



Úrad jadrového dozoru SR



***General safety requirements applied for  
Mochovce 3,4***

**International conference VVER 2013  
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# ***National and international safety requirements***

- ◆ **Slovak Decree No. 50/2006 Coll. on Laying Down Details of the Requirements for Nuclear Safety of Nuclear Installations**
- ◆ **Slovak Decree No. 430/2011 Coll. on Laying Down Details of the Requirements for Nuclear Safety**
- ◆ **IAEA Safety Requirements for Design**
- ◆ **WENRA Reference Levels (01/2008)**
- ◆ **European Utility Requirements**
- ◆ **WENRA Safety Objectives for New Power Reactors**

# Safety improvements of MO34

## » Principles of safety improvement program

» The Evolutionary design of Mochovce 3–4 takes Mochovce 1-2 as a base and implements design improvements to take into account:

- the most recent evolutions of safety goals and technology;
- the operational feedbacks from similar plants currently in operation;

» In accordance with the IAEA principles of Defence In Depth, the safety improvements of MO34 have been conceived with two basic goals:



» Accident prevention



» Accident mitigation



## *Safety improvements of MO34 (cont.)*

### » Principles of safety improvement program

#### » Accident prevention: further decrease the probability of accident occurrence

- reduce the probability of deviating from normal operation;
- improve the response of the plant to an abnormal state, preventing its escalation to a severe accident (accident with core melt-down)

#### » Accident mitigation: improve plant response to accident conditions

- prevent accident progression and include means to control accidents resulting in severe core damage (through the protection of containment function)



## *Secondary containment*

- **According to international standards, secondary containment is used for additional collection, monitoring and controlled release or storage of leakages from the primary containment, to reduce the radiological consequences of an accident**
- **Although not prescribed by either national or international requirements, the secondary containment function has been introduced in Mochovce 3&4**
- **In this way, rooms surrounding the containment will be ventilated during an accident, the exhausted air being filtered before being sent to the stack**
- **This represents a further improvement with respect to Mochovce 1&2**
- **The result: further minimization of the consequences of an accident.**



## ***Protection against aircraft impact***

- **On July 15, 2008, in accordance with Article 43 of the Euratom Treaty, DG-TREN EC issued its viewpoint on the completion of Mochovce 3 and 4;**
- **The EC viewpoint included a recommendation about “*additional features, functional capabilities and management strategies*” against “*a deterministic impact from an external source (e.g., an impact of a small aircraft)*”, although acknowledging that this exceeds what prescribed by the current national and international requirements**
- **The recommendations have been fully adopted by ÚJD and transferred as binding conditions (with deadlines for their fulfilment) in the ÚJD decision No. 266/2008, issued in August 2008**



## *I&C Improvements*

- **State-of-the-art technology design (increased reliability, maintainability, integrity, security)**
  - **Use of advanced digital control system:**
    - **Increase of control and monitoring capacity of NPP**
    - **Implementation of predictive and supervision functions**
  - **Increased redundancies**
  - **Improved PAMS/SAMS panels)**
  - **High performances in terms of accuracy of measurements, stability, auto-diagnostics**



## *I&C Improvements (cont.)*

- **Inclusion of new, dedicated PAMS signals for the SAM strategy:**
  - **Core outlet temperature (signal for transition to SA)**
  - **Water level in reactor cavity**
  - **Hydrogen concentration in different compartments of containment**





## ***MCR habitability in case of a Severe Accident***

- **In the very unlikely case of severe accident with radioactive releases reaching the suction of MCR ventilation line, MCR will be isolated and provided with pressurized fresh air from dedicated reservoir tanks to provide slight overpressure in MCR and prevent the penetration of radioactivity or toxic gases from surroundings;**
- **This ensures adequate working conditions for MCR personnel for several hours;**
- **In such harsh scenarios, significant releases are expected to occur in the first hours from Severe Accident initiation: after this time span, the emergency ventilation line can be re-started manually;**
- **In this way, operator action can be credited at any time during a Severe Accident;**



## *Improved design of electrical systems*

**Goal: achieve additional, independent and highly-reliable source of power for each Unit. For this purpose:**

- **New equipment will be used (transformers, generators, switchboards, bus-bars, cables, etc.)**
- **Possibility of interconnecting safety bus-bars of corresponding safety divisions of adjacent units (solution for SBO);**
- **Creation of a 6-kV highway among 4 units that allows**
  - **long-term management of SBO scenarios;**
  - **higher flexibility for management of faults of electrical equipment (transformers, etc.);**
- **Possibility of feeding I&C safety systems from both DC and AC sources (from inverters)**
- **Provision of a SBO Common Diesel Generator for Units 3&4**



