

OPTIMIZING THE CONDITIONING OF NUCLEAR WASTE: THE RCR RESPONSE

J.-J. GAUTROT & P. LEDERMANN & H. MASSON

COGEMA
2, rue Paul Dautier
78141 Vélizy Cedex
France

INTRODUCTION

A new century is about to begin and deregulation is ruling the world utility industry. For the first time, consumers and companies will be able to pick their electricity suppliers as freely as they now choose their long-distance communication carriers. Then, utilities relying on nuclear power can choose between several solutions and service suppliers for their back-end management. Offering a broad and attractive set of flexible services to utilities is then a primary objective for industrial nuclear companies.

This international trend gives credit to those - like the COGEMA Group - whose constant commitment is flexible management and services. Ranging from appropriate waste conditioning in dedicated and standardized canisters (Universal Canister) to transportation means, the client-first strategy developed by the COGEMA Group gives utilities a real sense of priorities. Utilities can pick themselves what kind of services they really need, and the most clever planning regarding their nuclear policy and their long-term energy and financial strategies. Industrial flexibility is the key for lower electricity generation cost, which is the sole rationale for utilities.

The advantages of the RCR (Reprocessing - Conditioning - Recycling) option in terms of spent fuel management are demonstrated:

- Waste volumes to be disposed of are greatly lessened,
- Conditioning forms are dedicated to contained materials,
- Reusable materials are recovered and recycled.

In spite of the satisfactory achievements gained in the RCR field, the COGEMA Group has maintained its efforts to further improve its know-how in this sector. The COGEMA Group has also worked on making the handling, transportation and storage of the final materials easier thus contributing to make the reprocessing-conditioning-recycling option a custom-made one. RCR is then a global and evolutionary answer fully fitted to present and future challenges.

I / The industrial strategy

As previously underlined, the COGEMA Group's strategy lies on a combined offer: reprocessing, conditioning, and recycling. The reprocessing company takes the spent fuel, ships it from the

nuclear power plant to the reprocessing plant, reprocesses it and sends ultimate conditioned waste according to a flexible planning established by both parties.

The La Hague site offers a technically mastered and economically proven solution for spent fuel reprocessing. As a matter of fact, a near 30-years experience at La Hague demonstrates the industrial mastery of commercial reprocessing. Overall reprocessed quantities in La Hague plants, as for oxide fuel, exceed 11,100 tU. With the UP3 plant as well as the upgrading of the UP2 plant, the La Hague site is now operating at a full capacity of 1,600 tons per year. This unique industrial complex is able to serve nearly 100 PWRs, offering high quality recyclable energetic products and safely conditioned waste. Different type of fuels (LWR, GCR, MOX, FBR) having various burn-ups have been successfully reprocessed at the La Hague plant demonstrating the high degree of flexibility reached by the Normandy-based plant.

This matchless industrial site serves a strategy based on the optimization of the nuclear fuel cycle. Use of nuclear energy is by itself a wise choice when one considers various aspects such as energy security supply or global warming. Nevertheless disposing of hundred of tons of spent fuel through direct disposal does not match with the same rationale with respect to non-saving of reusable materials as well as to appropriate conditioning more particularly.

On the other hand, the COGEMA Group's RCR strategy brings a ready-made solution for interim and final conditioning disposal. Final waste arising during the reprocessing operation are conditioned in internationally agreed and dedicated forms ensuring a consistent answer in terms of volume, radiotoxicity and health care. In other words, utilities do not need to care about the ins and outs of their back-end strategies. The reprocessing company is then responsible for all the industrial aspects tied to the fuel cycle back-end management, including transports. This is a global answer. The COGEMA Group has developed several industrial tools aimed at turning the conditioning aspect of the RCR concept into a workable and result-oriented reality.

II / The industrial implementation

Waste volume reduction and optimization of available raw materials are primary imperatives for the industrial community. The COGEMA Group has translated this concept into a daily industrial reality with the implementation of a large spent fuel reprocessing-conditioning-recycling capability.

The long-lived wastes are conditioned in dedicated packages agreed by national and international safety authorities. The volume of these conditioned waste represents less than 0.5 m³/ton HM. This is compared with the direct disposal option, in which the spent fuel is considered as useless, where the volume to be stored reaches more than 2 m³. Based on its previous experience, the COGEMA Group continues to minimize both volume and radiotoxicity of long-lived ultimate waste. All the enhanced industrial tools and facilities set up for that purpose are still in operation or will start up very soon.

Like any other industrial operation, the nuclear fuel cycle generates waste. During the reprocessing operation, high level or long-lived waste (non-reusable parts of nuclear fuel, i.e. fission products, actinides, hulls and end-fittings) are separated from reusable materials (uranium

and plutonium), prior to recycling. Then, these wastes are conditioned in a proper manner, which ensures stability, and safety.

