HANDLING THE TYPE C PACKAGE TUK-145/C DURING SPENT FUEL REMOVAL FROM DNRI RESEARCH REACTOR, VIETNAM

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ABSTRACT

In 1963, the U.S. General Atomics constructed the TRIGA Mark II research reactor in Dalat Nuclear Research Institute. In 1983, the reactor was reconstructed to the Soviet Union design named IVV-9 reactor, which has used highly enriched uranium (HEU) VVR-M2 fuel assemblies. In 2013, under the Russian Research Reactor Fuel Return (RRRFR) Program the HEU spent fuel assemblies (SFAs) were removed to Russia for reprocessing.

The transportation was carried out by air involving a Type C package for the first time. Such a package for research reactor spent fuel (TUK-145/C) was developed in Russia on the basis of the SKODA VPVR/M cask; it satisfies all Russian, Vietnamese and international (IAEA) safety requirements. A procedure for "dry" loading of spent fuel assemblies into the SKODA VPVR/M cask through its top using a transfer cask and a support plate was developed for the first time ever.

The paper describes the work on preparation and implementation of the spent fuel removal.

INTRODUCTION

Dalat is located in the south of the Socialist Republic of Vietnam, 1500 km from Hanoi and 300 km from Ho Chi Minh City. This is the home place for Dalat Nuclear Research Institute (DNRI). The Dalat Nuclear Research Reactor (DNRR) is a pool-type 500-kW research reactor with a light water moderator and coolant consuming the Russian fuel VVR-M2.

a – outside view b – reactor pool

Fig. 1. DNRR reactor

In 2007, low enriched uranium (LEU) assemblies were supplied to DNRI and non-irradiated VVR-M2 highly enriched uranium (HEU) fuel assemblies were removed from DNRI to the Russian Federation for reprocessing within the framework of the RRRFR Program. Then the DNRI specialists started gradual replacement of the HEU VVR-M2 for LEU fuel assemblies in

the reactor core. In October, 2011, 106 irradiated HEU fuel assemblies were reloaded from the reactor pool into the spent fuel storage pool.

a – HEU SFAs in the storage pool b – LEU VVR-M2 FAs

Fig. 2. VVR-M2 fuel rods

Spent nuclear fuel has never been removed from Dalat Nuclear Research Institute before, the institute infrastructure was not fitted out for spent fuel loading into transfer and shipping casks. So, the consignor's site was explored, the scope of activities for the infrastructure modernization was determined and the data was collected for further development of the procedure and equipment for reloading the SFAs from the storage pool to the SKODA VPVR/M shipping cask.

MODERNIZATION OF FACILITY INFRASTRUCTURE

Following the requirements to the facility infrastructure, 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 loading time and to ensure safety of the operations. The equipment, developed and fabricated in Russia, was shipped to the Institute by sea in ISO containers. A horizontal ground was prepared for handling them there. A 16-ton capacity forklift was procured to deliver the SKODA VPVR/M cask to the reactor hall.

a – unloading the equipment b – delivering SKODAVPVR/M cask to the reactor hall

Fig. 3. Handling the equipment and SKODAVPVR/M cask

It was decided that the SFAs would be transported to the Russian Federation by air. All SFAs needed to be loaded in one SKODA VPVR/M cask. A procedure for reloading the DNRI research reactor spent fuel from the storage pool into the shipping cask was developed by the

specialists of Sosny R&D Company. An unique feature of the procedure was top loading of the spent fuel assemblies into the SKODA VPVR/M cask instead of usual bottom loading. For this purpose, a special transfer cask and ancillary equipment were used, which had been developed and fabricated particularly for this procedure. This was needed since it was impossible to install a SKODA VPVR/M cask directly above the pool, because it was located 4 meters above the floor level, and the crane in the reactor hall was limitted to 5 tons in its capacity.
Preliminary investigations and the data provided by DNRI enabled the Sosny experts to design the equipment with due regard to the peculiarities of the facility. In total, 27 types and 72 pieces of equipment and tools were fabricated; the designs of 10 of them were very sophisticated. Each ready-made piece of the equipment was subject to strength and performance tests at the fabricator's facility.
There are three groups of equipment and tools developed:

- for loading the SFAs into the transfer cask;
- for loading the SFAs into the shipping cask;
- for loading the shipping cask into an aircraft for air shipment.

