REPUBLIC OF SLOVENIA
MINISTRY OF THE ENVIRONMENT AND SPATIAL PLANNING
SLOVENIAN NUCLEAR SAFETY ADMINISTRATION

The Progress, Status and Challenges of the Slovenian NAcP

Siniša Cimeša, SNSA
Matjaž Podjavoršek, SNSA
Božidar Krajnc, Krško NPP

Contents

- The progress and status of the Slovenian NAcP
- Additional subjects to discuss

Progress & status of the NAcP: The SUP

- Progress of the Safety Upgrade Program (SUP) (action No. 1)
  - Initial plan - 2012
    - 2012-2013 – First implement severe accident mitigation modifications (DEC B area of improvements):
      - Replacement of active H2 recombiners with PARs
      - Installation of passive containment filtered venting system
    - 2012-2016 – Implement safety upgrades to further decrease SA probability (DEC A) modifications – concept of one big project – Bunker Building 2 project (BB2)

Progress & status of the NAcP: The SUP

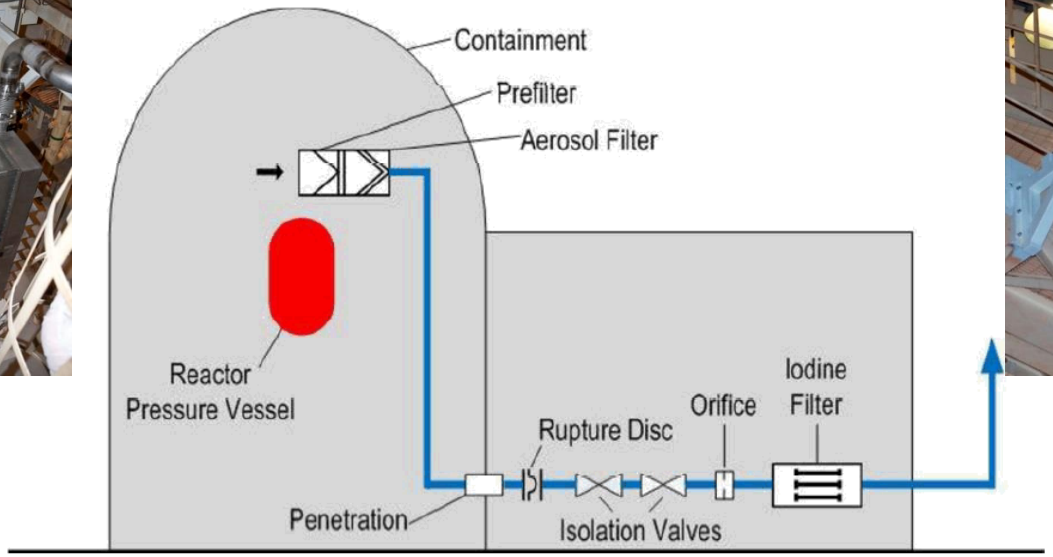
- Progress of the SUP
  - New circumstances during implementation
    - Inclusion of the Krsko NPP into the Public Procurement in Water Management, Energy, Transport and Postal Services Area Act
    - Krsko NPP performed bidding for BB2, got only one offer, which didn't include completion of BB2 until 2016
    - The operator applied for SUP implementation deadline extension – SNSA approves until 2018
    - Due to historically low price of electricity owners start doubting about the eligibility of life time extension with such high investments needed for complete SUP
    - Owners requested Economic and Risk Study of Life EXtension (ERALEX) – performed in 2014

Progress & status of the NAcP: The SUP

- Progress of the SUP
  - Krsko NPP decides to divide the SUP into three phases
  - Gets owners' approval for Phase II – condition is to perform ERALEX study - under implementation
    - December 2014 – ERALEX study completed – it confirms conclusions of OECD 2012 study by which the life time extension of NPPs is most economically efficient solution of energy production in OECD countries except the USA (for some US regions the natural gas is more economical)
  - Phase III will be conceived and implemented between 2015 - 2021
    - Additional studies ordered (to be completed in first half of 2015) with the aim to compare what safety upgrades will be performed in other EU countries
    - Krsko NPP performed additional benchmarking of its SUP with the industry from some EU countries (France, Sweden)
    - All above with the aim to assure that SUP will be in line with the best industry practice/plans and regulators requirements in EU
    - Krsko NPP will apply for new Phase III deadline in 2/2 of 2015

