ÚJD SR

Úrad jadrového dozoru Slovenskej republiky

# UJD SR activities and severe accident management

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# Highlights

- Nuclear installations in Slovakia
- Legislative framework for nuclear safety
- UJD SR
- Action plan – safety enhancements of NPPs in Slovakia
- MELCOR activities at UJD SR
- MELCOR input model

# Nuclear Installations in Slovakia

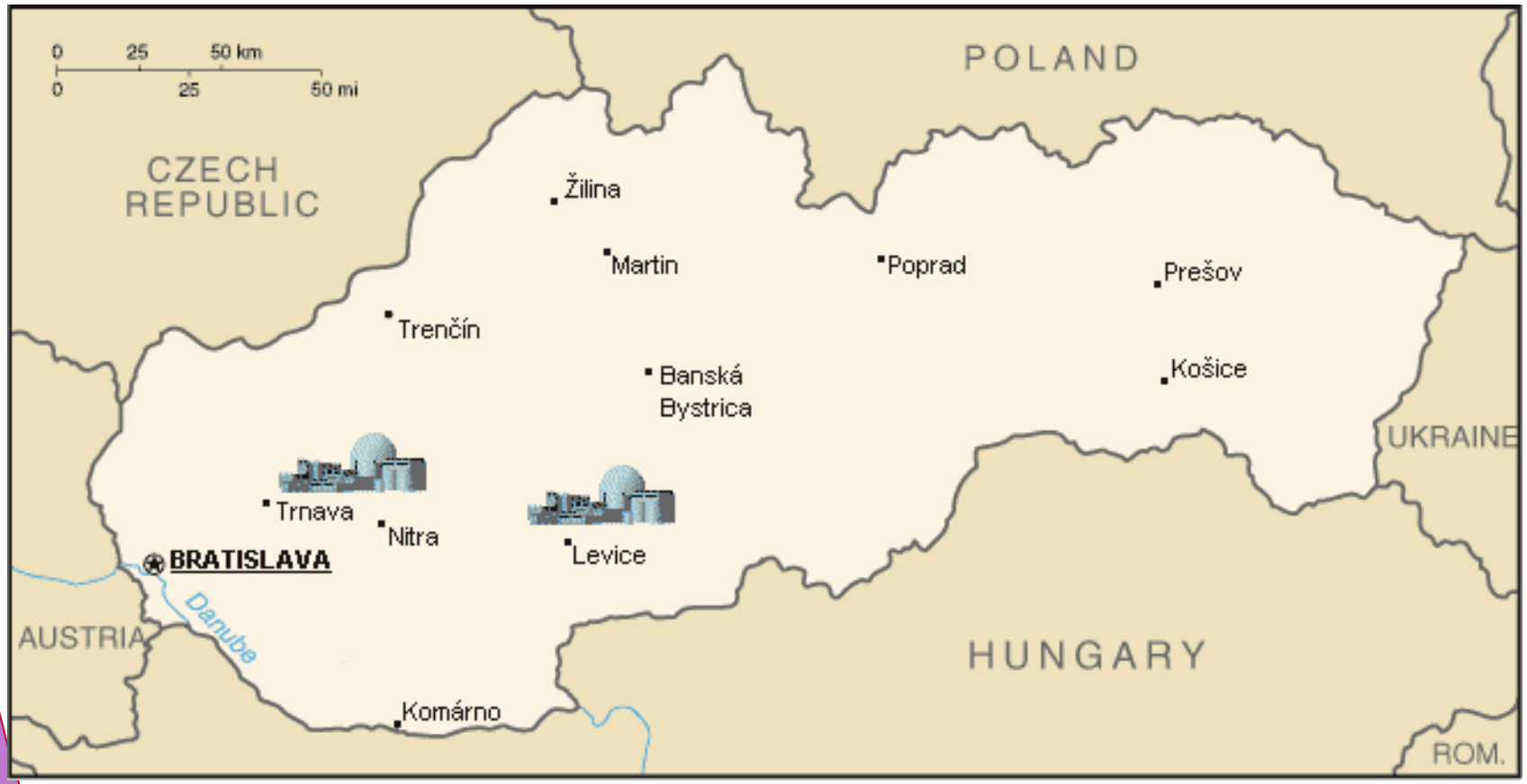
## BOHUNICE SITE

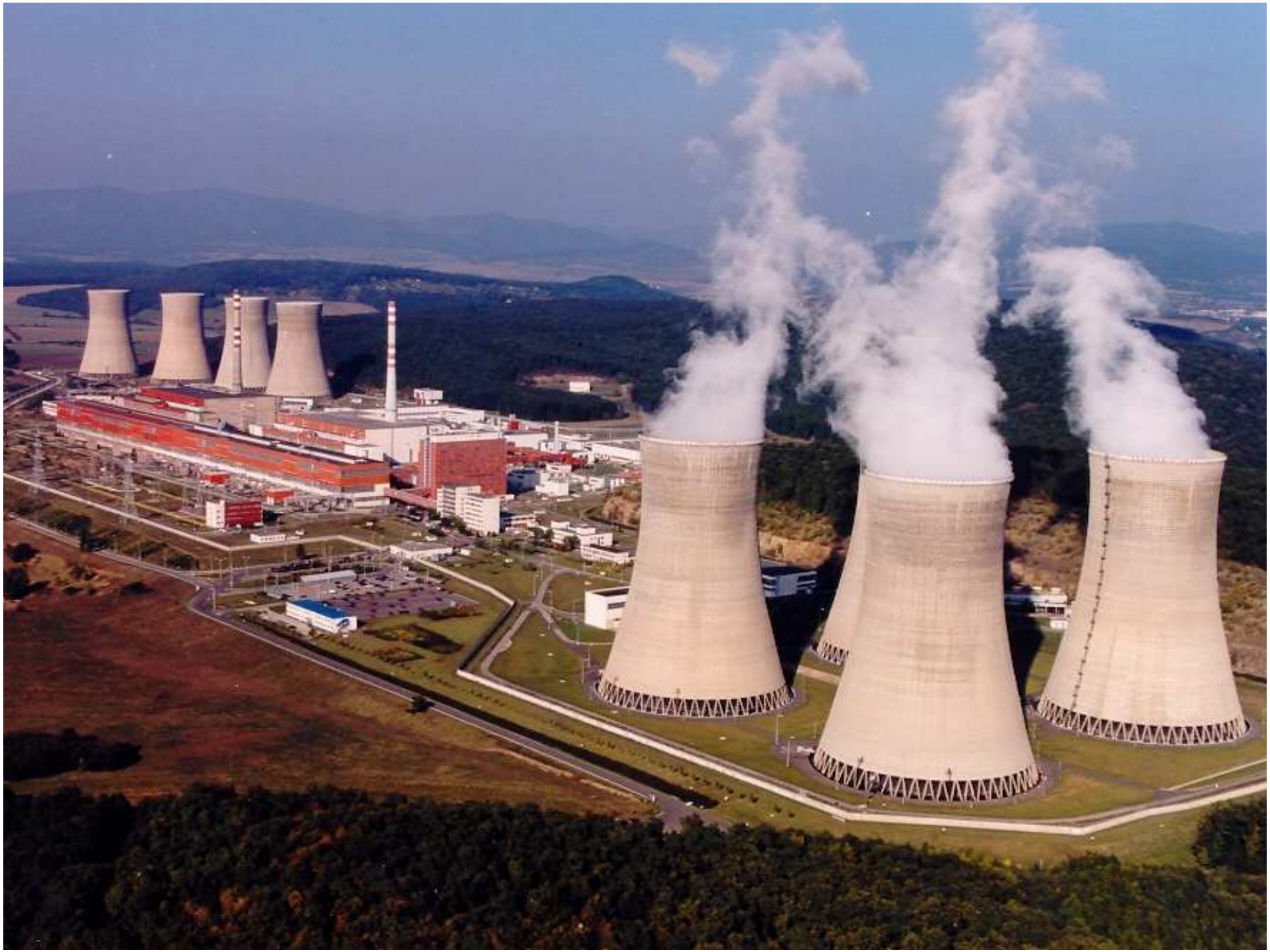
| facility | | status | licence holder |
|---|---|---|---|
| NPP A-1 | HWGCR | decommissioned | JAVYS , a.s. |
| NPP V-1 (EBO1,2) | WWER-440/230 | decommissioned | JAVYS, a.s. |
| NPP V-2 (EBO3,4) | WWER-440/213 | in operation | SE, a.s. |
| ISFS | wet type | in operation | SE, a.s. |
| treatment of RAW and SF | different technologies | in operation | JAVYS, a.s. |
| New NPP | feasibility study | | JESS, a.s. |

