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Status of Hungary after the HEU – LEU Conversion

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Abstract

The Budapest Research Reactor, the first nuclear facility of Hungary used HEU fuel from 1966 to 2012. The reactor was converted to LEU with the help and kind assistance of the RERTR Program. The spent HEU fuel and all the unused nuclear fuel was shipped back to the country of origin, i.e. to Russian Federation in the frameworks of the RRRFR Program between 2008 and 2013. After the last 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. The operation of the Budapest Research Reactor was planned up to 2023, the technical conditions after conversion allow even to extend this period for ten more years. During and after the core conversion there was no problem with the LEU fuel assemblies, only a small penalty had to be paid in neutron flux, there was no significant difference for the users. In this year the procurement of the fresh fuel assemblies for the next seven years was arranged. Fuel diversification is in progress, in cooperation with Technicatome (France) a new LEU type fuel is in development. As Hungary has an intensive extension program in nuclear energy, i.e. new NPP units are planned, there is a hope that the government will support the use of the research reactor on the long term.

1 Introduction

The Budapest Research reactor is the first nuclear facility of Hungary. The reactor was first put into operation in 1959. The 60 years anniversary of the reactor was celebrated in March 2019 with the participation of representatives of the RRRFR program.

The fuel of the Budapest Research Reactor was first the EK-10 type LEU fuel. The power of the reactor was 2 MW. The research reactor played an essential role in developing nuclear technology in the country.

In 1966 the reactor was reconstructed and upgraded. The fuel was changed for VVR-SM type, 36% enriched HEU fuel. The active core of the reactor was surrounded by Beryllium reflector. The power of the upgraded reactor was 5 MW.

The next reconstruction and upgrading happened between 1986 and 1992. The most part of the reactor was changed only the concrete shielding and the building remained. The fuel remained unchanged, the power became 10 MW. The long period of reconstruction was not due to technical problems, but the consequences of the political changes in Hungary caused the delay. The research center was reorganized; the Atomic Energy Research Institute was established by January 1, 1992. The new institute could only apply for the reactor license. In 2001 a cold neutron source was added to the reactor, which made it more attractive for neutron research.

The spent fuel problem became a major issue in the late nineties, as the fuel amount in the on-site storage facility approached to the limit of capacity. The solution could be realized from 2004, when the US DOE offered its help in conversion of the reactor to LEU and in solving the spent fuel problem by assisting in the transfer of spent fuel to the country of origin, i.e. to the Russian Federation.

2 Reactor Conversion

In the early years of the 21st century it became evident, that the use of HEU fuel provides an avoidable risk, and consequently all research reactors should be converted to LEU fuel. In case of the Budapest Research Reactor the conversion was relatively easy, as the enrichment of the HEU (36%) was not too high. The conversion of the Budapest Research Reactor started with the kind assistance of the RERTR Program. The Russian fuel supplier developed an LEU fuel with the same geometry as the 36% enriched VVR-SM fuel. In 2004 started the negotiations initialized by the RRRFR Program. In this framework not only the spent HEU fuel but the unused one as well could be sent back to the country of origin, to the Russian Federation.

The conversion started in 2009 and was finished in 2012. Four mixed cores were formed, containing more and more LEU fuel and less and less HEU fuel. As there was no difference in the shape and size of the fuel assemblies, the LEU fuel assemblies could be put in the same position of the core where the HEU fuel assemblies were located earlier. The conversion went smooth, no problem occurred during the operation of the reactor with the mixed core. After finishing the operation of the fourth mixed core a core containing only LEU fuel assemblies was realized and so the conversion was successfully finished.

3 Fuel Shipments

As mentioned earlier the preparations for the spent fuel shipment started as early as December 2004, however the first shipment could only be realized in September 2008 [1]. A lot of technical problems had to be solved, e.g. a complete building had to be built, where the crane moving the spent fuel assemblies from the storage pool to the transport containers could operate. However the technical part was earlier ready, than the administrative one. This long period was necessary, because international, intergovernmental agreements had to be closed. The agreements between the United States, the Russian Federation and Hungary were realized without major difficulty, but for the transport an agreement with the Ukraine was necessary too, as Hungary and Russia are not neighbors. The negotiations for this trilateral agreement were going on too slowly and therefore the project manager of the transport project (I. Bolshinsky) decided to use a different route. The final route of the first spent fuel shipment was on rail through Slovenia to the port of Koper, than on vessel to Murmansk and further on rail to the destination at Mayak in Siberia. This route seems to be complicated however it was the best solution, as it could be realized in time. All the spent fuel used in the Budapest Research reactor before 2005 was sent back.