Progress & status of the NAcP: The SUP

- SUP current status
  - Phase I: Completed as planned (2013)
    - Replacement of active H2 recombiners with PARs (action 1.5)
    - Installation of passive containment filtered venting system (action 1.5)



OECD/NEA/CSNI Status Report on Filtered Containment Venting, NEA/CSNI/R(2014)7, July 2014

Progress & status of the NAcP: The SUP

- SUP current status
  - Phase II: Implementation started (design phase) → 2018
    - Additional flood protection of the nuclear island (action 1.9) 2015
    - Operation support center reconstruction (part of action 1.10) 2016
    - Installation of pressurizer PORV bypass (part of action 1.4) 2016
    - Spent fuel pool (SFP) alternative cooling (action 1.7) 2016
    - Alternate cooling of RCS and containment (action 1.8) 2018
    - Installation of emergency control room, ECR (action 1.6) 2018
    - Upgrade of BB1 electrical power supply (part of action 1.1) 2018
    - ECR / Technical support center ventilation and habitability system (part of action 1.10) 2018
    - Additional independent instrumentation (part of action 1.6) 2018

Progress & status of the NAcP: The SUP

- SUP current status
  - Phase III: BB2 – ongoing
    - waiting for results of comparison studies,
    - finalization of conceptual design solutions;
    - waiting for operator's application for deadline extension; 2021(?)
      - Installation of additional water sources (alternative heat sink) (action 1.3)
      - Additional pumps for injecting into steam generators (action 1.2)
      - Additional pumps for injecting into the RCS, SFP, containment (action 1.4)

Challenges and good practices: The SUP

- Challenges
  - Large modifications, initial difficulties with the new procurement act → large delays, project cancelations, etc.
  - Owners doubts about the financial viability of the project (high project price / low electricity price)
- Good practices
  - Phase I implemented – improved mitigating capabilities (design basis is 24hr SBO and total core melt-through without any operator action – no use of DEC systems, SAMGs and/or mobile equipment)
  - Phase II and III underway
  - Additional third DG in bunkered building already built
  - Large quantity of mobile equipment stored on site (protected building), quick connection points, SAMGs and procedures for use of mobile equipment available
  - Use of mobile equipment regularly trained (also with use of BDBA simulator)

Progress & status of the NAcP: Legislation

- Progress and status of the "Legislation" (action No. 2)
  - SNSA is in the process of amending / revising its legislation based on the above stated commitments and/or considerations
  - The first drafts have been prepared
  - Update of WENRA RL is included
  - Final internal revisions are needed before public hearing
  - Expected to complete in 2015

- Challenges
  - Time and resource consuming
- Good practices
  - Updated WENRA RL incorporated in relatively short time

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response" (action No. 3)

1. Review of basis and assumptions for the National Radiation Emergency Response Plan and coordination of RERP with Croatia
   - This work is ongoing from 2012
   - Several analyses and calculations of different accident scenarios were performed to verify existing or propose new emergency planning zones
   - The inter-ministerial commission established a working group in 2014 comprised of:
     - The SNSA
     - Administration of the Republic of Slovenia for Civil Protection and Disaster Relief
     - The Krsko NPP
     - Jozef Stefan Institute
     - State Office for Radiological and Nuclear Safety (SORNS), Croatia
     - National Protection and Rescue Directorate, Croatia

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

1. Review of basis and assumptions for the National Radiation Emergency Response Plan and coordination of RERP with Croatia
   - The goals of the working group:
     - Renew strategies for off-site emergency arrangements
     - Harmonize these strategies between Slovenia and Croatia
   - Ultimate goals:
     - The planning zones of both countries should have equal dimensions and planned emergency measures
     - The activities of the response organizations should be coordinated during accident progression
   - The report of the WG is being finalized right now
   - The main results are:
     - Sizes of zones will remain 3, 10 and 25 km
     - Immediate evacuation of 10 km after general emergency is declared

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

1. Review of basis and assumptions for the National Radiation Emergency Response Plan and coordination of RERP with Croatia

- Challenges:
  - The major difficulty was reaching the agreement of the size of the emergency zones especially of the Urgent Protection Zone
- Good practice:
  - The two countries started cooperating in the emergency response area
  - In the long run both countries will have harmonized and coordinated response plans

