# Managing of the damaged fuel at Paks NPP

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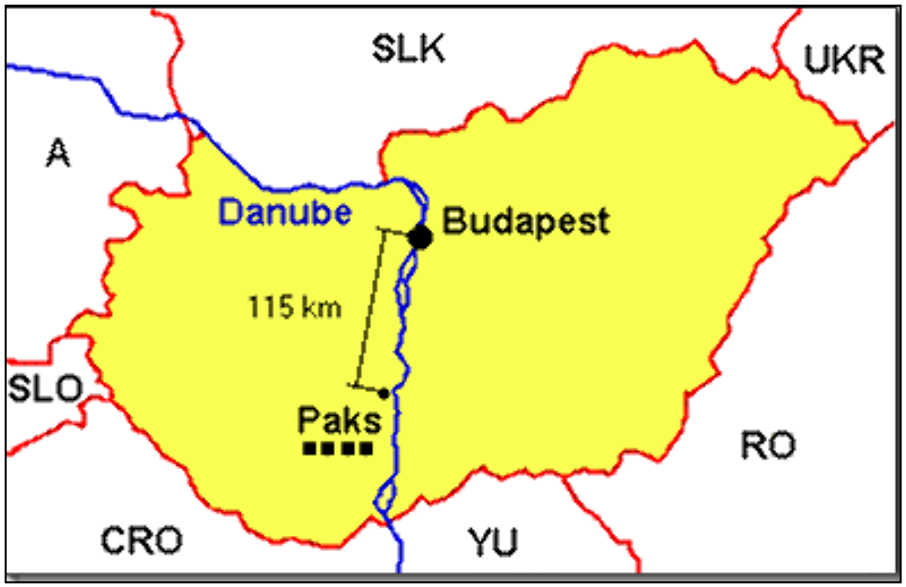
# General information (Hungary, Paks NPP)




**Location: Central Europe**

**Area: 93 000 square kilometers**

**Population: less than 10 million**

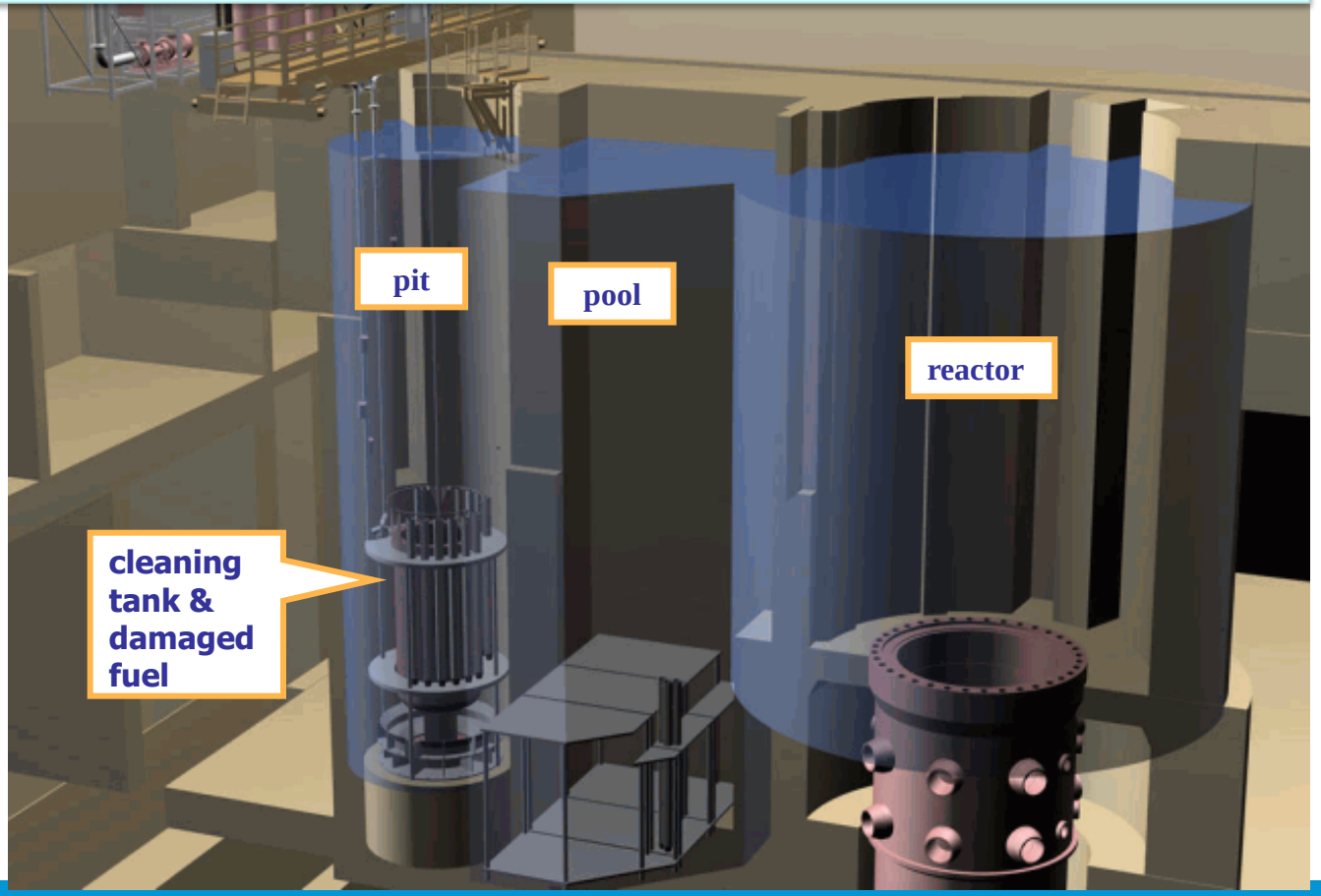
**4 VVER-440 type Units;**
**Commissioning time: 1982-1987**
**Original design: 1375 MW, 440 MWe,**
**After power uprate project 1435 MW, 500 MWe**

