



Status of the National Action Plan at the  
Paks NPP in Hungary  
on the implementation actions decided  
upon lessons learned from Fukushima  
Daiichi accident

**Answers to Questions on the  
National Report**

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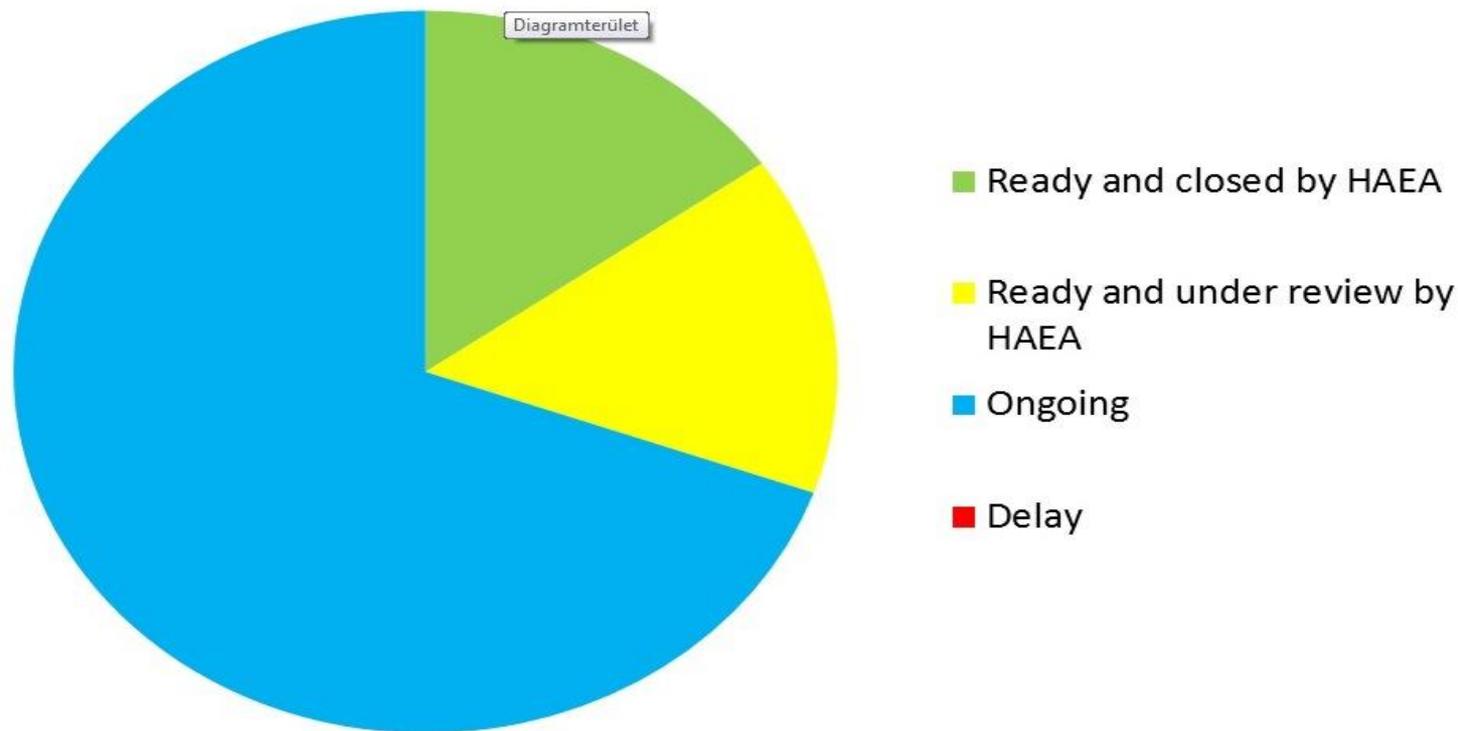
# Content of National Action Plan (NAcP)

- **Analysis** (*4 task from which 3 ready and 1 ongoing*)
- **Improvements of power supply** (*5;1;4*)
- **Improvements of cooling and heat sink** (*9;1;8*)
- **Improvements of protection against external hazards** (*11;1;10*)
- **Improvements of emergency response** (*10;0;10*)
- **Improvements of SAM** (*4;0;4*)
- **Review of procedures** (*3;1;2*)



# NACP's tasks status

Tasks	Ready and closed by HAEA	Ready and <b>under review</b> by HAEA	Ongoing	<b>Delay</b>
46	7	7	32	0





## Protection against external hazards

### 1.2 – Reinforcement of the fire station (1/2)

- **Measure:** *Interventions to protect the personnel and equipment in the fire brigade barrack, which is made of reinforced concrete, but has not yet been seismically qualified.*
- **Deadline:** *15th December 2015.*



- Concept plan ready



- Feasibility study ready -> NEW FIRESTATION IS NEEDED!



