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NPP Krsko Periodic Safety Review Action Plan

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ABSTRACT

In the current, internationally accepted, safety philosophy Periodic Safety Reviews (PSRs) [1] are comprehensive reviews aimed at the verification that an operating NPP remains safe when judged against current safety objectives and practices and that adequate arrangements are in place to maintain an acceptable level of safety. These reviews are complementary to the routine and special safety reviews. They are long time-scale reviews intended to deal with the cumulative effects of plant ageing, modifications, operating experience and technical developments, which are not so easily comprehended over the shorter time-scale routine of safety reviews.

The review was completed in 2005 and the next period will see the implementation of the action plan including some plant upgrades. The action plan [2] lists issues that should be implemented at NPP Krško together with associated milestones. The milestones were assumed based on best estimate resource availability and their ends can be potentially floated. In some cases, multiple corrective measures may be postulated to provide resolution for a given safety issue.

The Slovenian Nuclear Safety Administration by decree approved the first periodic safety review and the implementation plan of activities arising from it. The entire implementation plan must be carried out by 15 October 2010. Report on the second periodic safety review must be submitted by the NEK not later than 15 December 2013.

1 INTRODUCTION

The EU countries have all undertaken comprehensive safety reviews of operating NPPs [3] starting from the early 1980's. This practice was a result of increased knowledge and experience in both design and operation as well as in raising the standards for safety and reliability. The PSR have become a highly important segment of regulatory oversight.

The need for conducting a Periodic Safety Review for the Krško NPP (NEK) has been clearly recognised both by the NEK management and the regulator (Slovenian Nuclear Safety Administration - SNSA). The PSR is highly desirable both in the light of current trends in safety oversight practices and because of many benefits it is capable to provide. On January 2001 the SNSA issued a decision requesting the Krško NPP to prepare a programme and determine a schedule for the implementation of the programme for "Periodic Safety Review of NPP Krško". The programme [4], which is required to be in accordance with the IAEA safety philosophy and with the EU practice, was submitted for the approval to the SNSA by the end of March 2001.

Definition of Krško PSR project is a comprehensive safety review of the plant after ten years of operation. The objective is a verification by means of a comprehensive review using current methods that Krško NPP remains safe when judged against current safety objectives and practices and that adequate arrangements are in place to maintain plant safety.
This objective encompasses the following three main criteria or goals:

- Confirmation that the plant is as safe as originally intended,
- Determination if there are any structures, systems or components that could limit the life of the plant in the foreseeable future, and
- Comparison of the plant against modern safety standards and identification where improvements would be beneficial at justifiable cost.

The secondary goal is the following:

- Verification of the standards, best practices and review methods used for the PSR Project to confirm that they are in compliance with EC Members current practices and IAEA Safety Guides.

PSR project is structured in three phases:

1. Phase 1: Preparation of Detailed 10-years PSR Program,
2. Phase 2: Performance of 10-years PSR Program and preparation of associated documents (2001-2003), and
3. **Phase 3: Implementation of the prioritized compensatory measures and modifications after agreement with the SNSA on the design, procedures and time-scales (2004-2010).**

The result of the review and the second phase were 44 reports. NPP Krško is at the moment in the third phase. The Krško PSR resulted in the numerous corrective measures that were ranked through prioritization process.

2 RESULTS OF PSR REVIEW

All safety issues/findings from review process have been identified in a number of reviews task:

- PSR safety review task:
  - PSRA – Aging Management Program Scoping
  - PSRB – Assessment of safety factors (Operational Experience, Safety Culture, Emergency Planning, Environmental Impact and Radioactive Waste)
  - PSRD – Safety Assessment (including review comments from PSRC - Development of revised seizmotectonic model on Krško basin and update of NPP Krško USAR and PSHA analysis)
- Regulatory conformance program (RCP) compliance review
- Westinghouse Owners Group (WOG) catalog items screening
- SNSA recommendations/comments
  - The RAMP mission conclusion/findings. RAMP- REVIEW OF ACCIDENT MANAGEMENT PROGRAMMES was performed by IAEA in the year 2001.

