Treatment of Uranium and Plutonium Solutions Generated in the Atalante Facility, France - 12004

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ABSTRACT

The Atalante complex operated by the French Alternative Energies and Atomic Energy Commission (CEA) at the Rhone Valley Research Center consolidates research programs on actinide chemistry, especially separation chemistry, processing for recycling spent fuel, and fabrication of actinide targets for innovative concepts in future nuclear systems.

The design of future systems (Generation IV reactors, material recycling) will increase the uranium and plutonium flows in the facility, making it important to anticipate the stepped-up activity and provide Atalante with equipment dedicated to processing these solutions to obtain a mixed uranium-plutonium oxide that will be stored pending reuse. Ongoing studies for integral recycling of the actinides have highlighted the need for reserving equipment to produce actinides mixed oxide powder and also minor actinides bearing oxide for R&D purpose.

To meet this double objective a new shielded line should be built in the facility and should be operational 6 years after go decision. The main functions of the new unit would be to receive, concentrate and store solutions, purify them, ensure group conversion of actinides and conversion of excess uranium. This new unit will be constructed in a completely refurbished building devoted to subcritical and safe geometry of the process equipments.

THE ATALANTE COMPLEX

The Atalante project [1] was undertaken by the CEA in 1980 with the objective of consolidating on a single site all the research facilities necessary to investigate the back end of the fuel cycle: nuclear fuel recycling, ultimate waste management, new concepts for future nuclear systems. It was designed as a modular, upgradable facility, and the project was implemented in two major stages: Atalante 1, hot commissioned progressively from 1992 to 2000, and Atalante 2, from 2000 to 2003.

Atalante includes 220 engineers, researchers and technicians, and an operating staff of about 60 persons, with access to 19 000 m^2 of equipment and resources:

- seventeen laboratories with radiochemistry equipment in glove boxes,
- seven shielded lines comprising fifty-nine work stations with master slave manipulators,
- three shielded cells for treatment of solid and aqueous waste,
- an organic liquid waste treatment unit,
- a waste drum radioactivity measuring station.

The ongoing programs address the following three areas of investigation: scientific support for industrial recycling of spent fuel, high-level long-lived waste management [2] (in compliance with French legislation in 1991 and 2006), and fuel cycle research for future systems [3] (GEN IV International Forum, COEX™, GANEX™, etc.).

PROCESS CONSIDERED FOR SOLUTION TREATMENT

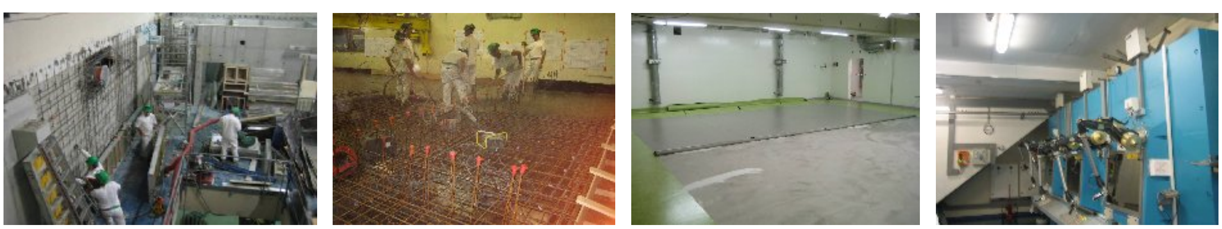
The plutonium and uranium solutions come mainly from the Atalante shielded lines where they were submitted to an initial purification cycle (PUREX process). In addition to U and Pu, these solutions also contain trace amounts of fission products and Minor Actinides (MA) except neptunium, virtually all of which is still in solution. The solutions are transferred to a buffer storage unit for concentration by evaporation prior to treatment. The resulting concentrates are transferred to the separation unit for partitioning of U/Pu and purification of the uranium and plutonium by extraction chromatography [4−7], a technique adopted for its ease of use.

The quantities of uranium treated in this way are much larger than for plutonium, hence the decision to install a dedicated uranium conversion line to produce U_3O_8 powder destined for the nuclear material interim storage unit. The purified plutonium is used to prepare mixed oxides (U, Pu, MA)O_2 and (U,Pu)O_2 for transfer to the Atalante shielded lines (R&D program) or to the material storage units.

