

STRESS TEST

First evaluation of progress reports:
BG, CR, HU, ROM, SK

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TARGET

- Obligatory: analysis of impacts of natural disasters:
 - 1. Earthquake and Flooding
 - 2. Extreme weather condition
 - 3. human induced events – as indirect initiating events
For example: damage of switchyard or grid connection of the NPP due to airplane crash
- Existing safety margins compared to the design basis are to be assessed.



Earthquake safety criteria

Basic design: DBE = Safety of the plant is demonstrated for an earthquake likely to occur once in 100,000 years (1E-5 /year)

Level 1 = plant is safely shutdown during an earthquake of 1° (grade) on MSK higher than the DBE;

Level 2 = plant is safely shutdown during an earthquake of 2° (grade) on MSK higher than the DBE;

level 3 indicates that an earthquake exceeding the one of level 2 can be (practically) excluded at this plant site..



Flooding safety criteria

Basic design: DBF= Safety of the plant is demonstrated for a flood likely to occur once in 10,000 years ($1E-4$ /year)

Level 1 = fundamental safety function is ensured if water discharge increased by a factor 1.5.

Level 2 = fundamental safety function is ensured if water discharge increased by a factor 2.

Level 3 = owing to the topography and the plant design considering the assessment criteria of level 2 a failure of fundamental safety functions is (practically) excluded.



BULGARIA

- **Content:** description of site & facilities, safety systems of Kozloduy unit 5/6 + Spent fuel storages, redundancies and diversity of safety systems (background information)
- **Kozloduy Area** is flat:
Altitude: 28-36 m over Sea level, the site is protected from Danube by a dike of 3.3 m.
- **NPP site** is on a "non-flooded terrace" at 35 m, maximal elevation of flood (1 in 10,000 years) is 33.5 m.



BULGARIA

- **Comment:** safety reserve for flood is not very large, 1.5 m.
- Assessment is not verified. A map with all relevant buildings and a vertical cross section would be helpful to understand the situation.



BULGARIA- Earthquake

- Investigations at Kozloduy (1967-1992). The last analysis was in cooperation with IAEA in 1990-1992: assessment of tectonic activity, active faults, landslides ...etc.
- **Conclusion** of IAEA: no evidence of active major faults, “Kozloduy NPP is located in the relatively most stable part of Mizia platform in terms of seismic.”
PGA for 100 years recurrence: 0,10g
PGA for 10,000 years recurrence: 0,20g
- **Comment:** Since 1992 seismic analysis has developed, design earthquake should be reevaluated with state of the art methods.



CZECH REPUBLIK

Content: brief evaluation of the operators reports by SUJB: “The reports describe in sufficient detail specified accidents caused by natural disasters and their potential impact on the operability of important safety systems in NPP, Loss of offsite power – complete loss of power, and loss of heat transfer capacity(UHS).”

- **Robustness of the plants** concerning external impacts is justified mainly by the site characteristic:
 - sites with minimal seismic risk.
 - sites with practically zero risk of floods



CZECH REPUBLIK

- An interesting thesis:

The operators assume that the main **SBO hazard is not caused by natural disasters but by instability of the grid, due to renewable power plants.** “The risk of loss of off-site power is very real in the CR, especially with respect to the installed output of renewable power sources. This puts more weight and significance on this assessment.”

- Comment:

Renewable power generation needs more flexibility of the grid, but there is no indication that renewables frequently cause grid failures.



HUNGARY

- Report of HAEA and of Paks NPP are available.
- In the last decade of the 20th century, a comprehensive safety re-evaluation program of Paks NPP was carried out. Improvements for severe accident management are in preparation as part of the LTE.
- Seismic characteristics of the site were reevaluated by state of the art methods. The new design basis is: PGA for the ten millennial earthquake is 0.25 g



HUNGARY

- Flooding is not a major problem, because of the elevation of the sites...
- dynamic effects as damage of the Gabcikovo dam and ice blockage will be re-assessed.
- The HU Report follows the ESREG specifications in the UHS of SBO and loss of UHS
- Some maps would be helpful to verify the results.
- The Hungarian Report is the only one of the 5 reports of Joint project countries which identifies specific deficiencies.



ROMANIA

- **Content:** a description of the CANDU 6 reactor with a focus on the control, safety and emergency systems. This is important information in order to understand the evaluation results.
- The CANDU core is very large, thus reactivity and heat control of the CANDU is very complex. CANDU operator claim that the installed safety systems which have a high redundancy and diversity guarantee that severe accidents could be prevented.
- CANDU units have big coolant reserves, evaporation of the coolant is slow, thus severe accident management measures can delay core melt significantly.



ROMANIA

- The CANDU core includes a large amount of zirconium, containment pressurization could be generated by hydrogen buildup and by thermal-chemical interactions of hot core material.
- Severe core damage could occur if fuel channels are not only be voided of coolant due to loss of cooling (PHT) and failure of ECC system, but they must lose cooling from outside due to loss of moderator, too.
- There are 2 reactors in operation: unit 1 since 1996 & unit 2 since 2007. No design differences between the units are mentioned in the progress report.



ROMANIA Earthquake

- **Progress report:** Original design basis earthquake (DBE) has a PGA of 0.2g, with a frequency of 1 in 1000 years. All SSCs which are part of the safe shutdown path after an earthquake would continue to perform their safety function up to 0.4g with a frequency of 1 in 500.000 years. (uncertainties unknown)
- **Conclusion of National Report:** This margin is considered adequate as it complies with the actual safety goals internationally applied for new NPPs.



ROMANIA Earthquake

COMMENT : Original DBE of PGA 0.2g, with a frequency of 1 in 1000 years. Design basis earthquake should be the maximal earthquake with a frequency of 1 in 10,000 years. (IAEA 2003) thus original design is too weak; But there are relative large safety margins compared to the design. :

DBE MSK 7°-8°.

DBE + safety reserve = 0.4g MSK 8°-9°.

PGA > 0.10g corresponds to MSK 7°

PGA > 0.25g corresponds to MSK 8°

PGA > 0,50g corresponds to MSK 9°

Compared to the German assessment level 1 would be achieved.



SLOVAKIA

- VVER 440/V213 reactors have inherent safety features favorable for plant recovery from operating events. These features include plant layout with six loops isolable by valves on each loop and two turbines, large water inventory in the primary circuit and in steam generators smoothing down disturbances between heat production and heat removal and providing convenient time margins for plant operators.



SLOVAKIA

Slovakian NPPs use the external atmosphere as the ultimate heatsink (UHS). This UHS cannot be lost, but normal cooling through the cooling towers could be interrupted. In this case several options for cooling the reactor exist: direct release of steam from steam generators to atmosphere through the steam by-pass stations, or by primary circuit feed & bleed, or by heat removal through the essential service water system.

Failure of all essential service water systems could have serious consequences regarding heat removal from the core, the spent fuel pool and the containment.



SLOVAKIA Earthquake

- The major hazard for the Slovak NPPs is earthquake: “The seismicity levels are in Mochovce corresponding to 8° MSK 64 with the maximum horizontal acceleration 0.143 g, in Bohunice corresponding to 9° MSK 64 with 0.344 g, for return period 1 in 10,000 years. Earthquakes have been considered in the plant design. Seismic margin assessment is ongoing and will be summarized in the final national report.”



THE END