Summary of issues Review Process:	Number of issues:
PSR total	336
PSRA	2
PSRB	87
PSRC	16
PSRD	231
SNSA	2
WOG, RCP	155
Total	**493**

3 RANKING OF SAFETY ISSUES AND PRIORITIZATION

The ranking of safety issues and prioritization of corrective measures were the main tasks needed for establishing an efficient action plan.

A methodology [5], developed for the ranking of PSR issues was developed to readily identify those safety issues of greatest significance to public and worker safety, the environment, and defense-in-depth and, in turn, allow for a time optimal reduction of residual plant risk and enhancement of defense-in-depth.

Pre-screening has eliminated from consideration in the ranking process all safety issues (25 issues) identified as desirable and requiring minimum effort to implement. As an example is minor corrections to plant procedures that can be implemented as a part of corrective processes and programs that normally take place in the plant.

Issues have been ranked and were divided into two groups: those where a direct link to plant safety could be established and those which were a re-evaluation of the safety basis only.

In the ranking of Safety Issues with a direct link to plant safety following generic attribute categories have been derived and established:

- Extreme event risk (public and environmental risk),
- Moderate event risk (worker risk),
- Fault tolerance (degradation of defense-in-depth),
- Prior risk information (historical information, precursor data),
- Qualitative cost evaluation,
- Additional attributes (regulatory performance, operational excellence, and external confidence).

Issues involving re-evaluations of the safety basis and potential identification of new risk and degradation of defense-in-depth were ranked independently of issues where a direct link could be established to the reduction of residual plant risk or defense-in-depth. In their ranking the following generic attribute categories have been derived and recommended:

- Re-evaluations of safety basis (potential identification of new risk and degradation of defense-in-depth issues),
- Prior risk information (historical information, precursor data),
- Qualitative cost evaluation,
- Additional attributes (regulatory performance, operational excellence, and external confidence).

A total of 468 PSR, RCP compliance review, WOG catalog items screening, RAMP [6] mission, and SNSA issues were ranked.

Additional methodology [5] was performed for the prioritization of available corrective measures.

The types of available corrective measures differ depending on the type of safety issue. Some typical deficiencies which were identified are as follows:

- Deficiencies of information
- Deficiencies of design
- Deficiencies of operation
- Deficiencies of safety culture

Due to the diversity in potential deficiencies, many possible corrective measures were identified. In some cases, multiple corrective measures were postulated to provide resolution for a given safety issue. Identification of the optimal corrective measure for a particular deficiency could allow for a time optimal reduction of residual plant risk and enhancement of defense-in-depth. Allocation of resources between the issues where a direct link to plant safety can be established and those which are a re-evaluation of the safety basis were determined only based upon severity, costs, and ease of remediation.

Corrective measures were first being prioritized based on the ranking that a given safety issue obtained. For example, corrective measures which reduce residual plant risk will receive the highest priority.

A sliding scale approach was utilized to prioritize available corrective measures. If the available corrective measure could yield a reduction in residual plant risk, a more rigorous quantitative approach to prioritization was employed. All other corrective measures were qualitatively evaluated utilizing expert judgment.

3.1 Results of Ranking

A total of 468 PSR, RCP compliance review, WOG catalog items screening, RAMP mission, and SNSA issues survived the pre-screening process. Of the 468 issues remaining, 346 issues 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.

The 346 issues with a direct link to plant safety were evaluated for reduction of residual plant risk and degradation of defense-in-depth. No issues were identified with the potential for reduction of residual plant risk. Table 1 summarizes the results of this evaluation. The result of these 346 issues is that 88 shortcomings require the taking of certain measures

The 122 issues requiring a re-evaluation of the safety basis were evaluated to determine what change, if any, there might be in the plant risk profile, potentially resulting in the identification of new safety issue(s). Table 2 summarizes the results of this evaluation. Out of the 122 shortcomings, 36 of them require the taking of certain measures.

Table 1: Summary of All Issues with Direct Link to Plant Safety

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 All Issues Requiring Re-evaluation of the Safety Basis

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

All direct link issues which at most could have a minimal impact on plant risk models are recommended for exemption from further consideration since the costs are not commensurate with the minimal benefit of resolution. For direct link issues which at most impact a single safety system, adequate plant safety is demonstrated by design single failure

criteria and any improvement that may be derived from implementation of corrective measures will not significantly improve plant safety.