**2000 MW, > 50% of domestic production**

# Cause of the accident

•In 2002 the Units 1-3 were operated at lower power (the coolant flow rate had decreased due to magnetite deposits on the fuel assemblies (FA).
•Paks NPP made the decision to clean up the FAs from the deposits during an annual outage.
•In April 2003 in course of cleaning of the fuel assemblies in a specially designed and manufactured cleaning tank, located in pit No. 1 of Unit 2 of Paks NPP, violation of the cooling regime took place with consequence of damage of the fuel assemblies

**On April 11, 2003 cooling problems during cleaning up a batch of 30 irradiated fuel assemblies caused an incident, damage of 30 fuel assemblies.**



# First phase of the liquidation of consequences of the incident

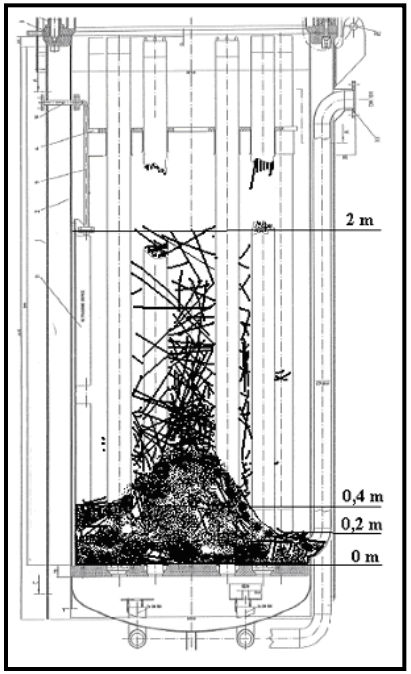
## In Paks NPP's case the full recovery of the consequences of the incident took more than 11 years.

**The purposes of the first phase were**:

- to investigate the cause of the accident and to understand the conditions of the fuel and the pit (4 weeks),
- to stabilize the fuel and to ensure the safe conditions of damaged fuel and the Units (4 months),
- to establish the project responsible for recovery (2 months).

**The works were implemented mostly by NPP's specialists and the domestic Research Institutes and Design Organizations**

$\sum$ ***mass SF > 6 t***
*$UO_2$ > 3,5 tons*
*U-235 > 70 kg)*
*Pu > 20 kg*
*only damaged, not molten)*



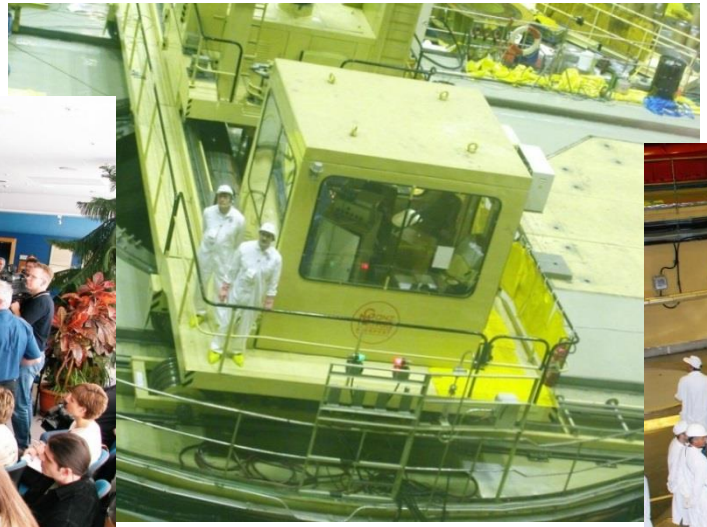

2003 2007 2013 2014

# Communication

## Proactive, open and systematic communication with the public both at the local and national levels.

**Goals:**
- **to achieve the public understanding of the situation,**
- **to provide true information and to enhance a trust of local people,**
- **to explain the possible management of damaged fuel in safe manner.**

***The 1st press release on the day of incident. 04.22 .2003-the first press release from the reactor hall; after stabilization of situation (in May) every day press release with new information. From July till November weekly press-release. Big international conference on the spot after the removal of fuel from cleaning tank.***



# Second phase of the liquidation of consequences of the incident

## The purposes of the 2nd phase were:

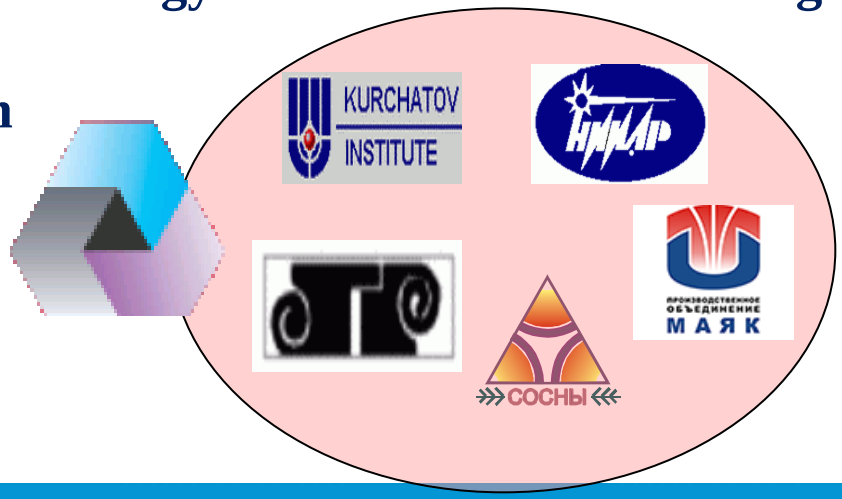
- preparation of the fuel removal (developing of technology, design of equipment and tools), licensing,
- fuel removal.

