

**“AREVA Back-End Possibilities
for the Used Fuel of Research Test Reactors”**

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ABSTRACT

One of the major issues faced by the Research and Test Reactor (RTR) operators is the back end management of the used fuel elements. RTR used fuel for both HEU and LEU types are problematic for storing and disposal as their Aluminium cladding degrades leading to activity release, possible loss of containment and criticality concerns. Thus, direct disposal of RTR used fuel, (without prior treatment and conditioning) is in this respect hardly suitable. In the same manner, long term interim storage of RTR used fuel has to take into account the issue of fuel corrosion.

Treating RTR used fuel allows separating the content into recyclable materials and residues. It offers many advantages as compared to direct disposal such as the retrieval of valuable fissile material, the reduction of radio-toxicity and a very significant reduction of the volume of the ultimate waste package (reduction factor between 30 and 50). In addition, the vitrification of the residues provides a package that has been specifically designed to ensure long term durability for long term interim storage as well as final disposal (99% of the activity is encapsulated into a stable matrix).

RTR fuel treatment process was developed several decades ago by AREVA with now thirty years of experience at an industrial level. The treatment process consists in dissolving the whole assembly (including the Al cladding) in nitric acid and then diluting it with standard Uranium Oxide fuel dissolution liquor prior to treatment with the nominal Tributylphosphate solvent extraction process. A wide range of RTR spent fuel has already been treated in the AREVA facilities. First, at the Marcoule plant over 18 tons of U-Al type RTR fuel from 21 reactors in 11 countries was processed. The treatment activities are now undertaken at the La Hague plant where 17 tons of RTR used fuel from Australia Belgium, and France aligned for treatment. In June 2005, AREVA started to treat at La Hague ANSTO's Australian RTR used fuel from the HIFAR research reactor. AREVA is able to offer true long term solutions for the back-end management of the three main types of RTR fuel: U-Al, the future U-Mo type of fuel, and even some silicide spent fuels.

Due to the diversity of the worldwide Research Test Reactor facilities, AREVA is experienced in developing customized solutions and services for international and domestic customers. It has developed a new generation of packaging that accommodates different types of baskets of high capacity allowing a large variety of HEU and LEU fuels to be handled safely. This packaging meets all IAEA regulations.

Finally, treatment of RTR used fuels, in a regional facility under international safeguards, is a key solution to proliferation threats represented by spent HEU fuel: it dilutes the HEU. Thus, it could be a useful mean for accelerating the Global Threat Reduction Initiative program launched in the United States.

The goal of this paper is to present AREVA's experience concerning RTR used fuel treatment and logistics.

INTRODUCTION

Test reactors are and will continue to be key tools for research, in various fields such as medicine, biology, and industry; they also bring direct contributions of utmost importance to education and to the production of radiopharmaceuticals for hospitals.

Although RTRs are scientific tools and serving general welfare, public acceptance of RTR has also been affected by the strong anti-nuclear campaigns of the few past years. They are under scrutiny especially as regards the management of used fuel arising from their operation.

Treatment of used Research Test Reactors fuel

RTR used fuel - although very diverse in sizes and shapes - are featuring a number of common characteristics:

- (i) The fissile part is an alloy - or cermet (metal ceramics) - of a metal (mostly aluminum) with uranium. In such alloy uranium is dispersed mostly as U metal, also as UO_2 , U_3Si_2 and USi_3 . Besides damaging due to the effect of irradiation, the metal is subject to degradation by corrosion, making the fissile material more liable to dispersion and change of geometry[1]
- (ii) RTR have been very generally —and for decades— using high enriched uranium (HEU) fuel. Uranium residual enrichment is much higher than that of power reactor fuel since it ranges from 70 to 85% of U235 in non Russian origin fuel down to 30-25% of U235 in Russian origin fuel reactors. Quite a number of reactors are yet converted to use low enriched uranium (LEU) fuel with a 19.75% U235 initial enrichment instead of HEU. Such high U235 enrichment levels require very specific design and operation control measures for any facility detaining such fuel.
- (iii) The fuel cladding constitutes - in RTRs as for power reactors —the first containment barrier. It is most generally made of thin aluminum plates (typically ~ 0.5 mm thick). Cladding is subject to through-corrosion when conditions are not permanently and

perfectly controlled. This is the case with stagnant water or when water quality is not appropriately controlled. Other configurations include corrosion due to galvanic currents or presence of humidity in a dry storage.