- Design requirements for the building are ready



- Design planning is ongoing



- Contract procedure for implementation plan



- Procurement for the construction of the building



# Protection against external hazards

## 1.2 – Reinforcement of the fire station (2/2)

### Main building of the fire station:

- According to the new implemented SAMGs, the fire brigade plays a vital role in providing possible outside cooling the containment
- Possible fire fighting in Severe Accident situations
- Performing technical rescue
- The fire station was not qualified for earthquakes. The MVM Paks NPP decided to build a new earthquake resistant fire station. ( $10^{-4}/y$  frequency)
- The design base of the new building is fixed. The process for the design contract started. The building should be ready until the end of 2015.





# Improvements of power supply

## 1.12 – New severe accident DGs (1/2)

- **Measure:** *Appropriately protected independent severe accident diesel generator(s) shall be installed after assessment of the necessary number and capacity, and determination of the design requirements including beyond design basis hazards. The design shall handle:*
  - *Supply for all customers in severe accident conditions during multi-unit events both units and spent fuel pools.*
  - *Higher external design loads than for the normal design basis hazards.*
  - *Long term operation.*
- **Deadline:** *15th December 2018.*
- Concept plan ready
- Feasibility study ready
- Design requirements for the building and DGs
- Design process for the building (minimum two-step process)
- Procurement for the DGs
- Construction of the buildings



# Improvements of power supply

## 1.12 – New severe accident DGs (2/2)

### Design requirements

- „Protected island” concept:
  - No function during safety earthquake ( $10^{-4}/y$  frequency)
  - Must be capable for operation after an external event that occurs  $10^{-5}/y$  frequency
- The design should be robust against internal events.
- „Independent power supply” concept:
  - Fully independent, no cooling or power need from the unit
  - Provisory cable connection for dedicated consumers
  - Protected connections between the two SADG
- Full maintenance replacement function for emergency DGs
- 2 SADGs for 4 Unit at Paks NPP
- 4-6 MW capacity



## Improvements of SAM

### 1.25 – Containment over-pressurization protection (1/2)

- **Measure:** *The system that is able to prevent the long-term, slow over-pressurization of the containment shall be developed and implemented.*
- **Deadline:** *15th December 2018.*