A SAFE GEOMETRY EQUIPMENTS BUILDING FULLY REFURBISHED

The project started in 2002, needed 4 years of civil engineering works and 60 000 hours of manpower. Works (Figure 1) impacted an area of 2400 m^2 in the facility and 90 rooms. At the end, 600 m^2 for future laboratories were created in the Safe Geometry's Equipments Laboratories (LEGS) building.

The main phases in the construction were first of all the preliminary works for dismantling and deconstruction, the cocooning of a whole shielded line, then the reinforcement phase with wiring of reinforcing bars, slabs and walls bracing and casting, and finally ventilation, utilities and electoral power supply.

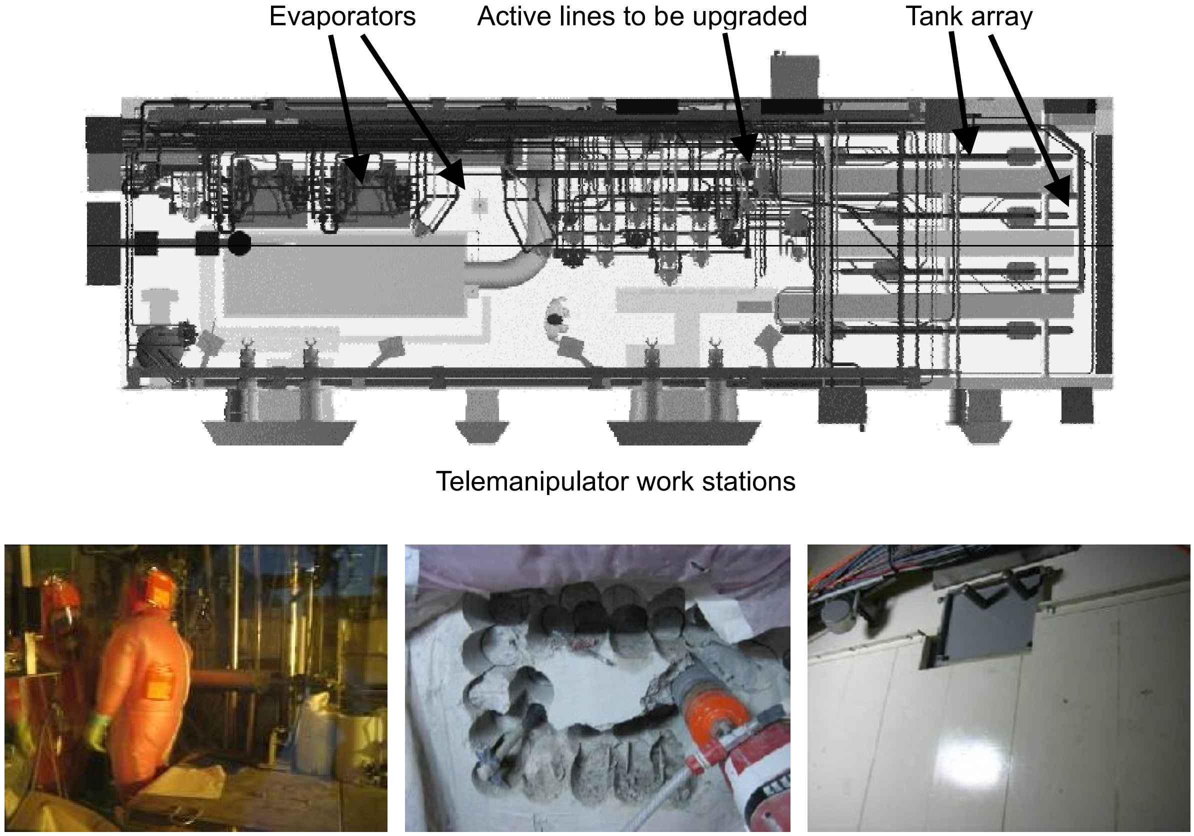


(Fig. 1) Some views of the refurbishment of the LEGS building

RENOVATION OF THE BUFFER STORAGE CELL

This safe geometry cell includes two evaporators, one in operation and the other on standby. The feed solutions to be concentrated by evaporation are collected in a large-capacity tank; two other tanks receive the concentrates. The distillate receiving tank is connected to the Atalante effluent discharge line via a tank with conventional geometry. Nonconforming distillates and concentrates can also be recycled in a dedicated tank if necessary.

After enhanced rinsing to allow hands-on operation around the process equipment, the refurbishing program for the coming years will entail modifying some 200 active lines inside the cell, upgrading the biological shielding protecting the operators, and installing a completely redesigned instrumentation and control system. On completion of the work the interim storage capacity in the cell will be doubled.