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

2. Revision of the National Radiation Emergency Response Plan
   - Provisions for the off-site support regarding the long term fuel supply
   - Provisions for providing additional pieces of mobile equipment
   - Revision of the NRERP will be completed in 2015 (or 2016 latest)

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

3. Procedure for dealing with post accident emergency situation
   - The SNSA developed a procedure for dealing with post-accidental emergency situation
   - This procedure should give first guidance information to the government regarding which steps need to be taken in the near and far term after the nuclear of radiation accident in order to:
     - protect the population from ionizing radiation
     - assure radiological monitoring of the environment
     - identify and implement strategic measures (e.g., prohibit or restrict the consumption of contaminated drinking water and food, temporary and permanent relocation, decontamination of the environment)
     - mitigate the effects of protective measures
     - inform
     - mitigate economic damages and provide compensation of the damage
     - revive the affected area

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

4. Large longer term exercises
   - Five year exercise plan was prepared and is being revised each year
   - The plan defines the severity of scenario, time duration, and participants
   - A national exercise, involving all interface points (national, regional and municipal), as well as neighboring countries (especially Croatia) is planned every three years
   - Out of those an exercise of longer duration (e.g. 48 hrs) is to be every five year
   - Such exercise was performed in November 2014

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

5. Enhancement of national early warning system
   - A review of the current status and comparison with the world practice was done in 2013
   - Based on that the proposals for improvements were prepared
   - The first part, "Replacing obsolete monitors with new ones" has been approved and is to be implemented in 2015
   - The second part of the improvements, "The replacement of the obsolete interface", has not yet been approved due to lack of funds

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"

6. Consideration of reference levels for importing food and trans-border processing of goods and services such as container transport
   - The national procedures and responsibilities for determining reference levels for importing food and trans-border processing of goods and services have been reviewed
   - It has been determined that these areas are under jurisdiction of Administration of the Republic of Slovenia for Food Safety, Veterinary Sector and Plant Protection
   - Based on that, the SNSA supplemented its own procedures for emergency events

Progress & status of the NAcP: Emergency response

- Progress and status of the "Emergency response"
- Other actions underway or being considered:
  - The program of intervention personnel training
    - The program was prepared, but it not yet implemented
    - Efforts towards implementation have been made by commission on radiation emergency planning
  - Preparing national strategy regarding solutions for treatment of potentially large volumes of contaminated water
    - Nothing has been done in this regard yet
    - Waiting for "good practice" from bigger nuclear countries

Progress & status of the NAcP: Inspections

- Progress and status of the "Inspections" (action No. 4)
  - Most inspections performed by SNSA inspection in years 2013 – 2014:
    - Inspecting test and maintenance of mobile (SAME) equipment together with procedures
    - Staff training on using SAMGs and other procedures
    - Use of SAME during exercises
    - Plant's capabilities to power communication equipment needed to communicate onsite (e.g., radios for response teams and between facilities) and offsite (e.g., cellular telephones, satellite telephones) during a prolonged SBO

Progress & status of the NAcP: Inspections

- Progress and status of the "Inspections" (action No. 4)
  - Some of those inspections performed periodically, e.g. inspection of SAME equipment, SAME test and maintenance procedures
  - Inspection for verifying the external flood protection equipment has not yet been performed (in the framework of NAcP inspections)
  - External floods is a regular topic in Krsko NPP, thus it is being reviewed and inspected regularly every few years
  - External floods inspection will be again performed in 2015, when several SUP modifications for flood protection of the nuclear island and BB1 building will be implemented
  - Inspections performed so far show good equipment, procedure and operator readiness in all areas

Progress & status of the NAcP: Additional studies

- Progress and status of the "Additional studies" (action No. 5)
  - Analyses regarding accident timing (core melt, reactor pressure vessel failure, basemat melt-through) using a different computer code required from the plant within the framework of licensing the PAR modification in 2013 (Krsko NPP's safety analyses originally done by MAAP, additional analyses shall be done by MELCOR)
  - The deadline for these analyses was the end of 2014, but due to technical difficulties with the code deadline was postponed until the end of 2015
  - SNSA still considering other additional analyses
  - SNSA is in the process of familiarization with the situation and existing studies from these areas
  - All additional studies (if needed) should be completed by 2017

