SHIPMENT OF SPENT NUCLEAR FUEL FROM THE CZECH REPUBLIC FOR REPROCESSING

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INTRODUCTION

ÚJV Řež, a. s. (formerly Ústav jaderného výzkumu Řež a.s., Nuclear Research Institute Řež) is a leading institution in all areas of nuclear R&D in the Czech Republic. ÚJV has had a dominant position in the nuclear field since it was established in 1955 as a state-owned research organization, and has subsequently developed to its current status.

The activities of ÚJV encompass nuclear physics, chemistry, nuclear power and many other topics. The main issues addressed at ÚJV in past decades have included research, development and services for nuclear power plants operating VVER reactors, development of chemical technologies for the fuel cycle, and irradiation services for research and development in the industrial sector, agriculture, food processing and medicine.

ÚJV`s daughter company, Research Centre Řež, operates the LVR-15 research reactor, which has been in operation since 1957. After more than 50 years of operation of this reactor, a large amount of SNF of Russian origin has been accumulated. Joining the Global Threat Reduction Initiative (GTRI) The Czech Republic was included in the GTRI program in 2004. In 2005, a contract between the US Department of Energy (US DOE) and ÚJV was signed.

With significant technical and financial aid from the US administration and US DOE (total of approximately 31 mil. USD), the Czech Republic became a pilot country, carrying out the first shipment from ÚJV to the RF by means of specially developed casks, which are compatible with the technology of research reactors of Russian design as well as the technology of the reprocessing plant in the RF.

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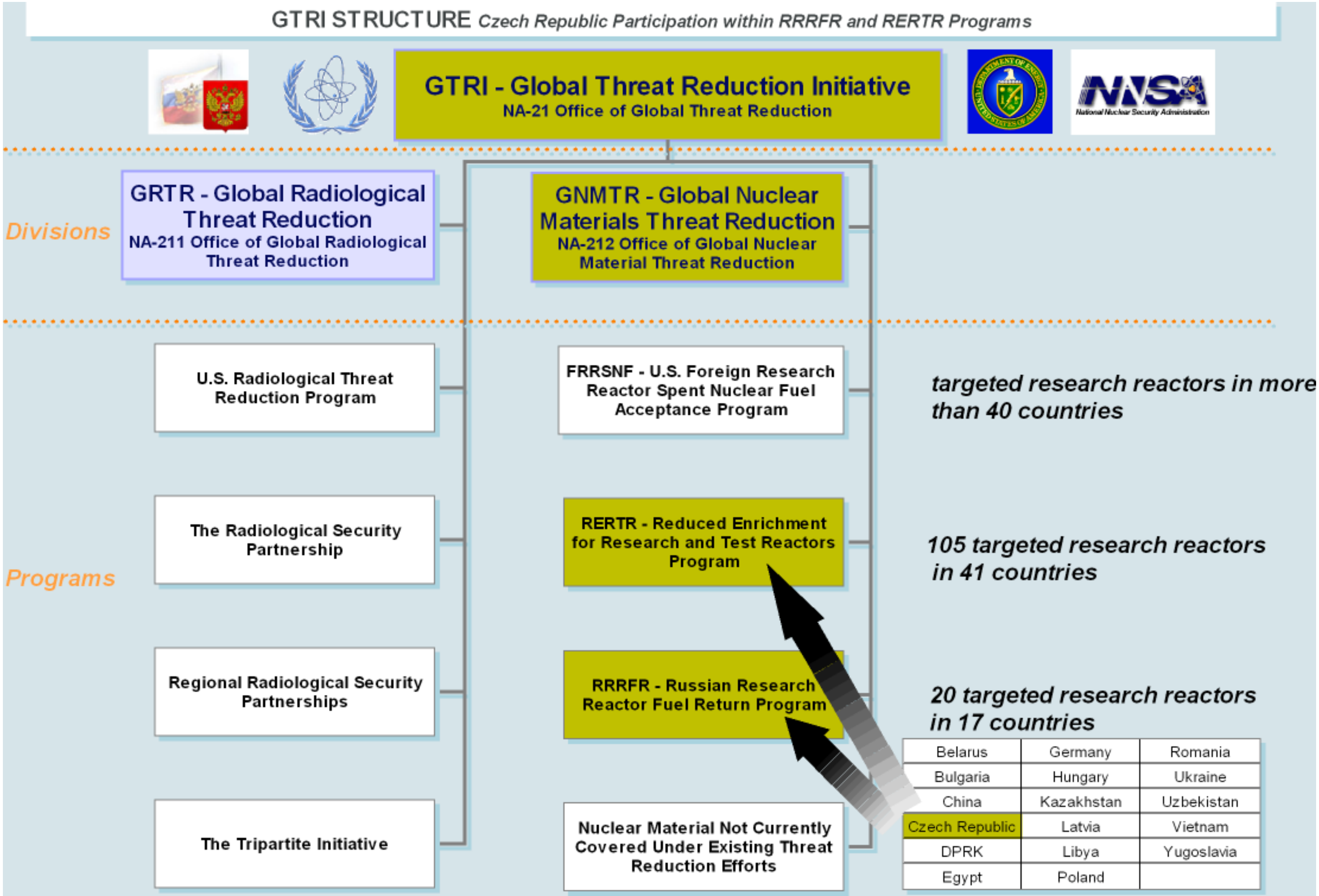