Consequently one of the major concerns of the research and test reactor operator is the appropriate management and control of the spent fuel elements prior to their final disposal. The treatment-conditioning of RTR used fuel in an existing industrial treatment plant offers a number of advantages such as the retrieval of valuable products, the reduction in radio toxicity and volume of the ultimate waste complying with existing approved specifications and stability which make them suitable for final disposition.

AREVA'S EXPERIENCE CONCERNING THE TREATMENT OF RTR USED FUEL

COGEMA has gained a large experience and know-how in RTR fuel treatment. At its Marcoule UP1 plant, COGEMA has treated over 12 800 kg of RTR used fuel from many countries and reactors, such as Osiris, Siloé, Pégase of CEA (Commissariat à l'Énergie Atomique), RHF of ILL in Grenoble France, BR2 of SCK-CEN in Belgium, GKSS and KFA in Germany, HER and HOR in the Netherlands, JMTR and JRR2 of JAERI in Japan. La Hague plant is already available to process aluminide and UO₂ spent fuel coming from RTRs. The RTR used fuel treatment program started in 2005 with the processing of Australian fuel from Ansto. Further development works are in progress to adapt the plant to process limited quantities of silicide, metallic natural uranium and some other special fuel. In addition, the feasibility of the treatment of the new U-Mo fuel presently under development in France, is already demonstrated.[2]

The treatment of RTR used fuel at La Hague plant follows the LWR standard treatment operations path.[3] The typical process steps for aluminum structure RTR fuel treatment are the following:

- Reception of RTR spent fuel casks
- Under water casks unloading
- Interim storage of used fuel in pool
- Used fuel Dissolution
- Dilution of the arising RTR fuel dissolution liquor into standard LWR fuel dissolution liquor.
- Extraction and purification of uranium and plutonium.
- Vitrification of fission products and TRUs into boro-silicate glass.

Following dissolution, RTR dissolution liquor is blended on-line with LWR liquors so that total U₂₃₅ is less than 2% and the resulting liquor is processed in the main LWR line. Thus, RTR spent fuel treatment-conditioning benefits from all the existing LWR treatment facilities.

The objective of used RTR fuel treatment is mainly to minimize the waste volume and reduce the radio-toxicity of the ultimate waste to be disposed of (treatment allows to reduce waste volume by a factor of 30 to 50 as compared to direct disposal and 99% of the activity encapsulated into

stable vitrified residues).[4] The ultimate products management includes the recovery of the recyclable materials (uranium and plutonium) with a very high efficiency (99.88%).

