used for the PSR project to confirm that they are in compliance with EU members current practices and IAEA Safety Guides,
- assurance that realization of PSR project's goals is optimal and
- timely performing of all internal interfacing activities within the PSR project.

In January 2001 the SNSA issued a decision requesting the Krško NPP to prepare a PSR program and determine a schedule for its implementation. SNSA required that the PSR program ought to be in accordance with the IAEA safety philosophy and agreed with the plant, that its implementation would be according to the EU practice. The PSR program had been prepared in accordance with the IAEA Safety Guide »Periodic Safety Review of Operational Nuclear Power Plants« No.-50-SG-012 and with European practice and was later reviewed by IAEA expert mission in 2001. SNSA then issued license amendment with the approval of the proposed NPP Krško PSR Program.

PSR is treated as a comprehensive safety review of the Krško NPP and the following safety factors were considered for review:

- Safety factor 1, Operational Experience: major operational problems, record requirements for operational data, evaluation of failure rates and safety performance data and feedback of relevant experience of other NPPs.
- Safety factor 2, Safety Assessment: safety standards and practices topic list review, operating limits and procedures, maintenance, test and inspection procedures, modification and backfitting procedures, radiological protection systems and procedures, probabilistic safety assessment, design bases accidents/severe accidents, seismic design and seismic PSHA analysis.
- Safety factor 3, Equipment Qualification and Ageing Management: equipment conditions, ageing management and equipment qualification.
- Safety factor 4, Safety Culture: organizational factors, quality assurance, human factors.
- Safety factor 5, Emergency Planning.
- Safety factor 6, Environmental Impact and Radioactive Waste and
- Safety factor 7, Compliance with License Requirements and Prioritization: Compliance with License Requirements.

SNSA requested that all IAEA safety factors must be incorporated in the review and have to be performed according to the practice in Europe. Programs, analysis, standards, methods,

tools and time schedule should be precisely defined. NPP Krško should produce two PSR status reports per year. Safety factor reports should have been delivered by the end of 2002, but they were delivered with a slight delay, and final PSR report was delivered in December 2003.

It was agreed that the corrective actions should be done according to normal licensing procedure. Only if very urgent corrective actions are found they must be implemented immediately.

2 MAIN FINDINGS OF THE NPP KRŠKO PSR

In the frame of NPP Krško PSR a comprehensive and documented review of the plant operational and design status had been performed. The review confirmed that the plant is as safe as originally intended and determined that there are no structures, systems, components, human activities or administrative processes that could limit the life of the plant in the foreseeable future. This review had not revealed any major safety issue. It was concluded that Krško NPP can operate safely during the time period until the next PSR. The review nevertheless identified a number of recommendations to further enhance the plant safety and its documentation. It has to be stressed that the review has not yet considered the results of seismic studies, the revised seismotectonic model of Krško basin and accordingly changed seismic PSA. This is in progress and should be included in the PSR by the end of September 2004.

The ranking of safety issues found by PSR and prioritization of corrective measures were the main tasks needed for establishment of an efficient action plan. The safety issues at NPP Krško were identified during the PSR and additionally during some other reviews going on at the same time as PSR. These processes are:

- Krško NPP Regulatory Compliance Program (RCP) review,
- Westinghouse Owner Group (WOG) catalogue items screening/review and
- SNSA's recommendations (including IAEA RAMP mission suggestions or recommendations).

All of safety issues have been included in the prioritization process. Pre-screening elimination from further consideration in the ranking process was done for all safety issues that required only a minimum effort for their implementation and for safety issues which required immediate or very near term resolution. All such safety issues, according to NPP Krško, do not require ranking as they must be accomplished in the near term to mitigate potential substantial economic consequences for the plant.

As a results of NPP Krško ranking evaluation a total of 468 items from PSR review, RCP review, WOG catalog items screening, RAMP mission findings and SNSA findings survived the pre-screening process. 346 issues of the 468 were found to have a direct link to plant safety while the other 122 issues were identified as a re-evaluation of the safety basis (see Tables 1 and 2).

346 safety issues with a direct link to plant safety were evaluated for their impact on reduction of residual plant risk and degradation of defense-in-depth safety levels. Among 346 issues no issue with the potential for reduction of residual plant risk was found (severity numbers above 6 in Table 1).

