Technical Meeting on Lessons Learned from High Enriched Uranium Take-back Programmes

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International Research Reactor SNF Take-Back Programmes as a Booster in Developing the Technologies and Equipment for Spent Fuel Preparation and Transport

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Introduction

- The irradiated fuel from the Russian-supplied research reactors located at various countries in Africa, Asia and Europe is imported to the Russian Federation under **the international repatriation program (RRRFR Program)**.
- **MNSR Conversion and Removal Program** is for high enriched uranium removal from the Chinese-built Miniature Neutron Source (MNSR) reactors located at Ghana, Iran, Nigeria, Pakistan and Syria for further return to the People's Republic of China.
- Each program is aimed at reduction of the global terrorism threat and nuclear weapon proliferation risks.
- Sosny Research and Development Company has been involved in various projects under the RRRFR Program since 2002 and the MNSR Conversion Program since 2015.
- Within its scope of work under the projects Sosny R&D Company develops technologies and equipment for safe SNF handling and loading into transport casks, both for conforming and damaged spent fuel. We also develop transport packages and equipment for SNF shipment by all conveyances.

Evolution of methods for loading research reactor SNF into transport cask

TUK-19

- Transfer cask with an automated grapple ensures safe SNF loading when it is impossible to arrange TUK-19 cask inside the research reactor cooling pool.
- Sosny R&D Company has developed special auxiliary for transfer cask arrangement above the reactor pool.

Evolution of methods for loading research reactor SNF into transport cask

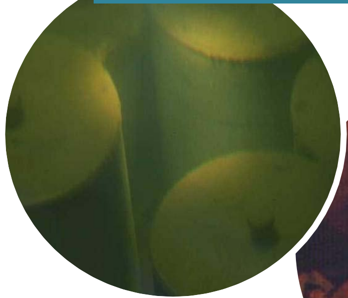
SKODA VPVR/M cask

- Sosny R&D Company has designed several transfer casks for SNF loading into SKODA VPVR/M cask modified for various research reactors.

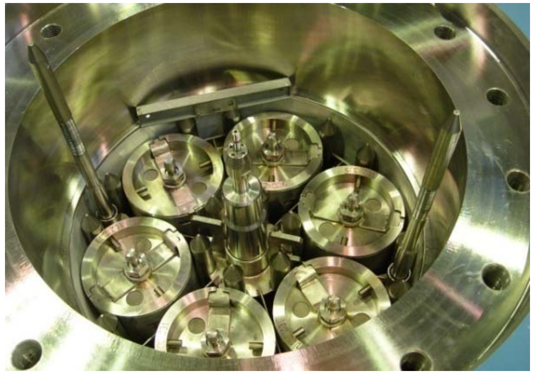
- Also we have designed the associated equipment, such as frames, a support plate, an adapter and guide tubes, necessary to arrange the transfer cask above the reactor pool and put it onto SKODA VPVR/M cask.

Preparation of the damaged spent nuclear fuel from research reactors for transportation

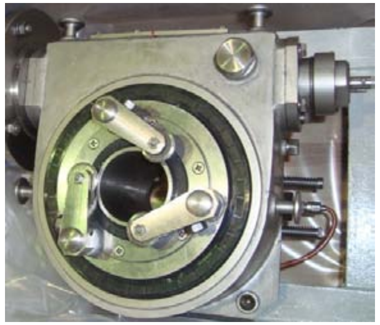
Damaged spent fuel of heavy water RA reactor, Vinča Institute, Serbia



8030 spent fuel assemblies of TVR-S type in non-standard packages which have been corroded because of their long-term storage in the poor-quality water.



- **Untight canisters for temporary storage and transportation of the spent fuel**
- **New baskets for SKODA VPVR/M casks**
- **Equipment and tools for cutting primary package, loading the SNF into canisters, handling the canisters and loading them into casks**



Preparatory activities for damaged SNF shipment for reprocessing:

1) Develop technology and equipment for SNF repackaging.
2) Develop new canisters and baskets for SNF.
3) Perform safety analysis for all stages of SNF handling process.
4) Fabricate, deliver and mount the equipment.
5) Train personnel from the Vinča Institute.
6) Perform on-site activities.

