

Legacy Waste Retrieval from Cladding Hulls and Fuel Hardware Storage

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ABSTRACT

Waste generated during nuclear fuel shearing and dissolution operations from 1976 to 1998 at the UP2-400 plant at La Hague, has been stored in bulk in a silo and in metal canisters. The waste has to be retrieved and conditioned before the implementation of the shutdown program. This paper gives a general presentation of the project to retrieve and condition this waste stored in the High Activity Oxide (HAO) facility. The topics discussed include a presentation of scenarios and technical solutions as well as a presentation of AREVA NC's approach to meet schedule commitment and to minimize overall project cost.

INTRODUCTION

The fuel reprocessing plant UP2-400 at AREVA's "La Hague" plant was started up in 1966 and was designed to treat used fuel from France's gas-graphite reactors and subsequently LWR fuel. In order to meet growing demand UP2-400 was backed-up in 1994 by the UP2-800 facility. In this new generation of plant (same as UP3 started in 1989), the systematic storage of cladding hulls and fuel hardware in interim storage is no longer in use and facilities have been designed to enable on line conditioning of this waste after treatment operations [1]. Shutdown operations of UP2-400 are now starting and are requiring first to deal with the interim waste storages. The waste generated during early fuel treatment operations and stored in interim storage has to be removed and packaged under the legacy waste Retrieval and Conditioning program (RCD).

Waste issued from nuclear fuel (LWR fuel and fast neutron fuel) shearing and dissolution at the High Activity Oxide (HAO) facility of UP2-400 was stored in bulk in a water-filled silo from 1976 to 1988 and then in metal canisters until 1998. This waste includes fuel structural elements from fuel shearing operations but also technological waste, ion exchange resins used for pool water treatment as well as dissolution fines that were added in the silo over the course of production operations.

The purpose of the HAO waste retrieval and packaging project is to implement technical solutions to retrieve, sort, characterize and package the waste in a form acceptable for final storage. This paper gives a general description of the scenarios and process foreseen for each type

of waste. Some technical issues and technical solutions implemented are also briefly described as well as AREVA NC's approach to meet schedule commitment and to minimize project overall cost.

BACKGROUND

Issues and challenges are numerous for the implementation of the HAO retrieval and packaging project. The overall cost of the project must be optimized; this includes capital and operating costs for the retrieval and packaging facilities, but also the cost of final waste storage. In terms of schedule, the waste retrieval operations in the HAO Silo have to be started in 2010 so as to comply with AREVA NC's schedule commitments to the French safety authorities. Last but not least, the variety of waste stored in the silo is a source of risk for the definition of the process. It will be particularly challenging to separate the waste completely, characterize it and package it into a final form acceptable by ANDRA, the French radwaste management agency.

Tools and overall approaches were developed during design studies to meet the schedule commitment and to control cost. The most important risks were identified early in the project and are constantly revisited through ongoing risk analysis. An action plan has been set up to manage the risks and sometimes involves R&D. In order to reduce costs, emphasis was placed at all times on using existing facilities and equipment and to simplify processes. Future operators and experts in maintenance, waste management, radiation protection and facility operations have been involved to ensure convergence towards the best overall technical solutions while complying with an overall reasonable cost.

Another line of thinking is to share functions among different projects with similar requirements. Within the frame of RCD program at the UP2-400 plant, a project to retrieve waste from Natural Uranium Gas Graphite fuel (NUGG) is also in progress. Ideas are constantly shared between the two projects in order to use identical functions and equipment, to optimize technical solutions and thus to minimize design studies and costs.

WASTE DESCRIPTION

Waste from HAO Silo

Waste canisters were poured in the HAO Silo from 1976 to 1988; thereafter the full canisters were directly stored in pools in the Waste Organized Storage (SOC). The silo is a stainless steel lined concrete pit of 1500m³ capacity. It is filled with water which level covers the entire waste pile. Waste in HAO Silo includes:

- Structural element of nuclear fuels: hulls, end-pieces, springs, grids, etc.
- Shearing and dissolution fines coming from the fuel processing (poured until 1998),
- Resins from the pool water treatment (poured until 1998), and
- Miscellaneous technological and process waste.

The main quantity of hulls originates from BWR and PWR zircaloy made fuel but the silo also includes stainless steel hulls from SENA fuel (27.3tu – tons of uranium) and PHENIX fast neutron reactor fuels (9.7tu). The average dimension of fuel hulls is 35mm.

