NUBIKI NUCLEAR SAFETY RESEARCH INSTITUTE

Review of PSA as Part of the PSR for NPP Paks

Attila Bareith

bareith@nubiki.hu

PSAM 14

Probabilistic Safety Assessment & Management

16-21 September, Los Angeles, USA

Outline

- Background
- Review Requirements
- PSA Scope
- Methodological Aspects
- Input Data and Analysis Tools
- PSA Results
- Review Findings
- Conclusion

Background

- NPP Paks consists of four PWR units of Russian design, designated as VVER-440/213
- Net output is 500 MWe per unit
- Periodic safety review (PSR) is mandatory in every 10 years: latest in 2017
- Hungarian Atomic Energy Authority (HAEA) issued a guide on PSR addressing goals, technical contents and approaches to be followed by the licensee during the review
- PSR includes review of safety analyses for the plant
- Review of PSA covered
  - Scope
  - Analysis methods and assumptions
  - Input information
  - Analysis tools
  - Results
  - Documentation and QA
  - Use of PSA in safety management

NUBIKI

Review Requirements

Concerning PSA, Reg. Guide on PSR recommends evaluation of the following aspects

- Fulfillment of PSA related regulatory requirements
- Conformity with the specific Reg. Guide on PSA and with good practices
- True and credible representation of actual plant conditions by adequately incorporating the effects of plant changes implemented and lessons learned from operating experience in the last 10 years
- Suitability for an up-to-date characterization of plant safety from a PSA perspective
- Appropriateness for use in fulfilling regulatory requirements on PSA applications in support of safety management at the plant.

PSA Scope – 1

- PSA was examined by using the following scope attributes:
  - Levels of the analysis
  - Sources of potential large releases
  - Initiating events
  - Plant operational states
  - Range of accident sequences models

PSA Scope – 2

Release source	Plant mode	Initiating Event	Unit 1	Unit 2	Unit 3	Unit 4
Reactor	Full power	Internal	+	+	+	+
		Int. Fire	+	+	+	+
		Int. Flood	+	+	+	+
		Earthquake	Ongoing	Ongoing	+	Ongoing
		Ext. weather	Unit 3	Unit 3	+	Unit 3
		Riv. Events	Unit 3	Unit 3	+	Unit 3
	LP & SD	Internal	+	+	+	+
		Int. Fire	+	+	+	+
		Int. Flood	+	+	+	+
		Earthquake	Ongoing	Ongoing	+	Ongoing
		Ext. weather	Unit 3	Unit 3	+	Unit 3
		Riv. Events	Ongoing	Ongoing	Ongoing	Ongoing
SFP	All	Internal	+	+	+	+
		Int. Fire	+	+	+	+
		Int. Flood	+	+	+	+
		Earthquake	Ongoing	Ongoing	+	Ongoing
		Ext. weather	Unit 3	Unit 3	+	Unit 3

Methodological aspects

- Some factors helped simplify PSA review from methodological points of view
  - HAEA had previously performed detailed independent expert reviews of PSA
  - There is a living PSA program in place that includes regular interfacing with regulatory staff
- Top level review covered key PSA areas / steps
  - Analysis of initiating events
  - Development of accident sequence models
  - System analysis and fault tree development
  - Analysis of dependent failures
  - Human reliability analysis
  - Assessment of input reliability data
  - Analysis of internal and external hazards
  - Risk quantification
  - Documentation

NUBIKI

Input Data and Analysis Tools

- The information sources used in PSA are complex and manifold, e.g.
  - Plant design data
  - Information on operations and maintenance
  - Results of accident simulations
  - Special-purpose supporting analyses, etc.
- All the sources were systematically evaluated in the PSR in two major categories
  - Input to developing accident sequence models
  - Input to quantifying accident sequence models
- Review of analysis tools included
  - Tools used directly for modeling and quantification of accident sequences
  - Tools used for generating input information in support of PSA modeling and quantification

PSA Results – 1

- Results of Paks PSA are updated annually in living PSA
- Results are evaluated and reported to HAEA during updates – a high level review of results was considered satisfactory
- Review highlighted changes in PSA results in last 10 years due to
  - Evolution in PSA scope
  - Improvements in modeling details as reflected in the living PSA program

PSA Results – 2

Low pov

events:

Review Findings

- Paks PSA broadly satisfies regulatory requirements and recommendations
- Deficiencies to meet some requirements on the use of PSA in safety management identified
- Importance of living PSA program emphasized
- Move towards site level risk assessment should be made
- Corrective actions have been proposed based on non-compliances revealed
  - External hazards PSA for SFP
  - Systematic analysis of combined external hazards
  - PSA modeling and quantification of post-Fukushima measures
  - Strengthening PSA applications
- Licensee PSR report and related proposals for corrective actions are subject regulatory evaluation at present

NUBIKI

Conclusion

- Plant specific PSA was an important component in the latest PSR for NPP Paks
- Review was performed in accordance with the specific Reg. Guide on PSR
- Review results show that the plant PSA and its applications broadly satisfy the relevant regulatory requirements and recommendations
- Some corrective actions have been proposed based on non-compliances identified
- The proposals are currently subject to regulatory evaluation

NUBIKI

Thank you for your kind attention!