- Concept plan ready



- Feasibility study ready



- Contract procedure for design plan



- Contract procedure for implementation plan



- Procurement for the construction

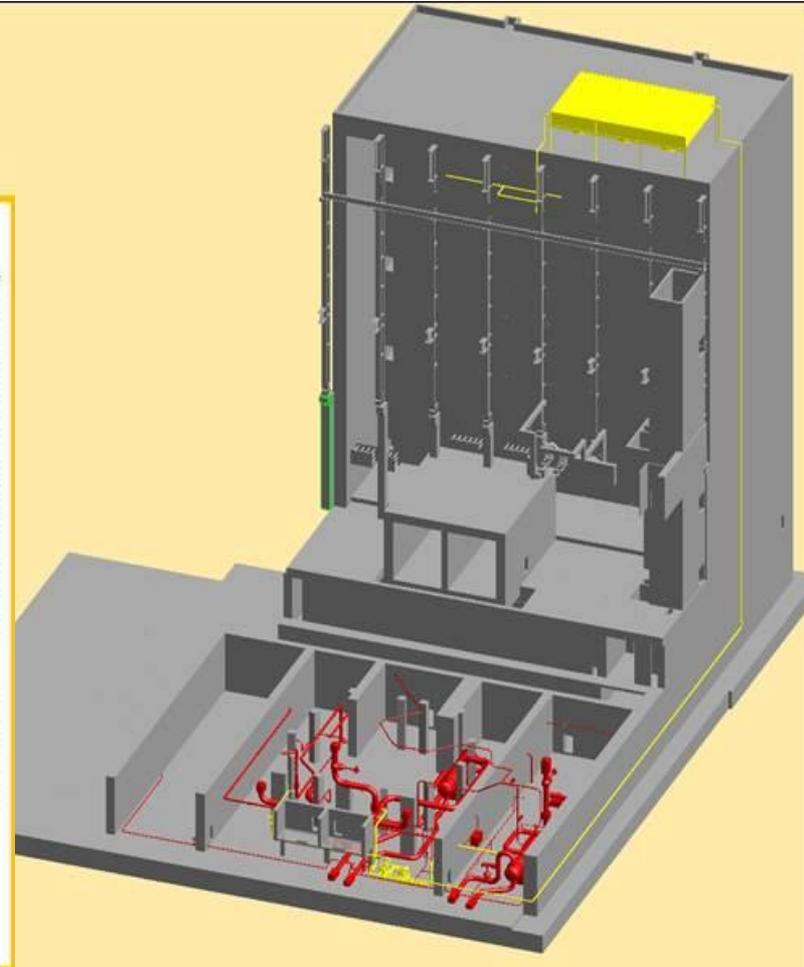
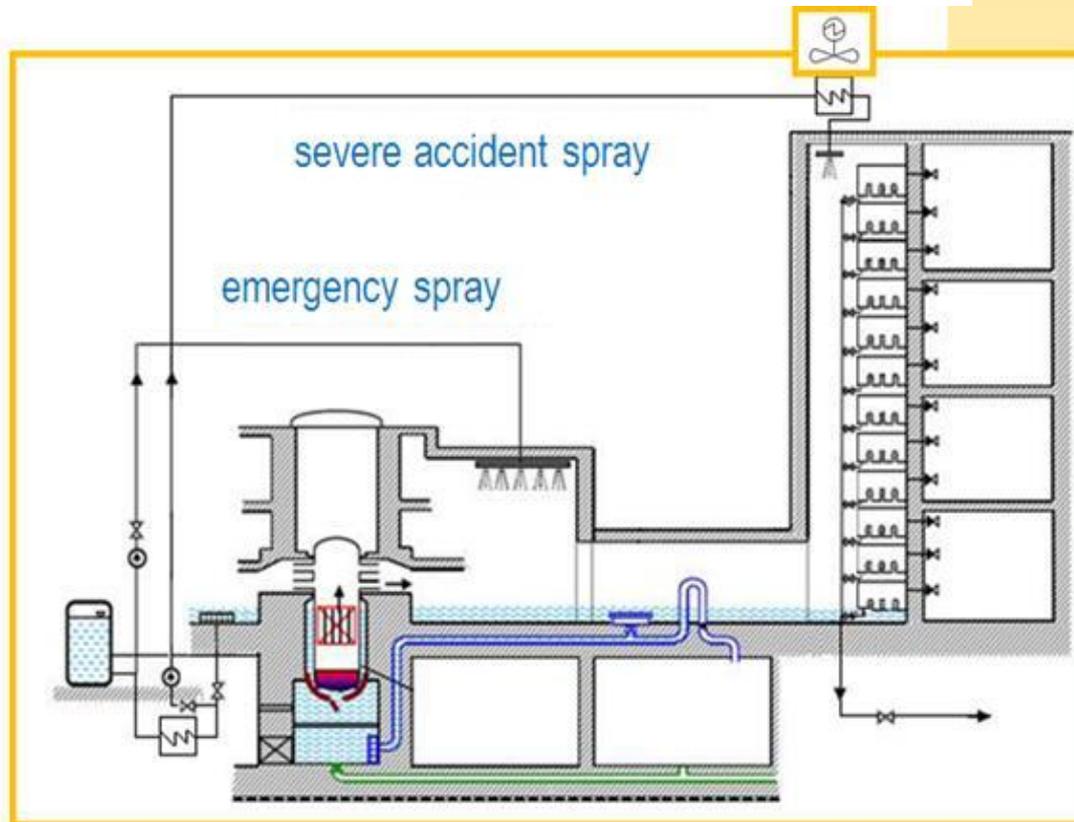


# Improvements of SAM

## 1.25 – Containment over-pressurization protection (2/2)

Planned SA containment cooling system:

- active SA spray system (2 pumps)
- air-cooled cooling (3 modules for 8 MW)
- power supply from the SA diesels.