The technological waste mainly includes aluminum canister covers that were disposed in the silo altogether with hulls and end-pieces when emptying the canister above the silo. It also includes miscellaneous waste from maintenance campaign: pumps, tools, cameras, flexible pipes and electrical cables. The quantity and characteristics of waste are shown in Table I.

Table I. HAO Silo waste quantity and characteristics

HAO Silo	Quantity	Activity
Hulls	700 t	123 TBq per tons of hulls and end fittings
End fittings	92 t	
Inactive Hulls from mock-up fuel	7 t	
Shearing fines	6 t	129 TBq / t
Dissolution fines	4 t	216 TBq / t
Resins	38 t	54 TBq / t
Canister covers	30 t (5,000 pieces)	
Miscellaneous process waste	10 m ³	

Waste in Metal Canisters from the Organized Storage (SOC)

After 1988 waste canisters were directly stored in the SOC pools. Those stainless steel canisters contain hulls, end pieces and other fuel structural elements (grids, springs, etc.). Hulls and end-pieces are stored in different canisters. Stainless steel hulls are also stored in the SOC storage. They originate from SENA fuel treatment (UOX and MOX). Once emptied, the canisters and its covers will be treated as technological waste. The quantity and characteristics of waste are shown in Table II.

Table II. SOC storage waste quantity and characteristics

SOC Storage		Quantity	
Pool S1	Fuel hulls	660 t	
	Shearing fines	4 t	
	Metal canisters with covers	486 t	5,000 pieces
	Head covers	30 t	5,000 pieces
Pool S2, S3	End-fittings	75 t	10,000 pieces
	Metal canisters with covers	122 t	1,200 pieces
	Head covers	4 t	700 pieces

The $\beta\gamma$ activity for fuel hulls and end-fittings is 160 TBq per ton of hulls and end-fittings.

Liquid Waste

The amount of liquid waste generated during the retrieval operation is estimated at 1,100m³/year. Some of the water used for rinsing the waste will come from the supernatant in the silo and will be redirected toward the silo after the rinsing operation, thus minimizing the amount of liquid waste generated.

The amount and characteristics of liquid waste generated by the decontamination operation is not known yet as decontamination process is still under definition.

WASTE OUTLETS

Emphasis was placed at all times on using existing facilities at La Hague site. The waste will be sorted, washed and characterized in order to be accepted in one of the existing waste processing facility. However the package specification may have to be adapted in some cases in order to have the final form accepted in the existing outlets. The main operations and the waste outlets are shown in Figure 1.

The HAO facility is located next to the R1 fuel shearing and dissolution facility which produces the same types of structural waste as those to be retrieved from HAO waste storage. Existing functions will be reproduced: transfer of the shuttle drum, non-contamination monitoring, drum decontamination and transfer to the hull compaction facility at the tail end. It is planned to build a tunnel to connect the facilities as well as buffer storage in the available rooms of the R1 facility.

The existing facilities that will be used to process the waste include:

- ACC facility (Hulls Compaction Facility) for compaction of fuel structural elements,
- AD2 facility (Waste Conditioning Plant) for packaging of technological waste,
- ACR facility (Resins Conditioning Plant) for cementation of resins and fines, and
- CENTRACO facility for melting of metallic technological waste.