Table 1: Summary of all issues with direct link to plant safety [2]

Severity Description	Severity Number	Number of Issues
Core damage with early containment failure	10	0
Core damage with late containment failure	9	0
Core damage (no containment failure) or major spent fuel pool accident	8	0
Partial core damage only (no containment failure) or minor spent fuel pool accident	7	0
Substantial degradation of multiple safety systems	6	5
Moderate degradation of multiple safety systems	5	83
Substantial degradation of single safety system	4	17
Moderate degradation of single safety system	3	30
Impacts confined to non-safety systems	2	4
No quantifiable plant risk and degradation of safety or non-safety system	1	207
Total		346

Table 2: Summary of issues requiring re-evaluation of the safety basis [2]

Severity Description	Severity Number	Number of Issues
A significant change in plant risk profile potentially resulting in the identification of new safety issue(s)	3	9
A quantifiable change in plant risk profile potentially resulting in the identification of new safety issue(s)	2	28
No quantifiable change in plant risk profile	1	85
Total		122

The selected recommendations for action plan are from severity categories from 5 to 10 in the case of issues with direct link to plant safety and from severity categories 2 and 3 for the issues requiring re-evaluation of the safety basis. Some of the recommendations which are not selected for the action plan will be still implemented by NPP Krško (for example shut down PSA).

The highest ranking recommendations for action plan come from WOG catalog items screening and RCP review. The highest ranking recommendations from NPP Krško PSR with direct link to Plant Safety Issues are connected with Instrumental and Control Safety Related Systems.

The highest ranking recommendations from NPP Krško PSR of re-evaluation of safety basis issues are connected with the review of non-seismic hazard analyses covering PSA external events like frequency of external floods from high river flow, frequency of external floods from dam failures, frequency of high winds and credit for operator actions.

3 SNSA REVIEW

The PSR project started at the beginning of 2002 and the first preliminary PSR reports were submitted to the SNSA for revision by the end of 2002. Until June 2003, a total of 61 reports and sub-reports were submitted. SNSA reviewed all the preliminary reports on-line and promptly provided comments to the NPP Krško. The SNSA review was focused on whether the PSR presents a complete review of a certain safety factor and to define eventually missing topics together with proposed additional recommendations. A new revision of the reports, taking into account some of the SNSA recommendations, was prepared and delivered to SNSA in September 2003. During November 2003 several meetings between SNSA and Krško NPP took place to discuss on individual PSR topics. The remaining open issues of final revision of the reports were discussed at these meetings. The unanswered (unsolved) comments of the SNSA were summed-up in meeting notes and remain to be solved in the course of preparation of PSR action plan and SNSA's approval of it.

In December 2003 the revised version of PSR reports and NPP Krško PSR Project Summary Report [3] were delivered to the SNSA. The NPP Krško PSR Project Summary Report contains review of safety factors, PSR results with explanation of prioritization process and a list of selected recommendations for action plan. After the review of the NPP Krško PSR Prioritization Process/Action Plan report [2], the SNSA evaluated the NPP Krško prioritization process of some selected PSR issues to confirm the ranking process of the issues. The PSR ranking methodology and in a consequence the ranking of selected recommendations for action plan are not completely satisfactory from the regulatory point of view. The ranking of the safety issues is based on risk perspective, cost and plant original design basis. The ranking seems to be almost completely limited to the fulfillment of the necessary plant and procedural improvements to maintain already reached safety levels. It was also noticed that the PSR issues, ranked according to the criterion "degradation of defense in depth", were ranked only one or two out of five levels of defense in depth. For some PSR issues the CDF and LERF values were not calculated even though they were needed for confirmation of their selection. Because of all these reasons SNSA prepared and performed its own ranking system criteria for the issues which are not included in the action plan. These issues are categorized in three different categories:

- Category I: recommendations which ensure basic nuclear safety (international standards and recommendations, IAEA missions recommendations, recommendations which are connected to the important safety issues which are poorly implemented or the implementation is not known),
- Category II: recommendations important for the nuclear safety (improving defense in depth safety levels, recommendations for performing the analysis for evaluation of NPP Krško Updated Safety Analysis Report and Technical Specifications changes, improvements of programs and procedures, recommendations, which improve the NPP risk profile, less important recommendations from IAEA missions, adjusting of plant with the modern safety standards) and
- Category III: recommendations less important from the nuclear safety point of view. They represent minor improvements of procedures, surveying the procedures or hardware, recommendations for contemporary methods.

According to this categorization SNSA reviewed all the PSR recommendations (findings) which have not been included in the list of selected recommendations for the action plan, including also the recommendations which were generated in the first (preliminary) PSR reports and were omitted in the next revisions as well as all the issues and comments identified during the SNSA review. The SNSA review identified 49 recommendations which

must be part of the action plan (issues from Category I) and emphasized further 196 recommendations (issues from Category II) for the NPP to consider them (Table 3).