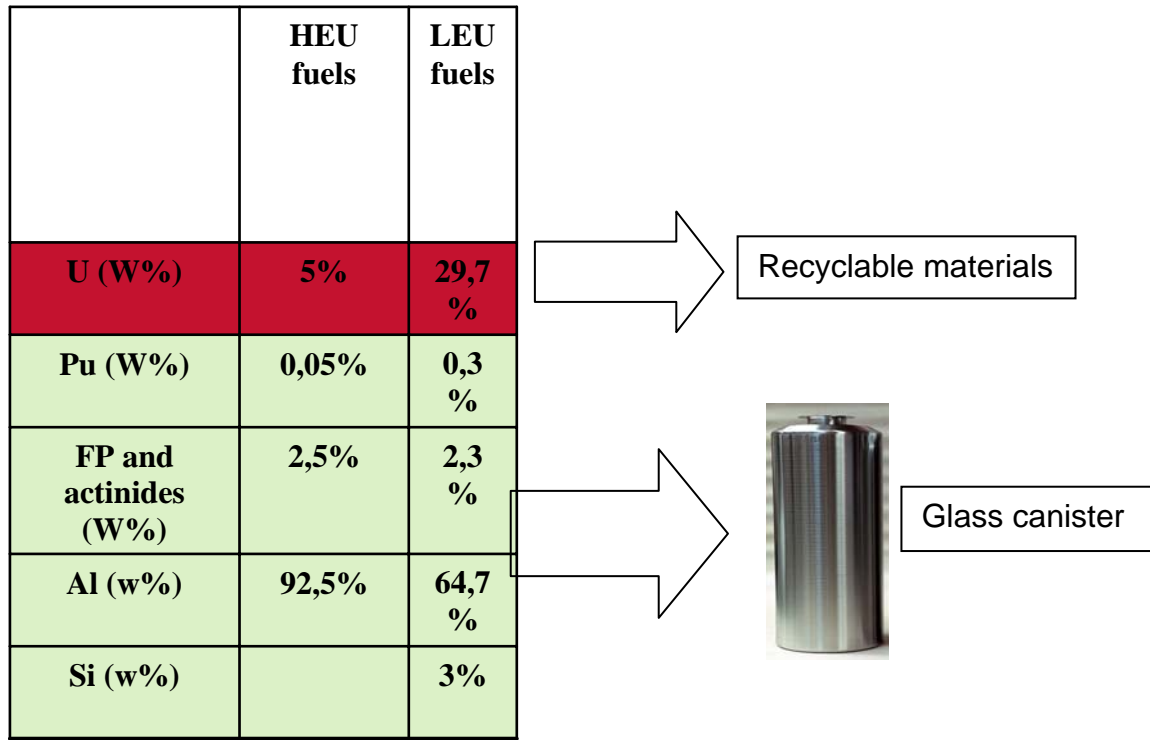


Fig. 1. Used RTR fuel typical composition

The ultimate residues are conditioned in a standardized packaging called “Universal Canister” (UC). This canister can accommodate either vitrified residues or process and maintenance waste in a compacted form. Its weight is around 500 kg for glass products and 800 kg for compacted residues.

The UC is 1.34 m high and has a diameter of 43 cm. This package is accepted in many countries by the respective Safety Authorities, the customers and the storage operators.

AREVA's efforts to reduce the final volume of ultimate residues makes it possible today to achieve a drastic volume reduction of waste that is bound to final disposal.

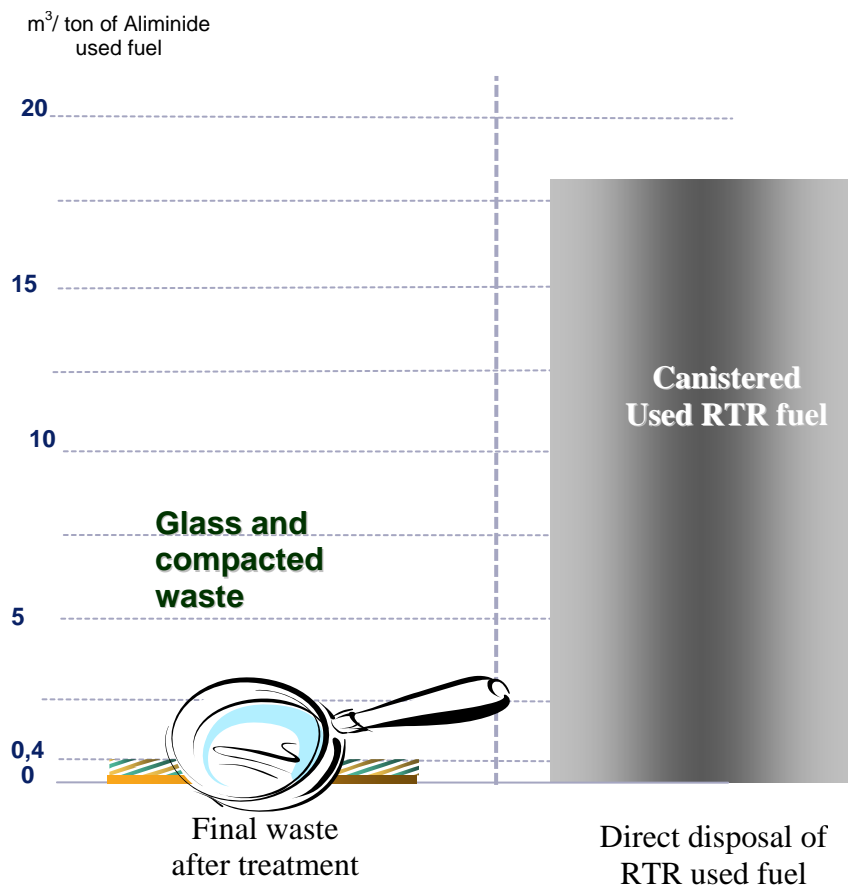


Fig. 2. Volume of residues generated by used RTR fuel treatment

Treatment of RTR used fuel results in only two types of residues to be returned to the country of origin. Both types are conditioned in one unique geometry, the Universal Canister. The UCs are easy to handle and to store, and approved by many national safety authorities. Moreover, for the return shipment to the customer, the Universal Canisters can be loaded into dual-purpose transport and storage casks. The dual purpose casks can also be stored in existing facilities without requiring sophisticated infrastructure or safeguards provision, and hence minimizing the control and operating procedure.