The increasing operability of the La Hague equipment has already allowed a significant reduction of maintenance operations, thus lessening the amount of technological waste. Even so, additional improvements are still underway regarding management of long-lived waste. More precisely, the COGEMA Group has two objectives concerning long-lived waste, which are reducing plutonium's toxicity, and reducing, via compaction, the volume of residues.

Reduction of plutonium's toxicity in waste

The La Hague plant achieves a 99.88% recovery of the fissile materials contained in spent fuel in order to extract as much plutonium and uranium as possible and to have lower radiotoxicity for underground disposal, in accord with current safety regulations. In-depth studies have shown that efficient plutonium extraction lessens the radiotoxicity of final waste by a factor 20 to 30. As a result, COGEMA has made recovery of plutonium a high priority.

This objective has been reached thanks to refinements to the PUREX process. PUREX features several extraction cycles aimed at ensuring a proper partition and purification of uranium and plutonium. Results are really conclusive: alpha activity of the waste is comparable to natural uranium α activity after 7,000 years. Regarding the direct disposal option, the same figure would be reached only after 200,000 years. Last, decontaminating alpha-bearing technological waste is of special importance for the COGEMA Group. In this regard, a dedicated dissolution process treats these wastes. Most of recovered plutonium is recycled in the reprocessing operation.

Reduction of volumes

Until 1995, hulls and end-fittings were cemented. Today they are stored underwater in dedicated drums pending the completion of a new compaction facility, which has begun. The ACC facility will compact fuel hulls and end-fittings as well as technological waste. This will decrease the volume of conditioned waste by a factor four. After the compaction operation, the waste will be inserted into a container of the same dimensions as the ones used for vitrification. This has been dubbed the Universal Canister Strategy.

Transport operations will be made easier. Needless to say, the canister's limited size and weight offers the possibility to increase the number of canisters transported by each operation, and thus to limit the number of transports from the La Hague reprocessing site to the interim and final storage sites. Moreover, Universal Canister gives the COGEMA Group's customers the ability to rationalize their waste repositories. Selection and construction of a sole site, with the same-sized boreholes or galleries and with the same handling-device systems will lessen the number of operations and the overall costs.

III / The tools

To make these measures an industrial reality has required adapting existing facilities or erecting new ones. Management of long-lived waste relies basically on the La Hague facilities for vitrification, compaction, plutonium recovery and treatment of alpha wastes.

Vitrification

Long-lived wastes are vitrified in two workshops: R7 for UP2-800 and T7 for UP3. These two units were commissioned, respectively in 1989 and 1992. Each unit was designed to produce more than 550 glass canisters per year. At the end of 1998, more than 6,500 glass canisters had been produced at both facilities. Vitrification operations at La Hague are based on the continuous process developed by the French CEA (Commissariat à l'Energie Atomique), and operated in the AVM (Atelier de Vitrification Marcoule) facility since 1976. Today, vitrification of fission products contained in one ton of spent fuel represents 0.1 m³ of glass, or around 2/3 of a Universal Canister.

Compaction

Hulls and end-fittings will be compacted in the ACC facility in the shape of discs. Each canister will contain about 5 to 7 discs depending on their thickness. Up to 2,400 canisters will be produced per year at the ACC facility. This represents at least 12,000 discs per year. An important campaign of R&D - which includes active and inactive tests - has been set up to demonstrate the feasibility of the process in terms of conception, maintenance and investments. The construction of ACC began in March 1995. The commissioning is scheduled for the end of 2000. The goal is to produce less than 1.5 Universal Canisters per ton of reprocessed spent fuel.

Plutonium recovery

The URP workshop for redissolution of PuO₂ powders and UO₂-PuO₂ powders was commissioned in 1995. This workshop is also in charge of americium-removal from plutonium. This workshop is located in the R2 facility of the UP2-800 plant.

Treatment of alpha waste

Two workshops, UCD and UTD, are dedicated to the treatment and management of alpha-bearing wastes.

- The UCD (Alpha Waste Centralized Unit) was commissioned in February 1997. It recovers most of plutonium contained in alpha technological wastes, by means of a leaching process.
- Alpha wastes from the plutonium purification and conditioning workshop (located at UP3) are directed to the UTD (Alpha Waste Treatment Unit), which performs the same kind of operation as the UCD.

CONCLUSION

Smooth management, conditioning and minimization of waste volume is a day-to-day commitment for COGEMA Group. This policy, plus the new industrial tools developed allow a drastic reduction of waste volume and radiotoxicity. Needless to say, this client-oriented policy is undertaken under the COGEMA Group QA/QC system, which has been recognized and praised by all of our clients throughout the world. All this gives utilities, our clients, a strengthened possibility to increase the nuclear KWh market share, thanks to RCR, a proven solution for final conditioning.