EXPERIENCE IN USING TYPE C PACKAGES FOR RESEARCH REACTOR SNF SHIPMENT BY AIR

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ABSTRACT

Implementation of the International Program on Russian Research Reactor Fuel Return offered Russian organizations many legal and organizational concerns, including those related to logistics, need for international transit agreements and confirmation of the certificate for the package design and shipment in transit countries, physical protection of the transported consignment. The developed TUK-145/C package (Type C package) ensured the required safety level, sufficiently facilitated the organization of SFA air shipment and reduced the time of delivery.

This paper describes the experience gained by Sosny R&D Company in preparation and implementation of RR SNF air shipments using TUK-145/C packages, describes the main engineering solutions to enhance the safety of nuclear material transport by air.

INTRODUCTION

TUK-145/C packaging has become the result of the project on Type C packaging development in Russia. The packaging is designed for the shipment of irradiated fuel of research reactors by any mode of transport, including air shipment, has no restrictions to the amount of the radioactive content and meets all Russian and international safe transport regulations. The TUK-145/C packaging consists of a SKODA VPVR/M cask and an energy absorbing container (EAC).

In 2013, within the framework of Russian Research Reactor Fuel Return (RRRFR) program, the TUK-145/C package was used to transport VVR-M/M2 SFAs with highly-enriched uranium for reprocessing in Russia. The VVR-M/M2 SFAs had been irradiated in DNRR reactor, Dalat, Viet Nam, and BRR reactor, Budapest, Hungary.

The following Russian organizations participated in different phases of these projects: FCNRS – as an authorized organization; Mayak PA – as a consignee; VNIIEF and IPPE developed the certificates of approval and safety justification documents; Sosny R&D Company developed the equipment for loading SFAs into the shipping cask, coordinated the physical work and shipment. Road transport of the packages in Viet Nam and Hungary was performed by foreign companies, and in Russia – by Mayak PA. The shipment by air was performed by Volga-Dnepr Airlines. All the projects were supervised by Rostechnadzor and controlled by Rosatom State Corporation. RF Ministry of Foreign Affairs provided considerable support in obtaining overflight clearances.

1. Preparation and Removal of SFA from Viet Nam

During the activities on SNF removal from the Dalat Nuclear Research Institute (DNRI), the experts of Sosny R&D Company developed a new SNF reloading procedure. Since it was impossible to install a SKODA VPVR/M cask directly above the spent fuel storage pool, the irradiated assemblies were loaded into the SKODA VPVR/M cask from the top, by a "dry" method, but not from the bottom, as usual. To ensure safety of these operations, a transfer cask and ancillary equipment were developed. The cask was used to withdraw the SFAs from the DNRR cooling pool, to transfer them and to load them into the shipping cask.

The infrastructure and the equipment of the site were upgraded to adapt them for the new SFA reloading procedure. Following the requirements imposed, the areas for loading the spent fuel into the transfer and shipping casks were provided with the main power supply and a backup system powered by a diesel generator. Enhancements were made to the polar crane in the reactor hall, and a jib crane was additionally installed to shorten the fuel reloading time and to ensure safety of the operations. Moreover, a 16-ton capacity forklift was procured to handle the equipment and the SKODA VPVR/M cask (Fig. 1).

Fig. 1. Unloading of Equipment and Delivery of SKODA VPVR/M Cask to Reactor Hall with a Forklift

To support the new procedure, 27 types of equipment and tools were developed; the designs of 10 of them were very sophisticated. In total 72 units of equipment were fabricated; each unit was subject to strength and performance tests at the fabricator's facility.

Nuclear and radiation safety of reloading the SFAs into the shipping cask as well as mechanical strength of the equipment and tools were analyzed.

The equipment performance was proven by integrated tests at the test facility in Dimitrovgrad, which had the structure approximated to the parameters of the DNRI spent fuel storage pool. Then, the equipment was packed and transported to the Czech Republic to UJV Rez a.s. by road. There, a dry run of the VVR-M2 loading equipment took place to verify its compatibility with the SKODA VPVR/M cask (Fig. 2).