Action plan, intended for precise determination of all the planned activities and the time schedules for carrying them out, was made on the basis of the categorisation of the results. These activities were harmonised with the Slovenian Nuclear Safety Administration.

4 ACTION PLAN

The Krško PSR resulted in the numerous corrective measures that were ranked through prioritization process. The action plan [2] "NPP Krško Action Plan Regarding to the Periodic Safety Review Insights", Revision 0, lists issues that should be implemented at NPP Krško together with associated milestones. The Action Plan was approved by SNSA. The milestones were assumed based on best estimate resource availability and their ends can be potentially floated. In some cases, multiple corrective measures may be postulated to provide resolution for a given safety issue. For each action are determined time schedule of internal review, and closure of the activity. The total number of activities in the action plan is 124. Most of them, 110, required analyses. The rest required changes in documents or actions, which not requires any analyses. In the Figure 1 is shown milestone for activities closure per years. All activities are entered into NPP Krško Corrective Action Program, which allows easy traceability of activity status. All the activities have to be finished till the end of the year 2010.

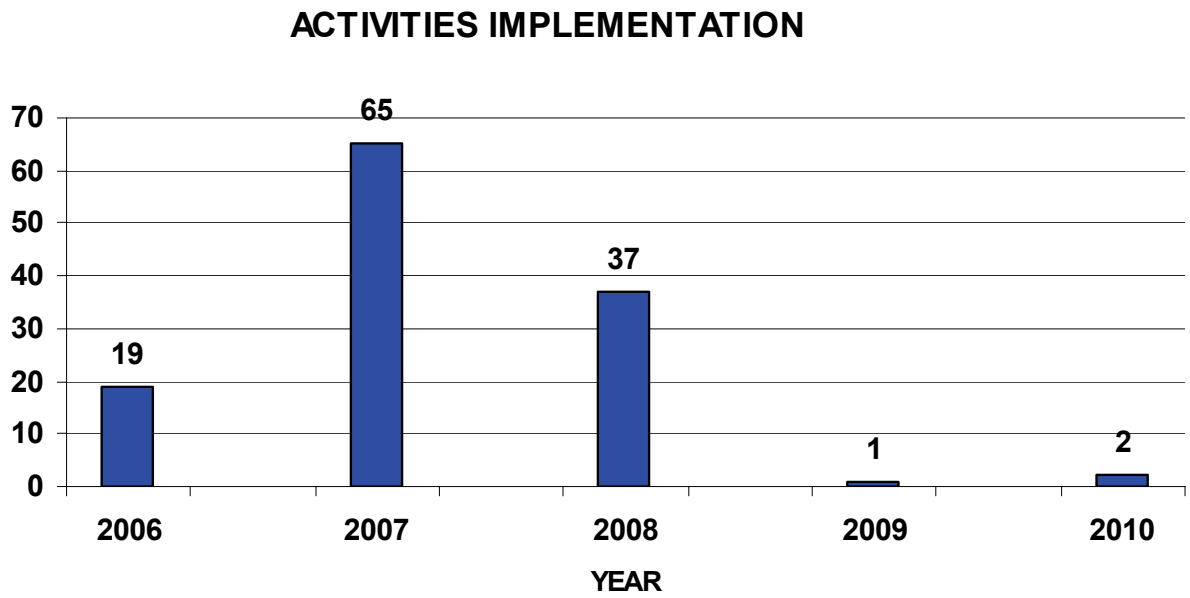

Figure -1 Activities closures per years

In the Table 3 are shown just few issues from NPP Krško Action plan [3].