March 24 2014

Presentation of Hungary at the 6th  
Review Meeting of the CNS



# Protection against external hazards

## 1.28 – New Backup Command Centre (1/3)

- **Measure:** *A Backup Command Centre that complies with protection requirements, and is equivalent with the Protected Command Centre in terms of management and communication, shall be established.*
- **Deadline:** *15th December 2016.*



- Concept plan ready



- Design requirements for the building are ready (10<sup>-5</sup>/y frequency!)



- Geotechnical investigations are ready



- Contract procedure for implementation plan is ongoing



- Procurement for the construction of the building



- The equipment's qualification



# Protection against external hazards

## 1.28 – New Backup Command Centre (2/3)

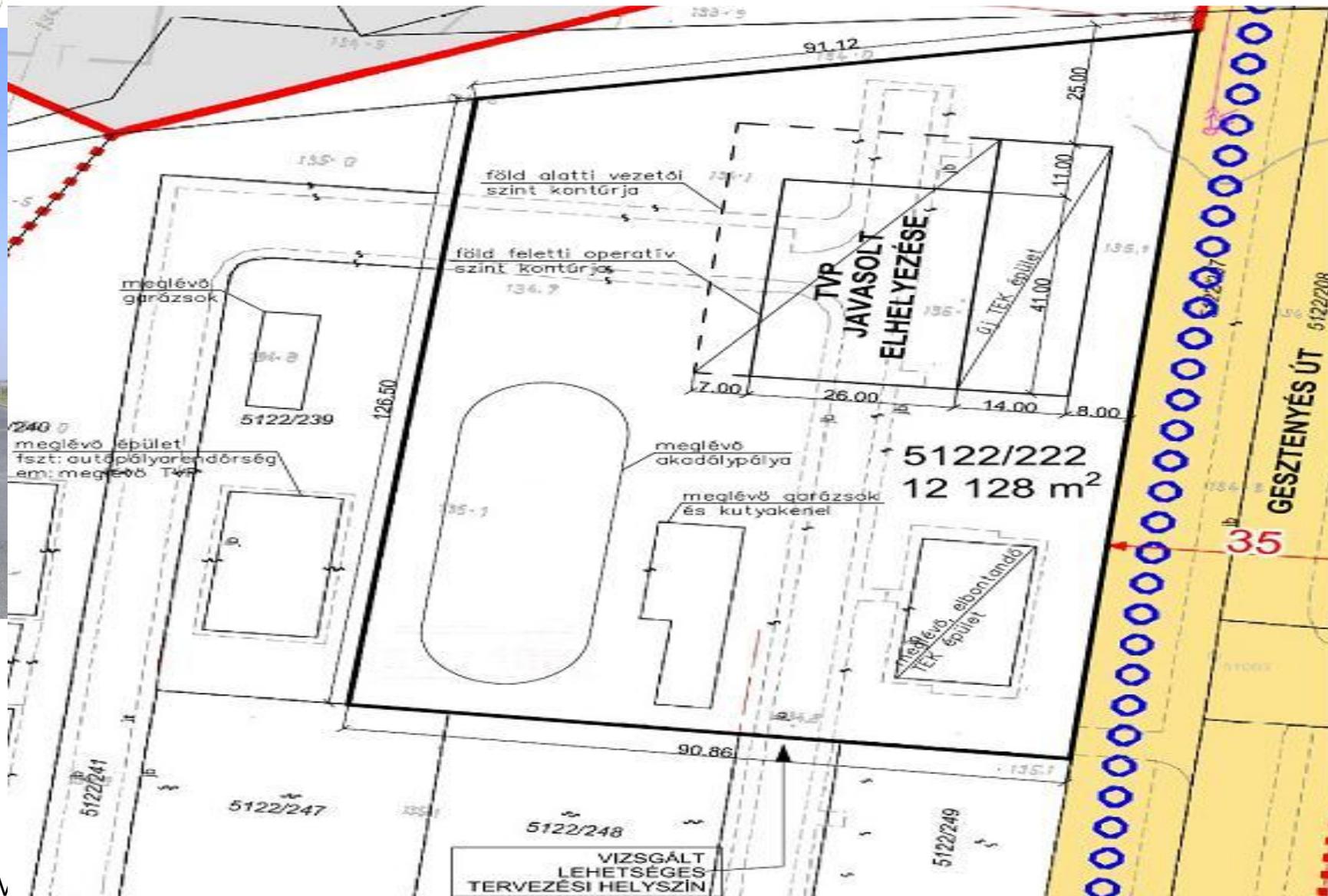
The existing Backup Command Center (BCC) has no ventilation system, and its' building unshielded. Supplementary diesel generator serves emergency management.