During the dry run a support plate with an adaptor and positioners was installed onto the SKODA VPVR/M cask; the load units with mock-up SFAs were transferred from the the dry storage pool in the SKODA basket using the transfer cask. The transfer cask was installed on the adaptor with its plug having been removed, and the load unit with three mock-up SFAs was put into the SKODA VPVR/M cask basket using an electric winch. After removing the transfer cask, the plug is remotely installed in the adapter cell with a hook rod.

Fig. 2. Dry Run of Newly Developed Equipment to Verify Its Compatibility with SKODA VPVR/M Cask

After the dry run the equipment was packed, loaded into ISO containers and delivered to the Slovenian seaport of Koper by trucks. In a month, Aspol-Baltic vessel Mikhail Dudin with the equipment arrived at the seaport of Cai Mep, Vietnam. The ISO containers with the equipment were delivered from Cai Mep to Dalat Nuclear Research Institute by trucks.

In DNRI, the equipment was unpacked and assembled; the reactor personnel got acquainted with the purpose and principle of operation, as well as trained to use each piece of the equipment in practice. During the practical training, VVR-M2 FA dummies were used. Moreover, the personnel were briefed into the design and methods of handling the SKODA VPVR/M cask.

After the training, the personnel started reloading VVR-M2 SFAs from the storage pool into the SKODA VPVR/M cask (Fig. 3). The operations took 4 working days. The representatives of the US Department of Energy, IAEA and Vinatom supervised all the operations.

Fig. 3. Unloading of SFAs from Storage Pool and Loading into SKODA VPVR/M cask Using Transfer Cask

Once all 106 DNRR SFAs were loaded into the SKODA VPVR/M cask, the cask was dried up from the inside. The forklift moved the SKODA VPVR/M cask out of the reactor hall, and a truck crane installed the cask in the tilter to put on the lower shock absorber. After that, the SKODA VPVR/M cask was transferred into a special ISO container, where the upper shock absorber was put on it; then, the cask was tied down.

On July 1, 2013, the ISO container loaded with SKODA VPVR/M in a vehicle convoy guarded by the police and the military arrived at Bien Hoa airport, Vietnam. On the same day, the AN-124-100 aircraft of Volga-Dnepr Airlines arrived from Russia with the energy absorbing container on board. The ancillary equipment was installed near the airplane. The SKODA VPVR/M cask was relieved from its standard shock absorbers and then installed in the EAC. The TUK-145/C package was built up and loaded into the aircraft with a winch (Fig. 4). The ancillary equipment and the standard shock absorbers were loaded into freight containers and later sent to the Czech Republic by sea.

Fig. 4. Buildup of TUK-145/C Package and Loading into AN-124-100 Plane

The air shipment from Bien Hoa airport to Koltsovo airport (Ekaterinburg, Russia) took place on July 3, 2013. To follow safety requirements, the flight route was set above the sea to avoid flying over large cities and densely populated areas. The flight provided for a refueling stop-over at the airport of Vladivostok.

The TUK-145/C package was delivered from Koltsovo airport to Mayak PA by truck.

2. SFA Removal from Hungary

Three months since the first use of TUK-145/C package, 279 VVR-M\M2 SFAs (single and triple ones) were removed from the Budapest research reactor.

SFAs had been removed from the site before, loaded into SKODA VPVR/M casks, so there was no need to modify the site infrastructure. All SFAs were loaded into six SKODA VPVR/M casks by a standard method and were kept in the storage building where TUK-145/C package build-up was planned.

By that time, the second energy absorbing container had been fabricated in Russia. Both EACs were delivered to Hungary by An-124-100 plane of Volga-Dnepr Airlines. The peculiarity of this shipment was the transportation of the EAC and TUK-145/C package on special low-bed semi-trailers equipped with a special Crab tie-down system (Fig. 5). The EAC and TUK-145/C package were arranged on these semi-trailers in the aircraft.