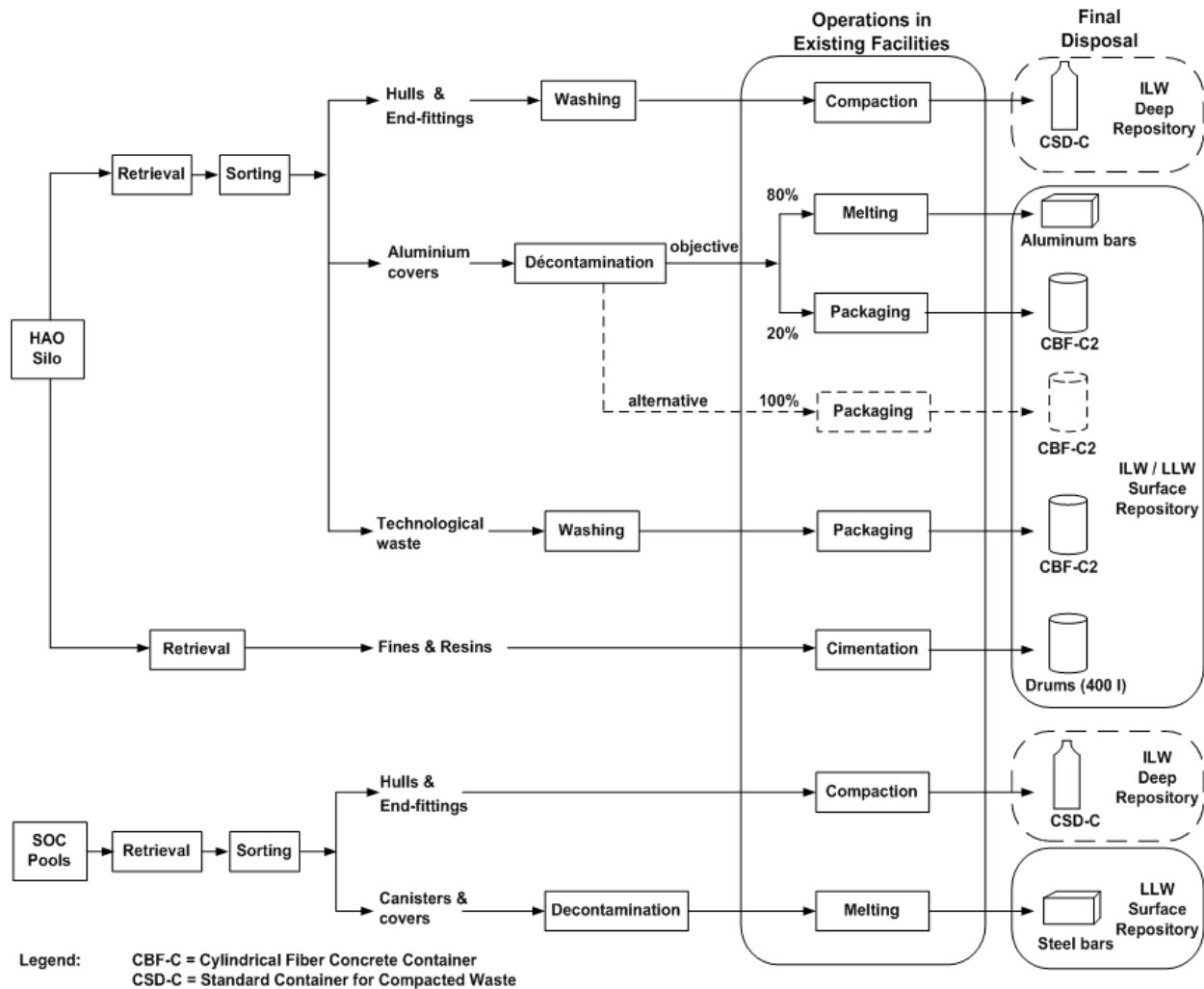


Fig. 1 – HAO Silo and SOC storage waste management

RETRIEVAL PLANNING

The planning for HAO Silo waste retrieval and treatment includes 4 industrial phases. The objective is to retrieve all the silo content, to treat and package all waste in several steps depending on the level of knowledge on process to be implemented and depending on the results of R&D qualifications.

Phase 1: Solid Waste Retrieval with Help of Grapple

Phase 1 relates to the retrieval of solid waste with a grapple and to the treatment of those waste. Retrieval and sorting operations will take place in a hot cell to be built on top of the silo. The waste will be extracted with a grapple that will be plunged in the silo through one single opening in the middle of the cell. The movement of the grapple being only vertical, a gathering system installed in the silo will bring the waste underneath the opening.

Once grabbed, the waste is rinsed in the silo in order to remove the resins and the fines from the solid waste. The grapple is then lifted in the cell and the waste is poured on a table. Waste is visually sorted to separate the hulls and end-fittings from the technological waste and to remove and cut the elements that have lengths that cannot be accepted on the next process in ACC plant. A spectrometric gamma measurement is carried out on the table to characterize the waste. The hulls and end-fittings are then evacuated in a shuttle drum to an intermediate storage in the adjacent facility. The technological waste is eventually fragmented in the cell before being sent to the adjacent decontamination cell.

The facility, equipment and tools for this phase are at detail design stage and the first purchase orders have been placed. The active commissioning is forecasted at the end of 2010.