Progress & status of the NAcP: Additional studies

- Progress and status of the "Additional studies"
  - Good practice
    - In winter 2014 freezing rain hit almost entire country, which caused large damage to the electrical network (around 250,000 people left with no power for weeks)
    - Krsko NPP survived the event without a problem (the freezing rain was less severe in eastern part of the country)
    - SNSA requested the plant to perform a detailed freezing rain survivability analysis taking into account even more severe scenario of the event (loss of offsite power for one week, no connection to the dedicated gas power plant Brestanica, ventilation openings blocked due to glaze formation on walls (15-20 cm thick), load on roofs more than 150 kg/m2 , etc.)
    - Results showed the plant can endure even such scenario (with minor improvements of its procedures)

Progress & status of the NAcP: Nuclear safety infrastructure

- Progress and status of the "Nuclear safety infrastructure" (action No. 6)
  - In recent years SNSA has been drawing attention to the situation regarding financing of the Slovenian nuclear safety infrastructure, which is not in its best state
  - This was done by:
    - preparing proposal of national resolution on nuclear and radiation safety, which gives stress on importance of stable financing of nuclear safety infrastructure (resolution adopted by Government in 2013)
    - calling attention on it in its annual reports to the Parliament
    - organizing two special conferences, at which all Slovenian nuclear industry was gathered and discussed different topics, such as political support, research financing, cooperation of stakeholders, etc
  - Up to now no major progress noted
  - SNSA will continue to strive to make progress in the area of improving and stabilizing the Slovenian nuclear safety infrastructure

Progress & status of the NAcP: SNSA processes

- Progress and status of the "SNSA processes" (action No. 7)
  - SNSA reviewed its priority order of participation in international meetings and based on that revised its own procedure administrating international cooperation
  - SNSA reviewed its training plan in the area of severe accident and severe accident management guidelines – No additional actions were required
  - SNSA reviewed its capability for evaluating defense-in-depth
  - Two new projects are being developed that would further enhance SNSA defense-in-depth evaluating capabilities (2015)

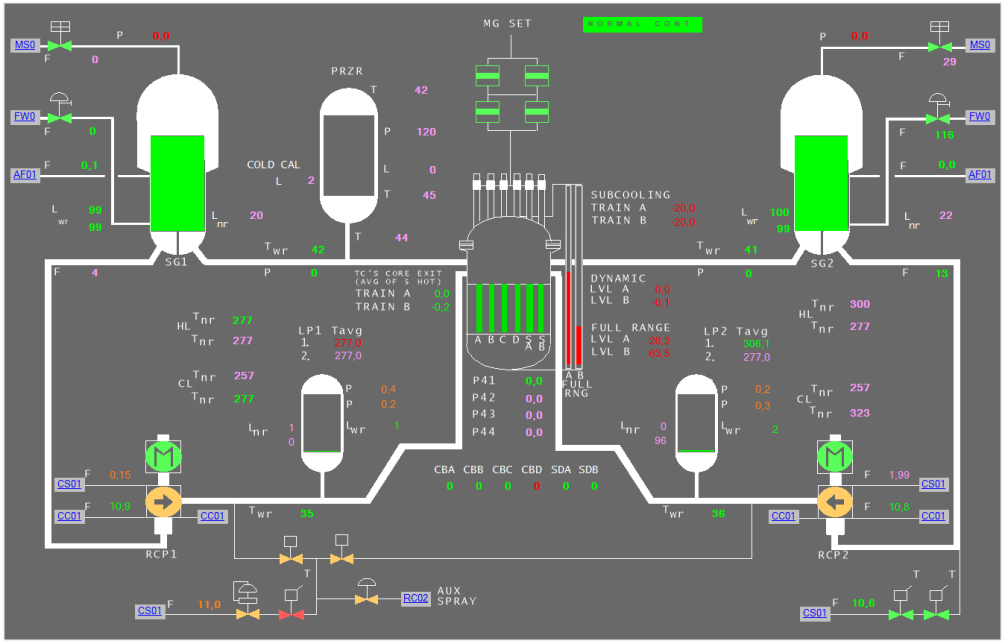
Progress & status of the NAcP: Peer reviews