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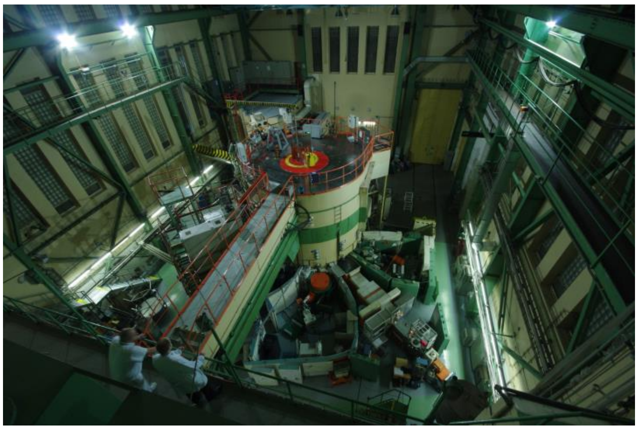
LVR-15 (VVR-S) RESEARCH REACTOR

The VVR-S research reactor began operations in 1957. The original EK-10 fuel was made up of rods of a 10 % enriched uranium dioxide-magnesium alloy in aluminum cladding. The fuel assembly (FA) consisted of 16 rods in an aluminum casing. The reactor was operated at 2 MW_{th} maximum output until 1969, when the power was increased to 4 MW_{th}. In 1974, IRT- 2M fuel with 80 % enrichment was introduced. This consisted of 3 or 4 concentric square tubes of uranium/aluminum alloy fuel/metal clad on either side with aluminum.

The power output of the reactor was increased to 10 MW_{th}. In the years 1988 – 1989 the reactor was completely reconstructed into the LVR-15 reactor, with maximum output of 10 MW_{th}. In 1996, IRT-2M fuel with 36 % enrichment using uranium dioxide was introduced. As a result of the Reduced Enrichment for Research and Test Reactors (RERTR) Program, the IRT-4M fuel has been used since 2010. It contains a maximum of 20% ^{235}U, which is the conventionally recognized limit between low- (LEU) and high-enriched (HEU) uranium.

LVR-15 reactor hall



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ŠKODA VPVR/M TPS CASK

The ŠKODA VPVR/M cask is a type B(U) and S cask system designed and licensed for the transport and storage of SNF from research reactors of Russian origin.

