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AIR SHIPMENT OF SPENT NUCLEAR FUEL FROM THE BUDAPEST RESEARCH REACTOR

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ABSTRACT

The shipment of spent nuclear fuel is usually done by a combination of rail, road or sea, as the high activity of the SNF needs heavy shielding. Air shipment has advantages, e.g. it is much faster than any other shipment and therefore minimizes the transit time as well as attention of the public. Up to now only very few and very special SNF shipments were done by air, as the available container (TUK6) had a very limited capacity. Recently Sosny developed a Type C overpack, the TUK-145/C, compliant with IAEA Standard TS-R-1 for the VPVR/M type Skoda container. The TUK-145/C was first used in Vietnam in July 2013 for a single cask. In October and November 2013 a total of six casks were successfully shipped from Hungary in three air shipments using the TUK-145/C. The present paper describes the details of these shipments and formulates the lessons learned.

Background

The Budapest Research Reactor, the first nuclear facility of Hungary has been in operation since 1959. The reactor used highly enriched Uranium (HEU) fuel for a long period of time (1966 - 2012), consequently the repatriation of the HEU SNF became a security issue. The first part of this spent fuel was taken back to Russia, i.e. to the country of origin in 2008 [1]. After this shipment had been completed, the conversion of the Budapest Research Reactor to low enriched Uranium (LEU) fuel was done. The conversion was completed in 2012; since November 2012 the reactor only uses LEU fuel. The remaining fresh HEU fuel was sent back to Russia in two shipments (2009 and 2012), and equivalent amount of fresh LEU fuel were delivered to Hungary in 2009 and 2013. The second and last SNF repatriation was foreseen for late 2013.

Preparations

The preparations for the second shipment started early 2011. The shortest and cheapest way from Budapest to Mayak facility (western Siberia) is certainly by rail via the Ukraine. However in 2008 the lack of a tri-lateral agreement between Russia, Ukraine

and Hungary on the transportation of nuclear material jeopardized this option. Since 2008 a lot of progress was achieved, but the agreement was still not ratified by the Parliament of the Ukraine. As the date of the ratification was unforeseeable the project management decided to look for other options that did not involve crossing the borders of the Ukraine.

Three options were considered. The first option was the one used in 2008, i.e. by rail to Koper, Slovenia and then by vessel to Murmansk and again on rail to Mayak. This option is obviously feasible, but requires a very long time due to the long sea route. The second option was similar to the first one, but was much shorter via rail through Slovakia and Poland, to the port of Gdynia. Gdynia to Murmansk by sea is less than half the way from Koper to Murmansk. The third option was rather non-conventional, using air shipment. This was made possible by the recent development by Sosny of a Type C overpack compliant with IAEA Standard TS-R-1 for the VPVR/M type Skoda container, the TUK-145/C. The three options were compared in a short study [2]. The conclusion of the study was to recommend air shipment, as the security benefit of its short duration offset slightly higher costs. It was also determined that the project risk of air transport was no higher than other modes of transportation.

The licenses and permits were granted in the usual way, similarly to the previous shipment. The TUK-145/C overpack was first used in Vietnam in July 2013. Watching this shipment gave valuable practice for the preparation of the Hungarian shipment. The manufacturing of the second overpack was finished in July 2013. Both overpacks arrived by air (using the AN-124 Antonov aircraft operated by the Volga-Dnepr aero-company) in August to Liszt Ferenc Airport in Budapest. The transport of the empty overpacks to the Budapest Research Reactor site was done during the night with the help of the police to minimize public attention. Loading of the spent fuel to the Skoda VPVR/M casks was performed in September 2013, similarly to the fuel loading in 2008.

The Shipments

The last fuel assemblies were removed from the reactor in November 2012. The radioactivity and heat load of the SNF was calculated for transport in October 2013. The calculations showed that neither the radioactivity nor the heat load would reach the limits given in the license of the VPVR/M cask. However it was decided to utilize six casks although the SNF could be loaded into five as well. This measure increased the margins to the limits. As only two overpacks were available, three shipments were needed to transport the six Skoda casks.

The first shipment started after midnight on October 7 from the site of the Budapest Research Reactor. It took about an hour to reach the airport. The loading of the filled overpacks to the airplane was similar to the unloading procedure and was finished well ahead of the scheduled departure time of the plane. The plane started in the early morning and arrived to Koltsovo airport in Yekaterinburg in the early afternoon local time. The flight was about four and half hours. At Koltsovo airport the title was transferred to the Russian partner. The rest of the route to the Mayak facility was covered on road.

Fig. 1. Placement of the Skoda cask into the overpack

The second and third shipments were similar to the first one, starting October 21 and November 4 respectively.

Fig. 2. Loading of the overpack into the aircraft

After the third shipment was completed, Hungary was declared to be free of HEU. The removal of the entire inventory of HEU from the country represents a substantial contribution to nuclear risk mitigation.

Lessons learned

Air shipments are possible if the amount of SNF is not too great. The greatest advantage of this type of shipment is that it is much faster than any other shipment mode and therefore minimizes the transit time as well as attention of the public. The transit time minimization is a goal itself, as it helps in optimal use of equipment and in keeping schedules. The attention of the public may have negative influence due to the special character of the transported material.

Disadvantages of the air shipment are the slightly higher price and the limited capacity of the airplane compared to train and sea vessel. In our case these disadvantages were not essential, as the price was only slightly higher, as mentioned earlier and three shipments could be realized easily within a month. However in cases where really large amounts have to be transported, the air shipment may not be feasible. In the Hungarian shipment in 2008 16 Skoda casks were transported, which would have required eight air shipments. Eight similar shipments would probably cause increased public attention and the costs could have been too high as well.

It is worth mentioning that the trilateral agreement between Russia, Ukraine and Hungary was ratified just days before the last shipment. This confirms that the decision was correct not to use this type of transport. In case we had been waiting for this ratification, the first shipment could have been started only recently and the Budapest Research Reactor would have had to be closed earlier because of a lack of spent fuel storage capacity.

References

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