

## **La Hague Legacy Waste Recovery Program: Scope, Progress and Issues-12080**

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### **ABSTRACT**

A significant inventory of process waste of varying natures and quantities has been generated during the thirty years of operation of UP2 400 facility on the site of La Hague, France. The retrieval, packaging and final storage of such an inventory has never been achieved before in France and thus requires the design and qualification of new processes, equipment, and waste packages. Following AREVA strategic decisions and French safety authority requirements, the legacy waste program has begun around the year 2000 and is scheduled to be completed around the year 2025. It is under the responsibility of AREVA Site Value Development Project teams.

For each category of waste to be recovered, AREVA teams conducted detailed investigations, defined recovery modes, treatment processes, as well as final waste package forms, which they subsequently submitted to French safety and waste management authorities.

A Task force initiative was subsequently launched to optimize the program cost and scenario, and lead to an optimization of about 15% of the entire program.

The qualification of processes and waste packages required a significant amount of research and development which is now well under way for processes, and scheduled to be completed in 2015.

Preparation work has begun on several installations to clear space for the construction of future retrieval facilities, scheduled to begin in the coming three years

### **INTRODUCTION**

UP 2 400 in La Hague, France, was commissioned 1967, and operated until 1998. Over the period, it re-processed over 9500 tonnes of fuel, 5000 tonnes of which were gas cooled natural uranium fuel (UNGG)

For UNGG fuel, the reprocessing cycle, involved mechanical decladding in the first place (later replaced by chemical peeling), followed by PUREX dissolution, extraction on separation of Uranium and Plutonium.

Starting from 1976, once the high activity oxide (HAO) facility was built, oxide fuel from light water reactors was also treated within the facility. Approximately 4500 tonnes of such fuel was treated until the facility was shutdown in 1998.

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During that period, graphite sleeves and magnesium cladding recovered during the process were stored in vast silos. The accumulated total amounted to 1100 tonnes at the end of the period.

In a similar way, spent fuel zircaloy cylinder pieces and fuel rod accessories were recovered and stored in silos following the dissolution process. Today, the amount stored represents 2300 tonnes.

Furthermore, maintenance and operation of the facilities required effluent treatment and filtration resin replacement. Spent contaminated resins were recovered and stored in silos as well, and accumulated for a total of about 200 tons, stored in silos as well.

The effluent treatment facility generated a total amount of 9400 m<sup>3</sup> of sludge which accumulated in the bottoms of the facility's tanks.

Finally, operation of the uranium and plutonium treatment lines generated 2400 drums of alpha contaminated process waste which were stored in a vault, in the absence of adequate disposal facilities.

Upon final shutdown of the facility in 1998, AREVA opted for immediate decommissioning and legacy waste recovery and launched the D&D program with a target end of operations scheduled for the year 2030.

Approximately ten years later, French safety authorities set binding milestones for the beginning and ending of each legacy waste recovery program, as part of the safety case instruction process. Most recovery operations are scheduled to begin in 2015 - 2016 and end around 2025 to allow for the D&D and storage silos and tanks before 2030, with the exception of the Alpha contaminated drums for which recovery and re-processing is scheduled to be completed by the end of the year 2012.

## **WORK CONDUCTED**

Upon the initiation of basic design for each category of waste, three aspects were examined: The recovery process, the treatment and conditioning process, and the final waste package definition which in fact determines for a significant part the two previous processes.

### **HAO spent fuel cylinders**

UP2 800 and UP300 facilities routinely produce, condition, and package spent zircaloy cylinders and alpha contaminated process waste. In the absence of repository, both types of waste are compacted and packaged in containers very similar to the glass containers used for fission products.

Consequently, compaction was the selected solution for HAO zircaloy cylinders, while building 119 alpha contaminated drums were to undergo a specific rinsing operation prior to compaction into final packages.

However, although the conditioning and packaging were easily defined for HAO waste, the recovery itself, and waste segregation required prior to compaction, represented new issues which required a significant amount of R&D and qualification, for both technical and safety reasons.

### **Alpha contaminated drums**

Facilities have been present for several years on the site of La Hague for the conditioning and final packaging of alpha contaminated technological waste.

Ripping followed by nitric acid rinsing for decontamination is the standard process applied to such waste, the effluents being subsequently re-routed to vitrification.

We thus opted for this solution for the 2400 drums of alpha contaminated waste included in the legacy waste retrieval program.

### **UNGG graphite and magnesium waste**

Unlike HAO waste, the definition of a conditioning method and final package for magnesium and graphite fragments represented a challenge in itself. Encapsulation in a cement matrix was the preferred solution for the final waste package for reasons of long term stability. Figure 1 below shows the content of a UNGG silo.