## MOCHOVCE SITE

| facility | | status | licence holder |
|---|---|---|---|
| NPP EMO1,2 | WWER-440/213 | in operation | SE, a.s. |
| Ra-waste Repository | near surface | in operation | JAVYS , a.s. |
| NPP EMO3,4 | WWER-440/213 | under construction | SE, a.s. |

# Existing Nuclear Sites in Slovakia





# Legislative Framework for Nuclear Safety

- **Legal instruments of EU**
- **International treaties, conventions and agreements (EURATOM treaty, Convention on nuclear safety)**
- **National legally binding instruments (acts, decrees)**
- **Legally binding decisions issued by regulatory bodies annually on specific subjects**
- **Regulatory guides (not legally binding)**
- **A list of legislative documents available on UJD SR web site – www.ujd.gov.sk**

# UJD SR and its competences

- **UJD SR is a central state administration authority; UJD SR was established in 1993 by Act No.2/1993 on Governmental Organization and Central State Administration Organization (Competency Act)**
- **Chairman and Vice chairman are appointed by government**
- **In the field of nuclear safety of nuclear installations the main responsibilities:**
  - **Legislation**
  - **Review and assessment**
  - **Licensing**
  - **Inspection and enforcement**
  - **Emergency preparedness**
  - **Nuclear material safeguards**
  - **Transport of nuclear and radioactive material**
  - **Public information**
  - **International co-operation**

# Action plan and SAM projects (1)

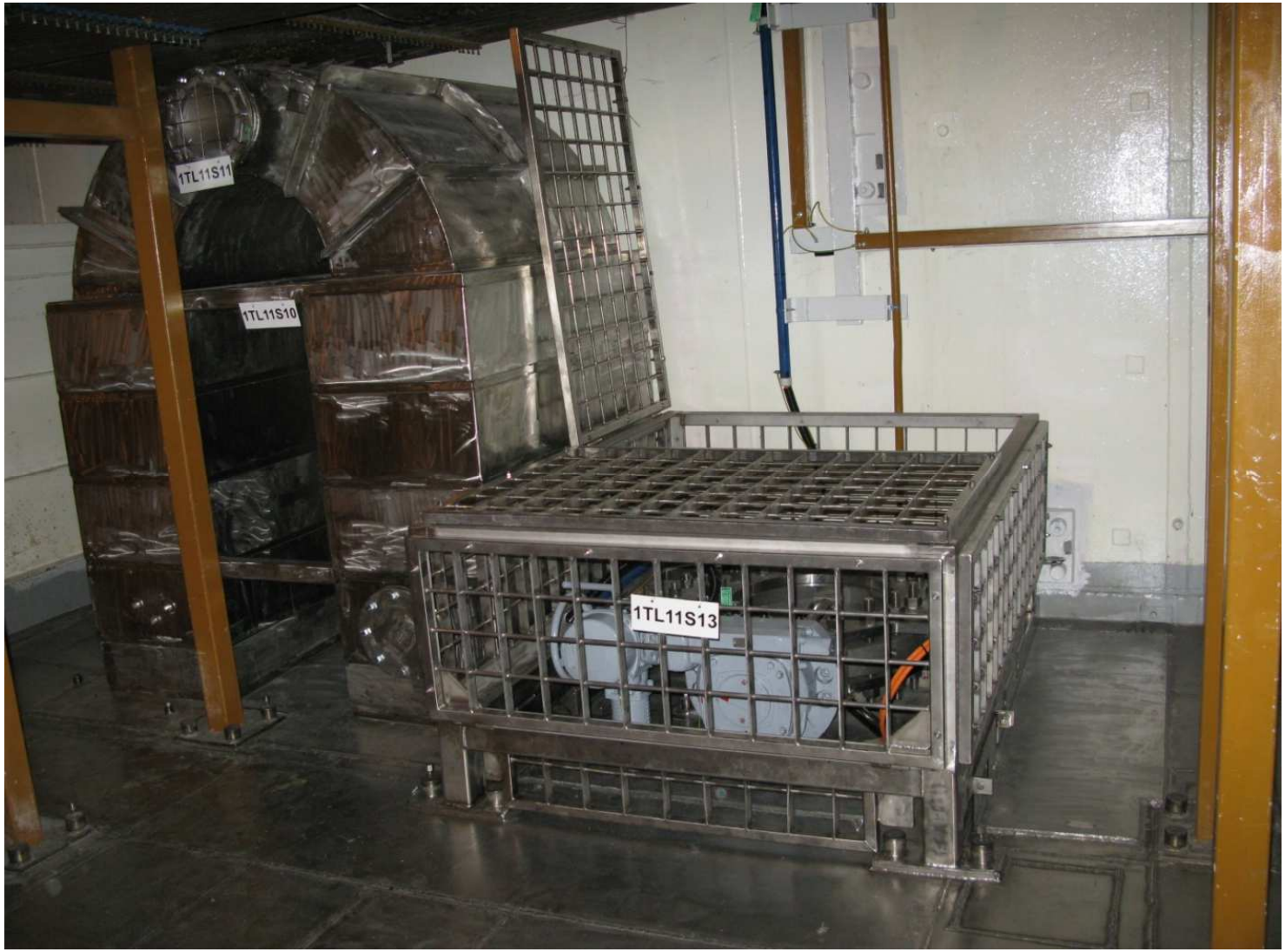
- Measures implementation plan of stress tests performed
- It reflects recommendations of communication between European Commission, European Council and European Parliament
- Targets of achievement:
  - Reinforcement of the 3rd, 4th and 5th levels of Defense in Depth
  - Increase NPP resistance to relevant extreme external events
  - Creating the conditions for further increasing of nuclear safety and security
- Main tasks
  - Increase resilience of nuclear units to extreme external events (torrential rains, strong winds, earthquakes)
  - Increase slack time for the provision of basic safety functions in case of total loss of AC power or final heat removal
  - Severe accident management and mitigation of radiological consequences

# Action plan and SAM projects (2)

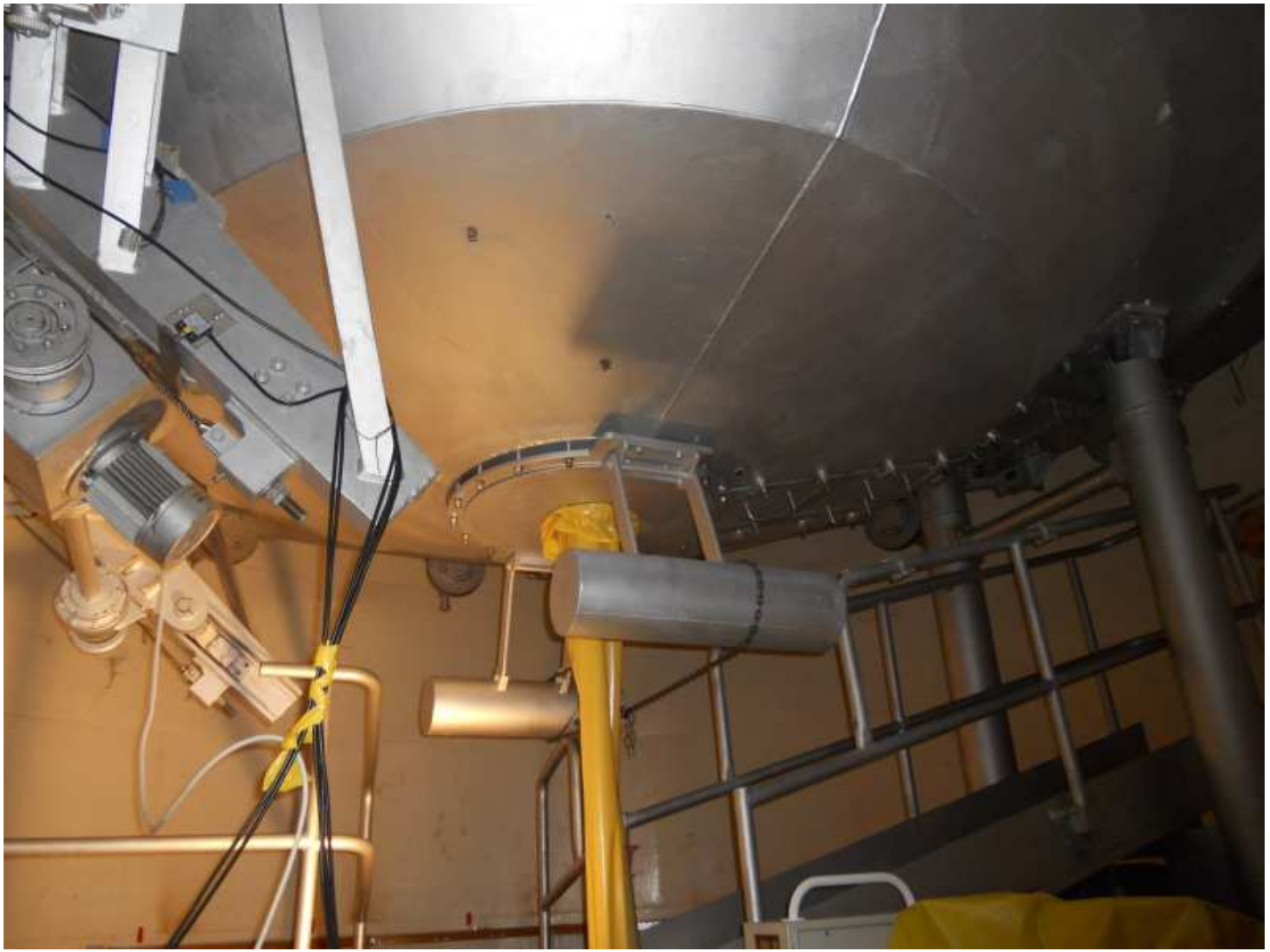
- **The SAM project is divided into following subprojects:**
  - **Reactor cavity flooding including „SIPHON“**
  - **Depressurization of primary circuit**
  - **Hydrogen management in containment**
  - **Vacuum breaker in containment**
  - **Alternative coolant system**
  - **Alternative electric power supply system**
  - **Information sources I&C – PAMS and control**
  - **Long-term heat removal from containment**

