Russian Experience and Proposals on Management of Non-Conforming SNF of RBMK Reactors

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Introduction

- RBMK-1000 power reactors have been operated at Leningrad, Kursk and Smolensk NPPs in the European part of Russia
- Before 2012 all SFAs were stored in at-reactor and away-from-reactor wet storages facilities at NPPs
- In late 2011, a centralized dry storage facility at the Mining and Chemical Combine (MCC) in Krasnoyarsk region (Siberia) and a complex to prepare SNF for dry storage at Leningrad NPP were commissioned
- Since 2012 the RBMK-1000 SNF has been shipped to the centralized storage facility

Complex for SNF preparing for dry storage at NPP

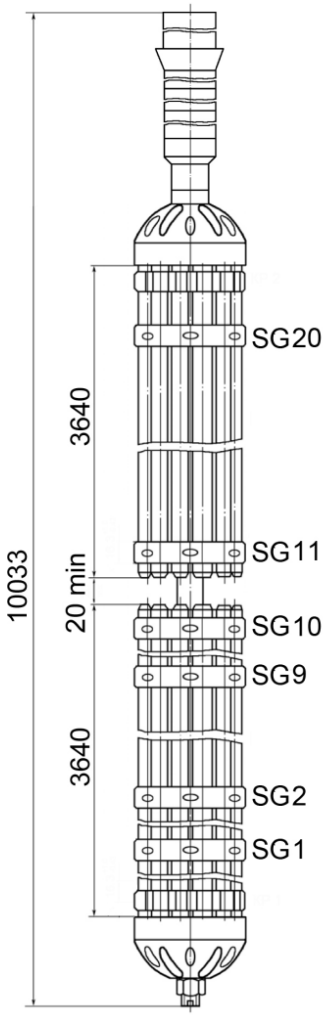
- Cut SFAs into the bundles
- Place the bundles into the ampoules
- Load the filled ampoules into a basket
- Load the filled basket into TUK-109 cask
- Dry SNF in TUK-109 cask
- Prepare TUK-109 cask for shipment

Centralized dry storage facility at MCC

- Receive the TUK-109 cask with SNF
- Open the TUK-109 cask
- Transfer the basket with SNF to the hot cell
- Reload the ampoules with SNF into the canisters
- Seal the canisters with welding
- Place the canisters into the storage cells

Receiving defective and leaky spent fuel (non-conforming SFAs) for dry storage is prohibited.

1. Non-Conforming SFAs

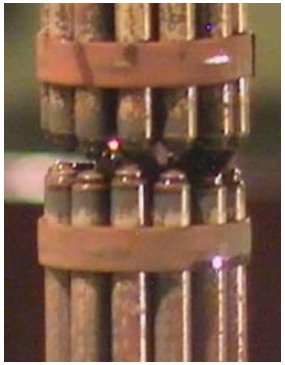


1. Leaky SFAs
2. Tight SFAs with structural damages:
   – more than two destroyed SG in succession
   – damaged or destroyed SG 10 or SG 11 located near the gap between the bundles
   – local increase of the SFA diameter more than 87 mm induced by the damaged SG
   – a gap between the bundles is less than 9 mm
3. Severely damaged SFAs (bent, deformed, partially destroyed) and pilot SFAs with a peculiar structure

Damages of RBMK-1000 SFAs

SG crack

SG tear



small gap

2. Removal and Reprocessing of Pilot Batch of Leaky SNF in 2011

It was expected that the amount of non-conforming RBMK-1000 SFAs would make up 3-5 % and the most SFAs would be leaky.

The aim was to confirm practicability of delivery and reprocessing of leaky RBMK-1000 SNF.