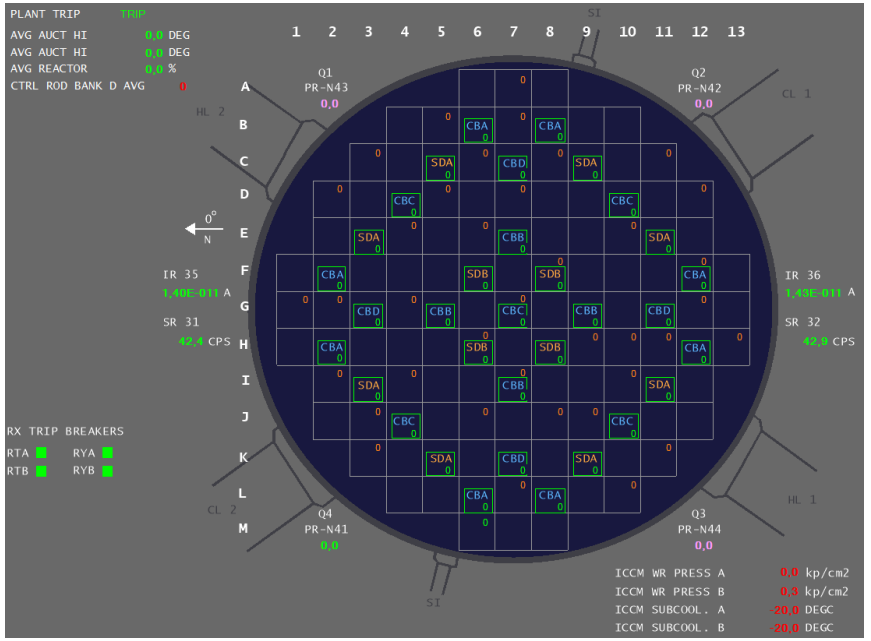
- Progress and status of the "Peer reviews" (action No. 8)
  - SNSA hosted IRRS follow-up mission in September 2014, which also highlighted the problems of financing the SNSA and research activities on nuclear safety
  - SNSA invited two additional missions, namely the OSART and EPREV missions, which will both take place in the year 2017
  - RAMP mission will be invited after the completion of the SUP

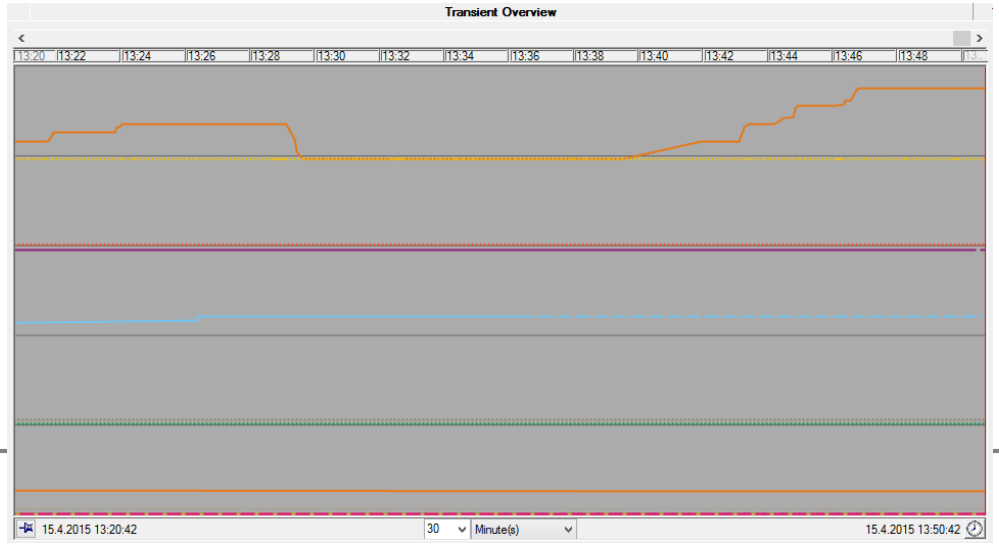
Progress & status of the NAcP: ERDS

- Progress and status of the "ERDS" (action No. 9)
  - In March 2014 SNSA issued a decision by which the Krsko NPP must upgrade the Emergency Response Data System (ERDS) by April 2015
  - The upgrade has been completed in February 2015
  - Upgrade includes:
    - more reliable data connection
    - more reliable data storage
    - interface with enhanced review capabilities
    - better maintenance and upgrade capabilities
    - higher level of cyber security
  - Also includes approx. 4.5 times more parameters (ca. 900), including all parameters needed for evaluating severe accidents!

