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Swedish presentation at the ENSREG National Action Plans Workshop

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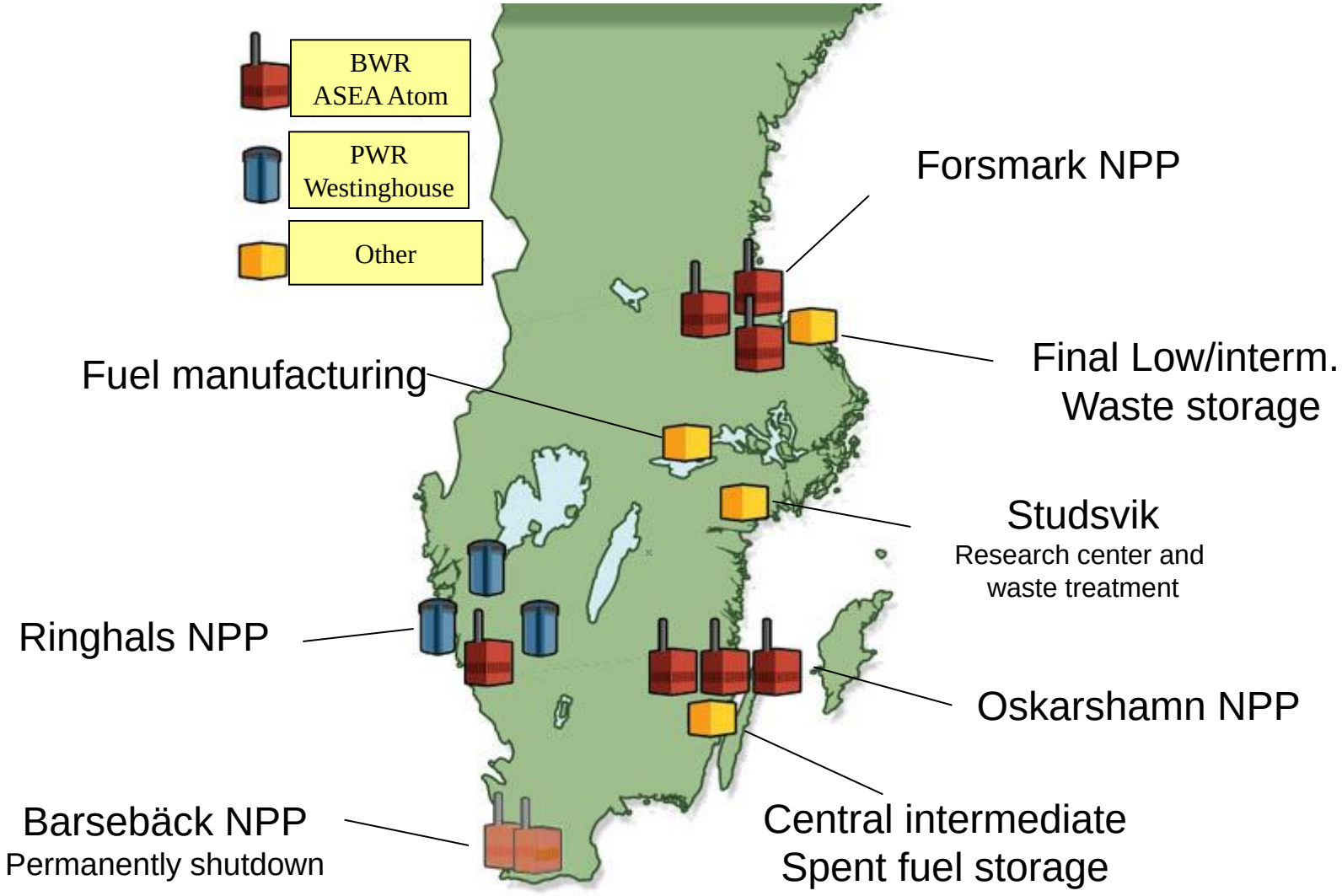
Swedish nuclear facilities



Safety modernizations

- Important safety improvements in the plants due to experience from events were implemented before the accident in Fukushima
  - Severe accident mitigation system installed in all plants following TMI
- Requirements issued in 2005 lead to significant back-fitting measures for all plants
  - Plant specific implementation programs issued in 2006
  - For the majority of the reactors, the modernization projects are completed
  - Remaining measures will be implemented during outage 2015

Safety modernization, cont.