Concept of leaky SNF handling:

- Use the leak-tight expendable ampoules
- Do not dry SNF in the ampoules
- Cut SFAs in the hot cell of Unit 2 at Leningrad NPP
- Use TUK-11 cask

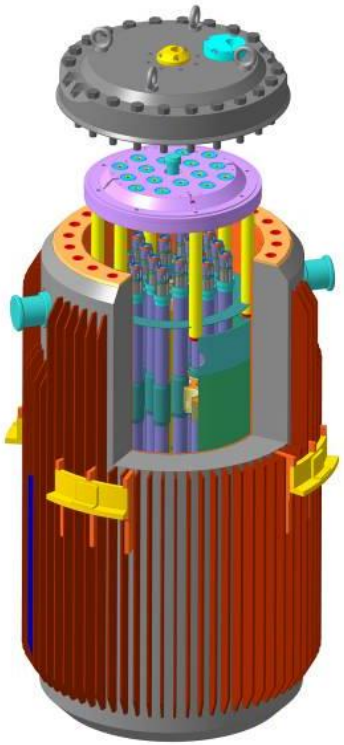
2. Removal and Reprocessing of Pilot Batch of Leaky SNF in 2011

Performed Work

- Analyze the possibility to use the reprocessed uranium from RBMK-1000 SNF
- Analyze the technical capabilities of Leningrad NPP and RT-1 plant for RBMK-1000 SNF handling
- Perform calculations and experiments to measure the accumulation of radiolytic hydrogen in an ampoule containing leaky RBMK-1000 SNF
- Modify the procedure for SNF loading into a cask
- Design and fabricate the ampoules
- Modify a basket of TUK-11 cask
- Design and fabricate the auxiliary equipment for Leningrad NPP and RT-1 plant
- Prepare the Safety Analysis Reports
- Obtain licenses on activities to be performed and a certificate of approval for package design and shipment
- Carry out the combined trials of the equipment

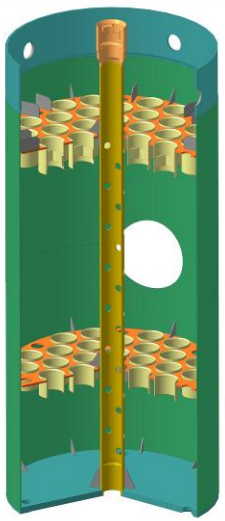
2. Removal and Reprocessing of Pilot Batch of Leaky SNF in 2011