Progress & status of the NAcP: ERDS







Progress & status of the NAcP: PSA

- Progress and status of the "PSA" (action No. 10)
  - Krsko NPP started preparing the PSA for the spent fuel pool on its own initiative in 2014
  - It also started a project of developing the PSA for the low power and shutdown modes
  - Both should be completed in 2015
  - Regarding the legislation SNSA added a requirement for PSA for spent fuel pool in the drafted JV9 regulation (Rules on operational safety of radiation or nuclear facilities)

Progress & status of the NAcP: Safety culture

- Progress and status of the "Safety culture" (action No. 11)
  - SNSA reviewed the current status of transparency, relationships between regulators, operators and the public, and its processes for assessing, achieving and maintaining high level of safety culture
  - The view of the SNSA is that this action is already being implemented on a daily basis with available processes and procedures in place
  - No additional measures are necessary

Progress & status of the NAcP: Dry cask storage

- Progress and status of the "Reviews and NPP improvements – Dry cask storage" (action No. 12)
  - Based on SNSA decision on Krsko NPP life time extension (2012) and Fukushima lessons learned Krsko NPP decided to speed up the construction of dry cask storage (from 2023 to 2018-2019)
  - It prepared the conceptual design package for the purpose of starting a bidding process
  - Currently the Resolution on the 2006-2015 National Program for Managing Radioactive Waste and Spent Nuclear Fuel is in the process of amending
  - It is expected that the new Resolution could be adopted by the Parliament until the end of 2015

Conclusion

- The Krsko NPP SUP is moving forward:
  - Phase I (DEC B part) complete in 2013
  - Phase II (DEC A part) underway and to be completed until 2018
  - Phase III (DEC A part) has green light – 2021
- Additional third DG in bunkered building already built
- Large quantity of mobile equipment stored on site (protected building), quick connection points, SAMGs and procedures for use of mobile equipment available
- Use of mobile equipment regularly trained (also with use of BDBA simulator)

Conclusion

- Other improvements:
  - legislation update (Updated 2014 WENRA RL)
  - emergency response (in cooperation with Croatia)
  - additional studies (new Melcore analysis)
  - upgraded emergency response data system (ERDS)
  - new PSA studies (SFP and LPSD PSA)
  - Dry cask storage
- The level of nuclear safety of Krsko NPP and radiation safety of Slovenia and Croatia will be further radically increased

Questions & Answers

Methods to evaluate and detect degraded safety culture

- Q: Could you elaborate on how action 11 is executed, especially concerning safety culture (required actions, evaluation and detection)?
- A: Action 11 was taken from the Convention on Nuclear Safety. SNSA is committed to open and proactive communication with all stakeholders. SNSA works well with media. Also meetings with non-governmental organizations (Greenpeace, Focus, …) take place twice a year.
  At the end of December 2012 SNSA adopted guideline "Collection of information, monitoring and assessment of safety culture in nuclear facilities" in order to increase awareness of the existing safety culture, to suggest possibilities for improvement and monitor the effects of changes and improvements over a longer period of time. In 2014 the guideline was revised. As a part of the guideline there is an appendix "Information on safety culture", which is designed to gather information and review of safety culture during visits in the NPP Krško nuclear facilities and other activities related to the licensing and supervision of safety. All the gathered information is sorted in accordance with IAEA SCART guidelines into 37 safety culture attributes. After that a report about safety culture in the Krško NPP is written and sent to the operator. The findings are also discussed annually in the management meeting between SNSA and NPP Krško.

Questions & Answers

Delays in SUP project

- Phase I: Completed as planned (2013)
  - Installation of PARs in CNT
  - Installation of passive containment filtered venting system
- Phase II: Implementation started (major part of SUP)
  → 2015 – 2018
- Phase III: BB2 – ongoing
  - Conceptual design under development and verification with best industry practice/solutions
  - For implementation more time is needed
  - waiting for operator's application for deadline extension
    → 2021(?)

Questions & Answers

Present progress of the SUP project, especially phase 2

- Design phase of the SUP Phase II have started
- Completion of first project in 2015
  - Additional flood protection of the nuclear island
- Continues in 2016 and 2017
  - Operation support center reconstruction
  - Installation of pressurizer PORV bypass
  - Spent fuel pool (SFP) alternative cooling
- And finishes in 2018
  - Alternate cooling of RCS and containment
  - Installation of emergency control room (ECR)
  - Upgrade of BB1 electrical power supply
  - ECR / Technical support center ventilation and habitability system
  - Additional independent instrumentation

Questions & Answers

Compensatory measures for coping with DEC

The Krško NPP operates in accordance with valid design basis requirements, while the SUP represents the improvements covering beyond design basis events (or DEC). Thus the compensatory measures are not required by the SNSA.