Preparation of the liquid spent nuclear fuel from research reactors for transportation

Uranyl sulphate solution enriched to 90% in uranium-235 from the IIN-3M reactor at FOTON JSC, Tashkent, Uzbekistan

Due to planned decommissioning of the IIN-3M reactor , it was necessary to discharge liquid SNF from the reactor vessel and remove it for reprocessing.

- **Special equipment for batch discharge and temporary storage of the high enriched uranyl sulphate solution**

- **Canisters for liquid SNF and polyethylene shock absorbers intended to ensure dynamic protection of the radioactive content of the SKODA VPVR/M cask**

- **Transfer cask for loading liquid SNF into SKODA VPVR/M cask**

Preparatory activities for liquid SNF shipment:

1) Develop technology and equipment for discharge and temporary storage of liquid SNF.
2) Develop new canisters for SNF.
3) Perform safety analysis for all stages of SNF handling process.
4) Fabricate, deliver and mount the equipment.
5) Develop technology and equipment for receipt, interim storage and reprocessing of the uranyl sulphate solution at MAYAK PA.
6) Perform on-site activities.

Evolution of research reactor SNF shipment by land

TUK-19 casks were initially transported by roads on special frames any by rail in TK-5 rail cars

Type B(U) package

- As a result of **the transport overpack** development (a *special large-capacity freight container with the tie-downs for three TUK-19 casks*), the process for loading and unloading TUK-19 cask was unified

Type B(U) package

SKODA VPVR/M cask is transported in the freight ISO container

- **Obtainment of the certificate of approval** for SKODA VPVR/M cask shipment within the territory of the RF and development of the procedure for the cask receipt at MAYAK PA formed the ground for extension of the fleet of transport casks to be used for the RRRFR Program

Evolution of research reactor SNF shipment by water

At early stage of the RRRFR Program a sea–river vessel and the INF-2 licensed Danish LYNX barge were used for shipment by sea


before refitting

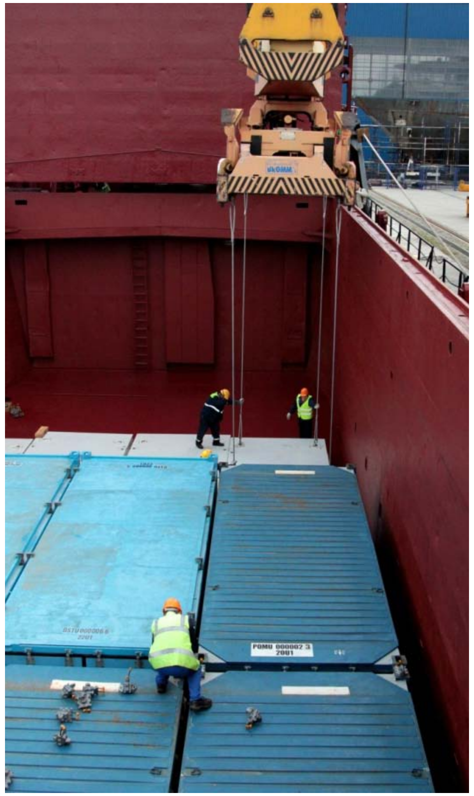
- Due to the increased scope of shipments it was decided to use a Russian sea vessel.
- MCL Trader vessel owned by J/S ASPOL Baltic Corporation was refitted to meet the INF-2 class requirements, the ship crew was trained and all necessary documents were issued.
- This vessel has a big displacement, allows for loading packages with deck cranes and is fitted for navigating in arctic seas.


after refitting

Evolution of research reactor SNF shipment by water

Modern vessels owned by ASPOL Baltic:

- *Mikhail Dudin* , date built 1996
- Flag: Belize, CallSign: V3VB
- Ice class: 1B   INF class: INF-2
- Gt/Nt (Gross Tonnage/ Net Tonnage): 2319/1034 mts
- DWT (Deadweight tonnage): 3060 mts
- Overall dimensions (L / B / D): 89.50 / 13.40 / 4.50 m
- 2 Holds / 2 Hatches
- Hold №1 61086,3 cbft
- Hold №2 59673,9 cbft
- Dimensions of holds in the clear: 25,0x10,57x6,04 m