**Main facts:**

- In 2003 the power plant and Hungary were not in possession of suitable technology, and had not enough experience for liquidation of the incident consequences.
- The works had to be performed in environment of power plant in operation.

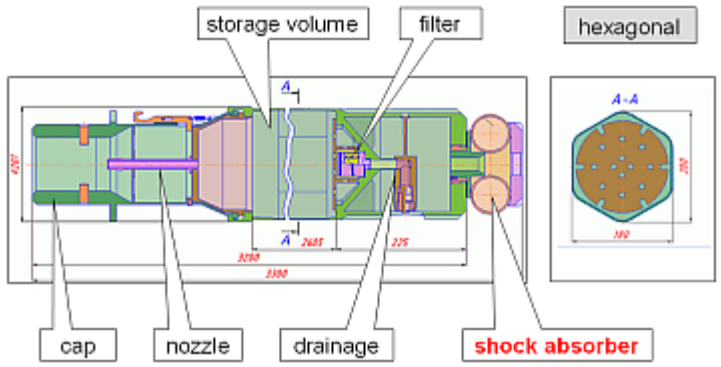
**In 2003 OAO "TVEL" and Paks NPP entered into a contract, in accordance with which Russian specialist, in compliance with all requirements of nuclear and radiation safety had to elaborate technology for removal of the damaged fuel assemblies from the cleaning tank, emptying pit No. 1, as well as to perform the practical works.**

**For solution of the tasks in Russia a team has been established under leadership of OAO "TVEL" including leading companies of the industry.**



# Canisters & casks

## Broad (28 type) canister




- for almost intact FA parts without head/leg
- fill limit 196 kg

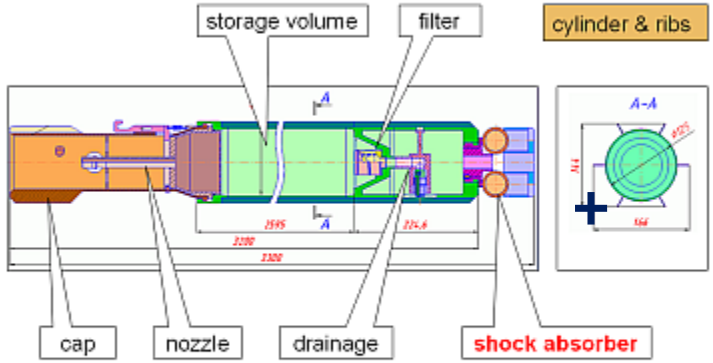


## Solid radwaste cask

- For removed FA head /leg
  - head
    - = screwed in, fixed by milling
    - = for connection of refueling machine or crane
  - cloak
  - lower grid (to drain)
  - utilization in reactor hall vault storage