Transport packaging for leaky RBMK-1000 SNF and its components



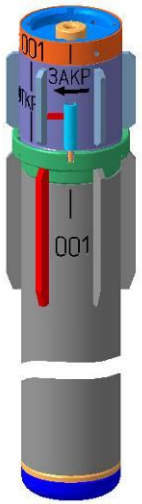
Transport Package

Internal Plate



Modified Basket of Type 12

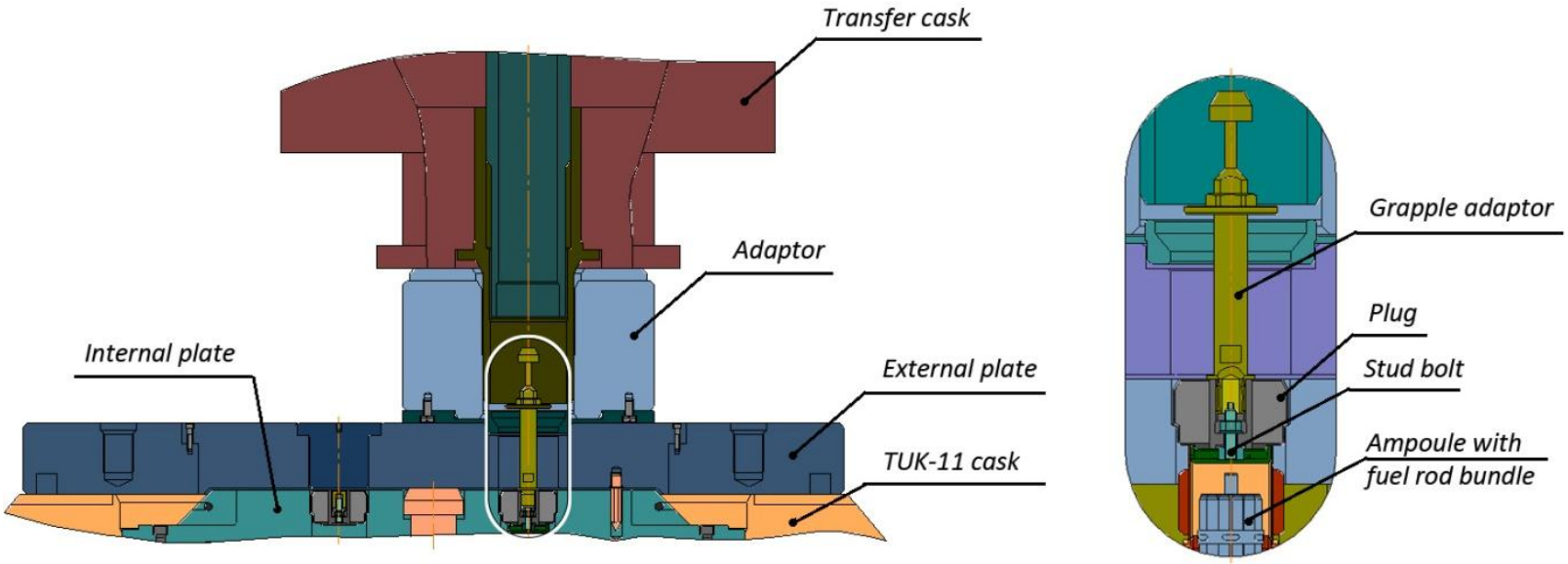
Insert



Tight Expendable Ampoule

2. Removal and Reprocessing of Pilot Batch of Leaky SNF in 2011

SNF loading in a cask



A transfer cask and two steel plates with holes and plugs
were used to load ampoules with SNF into a transport packaging

2. Removal and Reprocessing of Pilot Batch of Leaky SNF in 2011

Main Results

- Feasibility of delivering the leaky RBMK-1000 SNF for reprocessing was demonstrated
- Feasibility of using the uranium reprocessed from leaky RBMK-1000 SNF was demonstrated
- Eight leaky SFAs were shipped from Leningrad NPP and reprocessed
- Procedure for SNF loading in a cask at Unit 2 of Leningrad NPP was improved

But the developed procedure can be used to deliver only a small amount of leaky SNF from Unit 2 of the Leningrad NPP for reprocessing.

To remove the non-conforming RBMK-1000 SNF for reprocessing on a regular basis, the procedure for transport and handling at of RT-1 plant and the equipment of NPP complexes shall be modified.

3. Removal and Reprocessing of Leak-Tight Damaged SNF in 2014

The aim was to start delivery of leak-tight damaged RBMK-1000 SNF for reprocessing on a regular basis

Concept of leak-tight damaged SNF handling:

- Cut the SFAs in the hot cell (cutting bay) of Leningrad NPP complex
- Use the non-tight expendable ampoules
- Use TUK-109 cask

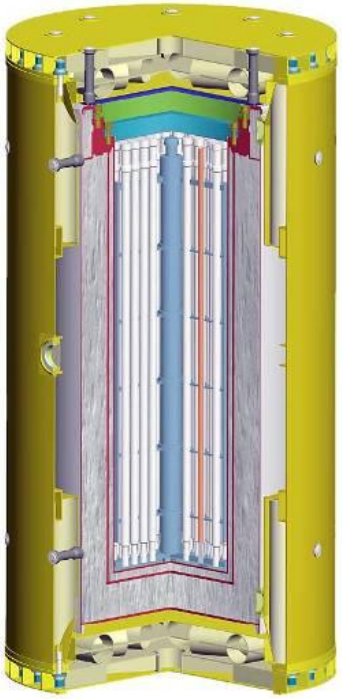
3. Removal and Reprocessing of Leak-Tight Damaged SNF in 2014

Performed Work

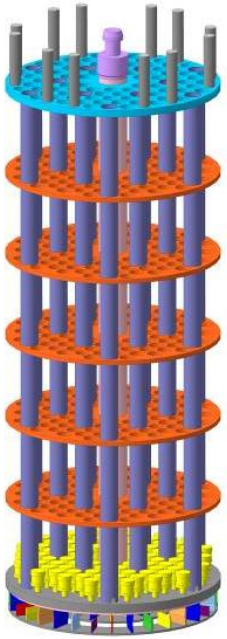
- Design and fabricate the non-tight expendable ampoules and basket for TUK-109 transport packaging
- Design, fabricate and mount the equipment for handling the new ampoules in the hot cell (cutting bay) of Leningrad NPP complex
- Acquire a hydraulic crane, special yokes and a railcar for the cask handling facility at RT-1 plant
- Increase the load capacity of cranes in the storage facility at RT-1 plant
- Modify the hoist trolleys in the pool the storage facility at RT-1 plant
- Arrange an area for reloading of some ampoules from one basket to another in the storage pool at RT-1 plant
- Design and fabricate the auxiliary equipment for handling casks, baskets and ampoules at RT-1 plant
- Prepare the Safety Analysis Reports
- Obtain licenses on activities to be performed and a certificate of approval for package design and shipment
- Carry out the combined trials of the equipment