- *Baltiyskiy-202*, date built 1994
- Flag: Belize, CallSign: V3VL3
- Ice class: 1B   INF class: INF-2
- Gt/Nt (Gross Tonnage/ Net Tonnage): 2506/1185 mts
- DWT (Deadweight tonnage): 3367 mts
- Overall dimensions (L / B / D): 89,50 / 13,20 / 4,88 m
- 2 Holds / 2 Hatches
- Hold №1 26,25 x 10,54 x 7,24 m
- Hold №2 25,80 x 10,54 x 7,24 m
- Hold's openning: 24,60 x 10,54 m

Evolution of research reactor SNF shipment by air

Certification of the TUK-19 cask as a part of an overpack for fuel shipment by air in Type B(U) package became an incentive for creation of Type C package for fuel air shipments without activity restrictions.

- TUK-145/C consists of the energy absorbing container and the SKODA VPVR/M transport cask.

- TUK-145/C is certified for fuel shipments by land, water and air.
- To transport TUK-145/C by roads, a special semi-trailer with a removable frame for the cask fixation and the special devices for fastening the semi-trailer inside the AH-124-100 aircraft were designed.
- TUK-145/C can be loaded on board and transported by the aircraft using a roller system or a semi-trailer.

Options for shipping the research reactor SNF in TUK-145/C cask

Step 1:
Transport the SKODA VPVR/M cask
with the spent fuel in an ISO container
to the airport by road

Step 2:
Make up the TUK-145/C package
at the airport

Step 3:
Move the cargo
into the AN-124-100 aircraft
along the roller track

Options for shipping the research reactor SNF in TUK-145/C cask

Step 1:
Transport the SKODA VPVR/M cask with the spent fuel in an ISO container to the airport by road

Step 2:
Make up the TUK-145/C package at the airport on the semi-trailer

Step 3:
Drive the semi-trailer with the TUK-145/C package in the AN-124-100 aircraft

- An AN-124-100 aircraft can accommodate two semitrailers with TUK-145/C packages.

Options for shipping the research reactor SNF in TUK-145/C cask

Step 1:
Make up a ТУК-145/C package on the consignor's site

Step 2:
Transport the TUK-145/C package to the airport on a semi-trailer

Step 3:
Drive the semi-trailer with the TUK-145/C package in the AN-124-100 aircraft

- This option requires a good road infrastructure on the way from the consignor's site to the airport.

Options for shipping the research reactor SNF in TUK-145/C cask

TUK-145/C was modified to transport spent MNSR core. The modified package has a special SKODA VPVR/M basket with shock absorbers.

- In 2017 the modified TUK-145/C cask was used to transport spent MNSR core and eight fresh fuel rods from GHARR-1 reactor, the Republic of Ghana, to China

Evolution of multi-modal shipments of research reactor SNF

Consignor
Load the ISO container with SKODA VPVR/M cask onto the truck

→

Railway station
Load the cargo onto the rail car

→

Consignee
Receive

Consignor
Load the ISO container with SKODA VPVR/M cask onto the truck

→

Railway station
Load the cargo onto the rail car

→

Consignor's port
Load the cargo onto the vessel

→

Consignee's port
Load the cargo onto the rail car

→

Consignee
Receive

Evolution of multi-modal shipments of research reactor SNF (cont.)

Consignor	Consignor's airport	Consignee's airport	Consignee
Load the ISO container with the TUK-19 cask onto the truck	*Load the cargo on board of the aircraft*	*Load the cargo onto the truck*	*Receive*

Consignor	Consignor's airport	Consignee's airport	Consignee
Make up TUK-145/C package on the semi-trailer	*Load the semi-trailer with the TUK-145/C package into the aircraft*	*Unload the semi-trailer with the TUK-145/C package from the aircraft*	*Receive*

Conclusions

- High Enriched Uranium Take-Back Programmes have really boosted the development of SNF safe handling technologies and the SNF transport equipment.
- Experience in multi-modal shipment arrangements and the engineering solutions developed by Sosny R&D Company are universal ones and can be applied (and have already been applied) to any projects related to handling spent nuclear fuel from the research, power and propulsion reactors.
- We have created the unique set of equipment and transport means for prompt removal of research reactor SNF even in case of natural disaster and/or terrorism threat for further safe handling, storage and reprocessing.

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Thank you for attention!

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