Fig. 5. Delivery of EAC to Storage Building by Semi-Trailer

When the TUK-145/C package was built up, the SKODA VPVR/M cask was installed into the lower EAC part secured right on the semi-trailer, then the EAC was covered with the upper EAC part (Fig. 6). To ensure safety of the BRR personnel during these operations, a special TUK-145/C handling manual was developed, training and functional tests were held.

For the first shipment by AN-124-100 aircraft, a consignment of two TUK-145/C packages on semi-trailers was made up Fig. 7). The shock absorbers of the SKODA VPVR/M casks were loaded into a separate ISO container and included into the same shipment.

The mass and size of the TUK-145/C package on a semi-trailer allow transporting maximum two packages in one shipment, so the transport of six TUK-145/C package required three shipments. These shipments were implemented in the shortest time possible with a two-week interval within the period from October 7 to November 4, 2013.

The transport of the semi-trailers with TUK-145/C packages from the BRR site to Budapest airport was performed by the Czech company DMS, that provided the trucks. The company has all necessary licenses to transport dangerous goods. After the aircraft arrived to Koltsovo airport, the semi-trailers with TUK-145/C packages were transported to the reprocessing facility by trucks provided by Mayak PA. There, when all customs procedures were completed, the SKODA VPVR/M casks were taken out of the EACs, and the EACs on the semi-trailers were immediately sent back to Hungary by air, were the next shipment of TUK-145/C packages was prepared.

Fig. 6. Build-up of ТУК-145/C Package on Semi-Trailer

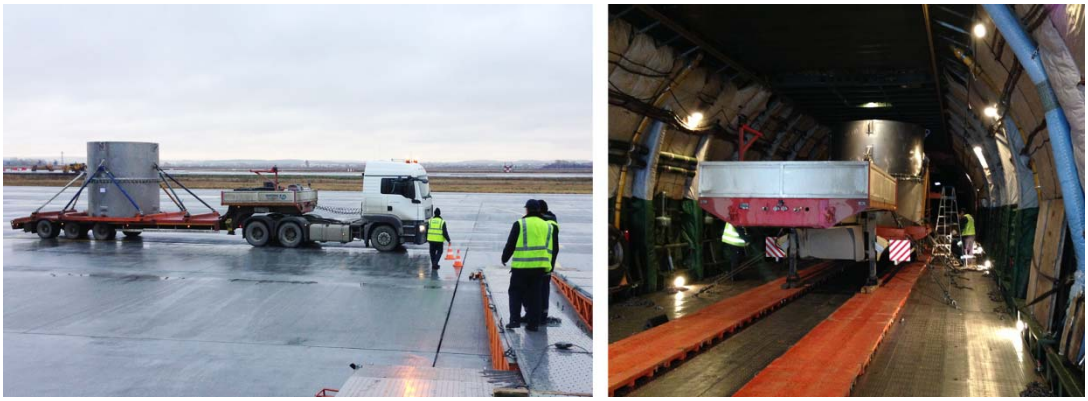

Fig. 7. Delivery of ТУК-145/С Package to Airport and Its Fastening in AN-124-100 Aircraft

CONCLUSIONS

Creation of the Type C package for the transport of RR SNF by air allowed a significant increase in safety and reliability of such transport.

Type C package can be used to transport:

- fragments of power-grade reactor SFAs for analysis and tests;
- high-level waste and sealed radiation sources;
- miniature neutron sources reactor (MNSR) cores;
- irradiated liquid fuel of research reactors;

as well as for emergency SNF transport in case of a war or terrorism threat or in case of natural calamities.

To simplify the certification procedure for air shipments with TUK-145/C packages, a TUK-145/C manual was drawn up that contains the package specifications, handling procedure and the results of calculations to justify the safety of the package design.