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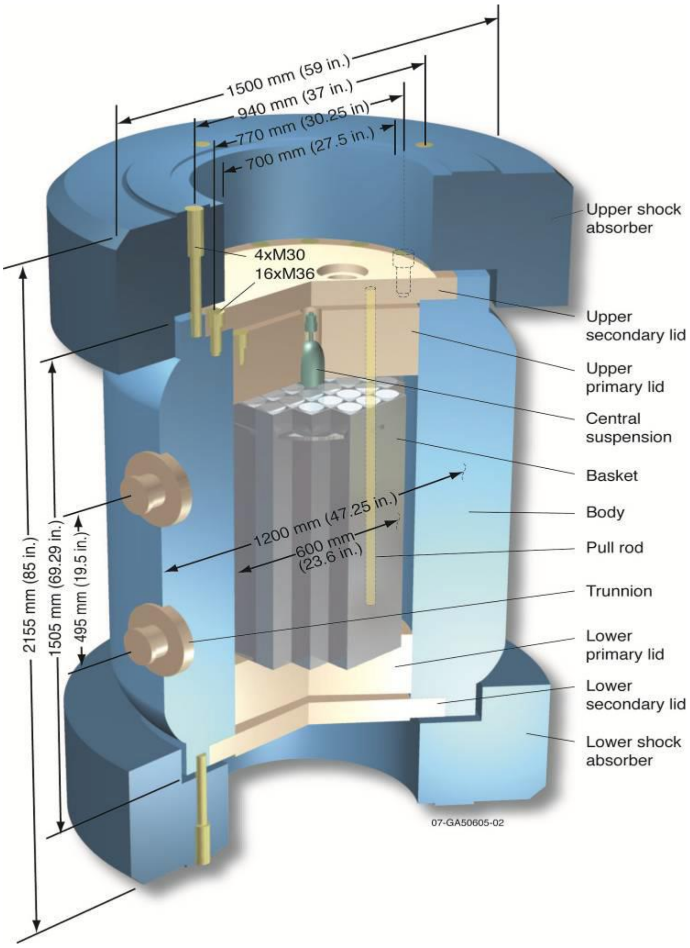
The unique design of the cask allows for easy use at almost any research reactor facility. The cask is closed by means of a system of two upper and two lower lids. The cask is loaded from the bottom, being placed above the SNF storage pool. It eliminates the need for a transfer cask, thereby reducing the number of manipulations and increasing the level of nuclear safety and radiation protection.

A specially designed basket handling tool suspended from a crane is connected to the central suspension of the basket and is used for lowering the basket from the cask into the storage pool. The basket is filled manually with FA by a special manipulation rod. The crane and the basket handling tool are equipped with a digital dynamometer that is used to monitor the weight of the basket during reinstallation into the cask. It prevents the disruption of the central suspension. The cask has a capacity of 36 FA, and 16 casks are now available. This means that 576 FA can be transported in one shipment.

Diagram of the ŠKODA VPVR/M cask



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VPVR/M CASK LOADING PROCEDURE

The TPS consists of:

- ŠKODA VPVR/M casks
- Cask baskets
- Special ISO containers for cask shipment
- Auxiliary equipment sets for cask handling
- Service ISO containers for shipment of auxiliary equipment
- Drying and He-leak testing equipment sets for cask testing after loading
- Service ISO containers for shipment of drying and Heleak testing equipment

The VPVR/M cask loading procedure:

- Cask transport to the SNF loading site and its dismantling
- Transport of the cask to the SNF storage facility (pool, hot cell)
- Putting the basket inside the loading facility (pool, hot cell)
- Loading the SNF into the basket, basket retraction into the cask
- Cask flushing with hot air, desiccation of the cask, cask completion, helium leak test
- Cask sealing with IAEA and EURATOM seals