3. Removal and Reprocessing of Leak-Tight Damaged SNF in 2014

Transport packaging for leak-tight damaged RBMK-1000 SNF and its components



Transport Package

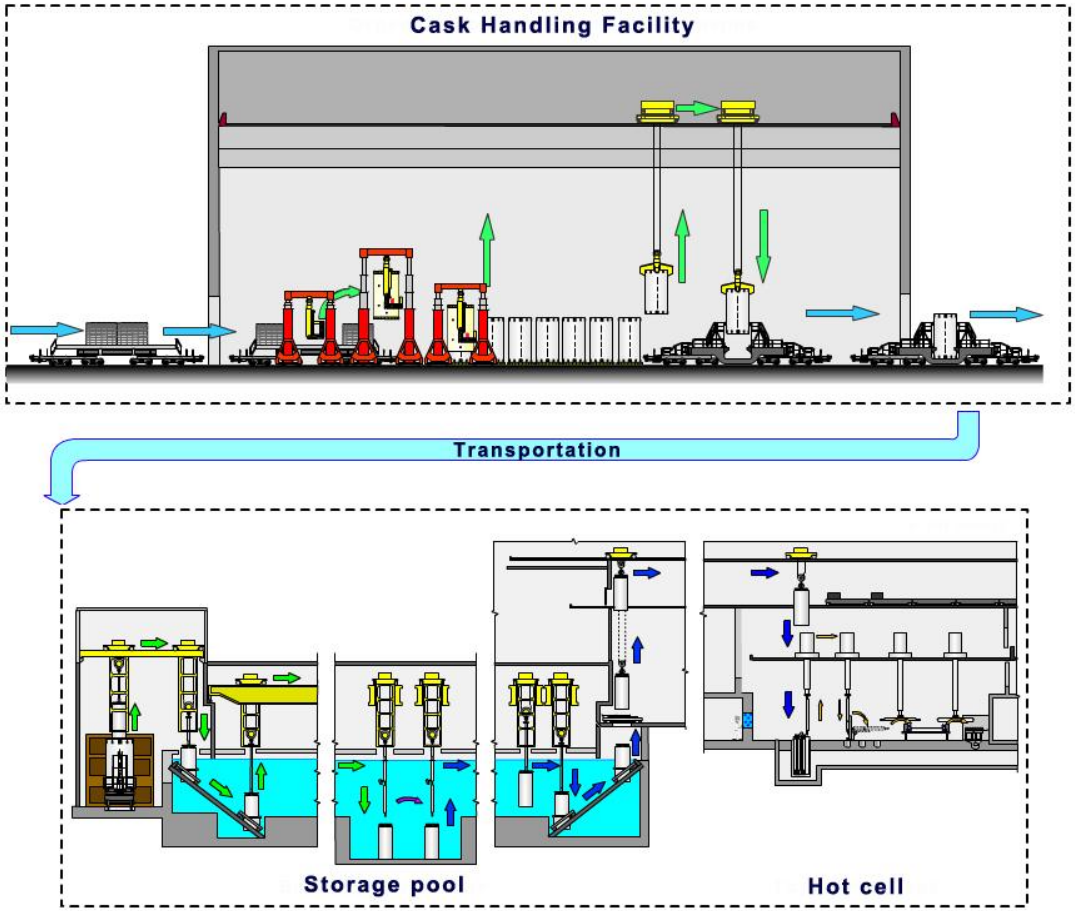


Basket

Non-tight Expendable Ampoule

3. Removal and Reprocessing of Leak-Tight Damaged SNF in 2014

Receipt and preparation of leak-tight damaged RBMK-1000 SNF for reprocessing at RT-1 plant