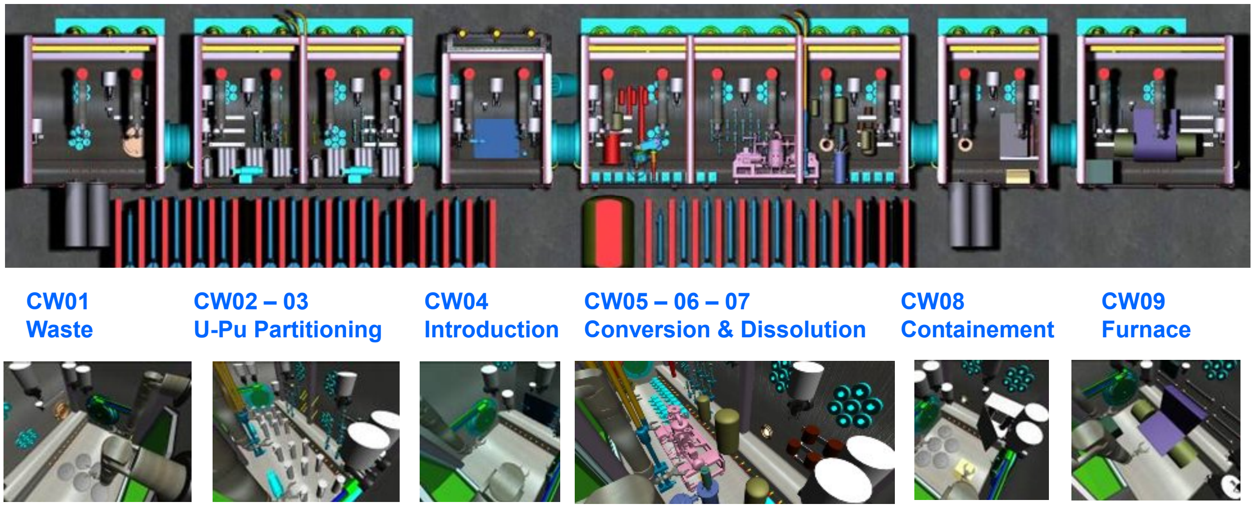
(Fig. 2) Model top view and works on buffer storage cell

Preliminary works have started since the two last years, including shielding concrete plug grouting for high activity solutions transfers and new biological protections due to higher source terms.

A DEDICATED NEW SHIELDED LINE

The choice of the appropriate treatment will establish the final go/no go decision for this last step. In the current studies, this project would be implemented in two 170 m^2 zones on levels: −5.10 m and +0.00 m of the LEGS building. The process would use the resources of the cell to be refurbished (Figure 2), an entire shielded line about 19 m long (Figure 3), and a complete laboratory comprising glove boxes for the uranium conversion steps, reagent preparation, and certain analyses. The process equipment layout was substantiated by a seismic analysis under static and dynamic conditions (degree 7 on the Medvedev-Sponheuer-Karnik MSK scale).

This new shielded line would be divided in nine working stations, including disposal of waste drums, partitioning process by extraction chromatography, conversion and dissolution units. This unit would be operated with new type of master-slave manipulators that can provide good maneuverability.



(Fig. 3) Scheme of the future shielded line

PROJECT MILESTONES AND MAIN ISSUES

The CEA as contracting authority for the project has subdivided it into three lots: the reinforcement of the LEGS building achieved by 2010, the renovation of the storage cell, and the construction of the shielded line and glove boxes laboratory, 6 years after a go decision. Final acceptance of the renovation of the storage cell and transfer to the operator are scheduled for the end of 2015. The feasibility study and complete specification for the rest of the process will be deliverable at the end of 2012.

The actions required to overcome the former and expected difficulties are:

- a general project's risk assessment including dedicated cost and delays killing actions,
- an exhaustive and independent technical supervision to guarantee safety assessment,
- a 3D computer-aided design to check the construction and the future dismantling of the shielded line and laboratory in some narrow rooms,
- since the early stage of the project and for 2 years, a working group involving 15 CEA's experts in the fields of partitioning, dissolution, filtration and conversion

CONCLUSION

The project to carry out treatment of uranium and plutonium solutions generated in the Atalante facility requires that all the equipment for a process still under development be specified well in advance of the installation. This difficulty can be overcome by efficient organization of the project team including project engineers and researchers, each subject to specific constraints (the milestones of the research programs must be compatible with the construction milestones). The CEA organization is capable of implementing programs of this complexity.

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