Cask prepared for loading onto the storage pool

Cask drying, helium leak test

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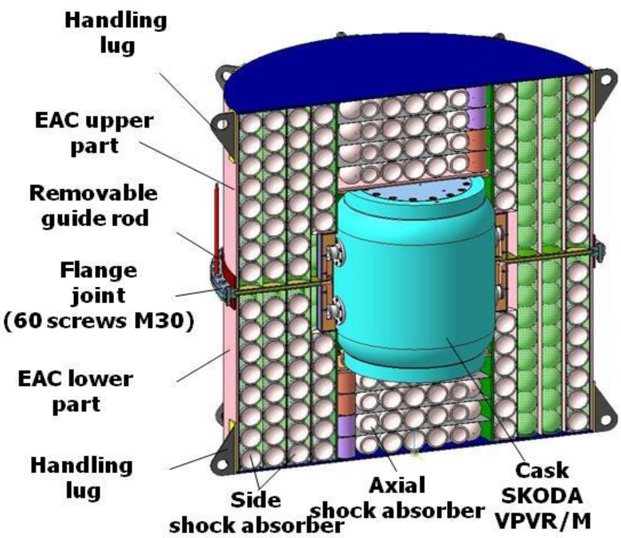
ROAD, RAILWAY, RIVER, MARINE AND AIR TRANSPORTS

The ŠKODA VPVR/M TPS can be used for not only road, railway, river and marine transport but, with the energy absorption container (EAC) which forms the TUK-145/C Type C package, also air transport.

The TUK-145/C Type C package was designed and developed by the SOSNY company (RF) and financed by the US DOE. The Type C package is designed for transportation of radioactive material without any restrictions on activity through different transport modes.

TUK-145 / C Type C transport package



Forming the TUK-145 / C transport package (Vietnam)

Reloading of the ISO container in port

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ÚJV'S PARTICIPATION IN SHIPMENTS OF SNF FROM OTHER COUNTRIES

The services of ÚJV comprise: ŠKODA VPVR/M TPS leasing, providing service and maintenance inspections of the TPS, transportation of the TPS, providing TPS documentation, training of personnel in TPS use and SNF loading, technical oversight and expertise during cask handling, SNF loading and cask closing and sealing, drying and helium leak testing of casks, and return transportation of the empty casks and auxiliary equipment to ÚJV.

Performed shipments review

Country (Facility)	Shipment	No. Of casks	No. Of FA	Route
Czech Republic 1 (LVR-15)	12/2007	16	568	Road, rail
Bulgaria (IRT-2000)	07/2008	3	108	Road, rail,river
Hungary1 (BRR)	08/2008	16	576	Road, rail,sea
Poland 1 (EWA)	09/2009	16	864	Road, rail, sea
Poland 2 (EWA)	02/2010	8		
Ukraine 1 (VVR-M)	05/2010	7	252	Road, rail
Belarus (PAMIR-630D, IRT-M)	08/2010	4	144	Road, rail
Serbia (RA)	11/2010	16	576	Road, rail, sea
Ukraine 2 (VVR-M)	03/2012	4	98	Road, rail
Poland 6 (EWA)	08/2012	3	90	Road, rail,sea
Czech Republic 2 (LVR-15)	03/2013	6	112	Road, rail, sea
Vietnam (DNRR)	07/2013	1	36	Road, air, rail
Hungary 2 (BRR)	11/2013	6	144	Road, air, rail
Total		**106**	**3568**	

TUK-145/C Type C packages inside the airplane (Hungary))

Loading of SNF in Poland

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LEGISLATIVE AND REGULATORY FRAMEWORK

Basic Legislative and Regulatory Framework

Preparation for transporting SNF to the RF included assuring compliance with a number of legislative and regulatory requirements contained in the Law on Peaceful Utilization of Nuclear Energy and Ionizing Radiation No. 18/1987 Coll. (the Atomic Act), as well as its implementing regulations.

Each of the regulations specifies what type of approval/decision is needed and which documentation must be submitted to the regulatory body.