Table-3 NPP Krško Action Plan Regarding to the Periodic Safety Review Insights

CAP Analysis	Task description	Internal Review	Status report	Actions implementation	Closure report	Category	Responsible group	Support group
Aging Management Program Activities (AMP)								
2005-404	PSR-NEK-3.2 SECOND PHASE OF AMP PROGRAM "AGING MANAGEMENT REVIEW"	29.12.2006.	01.08.2008.	01.12.2010.	15.12.2010.	AMP	ING.DOV	ING.MOD
2005-510	PSR WOG 8 -2 MATERIALS SUBCOMMITTEE - THERMAL AGING OF CAST STAINLESS STEEL COMPONENTS OTHER THAN PIPING AND FITTINGS	30.12.2005.	01.01.2007.	01.01.2008.	15.12.2010.	AMP	ING.DOV	ING.MOD
	Review of original MUHP-1080 requirements	30.12.2005.						
	Preparation of NEK plant specific report related to generic requirements and identification of possible future activities		01.01.2007.					
	Implementation of possible activities and preparation of PSR closure report			01.01.2008.	15.12.2010.			
2005-545	PSR WOG 7-1 THROUGHT 7-15; STEERING COMTEE SUBCOMMITTEE PROVIDE AN AGING MANAGEMENT REVIEW IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR PART 54 (LICENSE RENEWAL)	31.07.2006.	31.07.2008.	31.07.2009.	15.12.2010.	AMP	ING.DOV	ING.MOD - discipline engineers
	Review of original 10CFRpart54 according with WOG programs (MUHP-6113, 6114, 6115, 6116, 6117, 6118, 6119, 6120, 6121, 6122, 6123, 6124, 6125, 6126, 6127) and preparation of response plan in conjunction with CAP2005-404	31.07.2006.						
	Preparation of NEK plant specific report related to plant status of 10CFRpart54 requirements and resolutionof CAP 2005-404		31.07.2008.					
	Implementation of possible corrective measures/enhancements (also RCP status update)			31.07.2009.	15.12.2010.			
2005-546	PSR WOG 7-2 STEERING COMTEE SUBCOMMITTEE PROVIDE AN AGING MANAGEMENT REVIEW IN ACCORDANCE WITH THE REQUIREMENTS OF 10 CFR PART 54 (LICENSE RENEWAL)	29.12.2005	31.07.2008.	31.07.2009.	15.12.2010.	AMP	ING.DOV	ING.MOD - discipline engineers
	Review of original 10CFRpart54 according with WOG programs (MUHP-6113, 6114, 6115, 6116, 6117, 6118, 6119, 6120, 6121, 6122, 6123, 6124, 6125, 6126, 6127) and preparation of response plan in conjunction with CAP2005-404	29.12.2005						
	Preparation of NEK plant specific report related to plant status of 10CFRpart54 requirements and resolutionof CAP 2005-404		31.07.2008.					
	Implementation of possible corrective measures/enhancements (also RCP status update)			31.07.2009.	15.12.2010.			
Krsko Plant Specific EOP Supporting Activities (EOP)								
2004-3945	PSR 2.2B-6OPERATING LIMITS AND PROCEDURES REVIEW - COMPLEMENTARY EOP VERIFICATION ON SPECIFIC TOPICS	31.01.2006.	30.06.2006.	01.01.2007.	15.12.2010.	EOP	ING.DOV	TO.PR
	Complementary EOP verification on specific topics by EOP/Safety Analyses specialists to ensure full consistency between EOP and plant Design Basis, and eventually improve plant safety by means of EOP.	31.01.2006.						
	Preparation of NEK plant specific report related to status of NEK EOPs		30.06.2006.					
	Implementation of possible corrective measures/enhancements and upgrade of the NEK EOPs			01.01.2007.				
	Approval and closure of PSR item				15.12.2010.			
2004-4166	PSR PREGLED IN ANALIZE 2.2B-3 AOP/EOP SETPOINT CALCULATION UPDATE	1.2.2006	01.07.2006.	01.12.2006.	15.12.2010.	EOP	ING.DOV	TO.PR
	Review of NEK EOP setpoint study (technical report) and calculation update should be pursued, with emphasis on channel uncertainty calculation.	1.2.2006						
	Revision of NEK EOPs Setpoint Study and development the new technical report related to NEK plant specific AOP Setpoint study.		01.07.2006.					
	Final review and approval of both (EOP and AOP) setpoint study and status reports.			01.12.2006.				
	Approval and closure of PSR item				15.12.2010.			
2005-503	PSR WOG 1 -9 OPERATIONS SUBCOMMITTEE - OPERATOR RESPONSE TIME	30.12.2005.	30.12.2006.	01.06.2007.	15.12.2010.	EOP	ING.DOV	TO.PR
	Review of original MUHP-2065 requirements	30.12.2005.						
	Preparation of NEK plant specific report related to generic MUHP-2065 requirements and identification of possible future activities		30.12.2006.					
	Implementation of possible activities and preparation of PSR closure report			01.06.2007.	15.12.2010.			
2005-504	PSR WOG 1 -7 OPERATIONS SUBCOMMITTEE - CRITICAL TASKS (CTS) WITHIN THE EMERGENCY RESPONSE GUIDELINES	30.6.2006	30.12.2006.	30.06.2007.	15.12.2010.	EOP	ING.DOV	TO.PR
	Review of original MUHP-2013 requirements	30.06.2006.						

