

# Spent fuel situation at the ASTRA Seibersdorf and the TRIGA Vienna Research Reactors

H. Böck<sup>a</sup>, A. Musilek<sup>a</sup>, M. Villa<sup>a</sup>, F. Meyer<sup>b</sup>

<sup>a</sup> Atomic Institute of the Austrian Universities, Vienna, Austria

<sup>b</sup> Nuclear Engineering Seibersdorf GmbH, Seibersdorf, Austria

**Abstract.** In the past decades Austria operated three research reactors, the 10 MW ASTRA reactor at Seibersdorf, the 250 kW TRIGA reactor at the Atomic Institut Vienna and the 1 kW Argonaut reactor at the Technical University in Graz. Since the shut down on July 31<sup>st</sup>, 1999 and decommissioning of the ASTRA reactor and the shut down of the ARGONAUT reactor Graz on July 31, 2004 only the TRIGA reactor remains operational. The MTR fuel elements of the ASTRA reactor have been shipped in spring 2001 to Savannah River and the fuel plates from the ARGONAUT reactor Graz in December 2005 under the DOE fuel return programme.

## 1. Introduction

The TRIGA reactor Vienna is used intensively for education and training, all reactor systems are in excellent condition, spare fuel elements are available to operate this reactor for another 10 to 15 years and at present there is no indication whatsoever that this reactor should be closed down in the coming years.

This paper discusses the experience with the completed fuel shipment of the ASTRA reactor, while the fuel shipment from the ARGONAUT reactor is presented in a separate paper at this conference [1] further an outlook of possible options for the TRIGA reactor is given.

## 2. Historical survey

In the period between 1959 to 1965 three research reactors were built and operated until 1999. The first reactor was the MTR type ASTRA reactor at the Austrian Research Centre Seibersdorf (ARCS [www.arcs.ac.at](http://www.arcs.ac.at)) which for a long period was the main research facility for nuclear research in Austria as well as the planning centre for a nuclear power plant to be installed at the site of Zwentendorf (730 MWe BWR), and which as it is well known was never put into operation due to a public negative referendum in 1978. This also effected the further development of nuclear research and in particular the programs at the ARCS. For several non-technical reasons the 10 MW ASTRA reactor was finally shut down on 30 July 1999 and immediately decommissioning started.

The second reactor was planned as a typical university training and education reactor in Vienna. A TRIGA Mark II reactor was selected, built and reached first criticality on 7 March 1962. This reactor is well maintained and utilized and it is in operation without any specific deadline for shut down.

### 3. Present situation

#### 3.1. The ASTRA Reactor in Seibersdorf

After 39 years (1960 to 1999) of successful operation, the 10 MW multipurpose MTR research reactor ASTRA at the Austrian Research Centers Seibersdorf (ARC) has now been decommissioned [2] and the final release from the nuclear legislation has been issued by 19 October 2006.

The 54 MTR-fuel elements (310.5 kg of HLW), described in Table 1 were shipped to US-DOE Savannah River Plant for ultimate disposal in May 2001.

TABLE 1. ASTRA FUEL

Fuel	Fuel-Element Identification	No. of Elements	Mass/Element [kg]	Total-Mass [kg]	Costs [US \$]
HEU	AR-S-16 – AR-S-20	5	5.28	26.40	118 800
HEU	C-38 – C-42	5	4.52	22.60	101 700
HEU	AR-P-08 – AR-P-09	2	3.46	6.92	31 140
LEU	S-31 – S-33	3	6.38	19.14	71 775
LEU	AR-S-34 – AR-S-44	11	6.10	67.10	251 625
LEU	AR-S-45 – AR-S-60	16	6.22	99.52	373 200
LEU	G-497 – G-499, G-501 – G-503	6	6.29	37.74	141 525
LEU	AR-C-43 – AR-C-47	5	5.37	26.85	100 687
LEU	AR-P-10	1	4.21	4.21	15 787
Total		54		310.48	1 206 240

Before the shipment the following steps had to be performed:

- June 1997: First inspection of fuel element conditions by DOE and by the ASTRA managers
- November 1998: Visit by DOE, official statement by ARCS about permanent shut-down in 1999
- December 1998: ARCS formally applies to DOE about intentions to ship spent fuel
- May 1999: Contract raised by DOE received in ARCS
- November 1999: Return of the contract signed by ARCS, Austrian Federal Government, and Euratom
- November 1999 to February 2000: leak-proving of the fuel elements carried out in the reactor pool
- May 2000: completed papers were returned to DOE
- International tender, three suitable offers were received favouring Transnucléaire
- Transport to Rotterdam was carried out by Sommer and Grottko/Germany using two NAC-LWT-6 casks
- From Rotterdam to Savannah River transport responsibility was with NAC
- May 31<sup>st</sup> 2001: 54 spent MTR-fuel elements (310.5 kg of HLW) left Seibersdorf (six months later than scheduled)
- July 1<sup>st</sup> 2001: fuel received at US-DOE Savannah River Plant
- February 2003: Ten new elements still remaining were sold to GKSS-Forschungszentrum Geesthacht, Germany

In immediate succession and still under the operating license, all experimental facilities and components of the reactor within the vicinity of the core, or in intermediate storage within the building e.g. old beam-tube installations, 492 kg of ILW and 5 212 kg of LLW, were removed and treated. In the course of this procedure custom-designed, remote-controlled equipment was built and three GNS-Mosaik containers were filled, partly under water, with the remaining material. Also the task of clearing the reactor building from remaining experimental equipment, obsolete storage facilities and

the transfer of the structures of the industrial source services including a 21-ton-lead-cell to NES Hot Cell Laboratories were accomplished to 90% by May 2003.

A preliminary evaluation of the expected amount of material to be decommissioned was performed which showed that it would amount to approximately 1 600 t of total material of which 10% with 160 t considered radioactive waste.

Now that the decommissioning procedure is finished the actual values are as follows:

- Total material involved: 1 800 t
- Material free for recycling: 1 600 t or 89.5%
- Material free for storage: 120 t or 6.5%
- Radioactive waste: 80 t or 4.5%

### 3.2. *The TRIGA reactor at the Atomic Institute Vienna*

The reactor operated since its first criticality with an average of 220 days per year without any long outages. The TRIGA-reactor is purely a research reactor of the pool type that is used for training, research and isotope production (Training, Research, Isotope Production, General Atomic = TRIGA) [3]. Throughout the world there are around 50 TRIGA-reactors in operation, Europe alone accounting for 8 of them. The reactor core consists presently of 80 fuel elements (3.75 cm in diameter and 72.24 cm in length), which are arranged in an annular lattice. Two fuel elements have thermocouples implemented in the fuel meat which allow measuring fuel temperature during reactor operation. At nominal power (250 kW) the centre fuel temperature is about 200 °C. Because of the low reactor power level, the burn-up of the fuel is very small and most of the fuel elements loaded into the core in 1962 are still there. A summary of the fuel situation is shown in Table 2.

TABLE 2. FUEL ELEMENT SITUATION AT THE TRIGA VIENNA AS OF 1. 1. 2006

Number of FE	Location	Cladding		Enrichment	Remarks
		Al	SST		
80 plus 2 in storage	core	57	25	70 FE 20% 9 FE 70%	2 instr. FE
13	fresh fuel storage	-	13	20%	2 instr. FE
8	spent fuel storage	8	-	20%	1 instr. FE
1	hot storage facility	1	-	20%	cut into 3 pieces
Total: 104		66	38		

The TRIGA reactor is heavily used for training and education of students in the nuclear field but also used for national and international training courses with the IAEA and with neighbour countries (Germany, Czech Republic, Slovak Republic, European Nuclear Engineering Network –\_ENEN). Many cooperation projects exist with the IAEA as the TRIGA reactor Vienna is the closest nuclear facility to the IAEA and the irradiation services has increased since the shut down of the ASTRA reactor although for many requested services the TRIGA cannot offer the requested power and neutron flux. At present there is no indication from the government that an imminent shut down of this facility is taken into consideration.

#### REFERENCES

- [1] SCHACHINGER, E., NINAUS, W., "Repatriation of Spent Fuel of the Siemens Argonaut Graz Research Reactor to the USA", on this publication.
- [2] ARCS: [www.arcs.ac.at](http://www.arcs.ac.at)
- [3] TRIGA Wien: [www.ati.ac.at](http://www.ati.ac.at)