Phase 2: Fines and Resins Retrieval and Processing

During phase 2, the fines and resins will be retrieved and processed. These operations will be implemented after the solid waste retrieval operations. Large fines over 1mm will follow the same process as hulls and end-fittings whereas resins and small fines will be pumped and transferred toward a cementation facility. The silo water level that remained constant during the solid waste retrieval will start to be lowered. The water will be progressively pumped out of the silo and transferred to the liquid waste treatment facility. Several scenarios are being investigated and R&D activities are on-going to define tools to separate resins from the fines.

Phase 3: Silo Bottom Cleaning

The retrieval operation with the grapple and gathering system will be stopped when they reach the bottom of the silo and are not efficient anymore to retrieve the remaining waste. At the end of this phase 1, we expect that 80% of the solid waste will have been retrieved with the grapple and the gathering system. Then special tools will have to be developed to retrieve the remaining 20%. A remotely-operated mobile equipment (robot type equipment) coupled with a pumping system will be introduced in the silo to finish retrieval and cleaning operations. Several scenarios are being investigated and R&D activities are ongoing to define the tools. The final treatment and decontamination of the silo walls and bottom are also being investigated.

The expected durations of those phases may vary and will mostly depend on the efficiency of the retrieval systems.

SOC Waste Retrieval and Conditioning

The waste from the SOC storage will be processed in the same hot cell and the same way as HAO waste. The metal canisters from the SOC storage will be transferred inside the hot cell and poured on the table. Waste will be visually sorted to remove and cut the elements that have lengths that cannot be accepted on the next process in ACC plant. A spectrometric gamma measurement will be carried out on the table to characterize the waste. The hulls and end-fittings will then be evacuated in a shuttle drum to an intermediate storage in the adjacent facility. Metal canisters and covers are processed as technological waste. They will be rinsed in the hot cell before being sent to the adjacent decontamination cell.

The water contained in the canister will be either sent in the silo for future treatment or directed to a buffer tank if the liquid waste process has been defined at the time of SOC waste processing. Processing of waste from the SOC storage is forecasted to start at the end of phase 1 (that is when all solid waste from the silo has been retrieved with the grapple and gathering system). However the SOC waste processing could take place alternatively with phase 1 as practically no modification of the hot cell is required to process the waste from the SOC storage.

PROCESS DESCRIPTION

Waste Retrieval from the Silo

The grapple to extract solid waste plunges in the silo through one single opening in the middle of the cell. The movement of the grapple being only vertical, a gathering system installed in the silo will bring the waste underneath the opening. Sonar will also be installed in order to visualize the shape of the silo pile.

The gathering system is a square scraper that is moved on top of the solid waste pile to push the waste toward the center of the silo. It will be moved by cables and 4 motorized winches installed on top of each silo corners. The motorized winches are controlled and synchronized by a control module that calculates and controls the scraper position and trajectory depending on the cables length. This system has been tested on a half size mock-up of the silo and tests have been performed with success.

Another technical issue lies in dealing with waste contaminated with fines and resins. Waste contamination with fines and resins has a strong impact on the nuclear measurement used to characterize the waste and the final packages. Contamination influences measurement signals and increases uncertainty margins. This could lead to calculation of remaining fissile material to above the acceptable limit. In addition, the contamination of waste with resins is not compatible with the final package definition in which the amount of organic product is restricted. Consequently, waste washing is being investigated and tests are being performed to wash the waste in the cell or even directly in the grapple.

Sorting and Treatment

The hot cell will be built on top of the silo, in the existing hall. The equipment previously used to fill the silo will be dismantled to allow the construction of the cell. All process and maintenance operations will be performed with the use of shielded windows and master-slave manipulators without necessity to introduce personnel. The hot cell on top of the silo is illustrated in Figure 2.

The layout of the hot cell is first designed for the process operations of phase 1 and SOC waste processing (solid waste retrieval and treatment) but conservative design measures are foreseen to allow the implementation of the process for the following phases (phase 2 and 3) with the minimum amount of modifications.