Some of the major activities, which are going to be implemented through NPP Krško Action Plan arte:

- Implementation of the Ageing Management Program (AMP)
  It has started recently. The first phase - Aging Management Scoping and Screening is already done through the second phase of the PSR program in which was determined methodology for selecting SSC (Systems, Structures, and Components), which are going to be in the scope for AMP. The final result of the first phase was database, which would be used as a tool in the implementation of AMP program. Origin for implementation of AMP is NRC regulation and License Renewal Process – LR, which is based on the 10 CFR 54. The first step in continuing would be updating scoping and screening results and development system-specific AMP reports for all required systems within AMP scope. The next step would be engineering studies to demonstrate adequacy of plant-specific procedures and programs, and development of new and/or revised plant programs / procedures. It would be done identification of all applicable TLAA's, and reports on individual TLAA evaluations. A summary report describing the processes involved in making the AMP would be deliverable together with updated procedures, and updated design change process documentation.

- Environmental Qualification Process
  It has started recently. The objective of this issue is to establish the list equipment that is required to be maintained under the EQ requirements defined in the NPP Krško EQ program. The result would be update of the EQ equipment master list data base.

- RB Recirculation Sump Screens Replacement
  In the event of a HELB inside the containment of a PWR, energetic pressure waves and fluid jets would impinge upon materials in the vicinity of the break, such as thermal insulation, coatings, and concrete, causing them to become damaged and dislodged. Debris could also be generated through secondary mechanisms, such as severe post-accident temperature and humidity conditions, flooding of the lower containment, and the impact of containment spray droplets. In addition to debris generated by jet forces from the pipe rupture, debris can be created by the chemical reaction between the chemically reactive spray solutions used following a loss of coolant accident and the materials in containment. Subsequently, if the emergency core cooling system (ECCS) or containment spray pumps (CSS) were to take suction from the recirculation sump, the suspended debris could tend to increase the head loss across the screen through a filtering action. If a sufficient amount of debris were to accumulate, the debris bed would exceed the NPSH margin required to ensure the successful operation of the ECCS and CSS pumps in recirculation mode.
  At the moment are performing analyses to determine possible solution for strainer construction, which can assure adequate NPSH for ECCS and CSS pumps. Next step would be replacement of the existing strainers.

- Replacement of calcium-silicate insulation
  Evaluation based on methodology for the plant-specific evaluation of the emergency core cooling system (ECCS) or containment spray system (CSS) sump performance following all postulated accidents for which ECCS or CSS recirculation is required, with specific attention given to the potential for debris accumulation that could impede or prevent the ECCS or CSS from performing its intended safety functions resulted in action for

replacement of calcium-silicate with RMI insulation. Chemical reaction caused by interaction of calcium-silicate with anhydrous trisodium phosphate (TSP) cause debris, which mostly increase head loss across the screen.

- Enhancement of the AC Emergency Power Supply System
  The aim of this analyse was to evaluate alternative solutions for reducing the core damage frequency contribution from events that result in loss of electric power to the Emergency Power Supply (EPS) system. The principle contributors to these events include Loss of Off-site Power (LSP) and Station Blackout (SBO). It is also evaluated technical, risk and safety benefits versus budgetary cost of several options related to the enhancement of the emergency powers supply.

5 CONCLUSIONS

The first Periodic Safety Review was completed in 2005. The action plan [2] lists issues that should be implemented at NPP Krško. The Slovenian Nuclear Safety Administration by decree approved the first periodic safety review and the implementation plan. All the activities have to be finished till the end of the year 2010.

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