## *Improved Fire Protection*

- **A fire risk assessment (probabilistic and deterministic) for EMO12 has been performed according to NRA Regulation No. 50/2006**
- **At the present stage of design, the results of the probabilistic fire risk analyses carried out for EMO12 have been considered applicable also to MO34**
- **Measures identified to reduce the fire risk in MO34 represent an improvement with respect to EMO12:**
  - **Adoption of high-pressure fire-extinguishing systems**
  - **Fire detection system has been improved**
  - **All cables will be fire-retardant**
  - **Safety-classified cables will be fireproof**
  - **Cable channels and rooms and sensitive parts of the plant (both in nuclear and conventional part) will be equipped with a fixed fire extinguishing system**



## *Seismic upgrade*

- On EMO12, a seismic re-evaluation of the main civil and technological parts of the plant for the PGA (Peak Ground Acceleration) equal to 0.143g is in progress (as a consequence of the site-specific Probabilistic Seismic Hazard Analysis reviewed by IAEA in 2003).
- The probability of exceeding the PGA = 0.143g in a seismic event is  $10^{-4}/y$
- Upon request of the NRA, the PGA for the seismic upgrade of MO34 has been increased to 0.15g.



## *Severe accidents*

- **Hydrogen management** - qualified monitoring of hydrogen concentration and installation of passive recombiners and igniters,
- **Prevention of sub-atmospheric pressure** - Vacuum breakers installed between air traps and steam generator (SG) compartments,



## *Severe accidents (cont.)*

- **In vessel retention of the corium**
- ❖ **Provision of sufficient coolant inventory for cavity flooding by means of draining of the bubble condenser trays**
- ❖ **Modification of thermal shielding of the bottom of the reactor pressure vessel in order to enhance external cooling of the RPV**
- ❖ **Establishing circulation channel for coolant along the reactor pressure vessel wall between the SG compartments and the reactor cavity**
- ❖ **Modification of the drain line from the reactor cavity to ensure tightness of the reactor cavity**



## *Severe accidents*

- **Management of open reactor sequences:** Delivery pump and line from the dedicated external tanks for supply of coolant into the low pressure emergency core cooling system (ECCS) and the spent fuel pool
- **Reduction of containment source term:** External sources of coolant for containment spray and radioactivity wash-down in the early phase of a severe accident, consisting of tanks, pump and associated piping system
- **Long-term heat removal:** Use of existing spray system for long term containment heat removal

