TEN YEARS EXPERIENCE IN SHIPMENT OF SPENT FUEL FROM GKSS TO THE US UNDER THE FRRSNF ACCEPTANCE PROGRAM

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Abstract

Already in the 1980' GKSS-Research-Center decided to terminate operation of its two research reactors FRG-1 and FRG-2 on the HEU fuel cycle. This decision was made in acknowledgement of the aims of RERTR program, in which GKSS was a strong supporter from the beginning.

The FRG-2 (15 MW) has been used as Germany's largest material testing reactor for power reactor materials and safety test and has played an important rule in the conversion activities at the GKSS research centre. The FRG-2 was shutdown in 1991, therefore the conversion to LEU was not considered reasonable.

The FRG-1 (5MW) has been converted in February 1991 from HEU (93 %) to LEU (20%) in one step. Due to the unforeseeable termination of the take back policy of US-DOE in 1989 for spent HEU fuel elements there were from the former operation of the two reactors a large number of spent fuel elements to be stored at the reactor site. In 1996 the US initiated the Foreign Research Reactor Spent Nuclear Fuel acceptance program. Under this program GKSS has done 6 shipments with 141 spent HEU fuel elements and 150 spent LEU fuel elements to the US-DOE Savannah River.

In December 2005 the US-DOE and GKSS signed the contract "TERMS AND CONDITIONS FOR THE ACCEPTANCE OF FOREIGN RESEARCH REACTOR SPENT NUCLEAR FUEL AT THE SAVANNAH RIVER SITE" for the extension up to 2016.

Introduction

Two research reactors have been operated very successfully by the GKSS-Research-Centre over decades in a large connected pool system:

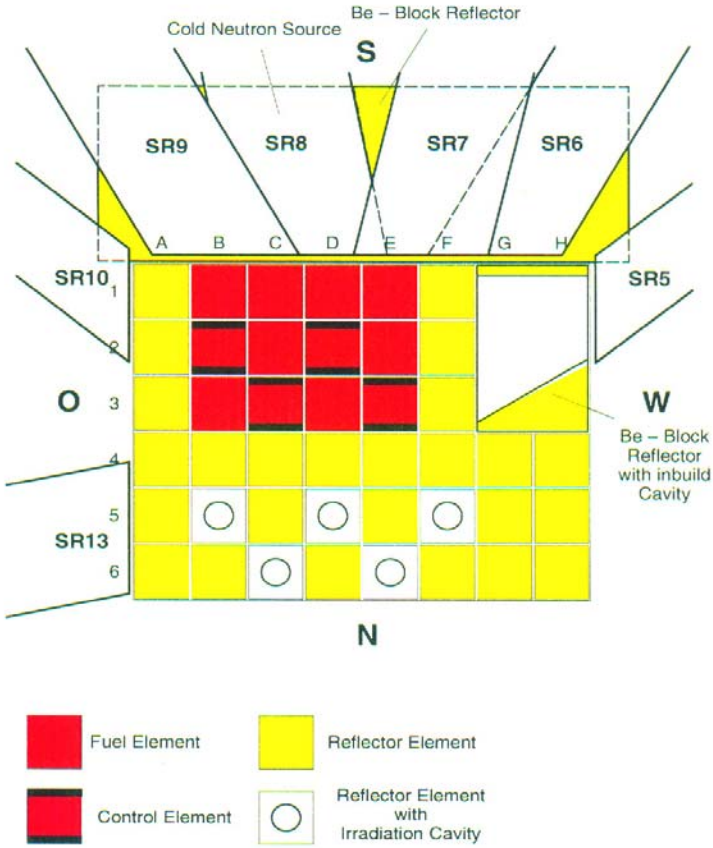
The FRG-2 (15 MW), criticality March 1963, was scheduled to shut down in 1991for lack of scientific and technical interest for future use. The reactor has been used as Germany's largest material testing reactor for power reactor fuel and power reactor materials development and safety tests. The FRG-2 has played an important role in the conversion activities at the GKSS-Research-Centre.

The research reactor FRG-1 has been originally designed and constructed in 1957/1958 (criticality on October 23, 1958) to serve general scientific research needs in different aspects of fundamental research and some applied research like cracking phenomena of organic coolants and isotope production.

It is clear that during the lifetime of the research reactor the research areas have been changed more than once. The outcome of such changes results on the one side in new experimental facilities at the beam tubes and on the other side in design changes at the reactor.