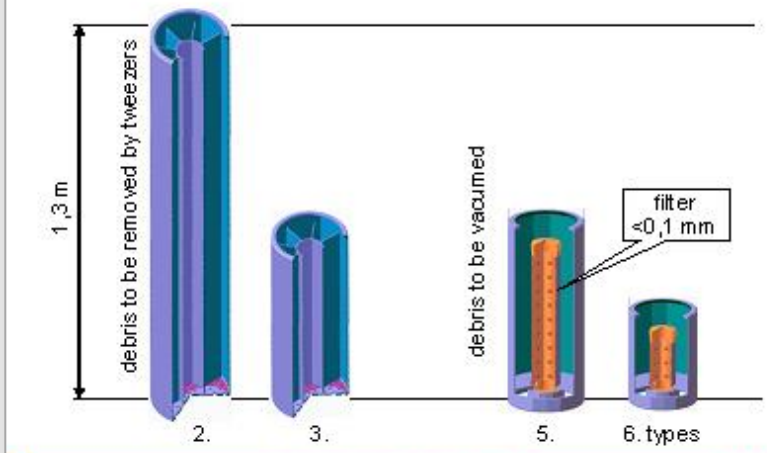
## Narrow (29 type) canister



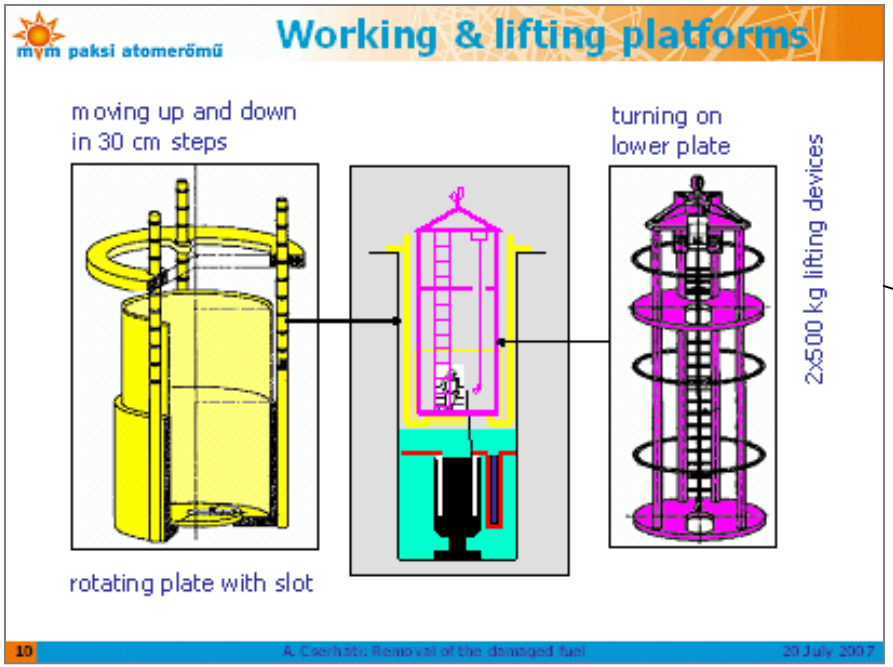

- for debris, loaded into space holders
- fill limit 70 kg

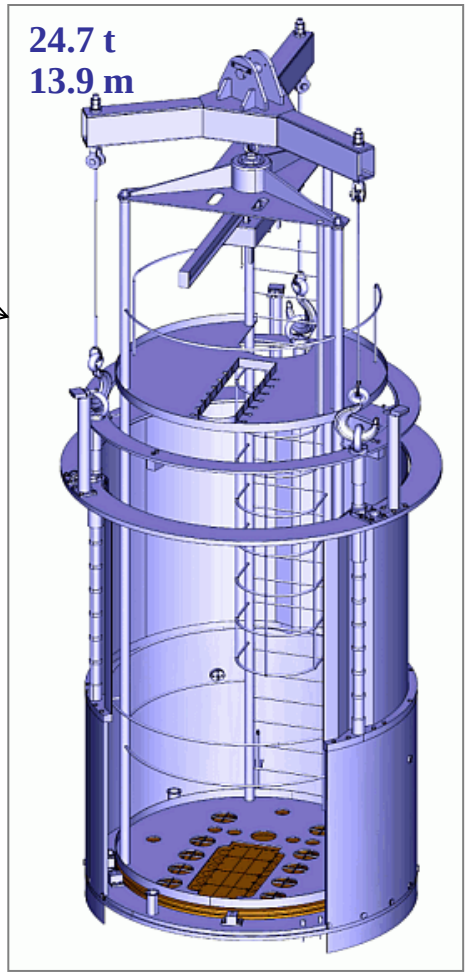


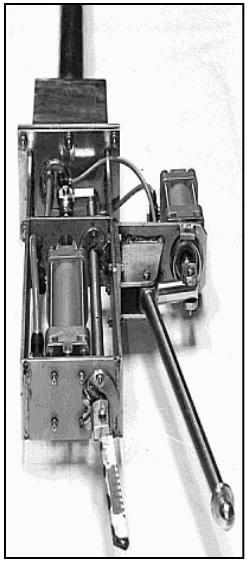
## Space holders



# Main recovery equipment, tools

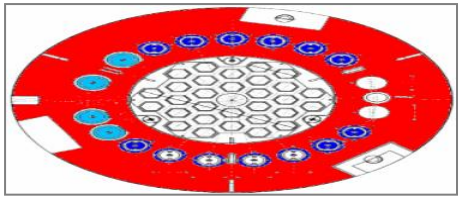


**>80 different kind of tools**

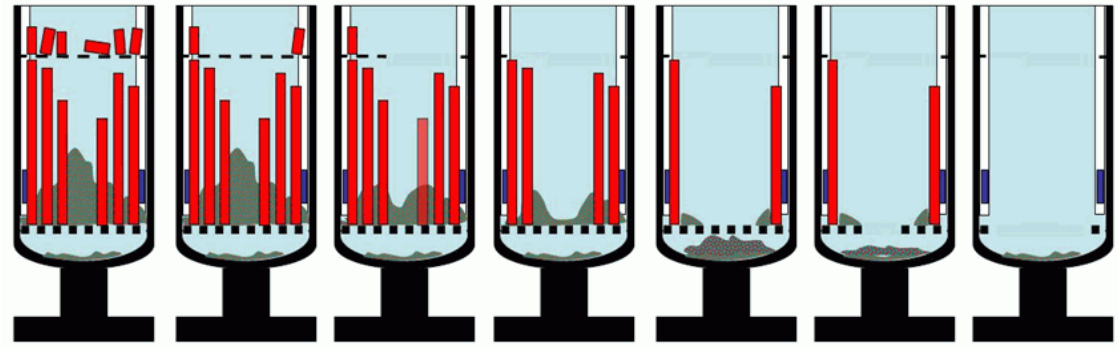
- Fixing,
- Drilling,
- Cutting,
- Catching,
- Suction,
- Washing,
- Lifting.



# Fuel removal operations

- **Technology characteristics:**
  - Loading of the fuel under water by remotely, pneu/hand-operated tools ,
  - FA without head/leg into vented canisters,
  - fuel rods and debris into space holders and canisters,
  - head/leg into SRW cask,
  - underwater weighing (safeguards, filling limits).

