

On the cleaning system incident at the Paks NPP

**Presented
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*Presentation from
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Event sequence (early phase)

- Crud deposition on fuel assemblies in three units due to earlier decontamination procedures
- 15.03. - installation of fuel assembly cleaning device (Framatom ANP)
- Cleaning of two loads (30 assemblies each)
- 29.03. - shutdown of unit 2
- Cleaning of three loads from unit 2
- 09.04 - start of cleaning the fourth load from unit 2
- 10.04. 16:30 - end of cleaning
- Opening of cleaning tank postponed for other activities on the critical path

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Primary chemical decontamination - inadequate passivation of RCS internal materials
Recurrent crud depositions

Event sequence (early phase)

- 10.04. 22:00 - increase of Kr-85 dose rate detected
- 11.04. 02:15 - Lid lock opened, bubble outburst
- 11.04. 04:20 - unsuccessful attempt to open the vessel-lid (rope rupture), vessel semi-open
- Elevated release of noble gases and iodine through the NPP stack
- Elevated, but <500 nSv/h dose rate at one of the 9 near-station monitors for a short period (background value: ~ 100 nSv/h)
- No other off-site effect detected
- Classified to INES level 2
- Extensive field exploration and monitoring initiated

Misaligned lift - sling cut. Heat deformation + bending of alignment pins

also 19:00 smaller Kr-85 rel
Mgmt meeting @ 16

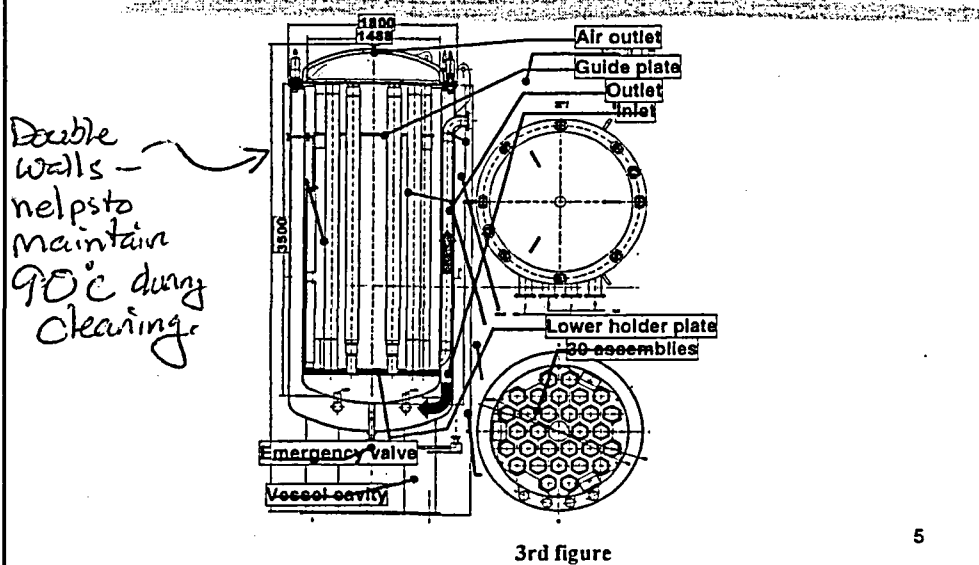
release hydraulic lock - lid tilted by itself