The following design changes have been made: increase of fuel loading, increase of burn up, reduction of enrichment, reduction of core size, new control rods, installation of a cold neutron source. At present the FRG-1 is being used with high availability for beam tube experiments for fundamental and applied research in biology, materials research, neutron radiography, neutron activation analyses etc.

The FRG-1 has been converted in February 1991 from HEU (93 %) to LEU (20 %) in one step and at that time the core size was reduced from 49 to 26 fuel elements. Consequently the thermal neutron flux in beam tube positions could be increased by more than a factor of two [1, 2]. It is the strong intention of GKSS to continue the operation of the FRG-1 research reactor with high availability and utilization. The reactor has been operated during the last years for approximately 250 full power days



per year. To prepare the FRG-1 for an efficient future use, the core size has been reduced in March 2000 in a second step from 26 fuel elements to 12 fuel elements. For this purpose the U-235 density has to be increased from 3.7 g U/cc to 4.8 g U/cc. So that finally the size of the reactor is being reduced from 49 fuel elements to 12 fuel elements over the last 10 years [3, 4]. The model of the FRG-1 compact core with the beryllium reflector and the beam tubes is shown in figure 1.

Figure 1: Model of the 3x4 core with beryllium reflector and beam tubes

The fuel elements for the operation of the FRG-1 are manufactured by CERCA using U. S. origin enriched uranium. Figure 2a and 2b shows the cross section of the fuel element.

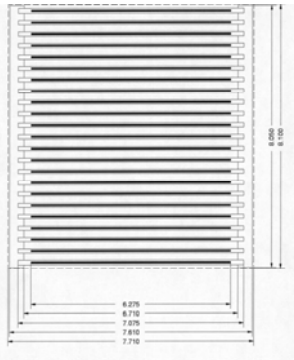


Figure 2a: Standard Fuel Element

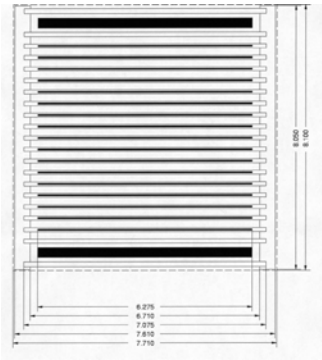


Figure 2b: Control Fuel Element

Problems at the back end of the fuel cycle

Due to the unforeseeable termination of the take back policy of US-DOE in 1989 for spent HEU fuel element there were from the former operation of the two reactors a large number of spent fuel elements to be stored at the reactor site. The large numbers of spent fuel serve problems as the storage capacity is limited and an increase of storage capacity causes in Germany severe licensing problems.

Shipments under the FRRSNF Acceptance Program

On May 13, 1996, the U. S. Department of Energy DOE announced the Record of Decision for the Final Environmental Impact Statement on a Proposed Nuclear Weapons Nonproliferation Police Concerning Foreign Research Spent Nuclear Fuel. Based on this policy, the U. S. DOE will accept and manage in the U. S. foreign research reactor spent nuclear fuel that was originally enriched in the U. S. Under the terms of the policy, aluminum based spent fuel will be accepted at the Savannah River Site of DOE.

A contract for the receipt of spent nuclear fuel elements was signed with the U. S. DOE as well as a contract with the Consortium NCS/GNS for the transport organization. The GNS-11 and the GNS-16 casks are used for the shipment. They have a maximum transport capacity of 33 MTR fuel elements. The maximum cask weight without shock absorber is 11.5 t for the GNS-11 and 13.2 t for the GNS-16. Due to the relatively small weight, this cask can be used in our facility. Both casks are transported in 20’ Open hard-Top Container. The transport casks GNS-11 and GNS-16 have been approved internationally for use in the shipment of spent fuel from foreign research reactor to Savannah River Site.

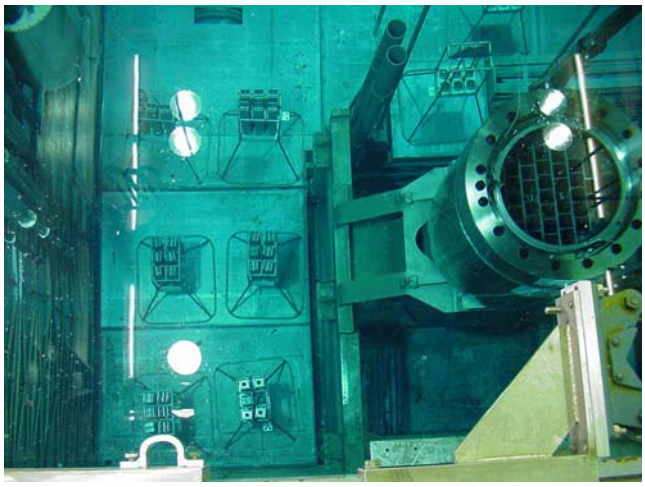
For each shipment and each type of fuel GKSS prepared a spent fuel acceptance criteria document. The Appendix A Agreement identify and categorize the spent fuel with the following information:

- Physical Dimensions
- Material Description
- Summary of Irradiation History
- Fissile Content
- Other Residual Activities
- Decay Heat
- Activity and Dose Rate
- Additional Information

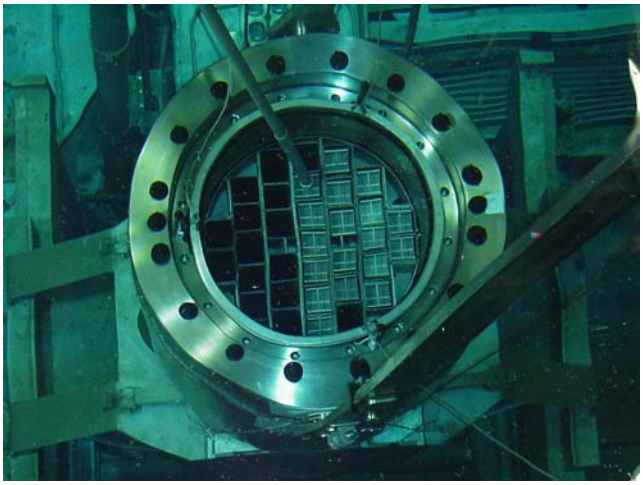
For the preparation and shipment of spent fuel GKSS has prepared a detailed step by step plan. This plan has been approved by the authorities and make sure that all steps in the process are performed safely and properly. This step by step plan includes

- Preparation of the facility
- Receipt of the transport cask
- Movement of the cask into reactor hall
- Preparation of the fuel elements
- Loading of the fuel into the cask
- Closure, sealing and testing of the cask
- Preparation for shipment
- Movement of the cask out of the reactor hall
- Loading of the cask onto the transport vehicle
- Radiation protection
- Shipment

For the receipt of the transport container and the movement of the cask into the reactor hall we need a mobile crane outside of the reactor facility. The preparation of the cask and the fuel elements in the storage pool is shown in Picture 3. Picture 4 is shown the loading of the GNS-16 cask with fuel elements.



Picture 3: Preparation of the cask and the fuel elements in the storage pool



Picture 4: Loading of the GNS-16 cask with fuel elements

The shipment of irradiated fuel is a highly regulated activity requiring extensive coordination between the reactor facility, the transport company, international, national and local governments, port authorities and the receiving facility. In fact of the good cooperation with the DOE and the Consortium NCS/GNS GKSS have done the following 6 shipments to Savannah River Site:

- August 1996, 33 HEU fuel elements in one GNS-11 cask
- March 1997, 66 HEU fuel elements in two GNS-11 casks
- July 1997, 33 HEU fuel elements and 26 LEU fuel elements in two GNS-11 casks
- September 2000, 9 HEU fuel elements and 24 LEU fuel elements in one GNS-16 cask
- September 2001, 66 LEU fuel elements in two GNS-16 casks
- July 2004, 33 LEU fuel elements in one GNS-16 cask

Conclusion

Since 1996 GKSS has shipped 141 HEU fuel elements and 150 LEU fuel elements to the Savannah River Site without any problems. After the extension of the FRRSNF Acceptance Program up to 2016 the US-DOE and GKSS signed the contract "TERMS AND CONDITIONS FOR THE ACCEPTANCE OF FOREIGN RESEARCH REACTOR SPENT NUCLEAR FUEL AT THE SAVANNAH RIVER SITE" in December 2005.

REFERENCES

[1] W. Krull: Enrichment reduction of the FRG-1 research reactor, International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR), Jakarta, November 4-7, 1991.

[2] W. Krull and W. Jager: Status and perspectives of FRG-1 after conversion to LEU, International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR), Seoul, October 6-10, 1996.

[3] P. Schreiner, W. Krull and W. Feltes: Increasing the neutron flux after reduction of the core size of the FRG-1, International Meeting on Reduced Enrichment for Research and Test Reactors (RERTR), Jackson Hole, Wyoming USA, October 5 - 10, 1997.

[4] P. Schreiner, W. Krull and W. Feltes: Increasing the neutron flux at the beam tube position of the FRG-1, Meeting of the International Group on Research Reactor (IGORR 6), Taejon, The Republic of Korea, April 29 - May 1,1998.