Figure 1: Graphite & magnesium legacy waste silo

However, it did raise issues with respect to:

- the reactivity of magnesium as well as the galvanic coupling between magnesium and graphite which can result in severe oxidation processes,
- the condition of the waste, composed of a panel of fragment ranging from dust size to large pieces of several centimetres

Furthermore, the varying sizes and types of waste present in the silos required the definition of different recovery and pre conditioning processes prior to encapsulation, all of which had to be performed in an inert atmosphere to mitigate the fire risks associated with magnesium and the pyrophoricity of uranium hydride.

### **Effluent treatment facility Sludge**

In the past years, bitumen was often the preferred solution for sludge packaging. However, French safety authorities have discarded this solution in the last few years. Cementation is an often selected alternative for low activity sludge. However, the sludge present in the effluent treatment facility ponds present activities in the range of 7 GBq/kg of beta gamma activity, and around 0.3 GBq of alpha activity per kg of sludge, which would lead to poor incorporation rates in cement matrices, and consequently lead to a very large amount of final waste packages that would represent both a technical and an economical nonsense.

On the other hand, dry sludge presents a significant dispersion risk and the safety authorities thus required AREVA to define a treatment method that would ensure a reasonable level of confinement.

Considering the above AREVA R&D teams opted for a drying/compaction process for the sludge, the final waste package being a large drum containing sludge pellets surrounded by a sand matrix. Such a package presented the double advantage of providing a stable, confined package while allowing for a possible future recovery and alternative conditioning of the sludge pellets should alternative technologies or repositories emerge.

### **Spent Contaminated Resins**

The standard conditioning mode for resins is encapsulation in cement matrices. La Hague resin cementation facility routinely performs such activities for UP2 800 and UP3 facilities. Mobile resin cementation facilities operated on EDF sites, using epoxy matrices.

However the resins present in UP2 400 were not compatible with the existing processes and installations due to their activity levels, in particular with respect to alpha contamination.

AREVA D&D project teams thus opted for the construction of a versatile facility capable of cementing any type of homogeneous radwaste, using a “lost stirrer” technology.

This design lead them to estimate a total production of approximately 5000 waste packages, 4000 of which would end as surface waste, while the remainder would go to sub surface repositories.

## RESULTS ACHIEVED

As of the end of 2011, the design and inactive scale one qualification of most process equipment is nearing completion.

### Effluent treatment facility sludge

Figure 2 below provides a 3 dimensional view of the sludge drying compaction process while Figure 3 provides a similar view for the HAO recovery and conditioning cell.