- **Action plan implementing schedule**
  - **Some measures have been implemented immediately after the Fukushima accident**
  - **Short-term – to be finished by 2013**
  - **Medium-term – to be finished by 2015**
  - **Additional measures, which may result from analyses defined by medium-term measures, will be implemented after 2015**

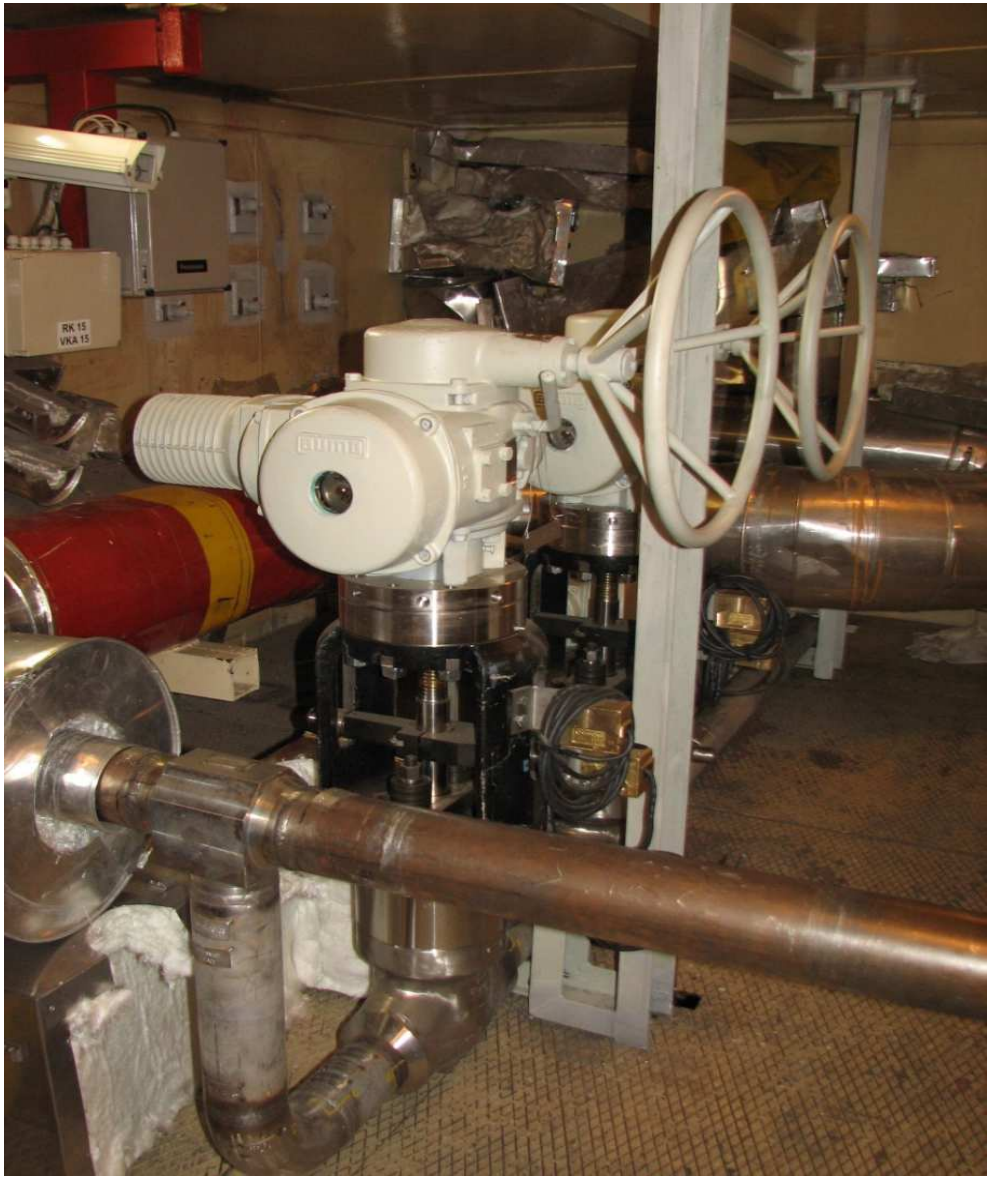
# „SIPHON“ and valve for coolant inflow into the reactor cavity through the ventilation system



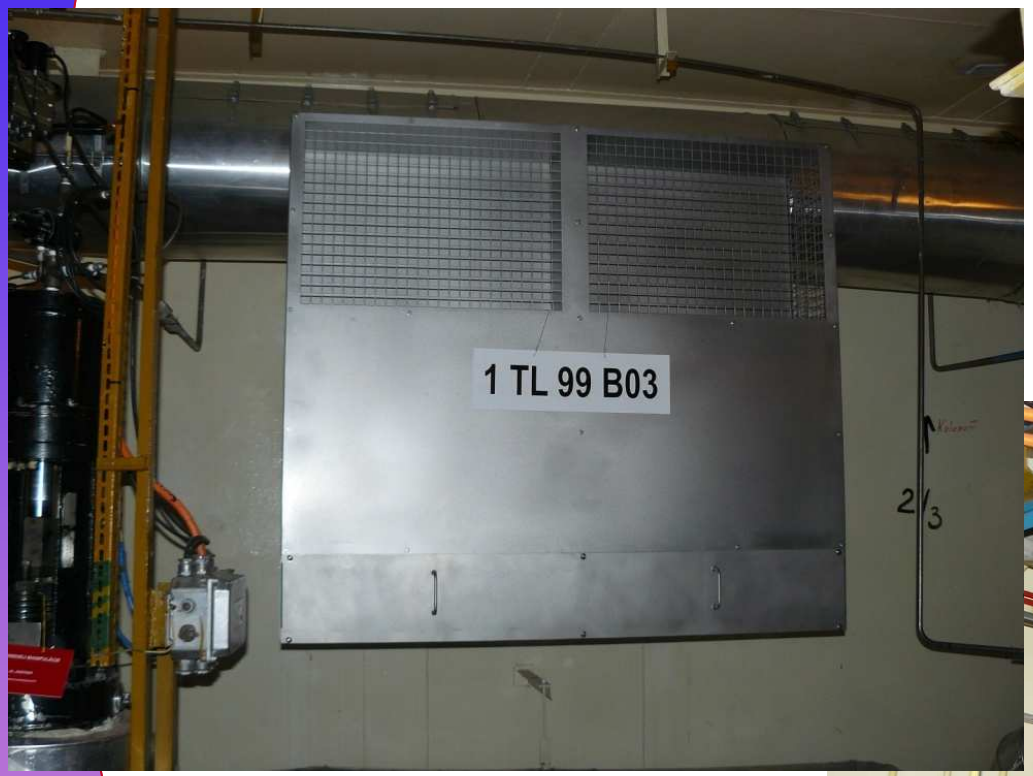
# Bottom part of reactor shielding with floaters for outside cooling of RPV