- Requirements concerning
  - Natural phenomena and external events
    - earthquakes, flooding, winds, ice, LOOP, Loss of UHS, etc
  - Common Cause Failures
  - Separation and Independence
  - SAM (long term cooling, etc)
- Examples
  - Replaced reactor protection systems
  - Additional redundant safety trains are introduced
  - Installation of hydrogen re-combiners (PAR)

New regulations

- SSM is currently revising regulations for nuclear power plants. This review will consider
  - The outcome from EU stress test and 2nd extraordinary CNS
  - WENRA RL's and IAEA safety standards
  - The IRRS mission in 2012
  - Requirements for new reactor's

The Swedish NAcP

- Structure
  - The Swedish action plan covers recommendations from the
    - Licensees stress test reports
    - National stress test report
    - Peer review national report
    - Compilation of Recommendations and Suggestions report
    - CNS
- Mainly further evaluations and analyses
  - categorized based on urgency and complexity with deadlines 2013, 2014 and 2015
  - all technical and administrative measures based on the results from assessments and evaluations will be implemented before 2020

The Swedish NAcP, cont.

- Coordinated with the modernization program
- Annual reporting on implementation
- Transparency
  - SSM Homepage
  - Local safety committee
  - Meetings with NGO’s
- Plant specific plans for implementation in spring 2016
- All the measures completed 2020

Significant issues and actions

- Risk informed strategy
  - Focus on measures with largest safety impact
- The independent core cooling function is considered to be of high priority and has been the main focus for the regulatory follow-up of NAcP 2013-2014
- Extreme external events (incl. weather conditions)
  - Return frequency of 10^{-5} /yr or 10^{-6} /yr
  - Combinations, e.g Flooding and waves
  - Flooding (2015)
  - Earth quake (2015)
  - Strengthened buildings e.g building for the EDG
  - Procedures are updated

Significant issues and actions, cont.

- Mobile equipment, emergency power supply to the filters, ECR,
- Containment filter venting systems for prolonged accidents
- Spent fuel pool cooling
- Multi unit events
- Hydrogen leakages
- Independent core cooling

Independent core cooling

- Currant status
  - Decision issued in December 2014
  - Acceptance criteria have been developed
- The final solution will be installed at the latest in 2020
- Transitional solutions for considerable reinforcement of the core cooling function’s independence shall be in place 2017
  - Includes important actions to strengthen emergency power systems

Independent core cooling, cont.

- The design basis
  - Loss of AC power for at least 72 hours
  - Loss of ultimate heat sink for at least 72 hours
  - The design basis events combined with extreme external conditions
  - Not necessary to fulfil the single failure criteria
  - Initiating events during all operational states must be considered.
  - Independent core cooling must be functionally and physically separated in respect of existing SSC credited in the safety analysis.

Independent core cooling, cont.

- Challenges
  - Level of independence
    - I&C-, electrical- and other safety systems
  - Robustness
    - Return frequency of 10^{-5} /yr or 10^{-6} /yr
  - Classification and qualification
  - Security issues

Challenges

- Seven different designs
- Ongoing modernization program
- Coordination with security
- Development of new regulations

Questions

- 85 questions
- Written answers have been provided
- Related to
  - Content of the updated NAcP
  - More detailed description of measures
  - Implementation time schedules
  - Independent core cooling

Question 1 – Filtered venting systems

Different suggested solutions for the use of the containment filtered venting system during prolonged severe accident conditions are discussed. Please, provide more information on results of these reassessments and possible improvements.