In 2009 the unused HEU fuel assemblies of the Budapest Research Reactor were sent back to the Russian Federation. As it was fresh fuel the transport was much easier, than in case of the spent fuel. With the kind assistance of the RRFR program, the institute got LEU fuel as the compensation of the HEU fuel.

In 2012 it was realized, that there is still some HEU material in the institute. In the early fifties the institute got some Uranium powder from the Soviet Union, which was partly used for the production of fuel assemblies of a critical assembly and partly remained unused. The enrichment was close to 20%, however it could not be proved, that it was LEU, so it had to be considered HEU. The institute was again compensated by LEU fuel assemblies; this helped a lot in the operation of the Budapest Research Reactor, as these assemblies enabled the reactor for an additional year of operation.

The last spent fuel shipment was realized between September and November 2013 [2]. Based on the difficulties of the first spent fuel shipment, the project manager was looking for a different transport option. The Russian company Sosny developed an overpack for the Czech transport container, which could be used in air transport, as it was tested for air crash accidents. Two overpacks were fabricated and they could be simultaneously transported in the airplane AN 124-100. Three air shipments were necessary to transfer all the spent HEU fuel. In November 2013 Hungary became a country free of HEU material. This is a significant mitigation of risks.

4 Operation of the converted reactor, future plans

The Budapest Research Reactor is mainly used for neutron research but the production of radioactive isotopes is an important task as well. The latter is rather significant in cancer diagnosis and treatment

The scientific use of the research reactor is coordinated by the Budapest Neutron Centre (BNC). The Budapest Research Reactor is the only equipment in Hungary used in international user system for basic and applied research as a neutron source. Around the research reactor there are 15 big devices.

In the frameworks of the user system Hungarian and foreign scientists can propose research for the devices of BNC. The proposals are evaluated by an international board. Due to the high demand only excellent and very good proposals can win. The international recognition of the user system is proved by the fact that researchers come from 20 countries every year.

Beside research intensive efforts were made for good industrial contacts as well. The reactor is used for solving different practical problems, beside others neutron radiography is used for checking the structural integrity of helicopter blades, small angle neutron scattering and prompt gamma neutron activation analysis are used for different tracings, e.g. archeological studies and criminal investigations.

All the above mentioned activities could be continued without any difficulty after the reactor was converted. The penalty in neutron flux is very small, less than 10% for the maximum, so it did not influence the use of the reactor.

Future plans depend mainly on demand and demand depends on the nuclear program of the country. In 2014 it was decided, that two more NPP units will be built in Hungary. When this program will be realized it will give some tasks to the research reactor. As the highest flux in the Budapest Research Reactor is higher than that at the pressure vessel of most power plant reactors, it gives an opportunity to study the neutron induced embrittlement of the vessel in advance. Such studies were made in the Budapest Research Reactor for the existing units of the Hungarian NPP and are foreseen for the new units. Other NPP related programs could be realized as well, e.g. test of different structures for resistance for gamma and neutron radiation.

The greatest problem of the near future was recently the supply of fresh nuclear fuel. This problem is solved, as with the financial help of the government a contract could be concluded with the Russian fuel supplier. In the frameworks of this contract fuel will be shipped to Hungary in early 2020. This amount of fuel allows us to operate the reactor until about 2027. The current license of the reactor expires in 2023; preparations for the extensions of the license are being made. The staff of the reactor is fit enough for operating the reactor until the end of the planned lifetime.

In the frameworks of the FOREVER European project Technicatom (France) developed a draft for possible alternative fuel for the Budapest Research Reactor, based on the data the institute provided. This effort will be continued if the INSPIRER proposal will be accepted. The institute intends to take part in the INSPIRER project.

5 Conclusion

Hungary is free of HEU. This important goal was realized in such a way, that the Budapest Research Reactor remained in operation and is foreseen for operation for at least 8 – 10 more years.

The help of the RERTR and RRRFR programs enabled Hungary to mitigate the nuclear risk in the country and continue to use nuclear energy and nuclear technology.

6 References

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