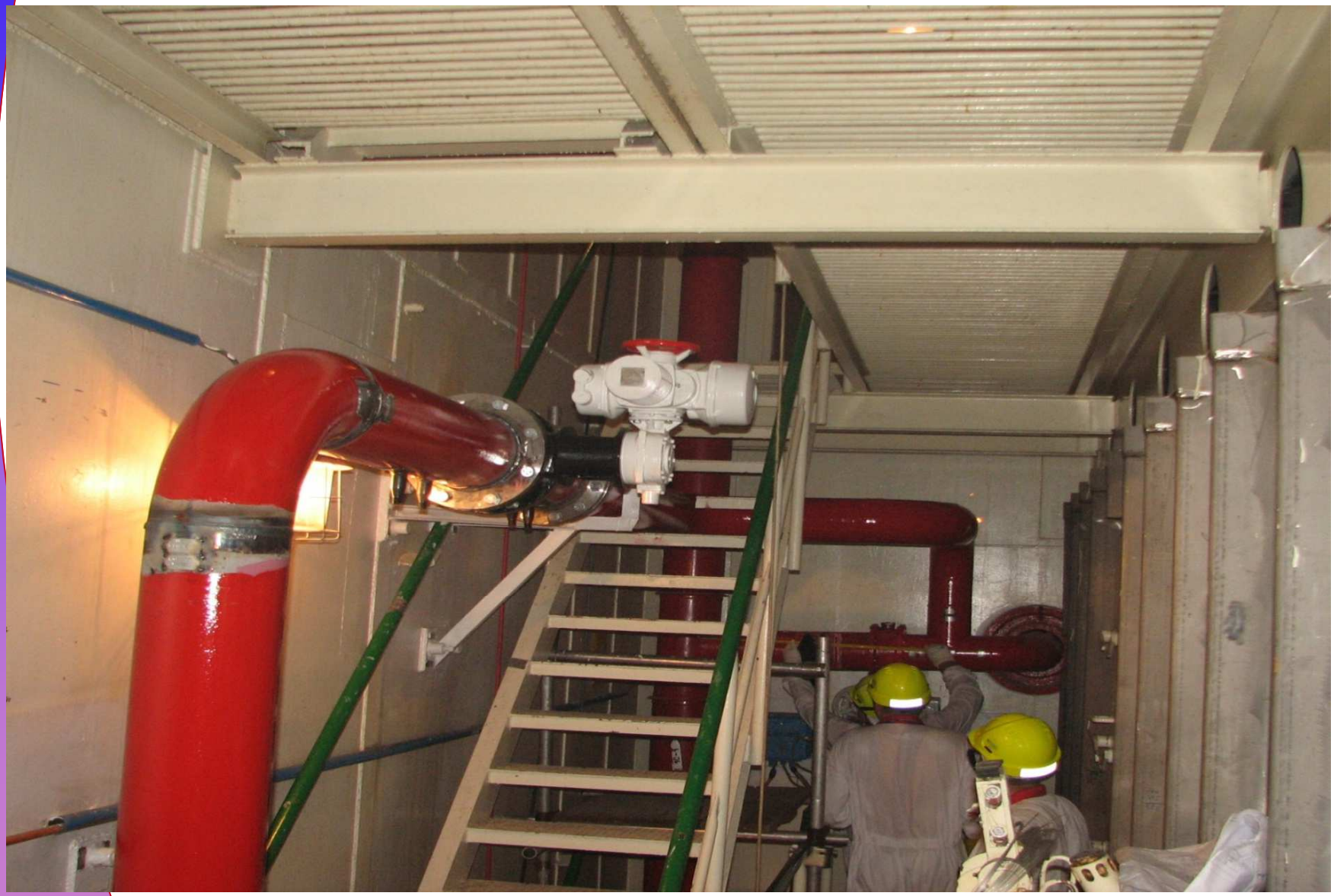
# Depressurization of primary circuit



# Passive autocatalytic hydrogen recombiners in the containment




# Vacuum breaker in the containment



# Alternative coolant system - RPV corium flooding