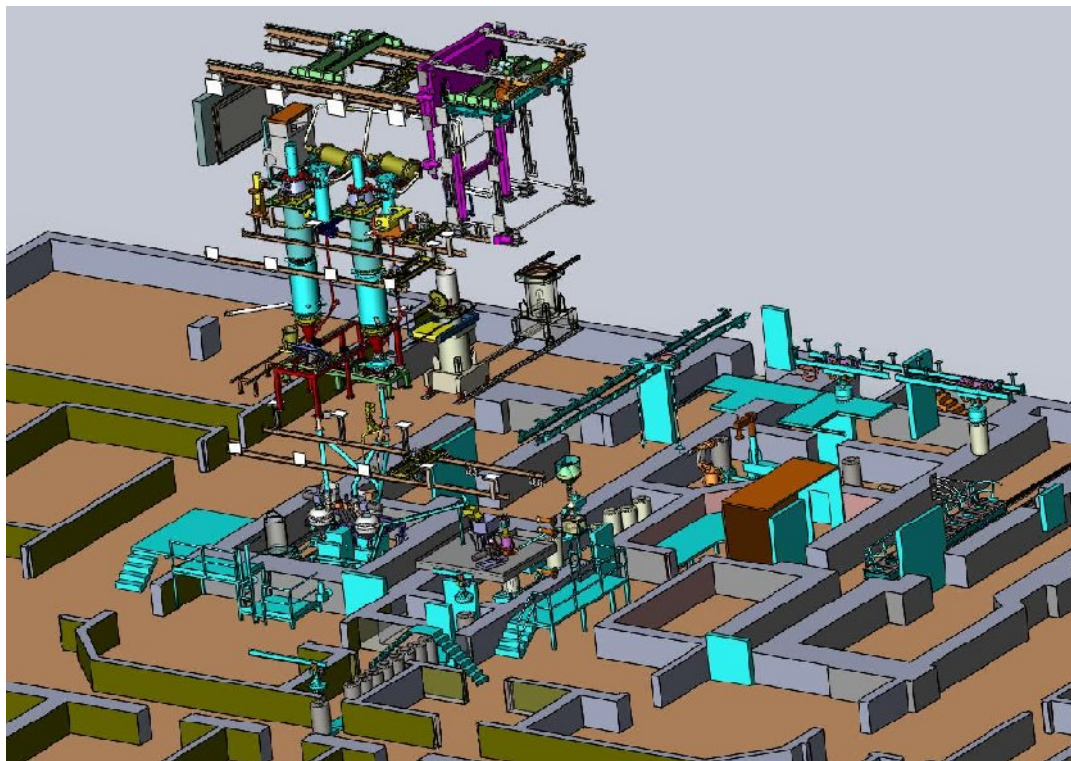


Figure 2: Sludge drying & compacting process line

Scale one inactive tests have been performed successfully on each element of the process.

Some challenges have appeared along the qualification process, and have been overcome only recently, such as the adjustment of the drying flows and temperatures to ensure suitable drying for compaction while minimizing oxy reactivity of the sludge during drying.



Figure 3: Zircaloy silo retrieval and conditioning cell

As of today, the drying and compaction process are qualified. The final waste package is still undergoing some R&D with respect to hydrogen release. Qualification of the entire process line is scheduled for 2012.

Preparation work within the host facility has begun, to allow for the beginning of construction of the new process in early 2014.

### **HAO spent fuel cylinders**

The basic design for the recovery and conditioning cell has been entirely completed. Scale one inactive tests have been performed successfully on each element of the process.

The difficulty resided in the ability to adequately rinse and segregate zircaloy fuel cylinders from surrounding sludge and resins (some resins have been found present in the HAO silo) prior to sending them for compaction, since the compacted waste package cannot contain organic materials for long term stability reasons (hydrogen release). However, this issue has been resolved following R&D.

Figure 4 below shows the rinsing/sorting table qualified for the segregation of resins from zircaloy fragments.



Figure 4: HAO spent fuel cylinders sorting table

Preparation work which consists in dismantling the process equipment currently present above the silo, has begun and is scheduled to end in the summer of 2012.

### **UNGG graphite and magnesium waste**

As for the other projects, basic design and full scale inactive qualification tests have been performed on each step of the process.

For UNGG fragments, the main issues consisted in defining an adequate, non-reactive cement matrix, as well as an appropriate process for the crushing and densification of the fragments in the waste package, while allowing for an adequate penetration of the liquid cement to ensure encapsulation.

As of today, a specific grabber has been developed and qualified, which crushes graphite sleeves upon recovery inside the silo. Densification and encapsulation have been qualified and provide adequate waste packages.

R&D is continuing regarding the development of a non-reactive encapsulating matrix, with encouraging results so far regarding the ability to reduce the release of hydrogen within the waste package. This R&D is expected to be completed before the summer of 2012.

### **Spent Contaminated Resins**

A small amount of about 10 cubic meters, compatible with existing waste package agreements, has been sent for encapsulation to an existing facility on the site of la Hague. Waste packages have been produced without any difficulty or issue.

Basic design has been completed, and R&D work continues to define the most suitable cement matrix.



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However, the project does not present any significant challenge in terms of R&D, the main issues being related to the adaptation of the design to guarantee the expected production rates.

### **Alpha Contaminated Drums**

As of the end of 2011, 1402 out of a total of 2400 drums have been recovered, conditioned and packaged for final storage.

### **Task Force Initiative**

During the year 2009, while basic design had been completed, a task force initiative was launched, in order to challenge existing scenarios and design, and explore all possible forms of optimization.

In one respect, the initiative confirmed rather than infirmed the relevance and pertinence of the main scenarios. On the other hand, it re-examined in detail all processes and technological choices, as well as the sequence of operations, and brought to light a number of optimizations in processes or scheduling of operations which resulted in a reduction of about 15% of the entire budget, and a gain of 2 to 3 years on the entire time schedule which spans from 2010 until 2030.

### **CONCLUSION**

La Hague Legacy waste retrieval program represents a significant challenge in the sense that it covers a significant variety and quantity of waste needing recovery and re-conditioning, with tight financial objectives and a binding recovery schedule.

During the past five years, AREVA SVD successfully conducted design, research, development, and qualification activities which lead to the definition of qualified processes and waste packages for each retrieval program.

Preparation work and supplier consultations are now on-going, in order to meet our objectives of beginning retrieval operations in compliance with our commitments to the safety authorities, in 2015 and 2016.