hydrogen product from zinc oxidat insufficient O₂

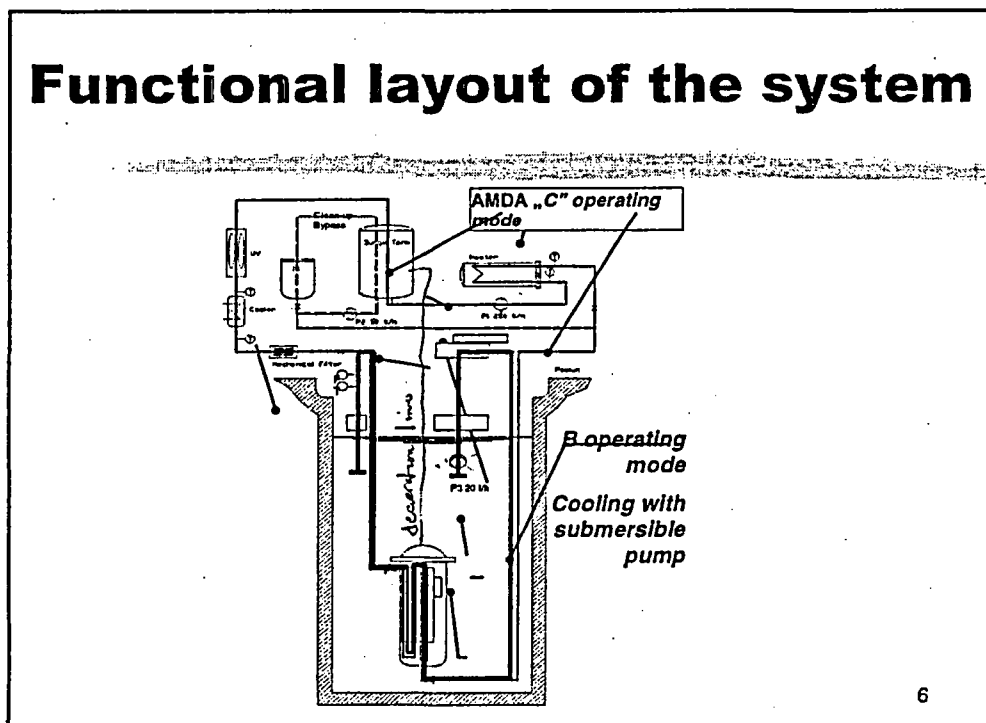
pool level ↑ sudden drop 4-5 m³

coolant exit + decreased after d

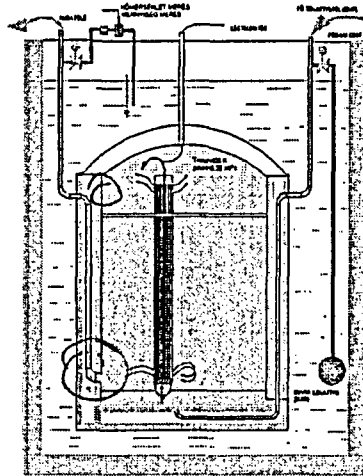
Structure of the tank



Functional layout of the system

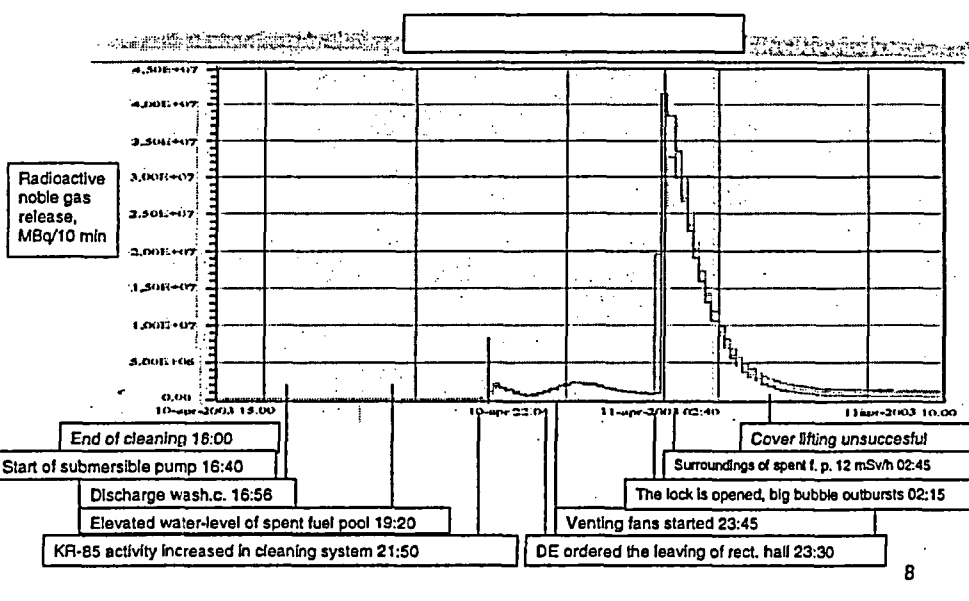


Layout of the B operating mode