and containment spray

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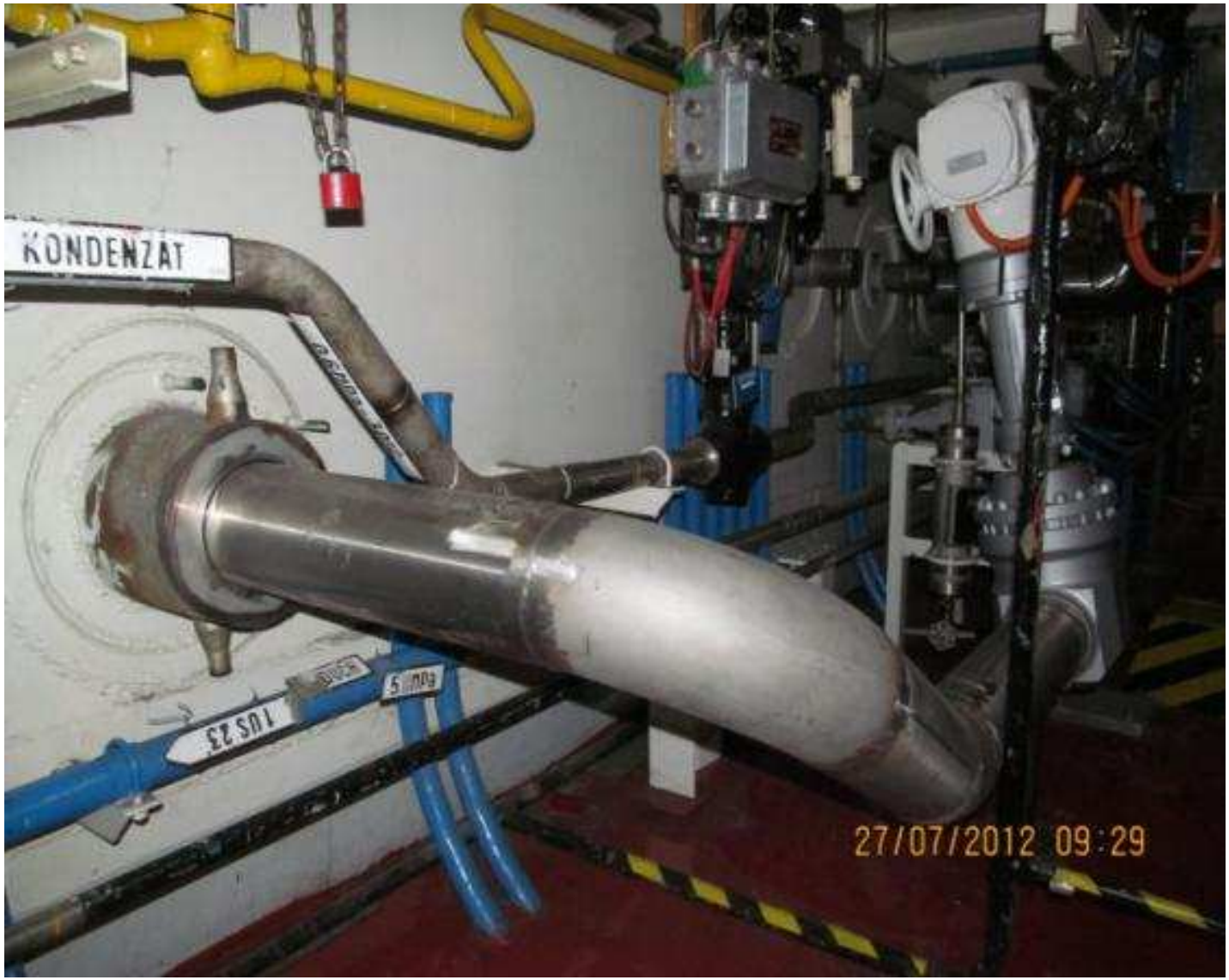
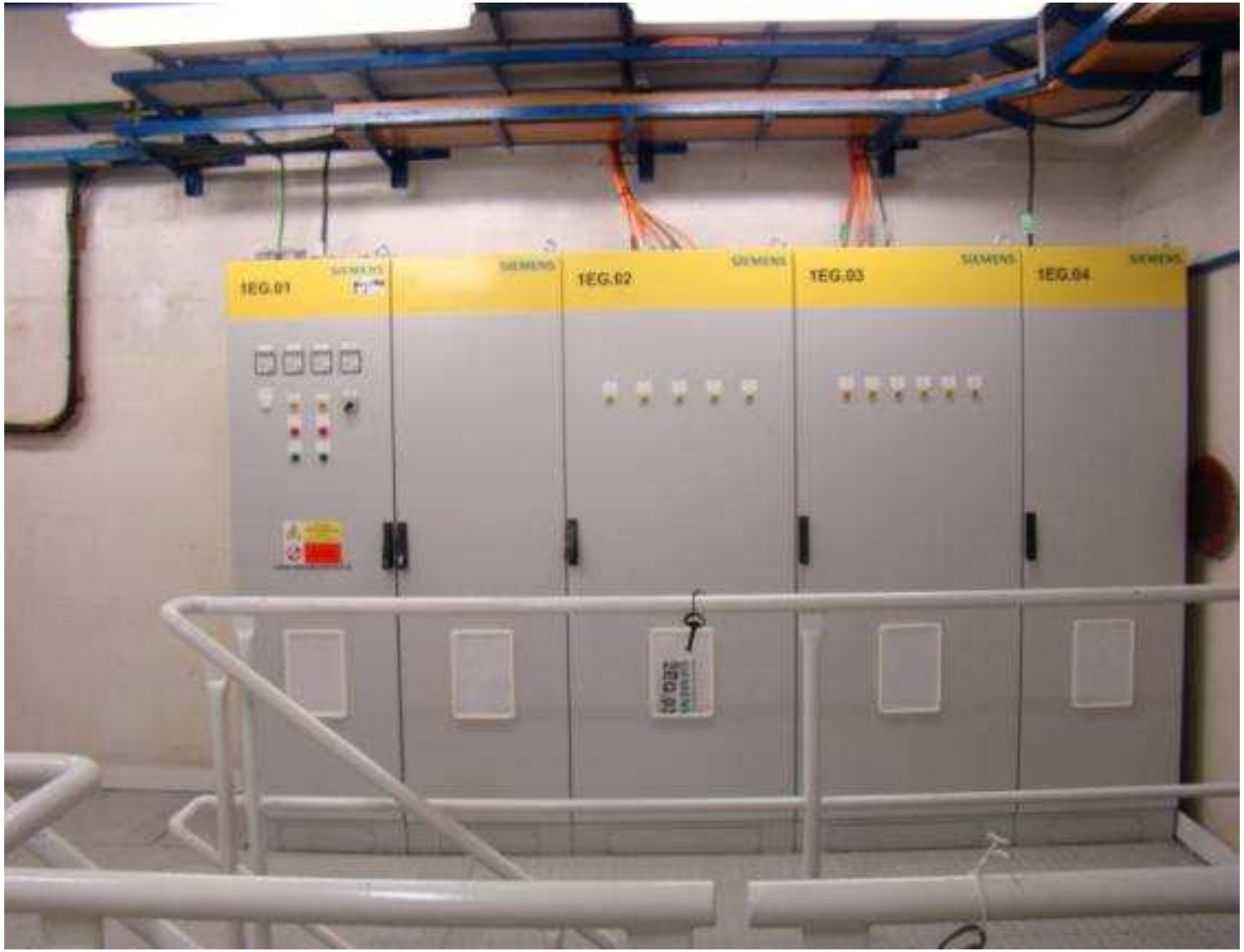
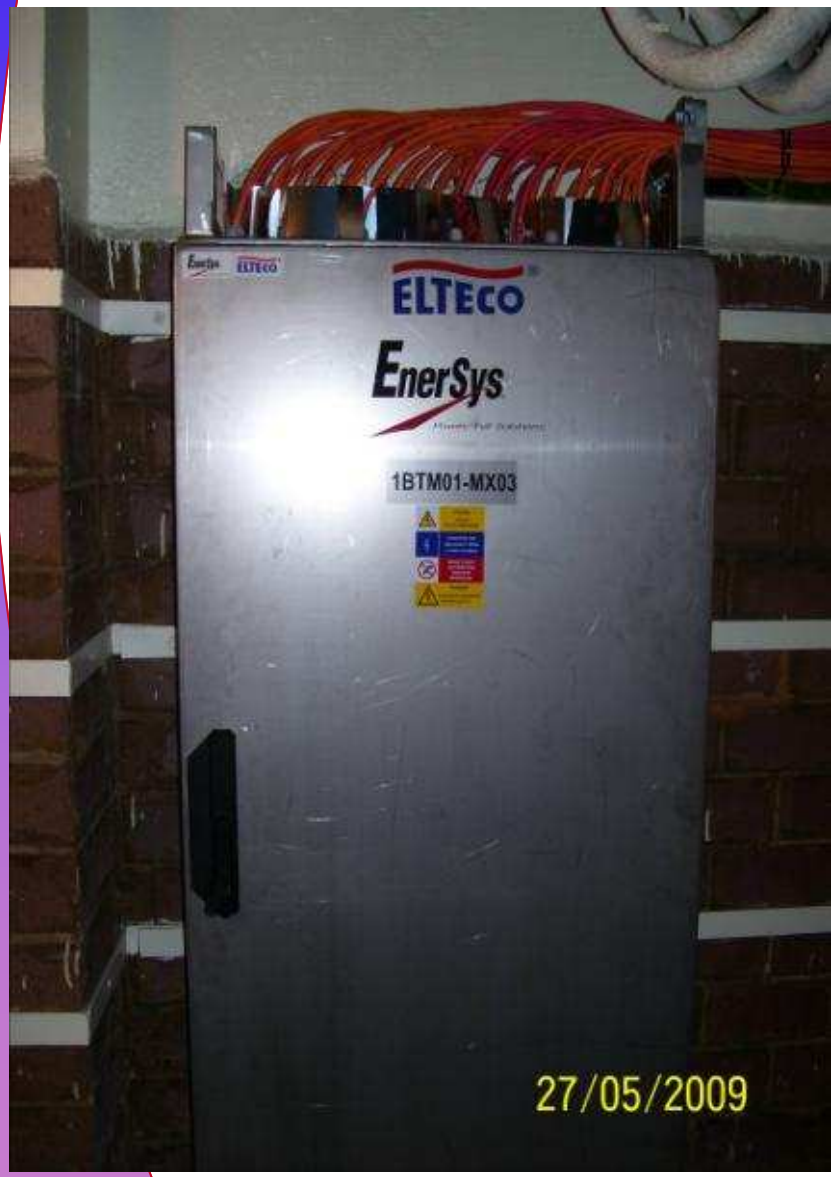
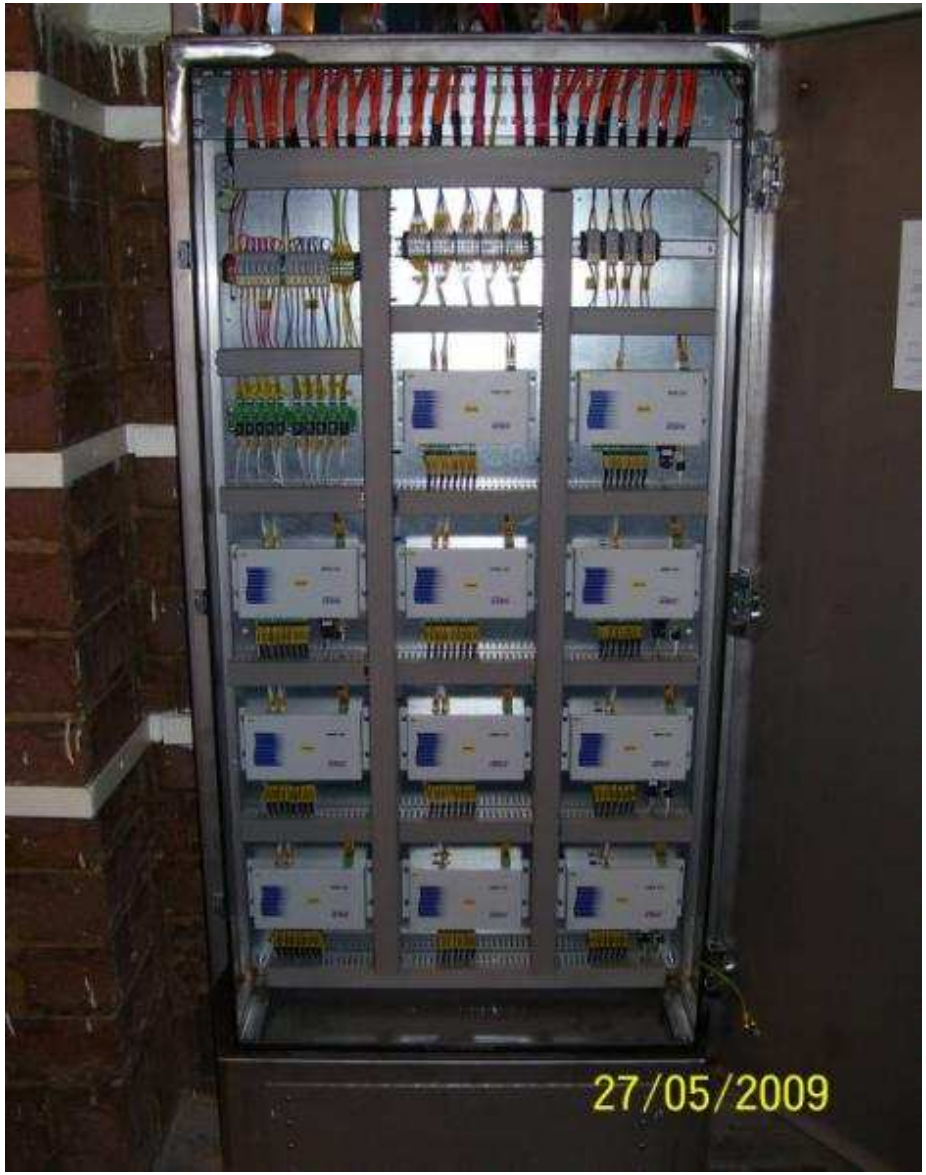