# Protection against external hazards

## 1.28 – New Backup Command Centre (3/3)





# Post-Fukushima questions/answers

- There was no specific research program established to address human behavior based on experiences of the Fukushima event. The Paks NPP prepared an instruction to manage the measures with the families of staff.
- The revision of the SAMG is continuous during NAcP implementation.
- No need for automatic scram during an earthquake. Consequences for false signal:  
**Station black out**



# Post-Fukushima questions/answers

- Current Comprehensive Emergency Management Plan considers the multi unit situations and have enough human resources to manage them. It considers events – defining tasks/obligations for cooperation with national and local disaster management organizations and for supplementation to access the site.
- Plant Emergency Communication Plan is the part of Current Comprehensive Emergency Management Plan. General Crisis Communication Plan exists on corporate level of Hungarian Power Companies Ltd. (MVM Zrt.) documents. In case of unintended events Public and Media Communication Group of Emergency Response Organization is responsible for related tasks.



# Post-Fukushima questions/answers

- **NACP protection against external events tasks:** New fire station; maintenance EQ fixing; Penetrations for ESWS pumps room; Sub-station; Demineralized tank station; Condenser pipelines; SA large diesel generators; Spent fuel pool external cooling; Shelters & protected command center; New backup command center;
- Alternative cooling for spent fuel pools will be constructed. The new pipelines which are able to lead the cooling media to the pool from the courtyard. All external water sources (fishing lakes, Danube, tanker, etc.) - after adding boron – could be used for cooling the spent fuel pool through this new pipeline (in the very low probability situation when all other cooling lines fail).



# Design, PSA, external hazards questions/answers

- Nowadays the climate models are not able to forecast correctly the change in the weather in 20 or 100 years. The design basis values are the extreme values of natural events with a frequency of  $10^{-4}$ /year, but the investigation was made for effects of natural events with a not lower frequency than  $10^{-7}$ /year.
- The results of the seismic PSA are dominated by the untested, non-qualified relays and cabinets failures. The correlated failure of this relays and cabinets can lead to the total power outage, diesel generator failure, all steam generators (SG) fast-acting valve simultaneous closing, all SG safety valve simultaneously open or all feedwater and active ECCS operating system incapacitation. The total loss of the feedwater and the primary feed and bleed inability of very rapid cooling contribute to the occurrence of core damage.



# Design, PSA, external hazards questions/answers

- The overall seismic core damage frequency is caused in about 25 % by the earthquakes in SEIS1 -SEIS3 acceleration ranges (less than 0.25 g). 75% of the seismic core damage frequency comes from the SEIS4 - SEIS7 acceleration ranges (0.25 g or greater acceleration).
- The seismic events are taken into account in all Plant Operating States (POS), in normal operation and the shutdown / refueling conditions as well.
- The external flooding phenomenon is a part of the external hazards PSA, study is in progress.
- All POS were taken into account in the fire and flood PSA study, the shutdown / refueling conditions as well.



# Design, PSA, external hazards questions/answers

- **Guidance documents of PSA in Hungary:**
  - IAEA Safety Series No. 50-P-4
  - NUREG/CR-4550
  - NEA/CSNI/R(97)16, Principal Working Group No. 5 OECD-NEA
  - IAEA SSG-3
  - IAEA SSG-4
  - ANSI/ASME/ANS RA-S-2008
  - ANSI/ANS-58.21-2007
- Multiple unit events are not considered as Initiating Events till now in the PSA study. No such requirements are in the legal regulation at Government Decree level. The evidence of the necessity of this type of study is clear, it is a part of the short-term plan of the NPP.