- Receive TUK-109 cask
- Unload TUK-109 cask
- Put TUK-109 cask upright
- Remove the energy absorbing container from TUK-109 cask
- Put TUK-109 cask on a railcar
- Transport TUK-109 cask
- Remove the lid
- Withdraw a basket
- Install the basket on a hoist trolley
- Transport the basket in the storage pool
- Reload some ampoules to another basket to reduce weight
- Install the basket on the hoist trolley
- Transfer the basket in the hot cell
- Withdraw the ampoules from the basket
- Put the ampoules in horizontal position
- Transfer the ampoules for chopping

3. Removal and Reprocessing of Leak-Tight Damaged SNF in 2014

Main Results

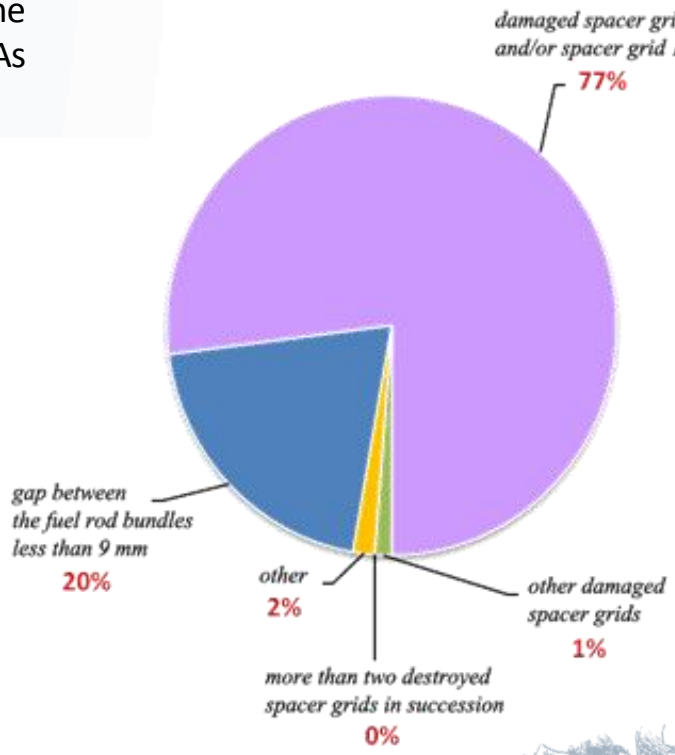
- Transport packaging for leak-tight damaged RBMK-1000 SNF was created
- Equipment for TUK-109 cask handling at RT-1 plant was prepared
- Equipment for handling non-tight expendable ampoules in the hot cell (cutting bay) of Leningrad NPP complex was prepared
- Preparation for regular delivery of leak-tight damaged RBMK-1000 SNF for reprocessing was performed
- 204 leak tight SFAs with damaged spacer grids were cut and shipped to RT-1 plant for reprocessing

4. Prospects

After start of transition SNF to dry storage it was found that the share of non-conforming SFAs located in the storage facility at the Leningrad NPP is 24%. And the most of them were leak tight SFAs with damaged structures.

Plans for Development and Implementation

- Repair SFA skeletons in order to perform further SFA cutting and transition in the centralized storage facility: removal of tears of spacer grids, clamps installation
- Disassemble SFAs with small gaps between the bundles
- Cut leaky SFAs in order to deliver them for reprocessing after the removal of the most leak tight SFAs and significant modification of the hot cells (cutting bays) at the NPP complexes
- Cut severely damaged and pilot SFAs in the reactor pools in order to deliver them for reprocessing after shutdown of the reactors for the decommissioning



Shares of leak-tight non-conforming SFAs with different damages (statistics on 2012-2014)

Conclusions

In 2011 and 2014, two batches of non-conforming RBMK-1000 SNF were shipped to Mayak PA and reprocessed.

Significant results:

- Concept of non-conforming RBMK-1000 SNF shipment and reprocessing in the expendable ampoules was verified
- Safe shipment of non-dried leaky RBMK-1000 SNF in the tight ampoules was proved
- Procedures for SNF transportation and handling at Leningrad NPP and RT-1 plant have become mutually acceptable

In future the technologies for delivery of leaky, severely damaged and pilot SFAs for reprocessing and a technology for SFA grid skeleton repair in order to remove all non-conforming RBMK-1000 SNF from the NPPs are to be developed and implemented.

Thank you for attention!