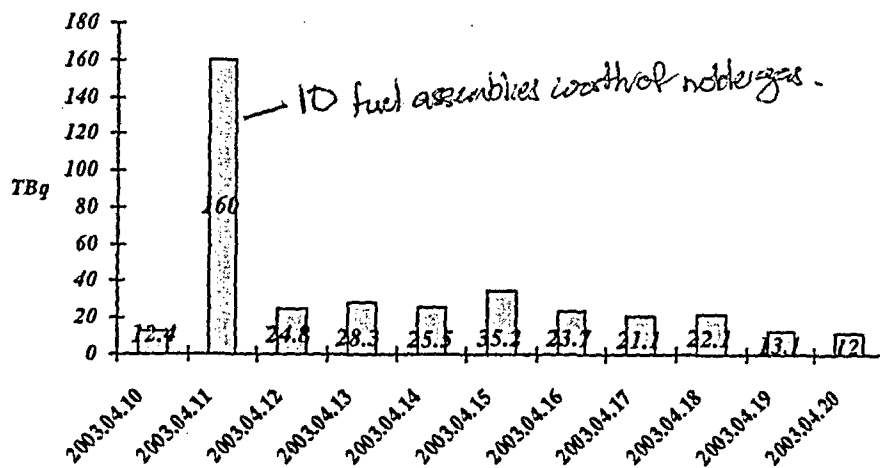
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Events during the incident



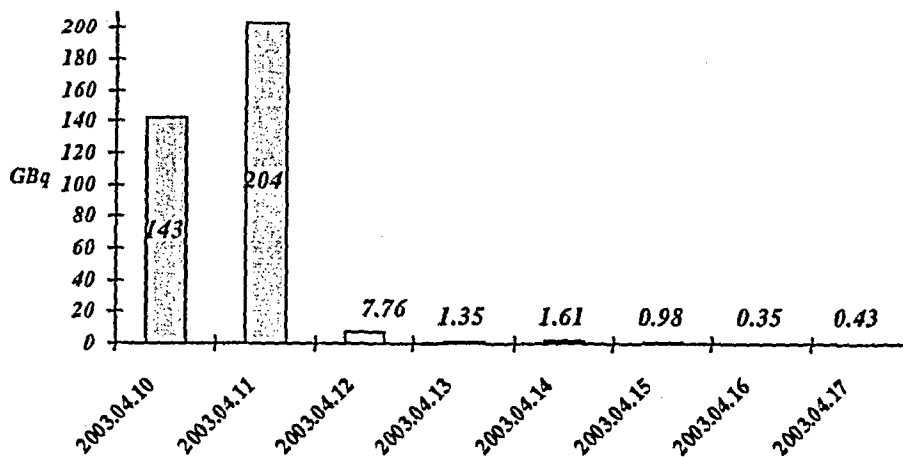
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Noble-gas release



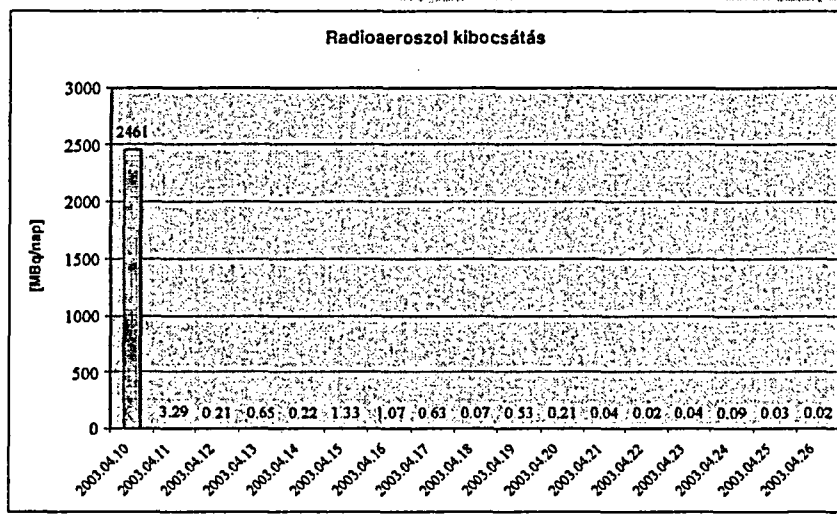
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¹³¹I-equivalent release