- **Direction of fuel removal:**



Clear out the upper plate of the tank from SFA and fuel rod fragments. Separate the SFA end parts from fuel columns and load them into SRW vessels

Clear out the fuel rod fragments from the middle of the tank

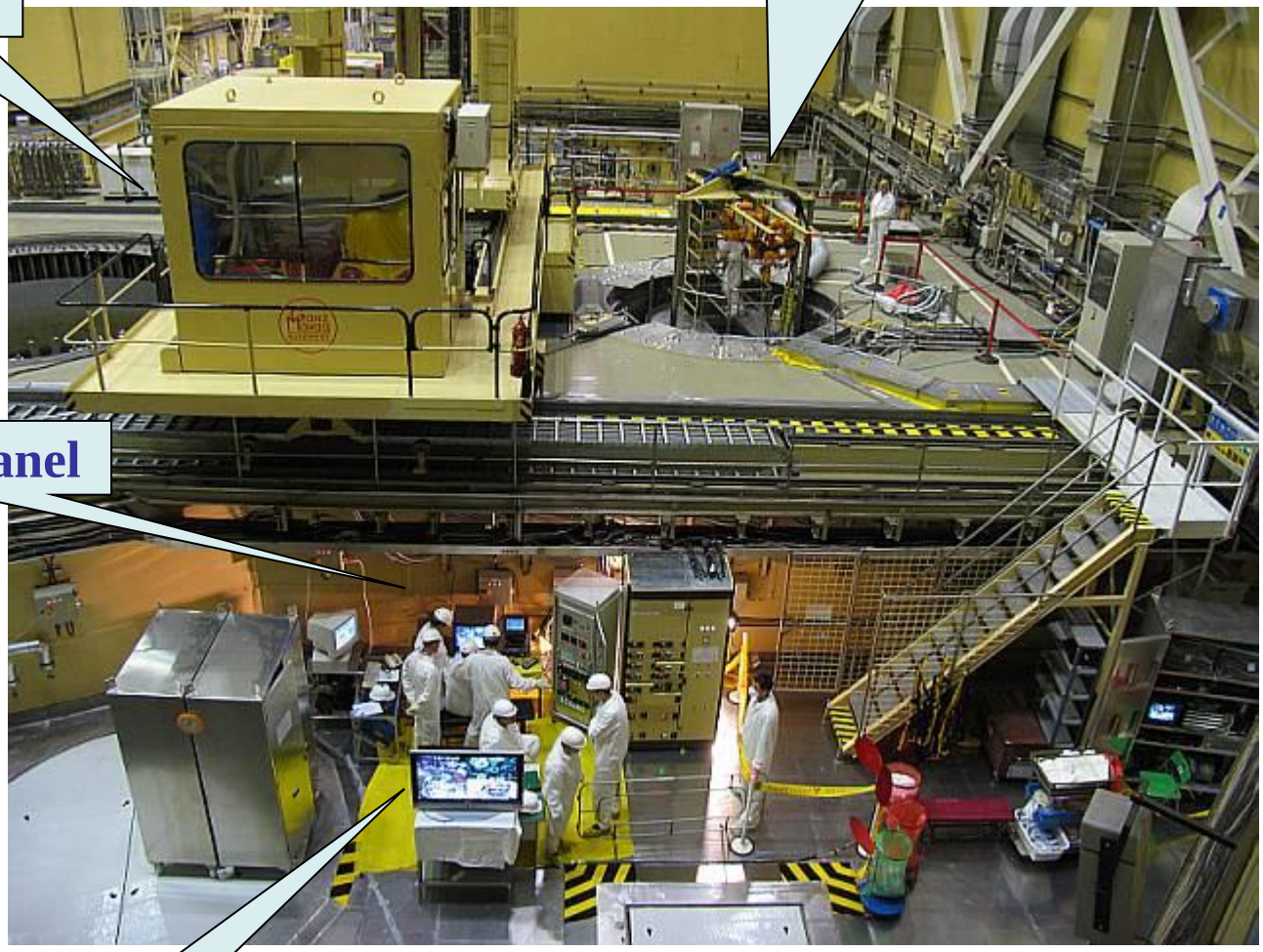
Cut the upper plate into fragments. Remove the SFA fragments from under the plate

Remove the bulk SNF and SFA fragments from the lower plate

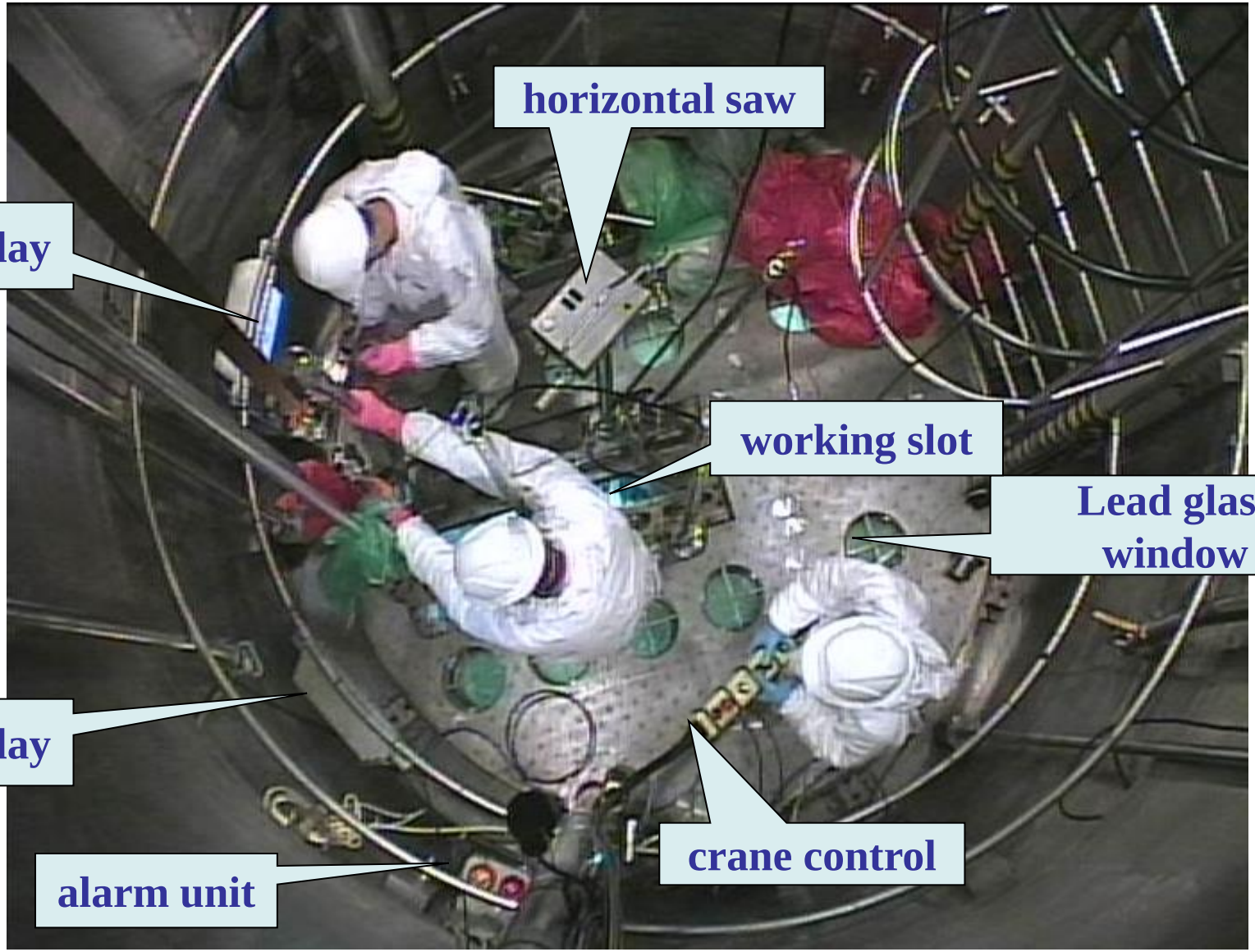
Drill through and remove the central part of the lower plate