Answer

A study of the ability to manage a severe accident with the containment filtered venting system beyond 24 hours has been conducted. The conclusion of the study is that the containment filtered venting can be used for more than 24 hours after a severe accident until the residual heat removal can be re-established.

The conclusion is based on the original design basis analysis that shows that prolonged pressure relief was a design case for the systems and no drain / refill is required for at least 30 hours. Less conservative analyzes shows that no drain / refill is required during 2.4 days assuming continuous pressure relief, which ensure at least 72 hours of operation. In addition, new analyzes have been carried out within the framework of the new Independent Core Cooling function showing that residual heat removal with the containment filtered venting systems can be used and these analyzes confirm the conclusion.

Question 2 – Seismic assessment

Why is the seismic reassessment limited to specific buildings and piping of the NPP? Is a probabilistic seismic assessment requested from licensees?

Answer

In the ongoing process to qualify the NPP:s for the the10^{-5}/year earthquake, several measures have already been taken. The text describes the remaining measures. The method used is SMA. The licensees are not requested to do a seismic PSA.

Question 3 – Extreme weather

The current Swedish regulation addresses extreme weather without quantification of the loads. Has the back-fitting of the already identified weaknesses during the stress tests been completed? Which additional weaknesses regarding the plant robustness against extreme weather were identified? What is the time schedule for the necessary back-fitting measures?

Answer

Due to the modernization instructions for handling external events was developed and some critical buildings have been strengthened.

Regarding flooding, preliminary results shows that the design value is estimated to correspond to a return frequency of 10^{-6}/yr.

Regarding extreme weather, new analyses of ice storm, extreme precipitation and extreme temperatures has been completed. Regarding ice storm, the SAR and related instructions have been updated. Regarding extreme precipitation and extreme temperatures, measures are ongoing, incl. establishing a local emergency task force (completed), contracts for external support (completed), review of instructions (partially implemented) and additional mobile equipment (partially implemented).

Question 4 – SFP cooling

The necessary instrumentation to monitor temperature and water level in the fuel pools will be introduced in connection with the introduction of an alternative function for cooling the fuel in the fuel storage pools.
- When and how will this be implemented ?

Answer

Forsmark:
The planned solution is feed-and-boil-off. Fuel pools fed with mobile equipment and the steam is discharged via gaps in the reactor hall. The function, including instrumentation, is scheduled to be introduced in 2016.

Oskarshamn:
Time schedule for the implementation of alternative SFP cooling and complementary instrumentation is not fully determined yet.

Ringhals:
The planned solution is feed-and-boil-off. The solution will consist of piping that makes it possible to feed water from an external mobile unit, dedicated instrumentation for level and temperature measurement that are independent from the existing plant functions and monitoring of radioactivity content in the steam for control of releases.

Question 5 – long-term management of hydrogen

New analyses are necessary to answer questions relating to the long-term management of hydrogen in the containment. Also the possibilities and consequences of hydrogen accumulating in the reactor building were to be investigated by 2014 and suggestions made on necessary instrumentation and management.

Answer

Investigation of the management of hydrogen after core degradation is performed within a joint-Swedish nuclear industry project Nordic Owner Group (NOG). So far the project has been concentrating on hydrogen production and accumulation within the containment. The conclusion of the study is that there is no risk for detonation in the containment for sequences with an initially nitrogen inerted containment. The analysis covers 180 days. If the accident is initiated during a planned shutdown, conditions for detonations may occur. The probability for this is however very low since this is a limited time of operation.

Some potential issues in the management of hydrogen have been identified (e.g. issues related to monitoring and recombination).

The result from the analysis of leakage of combustible gases to the reactor building and the consequence of such leakage shows that further studies are needed. Early results indicate that the risk for detonation in the reactor building is limited and potential consequences of such leakage are limited.

SSM have not reviewed the results yet.

Thank you for your attention!