Used RTR fuel transportation

AREVA / COGEMA Logistics provides solutions for international transportation of used Research Reactors Fuel. For the Back-End stage, customized solutions and services are available for international shipments. For example a new generation of packaging was developed to meet the various needs and requirements of the Research Laboratories and Research Reactors operators worldwide.

In this family four TN™-MTR casks and 2 TN™-106 casks with two different lengths of cavity (2200 mm and 2000 mm) are presently in use. The TN™-MTR cask can be equipped with 6 different types of baskets providing a capacity ranging from 4 to 68 fuel assembly elements.

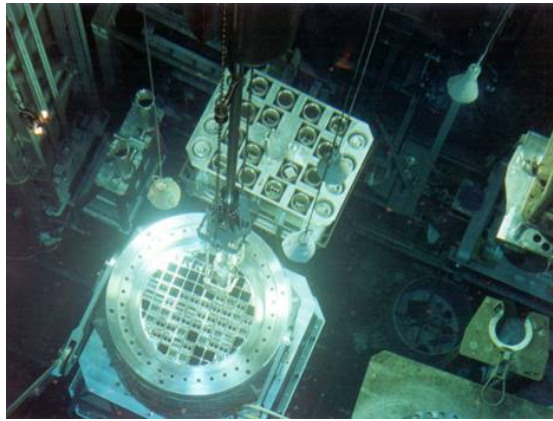


Fig. 3. Unloading of a TNTM-MTR cask at La Hague plant

All these packages meet AIEA 1996, T-S-R-1 regulations. Successful example of recent transport operations include: shipments of used fuel from Japan, Australia and Europe to US and France.

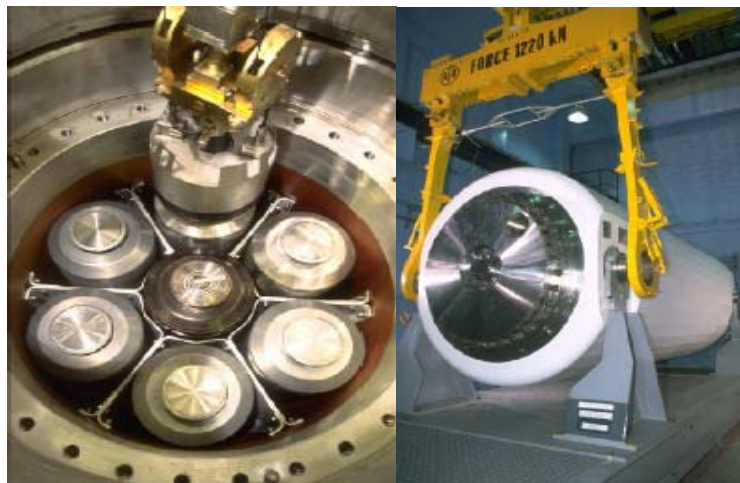


Fig. 4. Vitrified Residue Transportation Cask

CONCLUSION

AREVA provides comprehensive assistance, technical studies, dedicated services, packaging and transport systems at every step of research reactor fuel cycle. Finally, the treatment of research reactor used fuel can significantly help customers in charge of finding solutions for the disposition of used Research Reactors Fuel.

REFERENCES

1. "Corrosion of Research Reactor Al-Clad Spent Fuel in Water", LV. Ramanathan (IPEN, Brazil) & I. Ritchie (IAEA Vienna) and al. - RERTR 2002

WM'06 Conference, February 26–March 2, 2006, Tucson, AZ

2. "Origine et développement du combustible uranium-molybdène (U Mo)", M. Boyard, Technicatome and al, Revue Générale Nucléaire - Année 2002, N°3 mai-juin
3. "Reprocessing RTR fuel in the La Hague plants", F. Drain, A. David, SGN, J. Thomasson, COGEMA - RRFM 2001
4. "RTR spent fuel treatment: the COGEMA long term solution", J.Thomasson, M. Boisson, COGEMA - KTG 2000