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Aerosol release



Event sequence (later phase)

- 16.04 - successful attempt to remove lid
- remote camera-snapshot taken
- fuel assemblies highly damaged but not melted
- NPP Emergency Preparedness Organisation alerted, HAEA notified
- HAEA NERO alerted, IAEA and neighbouring countries notified
- "Communication emergency"
- Reclassification to INES 3
- Analysis of possible scenarios, no change in plant status nor in radiation circumstances

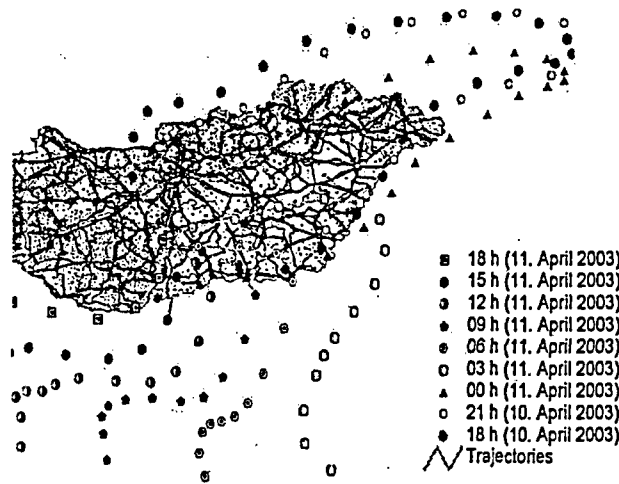
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Event sequence (later phase)

- Framatom and Russian experts invited
- Radiation evaluation three times a day - continuous decrease (c.f. figures above)
- Noble gas overestimation for deposition in device
- Analysis of possible criticality - k_{eff} is below 0.95 if C_{Boron} is about 16 g/kg (actual value was 15.3 g/kg)
- Addition of boron acid, installation of neutron and thermal measurements
- 20.04. 09:00 - emergency state called off, EPO alert is terminated
- Intensive media, professional and political interest

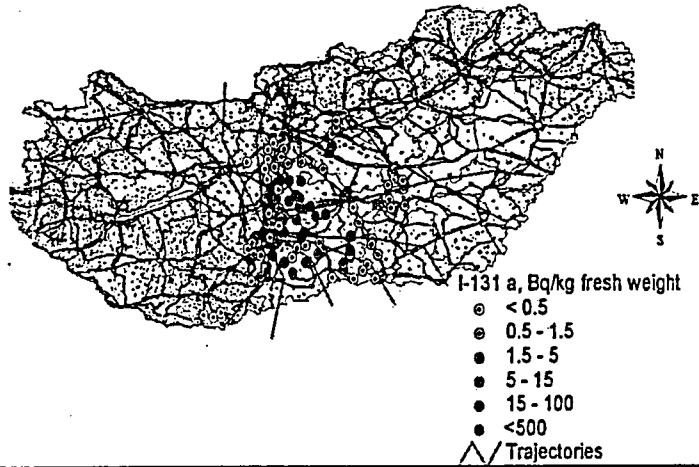
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Wind-trajectories

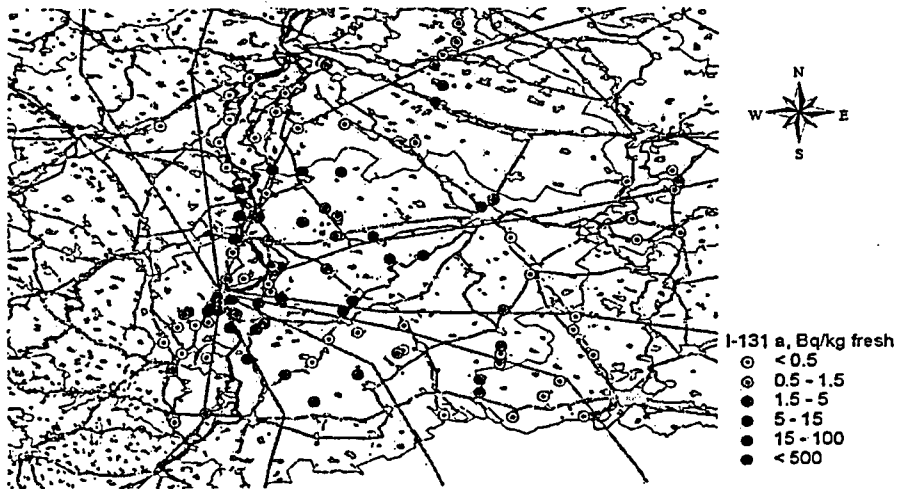


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Specific activity of I-131 in plants