Nuclear and radiation safety of reloading the SFAs into the shipping cask as well as mechanical strength of the equipment and tools were analyzed. Safe reloading of VVR-M2 SFAs into the SKODA VPVR/M cask was provided by the developed operation safety instruction.
On completion of fabrication, all equipment units were delivered to the experimental site in Dimitrovgrad, Russia, which had the structure approximated to the parameters of the DNRI spent fuel storage pool. The equipment was installed and its performance tests were carried out.

Fig. 4. Equipment installation at UJV

Then the equipment was packed and delivered to UJV, Rez a.s., the Czech Republic, by road. Once installed at UJV, the VVR-M2 loading equipment was tested for compatibility with the SKODA VPVR/M cask. During the tests a support plate with an adaptor and positioners were installed onto the SKODA VPVR/M cask; the load units were transferred from the dry storage pool in the SKODA basket using a transfer cask.
The transfer cask with the load unit was installed on the adaptor with its plug having been removed, and the load unit was put into the SKODA VPVR/M cask basket using an electric winch. After removing the transfer cask, the plug was remotely installed in the adapter cell with a hook rod.

Fig. 5. Compatibility tests of VVR-M2 loading equipment and SKODA VPVR/M cask

After the tests, the equipment was re-packed, loaded into the ISO containers and delivered to the Slovenian seaport of Koper by trucks; from there, it was sent to the seaport of Cai Mep, Vietnam, aboard an Aspol-Baltic vessel *Mikhail Dudin*. The underway time was about 30 days. The ISO containers with the equipment were delivered to Dalat Nuclear Research Institute by trucks.

At DNRI, the delivered equipment was unpacked, installed, adjusted and calibrated. Then the DNRI personnel training started with demonstration of video lessons with comments. After that the personnel learned all positions of the equipment, its purpose, composition and principle of operation. The next stage was practicing the use of the equipment and tools for handling mockup VVR-M2 SFAs. The personnel also learned the structure of the SKODA VPVR/M cask.

Loading the VVR-M2 SFAs into the shipping cask followed the training. The operations took 4 working days. Once the spent fuel was loaded, the lid with the metallic o-ring seals was installed, the cask was evacuated, and a leak test was performed. The IAEA Safeguards experts supervised all the operations.

Fig. 6. Practicing in loading VVR-M2 SFAs into the shipping cask

The forklift moved the dried SKODA VPVR/M cask containing 106 VVR-M2 spent fuel assemblies out of the reactor hall and placed it near the tilter. A truck crane installed the cask in the tilter to put on the lower shock absorber. After that, the SKODA cask was transferred into a special ISO container, where the upper shock absorber was put on it; then, the cask was tied down.

Fig. 7. Installing the SKODA VPVR/M cask in the tilter, loading into ISO container

Then the equipment was packed, loaded into the ISO containers and prepared for shipment to UJV, Rez a.s.

Fig. 8. Packing the equipment and loading into ISO containers.

On June 30, 2013, 4 ISO containers with the equipment and tools started in the vehicle convoy from Dalat to Bien Hoa Airport. On July 1, 2013, an ISO container with the SKODA VPVR/M package was convoyed from Dalat to Bien Hoa Airport too. The convoy was escorted by the police and the military.

Fig. 9. Delivering the equipment from Dalat to Bien Hoa Airport

On July 1, 2013, an *AN-124-100* aircraft delivered the energy absorbing container to Bien Hoa Airport. The handling equipment was deployed on the ground at the aircraft, and the SKODA VPVR/M cask and the energy absorbing container were joined together to build up the TUK-

145/C package. The TUK-145/C package was pulled into the aircraft with a winch, and the handling equipment was put into the ISO containers.

Fig. 10. Building up the TUK-145/C package and loading it into the aircraft

In the morning of July 3, 2013, the *AN-124-100* aircraft left Bien Hoa Airport for Koltsovo Airport (Yekaterinburg, Russia). The flight provided for a refueling stop-over at the airport of Vladivostok.

CONCLUSION

The HEU SFAs have been prepared for removal for three years. Meanwhile, a new procedure for loading the SFAs into the SKODA VPVR/M cask using a load unit was developed and the corresponding equipment was fabricated. Safe operation of the equipment was assured by strength, radiation and nuclear safety analysis, series of tests, as well as theoretical and practical training of the personnel.

Removal of the HEU SFAs from DNRI was the first air shipment with a TUK-145/C package certified for compliance with IAEA regulations for Type C package.

Effective cooperation of American, Vietnamese, Czech, Russian and IAEA specialists ensured the project success.

The technologies developed and the experience gained are useful for removal of the spent fuel from other research reactor facilities.