Remove the bulk SNF and SFA fragments from the bottom of the tank

# Control panel & displays



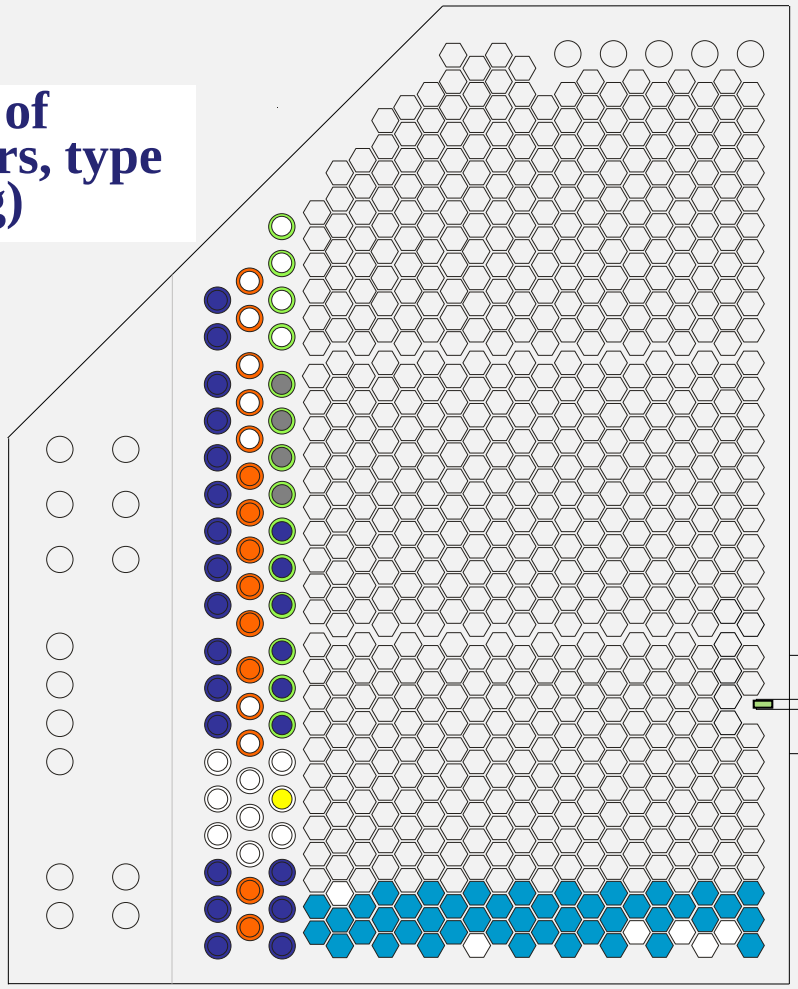
# Upper view of the platform

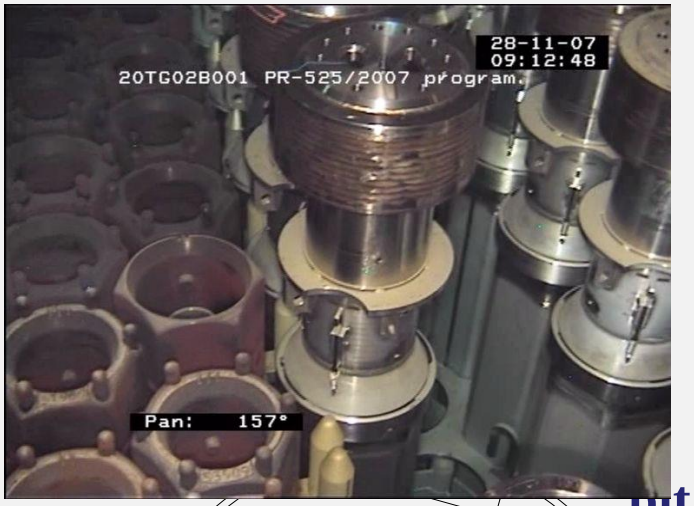


# Storage of canisters in the spent fuel pool

## „Wet” storage = „Ventilating compensator”

24 pcs. of canisters, type 28 (big)







8 SRW casks

44 pcs. of canisters, type 29 (small)

# Third phase of the liquidation of consequences of the incident

## Objective: to restore the conditions of the plant prior to the incident!

**Main steps:**

- elaboration and substantiation of the technology of drying and hermetical sealing of the canisters, licensing,
- substantiation of the transportation, licensing,
- drying out of canisters and transportation of all canisters to a reprocessing facility.