# Alternative (seismically qualified) electric power system



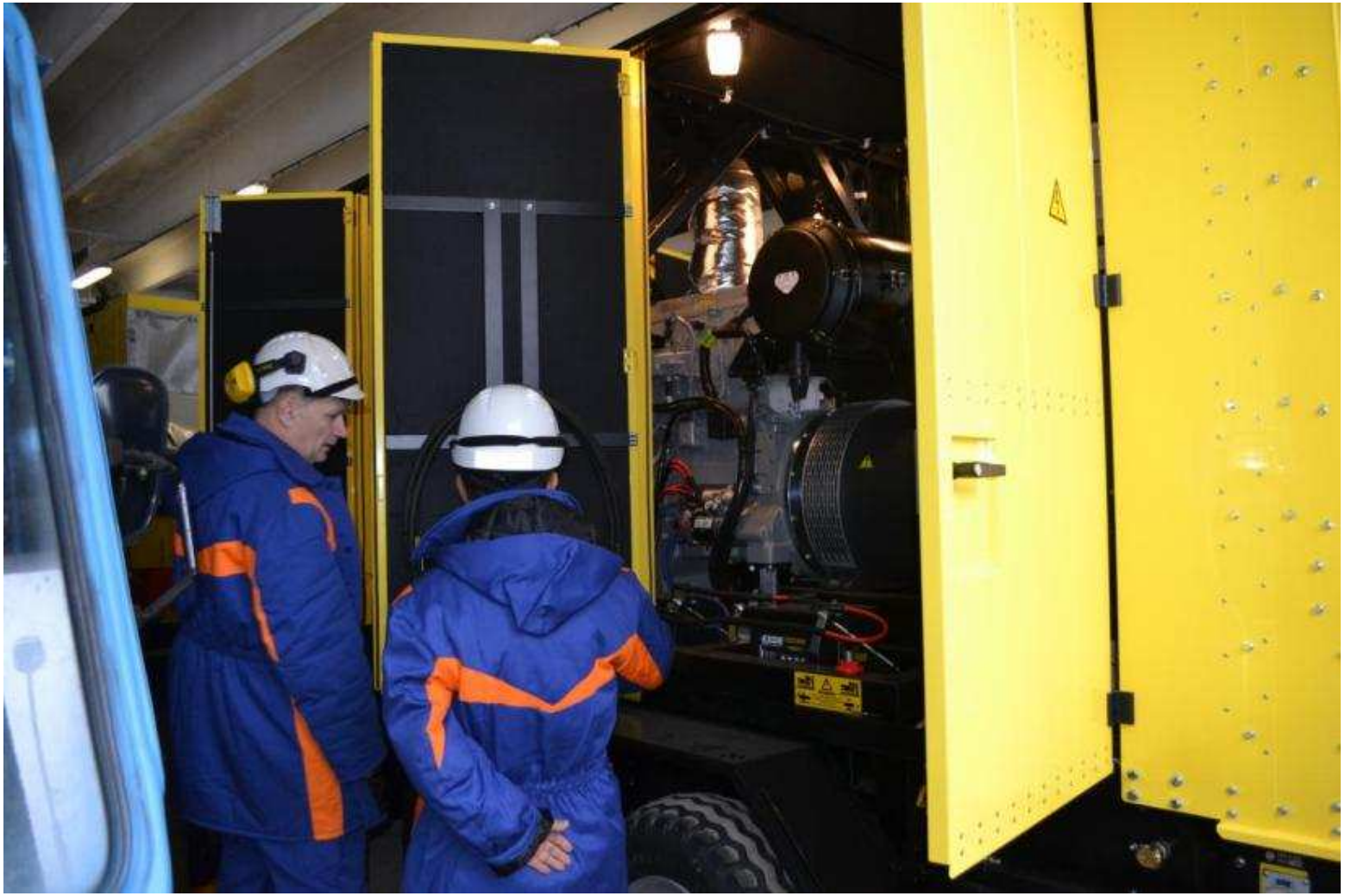
# Battery monitoring system



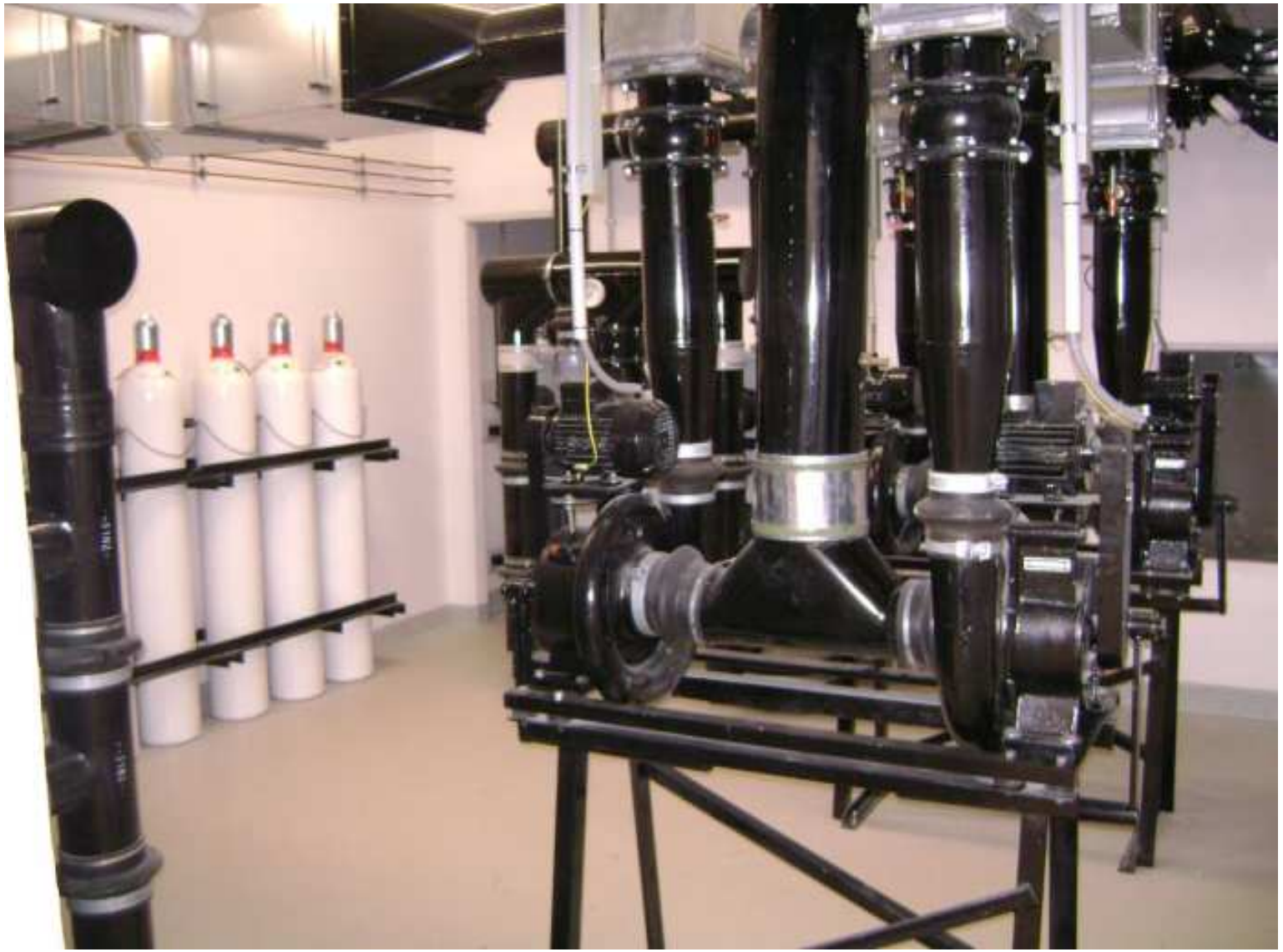



# Fire truck with high-pressure pump – 1/unit

# Mobile 0,4 kV DG – 1/per unit



# Bunkered