Specific activity - near Paks



A possible explanation

- Post-cleaning cooling insufficient for coolant by-pass
- Evolution of a steam-cushion
- Gap release due to assembly dry-out
- Thermal shock or steam explosion after lid opening crushes the assemblies

Investigation and verification is still underway

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Next steps

- Dedicated team of NPP for consequence management
- Keeping stabilised the assembly
- Isolation and safe deposition of waste
- Decontamination of the pools
- Restart of Unit 2
- Lessons learned, drawing conclusions
- Reporting

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Report submitted by the NPP

- Submission: 11. May 2003. to HAEA
- Main chapters:
 - Short summary of the incident
 - Evaluation of the incident covering radiation protection, technological circumstances, activity of the staff, documentation, efficiency of self-inspections, causes of fuel damage
 - Non-conformities detected during the investigation,
 - Consequences and safety impacts of the incident
 - Necessary countermeasures

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Main conclusions of the NPP

- Immediate cause: insufficient cooling
- Plans have not secured sufficient cooling for every possible case
- Safety analysis has not covered in-vessel flow-patterns for B-mode cooling
- Plans for system-parameter control have not guaranteed recognition of insufficient cooling

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Independent HAEA investigation

- Data collection phase (interviews, minutes, op. data, records) closed
- Report to be ready by end of May
- Shall also include the regulatory assessment of the NPP reports
- Accounts also for the activity of the regulatory body

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Contents of the HAEA report

- Characteristic data of the incident
- Preceding events and their evaluation
- Event sequence of the incident
- Process followed by the HAEA
- Causes of the incident
- Deviations (malfunctions) leading to the incident
- Evaluation of related operator's actions
- Nuclear and environmental safety assessments
- Necessary countermeasures

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Technological causes

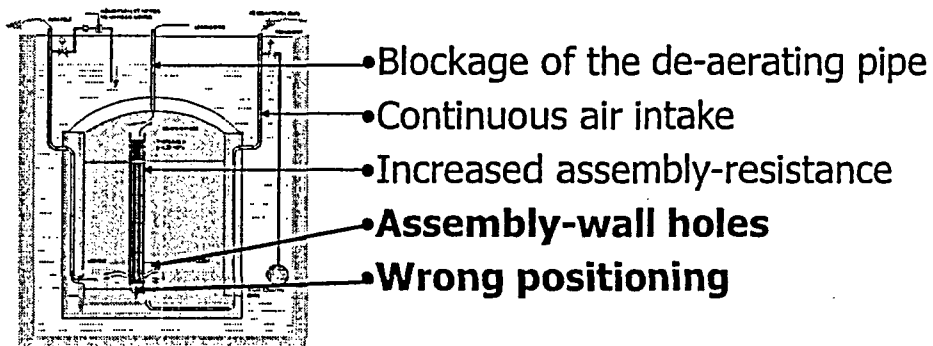
■ Antecedents:

- Magnetite deposition after SG decontamination in Unit 2 (1996), full load-replacement (1998)
- Multiple SG decontamination with incomplete passivation on units 1. - 3. (2000-2001)
- Cleaning with a 7-assembly unit (2000-2001: 170 assemblies)
- Building of a 30-assembly tank (2002)
- Shut-down and reloading of unit 3 (02.2003)
- Cleaning with the 30-assembly unit (03.2003-)

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Possible direct causes

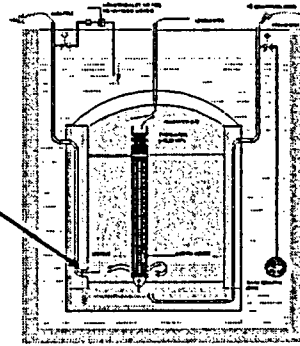
B operating mode: waiting for offloading



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Root-cause

Outlet at the bottom of the tank



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APROS model