**Requirements to the technology:**

•to optimize the needed resources,

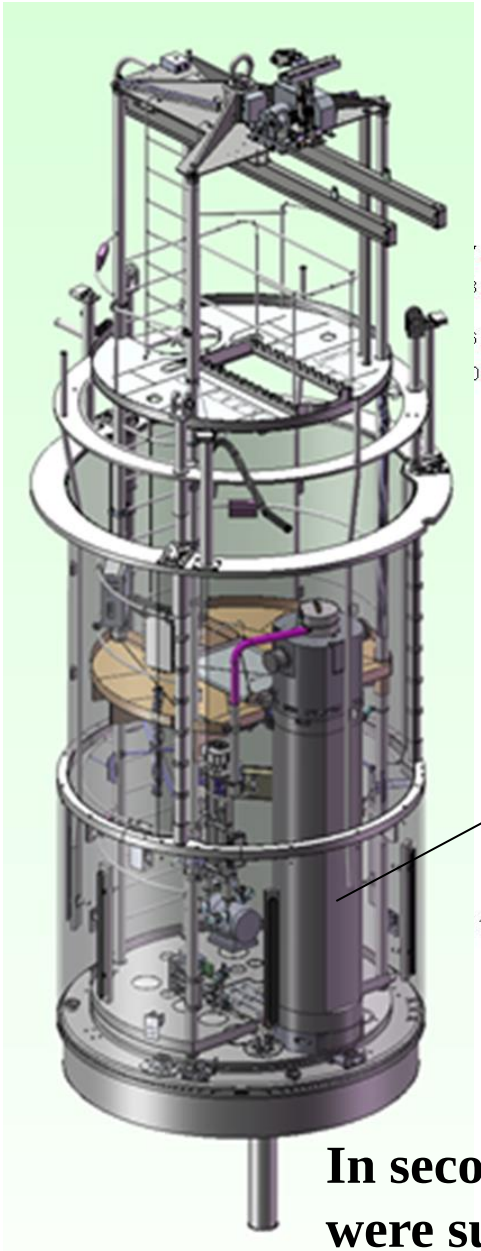
•to minimize the quantity of waste, activity release and radiation exposure of the personnel and population,

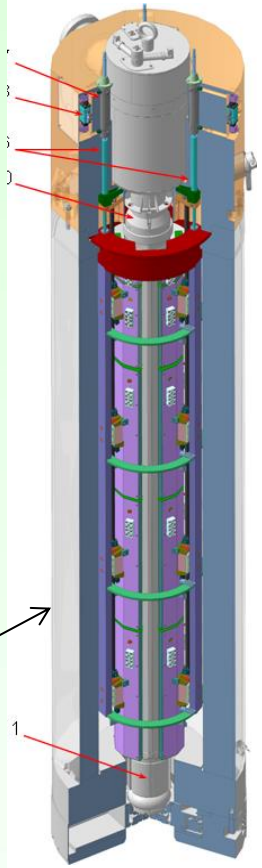
•the works should not disturb the normal operation of Units 1 and 2.

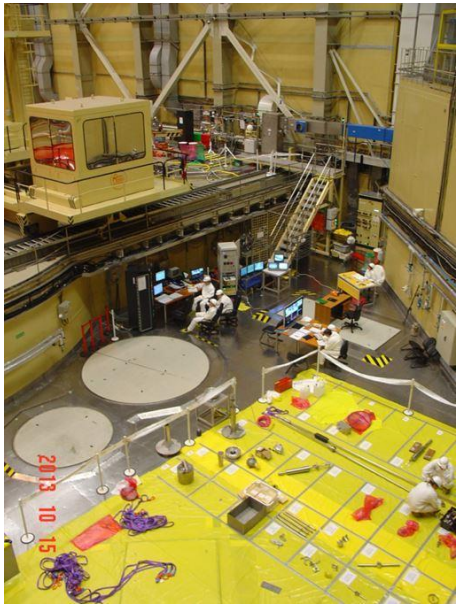
**It was necessary to carry out the experiments studying the behaviour of damaged nuclear fuel in canisters and verifying the feasibility of drying technology (these experiments have been carried out by Russian Research and Development company „Sosny" and Research Institute „NIIAR" in Russia).**

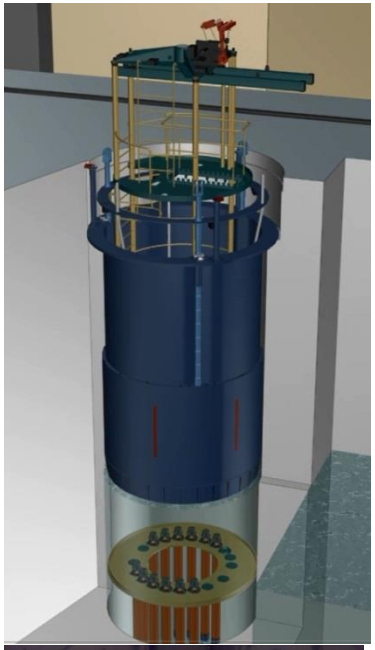
**On the base of research works the drying out of fuel and transportation of canisters to reprocessing facility in Russia became feasible (Hungary does not have reprocessing factory, the existing Spent Fuel Interim Storage Facility is licensed only for normal spent fuel).**