In addition the Krsko NPP has already implemented SUP I modifications (**PCFVS and PARs**), has developed **SAMGs** (already in late 90's), which were substantially improved after the Fukushima accident and also additionally supported by acquiring large number of different **mobile equipment** (complying with NRC's B.5.b requirements). This equipment is **regularly tested** and also used during regular drills/exercises, which are **supported with the full scope BDBA simulator** capable of simulating BDBA scenarios.

Questions & Answers

EPR cooperation with Croatia

- The two countries started cooperating within the working group established for verifying/revising emergency planning zones within the NRERP
- The group meets every 1 – 2 months
- The goals of the working group:
  - Renew strategies for off-site emergency arrangements
  - Harmonize these strategies between Slovenia and Croatia
- Ultimate goals:
  - The planning zones of both countries should have equal dimensions and planned emergency measures
  - The activities of the response organizations should be coordinated during accident progression

Questions & Answers

Seismic Hazard (questions from Austria, France, Greenpeace and public)

- Q1: What is the reason to select the extremely small safety margin of 0.04g for DEC analysis (0,6g against the updated design basis event of 0.56g)?
- A1: The value of PGA=0,56 g by itself conservatively takes into account number of uncertainties inherent to different phases of its development. The main DEC criteria used to determine PGA=0.6g was 10000 y return period. The actual design value was arbitrarily rounded to 0.6 g. This slight increase could be considered as an additional safety margin or only as a slight numerical rounding. **This is also in compliance with WENRA RL, Rev.1 (2014), section T.**

  Any additional increase of it would indeed represent additional conservatism, but on another hand would also mean large increase of cost or even make implementation impossible. In another extreme the question could also be: Why didn't you double, triple or even quadruple the PGA!

Questions & Answers

Seismic Hazard (questions from Austria, France, Greenpeace and public)

- Questions regarding peer review and new analysis
- A: SNSA does not intend to invite a dedicated Peer Review mission to reassess seismic hazard. Any reassessment of seismic hazard is kind of Peer Review anyway, where a number of experts discuss about their opinion and explanations of known data. The result is always very uncertain. We see no added value in inviting yet another group of people to Peer Review as for sure the result will not reduce uncertainties.
  However, GEN Energija, the owner of the Slovenian half of the Krsko NPP has contracted a new seismic hazard study of the area, so we will get new insights from the consortium of distinguished world experts.
  The investigations will be divided into three phases (about two years):
  - Phase 1: Field investigations – include: Tectonic geomorphic characterization, Geophysical investigation, Drilling, Paleoseismological investigation and Age dating
  - Phase 2: Fault capability and Seismic source characterization
  - Phase 3: Ground motion characterization, probabilistic seismic hazard analysis, and control point ground motion

Questions & Answers

Flood Hazard (questions from Greenpeace and public)

- Q1: Which safety margins are attributed to the new flood protections dike against natural hazards (earthquake and flooding) with a return frequency of 10,000 per year? When will the reinforcement project of the dyke be completed?
- A1: The dike upgrades were completed in 2012 and are designed to protect the plant against floods of up to 11,000 m3/s, which is greater than PMF flood (7,080 m3/s) and greater than floods with return period of 10,000 years (4,790 m3/s). The dikes are also seismically designed to SSE PGA.

Questions & Answers

Flood Hazard (questions from Greenpeace and public)

- Q2: What is the current status of the flood protection upgrade?
- A2: Further flood protection improvements of the nuclear island will be implemented in 2015 (assuming PMF and dike failure at the same time). Please note, that this is for Design Extended Conditions with the assumption of combined event of flooding with PMF river flow (return period of 10E-6) and above SSE earthquake (greater than 0.3 g PGA), which could cause failure of river dikes at the presence of PMF flooding level of Sava river.

Questions & Answers

In-vessel retention and/or ex-vessel cooling (technical solution)

- Q: N/A
- A: NEK has implemented design change to assure cavity flooding in case of DBA or BDBA. External flooding of the reactor vessel can be assured using severe accident management strategy within existing SAMG used at the plant.