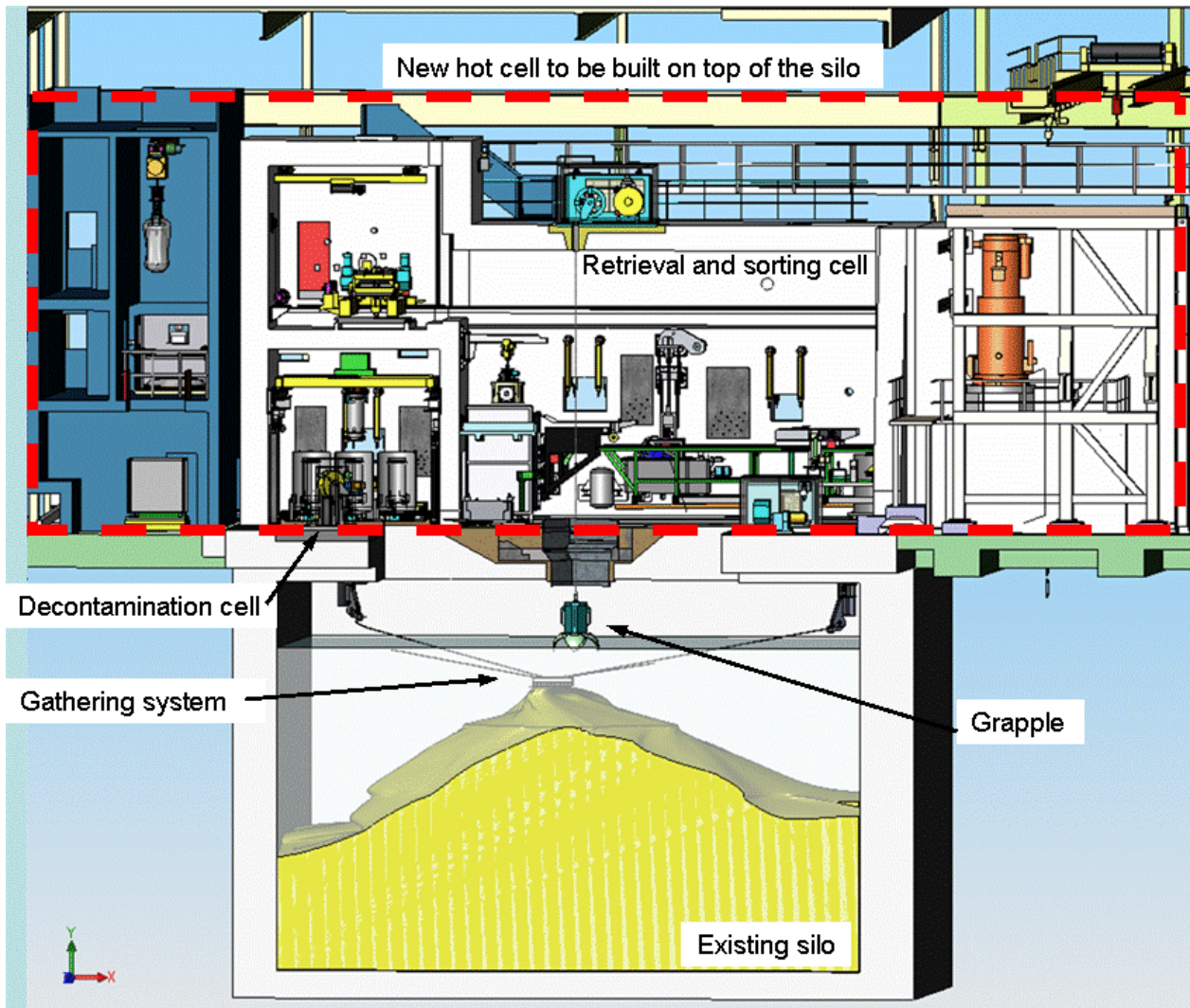


Fig. 2 – HAO hot cell for waste sorting and treatment

CONCLUSION

The detail design studies for phase 1 are now in progress and the first purchase orders have been placed. Civil work construction is expected to begin in November 2007. To this date, the approaches to optimize technical solutions and minimize cost have been successful. All the scenarios meet AREVA NC's objectives for retrieving the waste and reducing costs. The actual definition of buildings, equipment and process resulted in an overall project cost that was within the budget that AREVA NC set 10 years ago. Efforts are being maintained to optimize solutions and cost but above all to achieve active commissioning by the end of 2010 so as to comply with the commitments to the French safety authorities.

REFERENCES

[1] F. Drain, V. Londres, J.C. Dumont, G. Neliaz, "Management of solid waste in nuclear fuel cycle: COGEMA's answer", European Nuclear Congress, 2002.