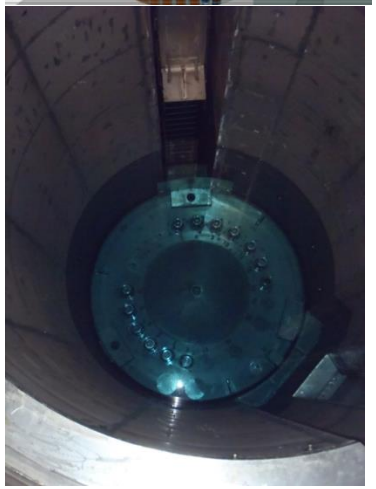
# TECHOLOGY used for drying and hermetical sealing the canisters







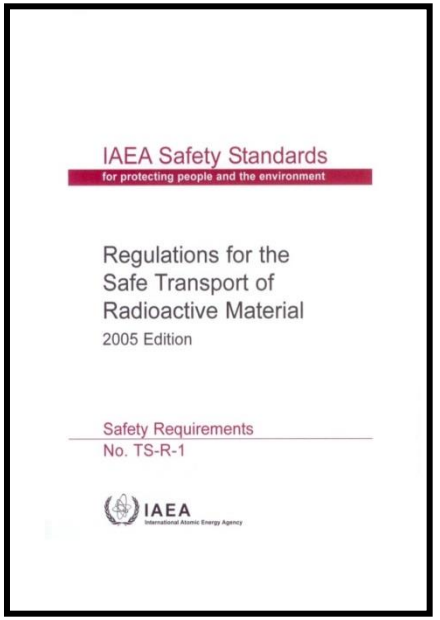



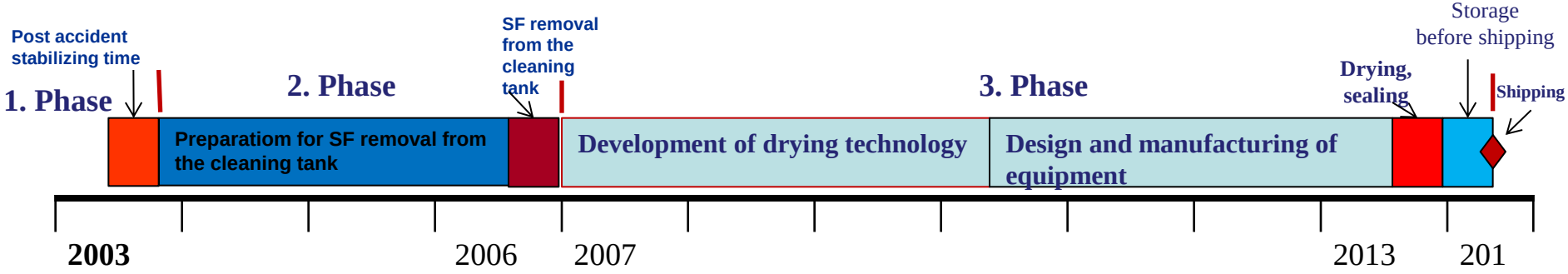



**In second half of 2013 all 68 capsules containing the spent fuel were successfully dried out.**

# Shipment of the SF to the reprocessing facility

**In summer 2014 the capsules were successfully shipped to Russia to "Mayak". By this the project for full recovery of the consequences of the accident of 2003 was successfully completed.**



# Main clues of the success (1)

- *Collection , analysis and utilization the information from around the world,*
- *Establishment of responsible project organization, permanent support from a management of NPP.*
- *The safety (nuclear, personnel protection, operational safety) had the highest priority.*
- *Enough time for all preparing works (no tight schedule) (in our case 11 years!).*
- *For solution of tasks the leading (design, research, engineering, manufacturers) companies of the industry were involved in Russia and in Hungary.*
- *Conservative approach in all works.*
- *All significant analyses were performed at least in 2 independent organizations, the results were compared and evaluated.*
- *Mock –up tests on all phases.*
- *Before implementation all equipment and technology were tested in place of fabrication and in real (but inactive) conditions at site.*
- *Only well trained personnel after additional examinations were involved in works.*

# Main clues of the success (2)

- *Each step of works was licensed by Hungarian Atomic Energy Authority. All requirements of National Nuclear Rues and IAEA Safety Standards were taken into consideration.*
- *Almost in all phases of recovery the Hungarian Atomic Energy Authority created additional strict criteria.*
- *All works were implemented with permanent consultation with Authority and under supervision of Authority.*
- *RU/US regulatory evaluation of the developed technology for the fuel removal (by HAEA NSD request).*

ГАН

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ВО «БЕЗОПАСНОСТЬ»
ГОСАТОМНАДЗОРА РОССИИ
ЭКСПЕРТНОЕ ЗАКЛЮЧЕНИЕ

*на отчет Федерального Государственного Унитарного Предприятия (ФГУП) "Гидропресс" «Разработка технологии выполнения работ" (У213-Пр-1764) по теме "Ликвидация последствий разрушения кассет в колодце №1 на блоке 2 АЭС "Пакш"».*

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US NRC

Battelle
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**Regulatory Observations for Recovery of Damaged Fuel**

Presented by George Kalman and Mikey Brady Raap
Pacific Northwest National Laboratory

USNRC-HAEA Consultation, Budapest, Hungary
April 19-21, 2004


Thank you for your attention!