emergency center



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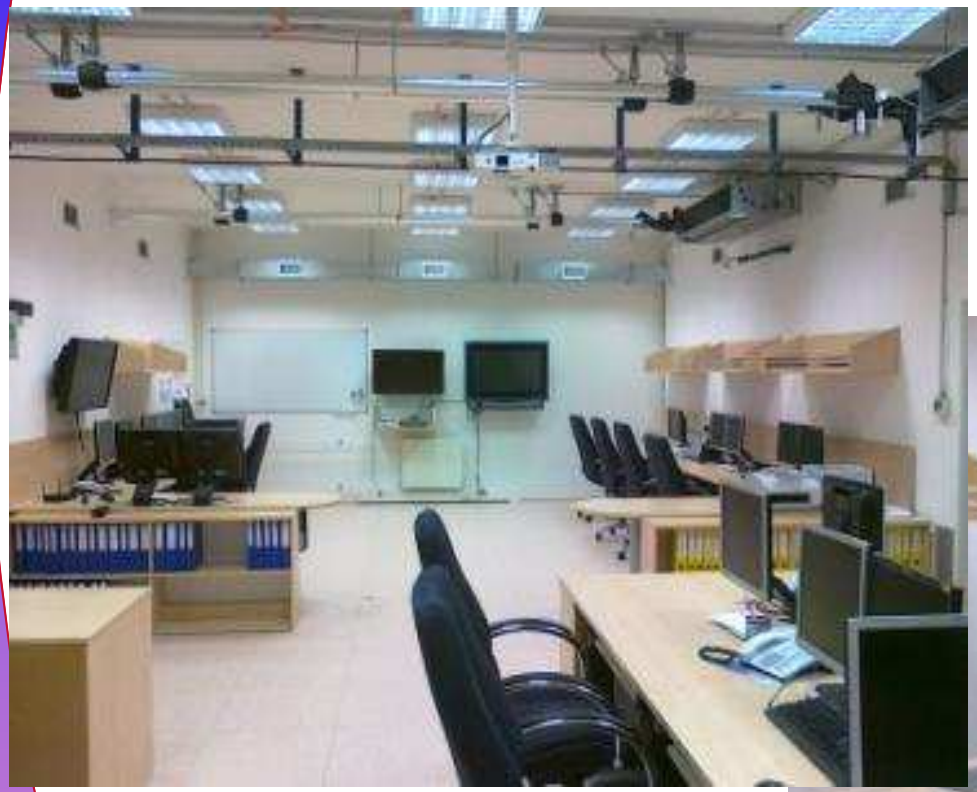
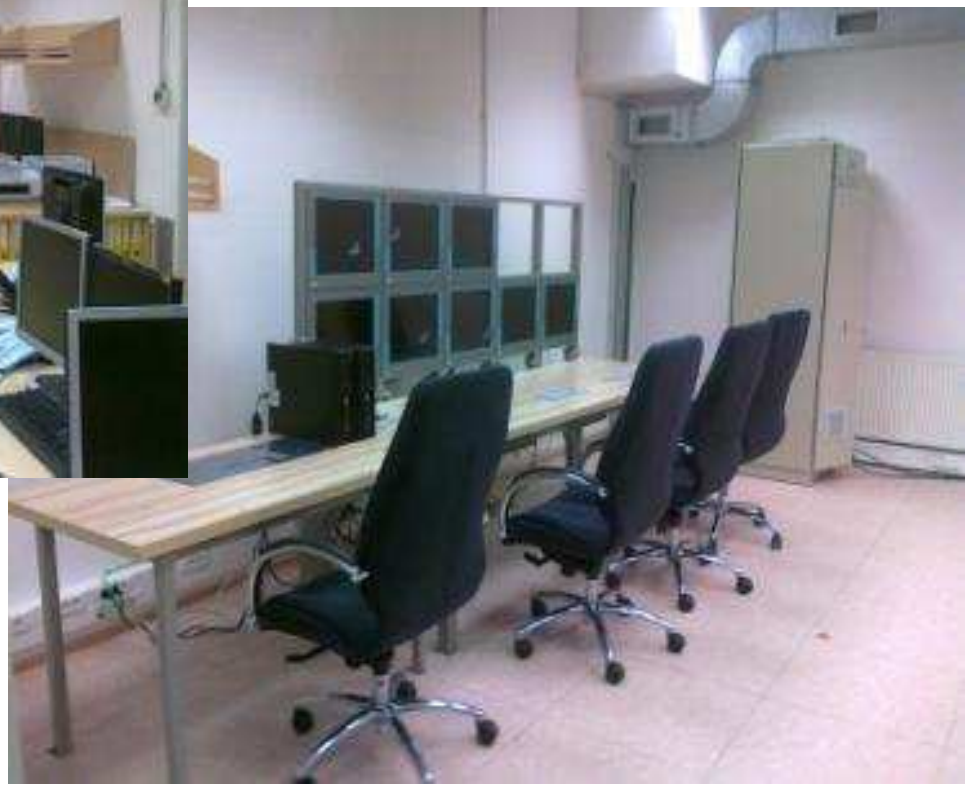
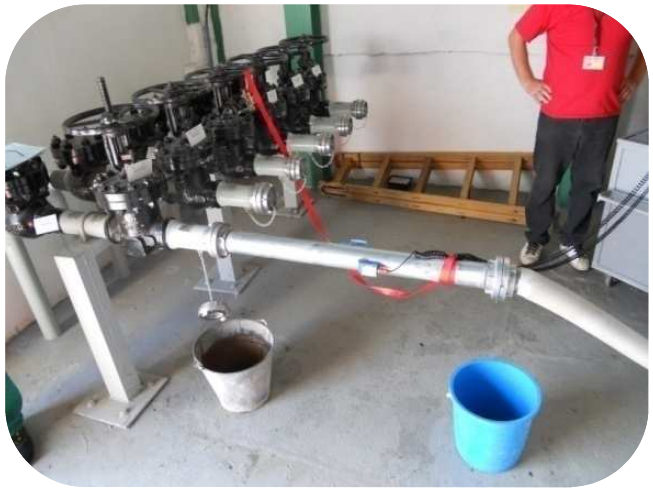
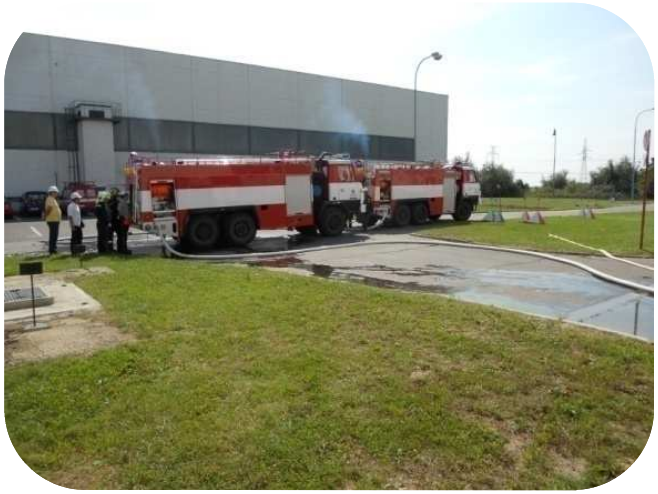
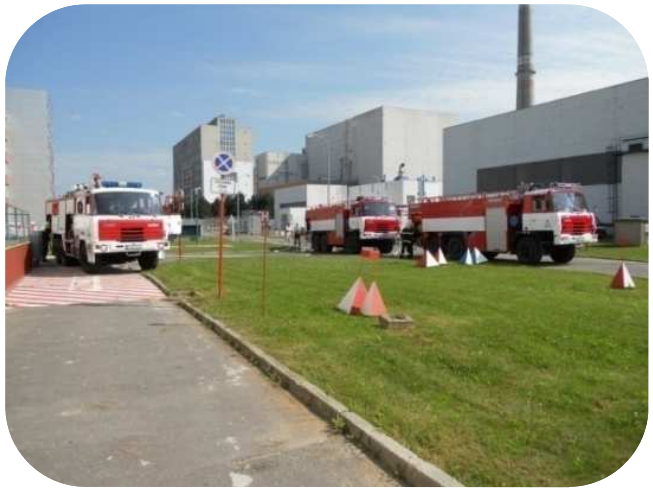