# Design, PSA, external hazards questions/answers

- **Spent fuel pool accidents in PSA:**
  - IE: outage of cooling, loss of coolant on a separable section of the cooling circuit, loss of coolant on a non-separable section of the cooling circuit, internal fire, and internal flood.
  - The annual fuel damage probability from internal initiating events of the spent fuel pool for the selected reference unit is  $2.1 \times E-07$ . This result includes the result from the full core offload operating state taken into consideration the operating state length weighting factors.
  - There is a two year long project for creating the seismic PSA of the spent fuel pool; it is expected to be completed at the end of the year 2014. For other external hazards than the seismic event, the creating of the spent fuel pool PSA is in progress, further investigation is necessary in this area.



# Design, PSA, external hazards questions/answers

- We started the investigation of the impact of a crashed aircraft according to the stress test. If the results of this analysis account for any change in the SAMG or other document in the Emergency Plan, we modify the relevant document.
- Our Level 1 Living PSA model was the basis of the Risk Monitor model developed for all Paks units. The Risk Monitor is ready for use. The software is the Risk Watcher (Lloyd's Register Co). We are going to implement in-operation maintenance as a test application for RIDM and RM. This application is in the phase of authorization.



# Design, PSA, external hazards questions/answers

- The seismic PSA basic steps are as follows:
  1. Determining the Seismic Level Groups (7 groups).
  2. Determining the seismic load curves as hazard functions.
  3. Selection of the damaged safety-relevant systems, structures and components (SSC) by earthquake as the definition of systems and components vulnerability curves.
  4. Evaluation of the fault tree - event tree model of the consequences of the earthquake initiators
  5. Numerical evaluation of event sequences.

The CDF due to earthquake for the reference unit is  $4.31 \times E-05$ /year in normal operation and the earthquake CDP during shutdown is  $4.7 \times E-06$ . The overall CDP due to earthquake in an annual year is  $4.41 \times E-05$ .



# SAMG training questions/answers

- The introduction of the SAMGs was preceded by a targeted training program for the personnel. This program is composed of a classroom theoretical module in addition to a simulator based practical training for the CRO staff only. Since the completion of the relevant initial training period, the training of SAM has been made an integral part of both classroom and simulator continuing training programs. The licensing exam scope has also been extended with the SAM topics.
- In Paks, the Control Room Operations staff is required to take a practical exam at the end of the annual simulator retraining period. At the moment, the exam scenarios do not feature any exercises that may require the use of SAMGs since the scope of simulation does not permit that.



# SAMG training questions/answers

- Development of a SAM training simulator for Technical Support Center (using SAMGs in Emergency Response Center) is in progress now.
- During verification process of the severe accident simulator all guidelines are planned to use in all possible plant damage state. The sequences are classified on the deterministic basis and depending on accident type.



# SAM questions/answers

- The capacity, number and the positions of the recombiners were identified on the basis of analyses prepared by the Hungarian institute VEIKI. The main goal was to decrease the containment pressure less than 3,35 bar abs (HCLPF) and hydrogen concentration less than 10 % in all hermetic compartments.
- For the 4 units there are 4 mobile SA diesel generators (100kW) installed. Supply for:
  - the pressurizer safety valves
  - the reactor external cooling system
  - the SA instrumentation system
  - charge the safety batteries.



# SAMG questions/answers

- Efficiency of in-vessel retention was calculated for all branches in containment event tree (one of the branch is question about steam explosion) for all dominant PDS sequences. In case of technological origin, internal fire and flooding events at nominal power higher than 90 % average success probability was calculated. This value is depending not only on steam explosion but also on SAMG user effect, time of drainage and amount of water in the sump, primary pressure reduction, etc. The effectiveness of the external cooling of the RPV by cavity flooding has been proven with several experiments performed on the CERES test facility (in Budapest, former KFKI AEKI).



# Maintenance, ISI questions/answers

- The ASME BPVC based ISI program has been introduced gradually and it is still in progress.
- The Hungarian Nuclear Safety Code prescribes that ISI performed on systems and system components should be qualified in order to prove that the inspection system – inspection equipment, inspection procedure and the inspection personnel – is able to fulfill the requirements under real circumstances.
- The qualifications are performed according to ENIQ (European Network for Inspection Qualification) EUR 22906 EN and IAEA EPB-WWER-11 methodologies. The main emphasis has been put on mechanized UT/ET inspections of safety related components. As a result of change of ISI rules to a new ASME BPVC Section XI. based ISI program, the former 4 year inspection period has been increased to a 8 year inspection cycle. This transition period is still in progress.
- The risk-informed approach not yet used in our inspection program.