Table 3: The number of NPP Krško selected recommendations for action plan. Recommendations noted as “SNSA additional recommendations” are those for which SNSA considers that they must be part of the action plan

Safety Factor	Recommendations	Selected for action plan	SNSA additional recommendations
Operational Experience	19	0	4
Safety Assessment and Analyses	322	49	30
EQ and Ageing management	2	2	
Safety Culture	30	0	10
Emergency Planning	35	2	3
Environmental Impact and Radioactive Waste	7	0	2
Total	415	53	49

SNSA reviewed also RCP report with PSR recommendations (Table 4). In general SNSA agrees with RCP proposed recommendations included in the action plan but, additionally SNSA asks for 16 items to be clarified. SNSA still needs to clarify for itself what the WOG proposals are and why they rank so high. SNSA agrees to include them in the action plan to have a transparent overview of all planned safety significant modifications in the NPP in the near future and will evaluate them during normal modification licensing procedure.

Table 4: RCP and WOG recommendations [2]

	Does not comply or upon implementation	Selected for action plan	SNSA requires further clarification
RCP report	90	52	16
WOG catalog items	73	11	-

It was also noticed that the list of selected recommendations for PSR action plan does not consider any recommendations for improvement in the fields of safety culture, operation, environment and radwaste and only a few from the emergency preparedness. Therefore SNSA proposed for some of them to be included in the action plan.

The action plan will be the matter of SNSA approval. For this reason the expert opinion for NPP Krško PSR Project Summary Report and for the action plan is needed. It will be provided by technical support organisation at the end of 2004.

4 PSR OPEN ISSUES AND WAY FORWARD

The PSR project is divided into three phases:

- Phase 1: Preparation of detailed 10-year PSR program,
 - Phase 2: Performing of 10-years PSR program and
 - Phase 3: Implementation of the action plan after SNSA approval of action plan.
- Phase 1 of the PSR project was successfully implemented. Phase 2 of the PSR project is in the stage of action plan preparation. Some open issues for its conclusion are still existing [4, 5], for example:

- Results of operating experience feedback should include safety performance indicators including radiation safety and radwaste management and their trends as well as proper evaluation of their development during the last 20 years of operation or at least for the last ten years.
- Safety culture evaluation concerns mainly organizational issues (technical support organization and its role is not covered in the report, similarly public communication, human factor are not covered).
- There is new information on external natural events concerning seismic and flooding analyses as well as man's caused hazards such as air traffic statistics. Its effects should be re-evaluated and its inclusion in the USAR should be considered.
- In the report it is presented that Krško plant waste storage will be full in 2010, provided there is no unexpected increase in waste production. However, this issue has not been ranked at all for the action plan of PSR issues and can be one of limiting issues for re-licensing of the plant.
- The review of PSHA (Probabilistic Safety Hazard Analysis) and review of NPP Krško seismic input for PSA will be performed through RAMG program assistance by IRSN (Institut de Radioprotection et de Surete Nucleaire). The work is in progress and it will be accomplished by the end of September 2004.

A new Act on Ionizing Radiation Protection and Nuclear Safety requires regular, full and systematic assessment and examination of radiation or nuclear safety by PSR (Article 81 of the Act). In the Regulation for Control of Radiological and Nuclear Facilities the required scope of the PSR program will be described in detail. Article 82 of the Act requires that the approved PSR report shall be a condition for renewing the license for the operation of the nuclear facility.

The next PSR will be in ten years, therefore SNSA expects that the modifications from the action plan will be implemented during the coming 5-year period. After that time the preparations for the next NPP Krško PSR could start.

5 CONCLUSION

SNSA expects that this PSR will constitute a comprehensive and systematic review of operation of the NPP Krško. The NPP Krško PSR gave a good review of the plant operational and design status which confirmed that the plant is as safe as originally intended and determined that there are no structures, systems, components, that could limit the life of the plant in the next ten years. This review has not revealed any major safety issue, nevertheless it has identified a number of recommendations to enhance further the plant safety.

In the new legislation PSR is obligatory for all nuclear installations. With the acquired experience the next PSR for NPP Krško will be more comprehensive and hopefully at the same time less demanding for the licensee. This PSR proved that it is a useful tool to identify issues that are important for improving nuclear safety. As a side effect it gave a lot of learning opportunities for the plant staff members and SNSA. It also provided an overall integral view of the safety status of the plant to the regulatory body.

According to the new Slovenian legislation PSR is the required condition for the extension of NPP Krško license for operation for the next 10 year period.

REFERENCES

- [1] I. Bašić et al: Krško NPP Periodic Safety Review Program, International Conference Nuclear Energy in Central Europe 2001, Proceeding, p. 501.1, Portorož 2001.
- [2] J. Lambright: NPP Krško PSR Prioritization Process / Action Plan, PSR-NEK-7.3, Lambright Technical Associates Inc., 2004.
- [3] T. Bilić-Zabrc et al: NPP Krško PSR Project Summary Report, Rev. 0, PSR-NEK-8.0, 2004.
- [4] Periodic Safety Review Project, Nuclear Power Plant Krško, Final report, CD, 2003.
- [5] Ilari Aro, Pierre Briegleb: PHARE Project SI/RA/03-task 4a, Report, Ljubljana 2004.