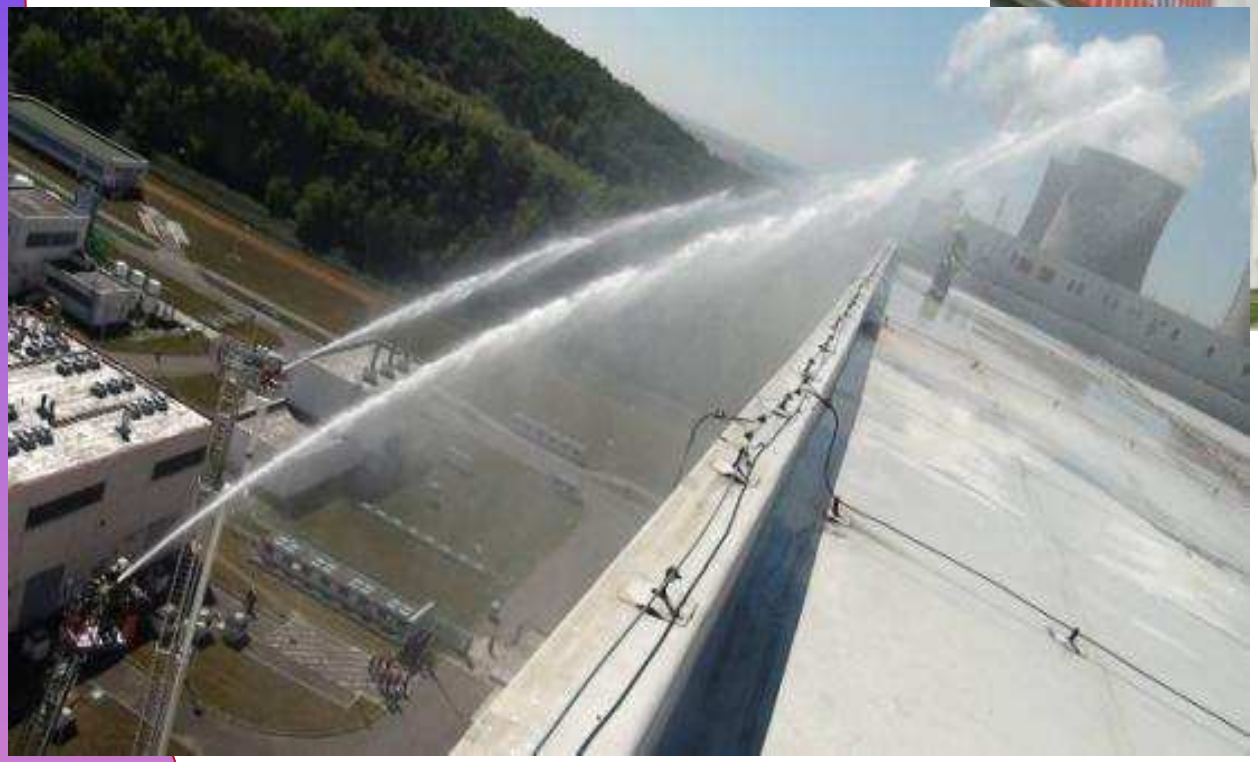
# Water supply to steam generators by mobile pump – exercise







# Exercises



# MELCOR activities at UJD SR (1)

- **Started within the SWISSLOVAK project (1996-1999) – MELCOR 1.8.3**
  - **Training in both deterministic and probabilistic safety assessment of NPPs**
  - **Input deck development for NPPs in Slovakia:**
    - **V2 Bohunice NPP and Mochovce NPP ( both VVER 440/213)**
    - **V1 Bohunice NPP (VVER 440/230)**
  - **Analyses of selected severe accidents covering various type of scenarios (SBO, LOCAs – from LB to very small, SGTR, interfacing system LOCA, Steam line break outside the containment)**
  - **More specific tasks:**
  - **Development of accident scenarios and estimation of radiological consequences for emergency planning activities of the UJD emergency response center**
  - **Regulatory review of severe accidents risk and potential impact of selected SAM actions for V2 Bohunice NPP (kind of limited scope PSA L2)**
  - **Calculation of benchmark sequence (SBO) within PHARE PR/TS/03 – SA mitigation for VVER 440/213 (various users with the same code)**
  - **Code-to-code comparison within EVITA project (2000-2003) – SBO and SBLOCA scenarios calculated with MELCOR 1.8.3 and ASTEC V.03 and V1.0**

# MELCOR activities at UJD SR (2)

- **MELCOR 1.8.5**
  - **Agreement with US NRC relating to participation in the US NRC Program on Severe Accident Research signed in June 2001 for 5 years**
  - **VVER-440/V-213 input deck adaptation for version 1.8.5 and improvement in cooperation with GRS, Germany**
    - **analyses for generic VVER 440/213**
    - **various scenarios calculated: SBO and LOCA 20 mm, LOCA 2x500 mm with/ without sprays in the containment**
    - **shutdown scenario with opened reactor vessel – man-induced LOCA accident**
  - **MELCOR 1.8.5 results for scenarios of SBO (2004) and LOCA 200 mm (2006) used for code-to-code comparison with ASTEC code (V1.0 through V2.0r2p2) within SARNET and SARNET2 projects (2004-2013)**

- **New Agreement with US NRC signed in January 2014 (MELCOR 2.0)**
  - **Foreseen activities – input deck adaptation/ development for Slovak VVER-440/V213 NPPs and MELCOR 2.x**
  - **Independent regulatory review of safety reports**

# MELCOR 2.0 input deck development (1)

- Primary and secondary circuits
  - 3-loops model consisting of:
    - a simple circulation loop with pressurizer
    - double and triple circulation loops
  - 69 control volumes (14 for RPV, 11 CVs per 1 loop, 4 CVs for PRZ, 4 CVs for HAs, 13 CVs for secondary circuit)
  - 94 flow paths, 199 heat structures
  - a relatively simple SG model:
    - primary side of SGs axially divided into 3 sections, each with 3 vertical levels of HS representing heat-exchange tube bundle
    - a single volume used for secondary side
- Core region
  - Divided into 8 radial rings (including annulus of RPV) and 19 axial levels
  - 312 fuel rods – located within Ring 1, 2, 4, 5 and 7
  - 37 control rods – located within Ring 3 and 6
  - Fuel in active core within axial levels 11 – 18 ; fuel section of control assemblies within axial levels 3 – 6
  - BWR model used – corresponds better to VVER-440 core with fuel rod canisters, however limitations for core shroud modeling

# MELCOR 2.0 input deck development (2)

- **RPV bottom**
  - 10 heat nodes in 9 segments
  - Particulate debris:
    - porosity =0.3
    - particle equivalent diameter =0.025 m
- **RN package**
  - 17 material classes specified
  - Combination of Cs and I2 atoms to form CsI molecules modelled
  - Formation of CsMo has not been activated
  - Revised CORSOR-Both model for high burn-up fuel used for RN release from fuel
- **Containment**
  - 77 control volumes + 3 CVs (reactor hall, surrounding rooms, environment)
  - 151 flow paths (including 2 FL paths for permanent leakages)
  - 180 heat structures + 7
  - Bubble condenser – 3 levels at the bottom modelled individually, upper levels 4 – 12 grouped by 3 levels per modelling horizontal level, a single air trap volume communicates with each group of 3 vertical levels

# MELCOR 2.0 input deck development (3)

- **Engineering safety features and operator actions**
  - **Emergency Core Cooling systems:**
    - **High-Pressure and Low-Pressure Injection Systems (3 trains per system)**
    - **Hydro-accumulators (4 HAs)**
  - **Active and passive spray systems in the containment**
  - **Passive Autocatalytic Re-combiners (33 PARs of high capacity, 16 PARs for DBA; modeled using ESF package)**
  - **Specific flow paths allowing to:**
    - **aggressively depressurize the primary and/ or secondary circuits**
    - **discharge the Bubble Condenser trays**
    - **flood the cavity by water (located on the floor of SG boxes)**
  - **Emergency Source of Coolant – possible use for feeding SS, ECCS, cavity flooding, feeding of SGs, etc.**
- **Redefinition of concrete composition in the reactor cavity**
- **Redefinition of decay heat and initial radionuclide composition**
- **Redefinition of some material properties**
- **In total app. 18 000 lines**

# Thank you for the attention