Return of RAW from reprocessing

The license for re-import of vitrified waste back to the Czech Republic represents a challenge for both ÚJV, as an applicant, and the regulatory body, as it will be the first time an application of this type will be dealt with. According to the Foreign Trade Contract (FTC) between ÚJV and Federal Centre for Nuclear and Radioactive Waste Safety (FCNRS) concerning SNF export and reprocessing in the RF, the vitrified waste from reprocessing of SNF should be shipped back to the Czech Republic after 2024 (first shipment) or 2033 (second shipment), respectively.

Casks ready for loading of SNF in Serbia

Truck with ISO container ready for transportation

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MANAGEMENT OF RAW FROM REPROCESSING

As the Czech SNF will be reprocessed together with other spent fuel (from NPPs, propulsion and research reactors), the separation of the waste from the Czech SNF is not possible. A so called “equivalent” of radionuclides will be returned to the Czech Republic.

The potential biohazard of the radionuclide mixture is evaluated by individual effective dose (Committed Effective Dose). The effective dose from the internal intake of radionuclides, in both of the supplied SNF batches as well as the batch of returned waste, is assumed as the dose equivalent of the total activity of the radionuclide mixture. The total dose equivalent is the sum of the products of radionuclide activities and relevant exposure factors.

The waste from reprocessing will be vitrified and will contain fission products and actinides, as well as the traces of uranium, plutonium and neptunium that will remain unextracted.

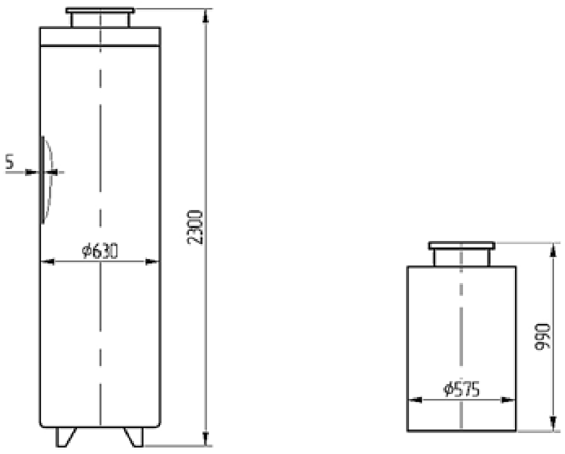
The vitrified waste produced is poured into 200l canisters made of carbon steel.
Two canisters are put inside one cylinder made from carbon steel (body) and stainless steel (filler) with a maximal total weight of 1350 kg. The cylinder has been designed for storage only; a new disposal cask will be developed in the future.

Four canisters with vitrified waste in two cylinders will be produced and returned to the Czech Republic.

The main radionuclides contained in the vitrified waste. (The contribution of these radionuclides to the total dose equivalent is about 99.6 %).

Fission Products	Actinides
137Cs (90Y)	238 Pu, 239Pu
90Sr (137mBa)	240Pu, 241Pu
	241Am, 243Am
	244Cm

Sketches of the canister and cylinder (dimensions in mm)



2 canister cylinder   Canister

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CONCLUSIONS

All SNF produced after more than 50 years of operation of the LVR-15 (or VVR-S) research reactor has already been shipped to the RF within the framework of the GTRI initiative.
Two shipments were performed in 2007 and 2013.

ÚJV is also participating in shipments of SNF from other countries.
The ŠKODA VPVR/M TPS was used for shipment of spent fuel from the Czech Republic and seven other countries to the Russian Federation for reprocessing within the framework of the GTRI project.
Thirteen shipments using a total of 106 casks have already been completed without any incident or accident.

One more shipment will be carried out.

A project for repatriation of SNF from Chinese Miniature Neutron Source Reactors (MNSR) has already been started. HLW will be generated from the SNF reprocessing. The vitrified HLW will be returned to the Czech Republic, as stated in the Russian-Czech Intergovernmental Agreement on Cooperation in Nuclear Energy.

The return of the waste represents very complex and complicated work, technically, legally and contractually. HLW will be disposed (probably with the SNF produced by the LVR-15 reactor after 2010) into the DGR.

The technology for long-term storage before disposal must be developed together with a disposal cask, for both HLW and SNF.