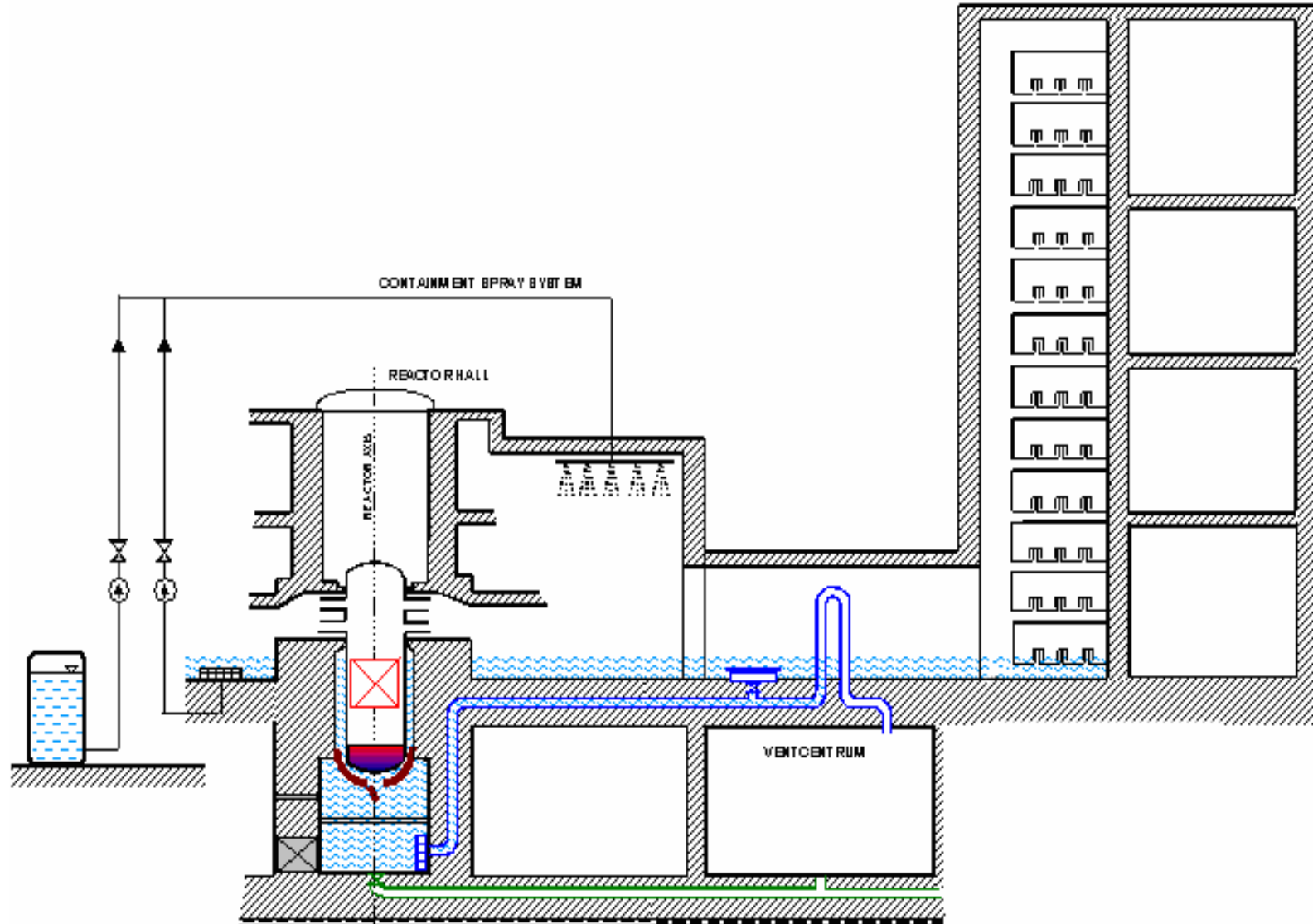


## Severe accidents (cont.)

- **Reliable power supply:** Dedicated diesel-generator for severe accident management
- **I&C for severe accidents:** Dedicated I&C severe accident control panel
- **Control room habitability:** Dedicated ventilation system of the main control room
- **Parameters for control of severe accidents:** Monitoring of parameters needed for accident management



# » Example - Overall arrangement for MO 34 reactor cavity flooding and containment spraying



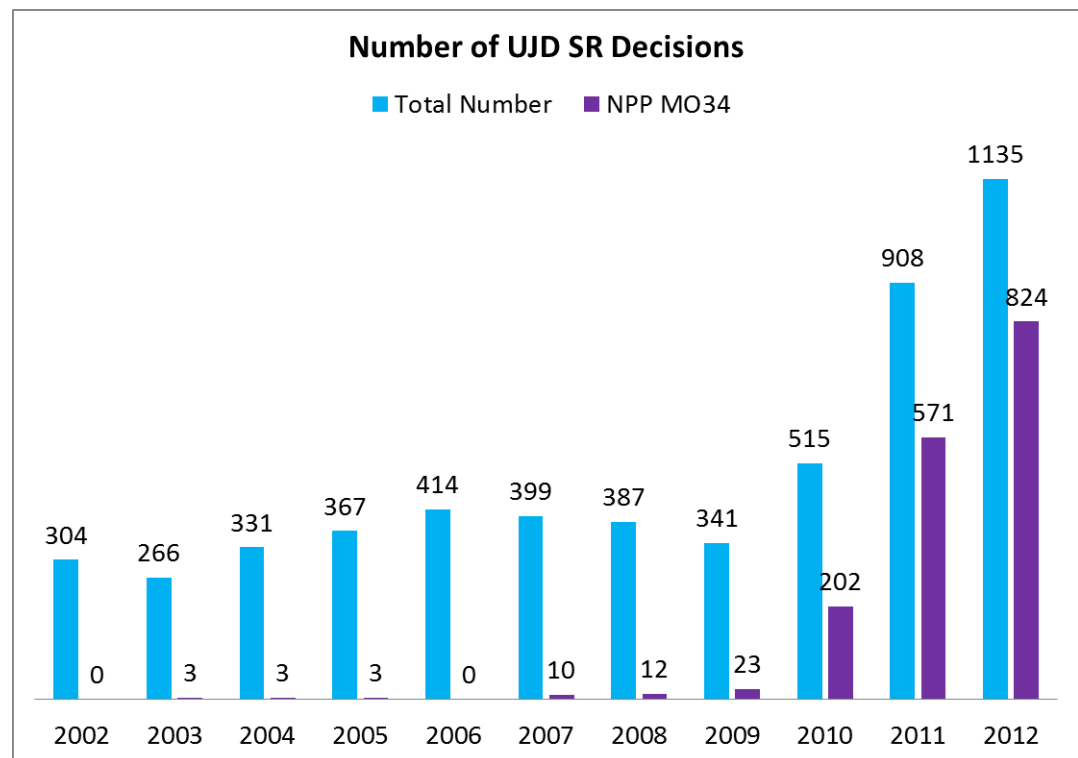


## ***Restart of construction MO34***

- **Review and approval of construction documentation, mainly quality requirements and quality plans of classified equipments**
- **participation on Factory acceptance tests FAT for classified equipments (Siemens – Areva, Atomstrojexport)**
- **preparation on supervision of NPP MO34 start-up (records, documentation, working group)**
- **reinforcement of UJD supervision activities on NPP MO34 site (four new UJD inspectors)**

# Restart of construction MO34

- **824 of 1135 UJD decisions in 2012**
- **2013 status: 670 of 905 UJD decisions**





**Thank you for attention**