GESTIÓN DE RESIDUOS

MAJOR MAINTENANCE OPERATION IN HOT CELL FUEL SOLVING UNIT – LA HAGUE PROCESSING PLANT

MARÍA RINCÓN
ORANO PROJECTS

CATHERINE VEYER
ORANO PROJECTS

PHILIPPE MORIN
ORANO PROJECTS

La Hague R1 reprocessing plant started commercial operation in 1994. In October 2018, after 24 years operation, signs of failure were observed on several buckets of the equipment identified as "dissolution wheel". A trade-off assessment to compare between repairing or replacing concluded that it was better to perform the replacement of the wheel by using the spare one (available since the start of the plant). The project was executed ahead of time. This paper discusses the key of the success: the capabilities and synergies of the teams involved, the provisions made during design and the use of modern technologies.

INTRODUCTION

Nuclear industry experience long life cycles. It might be difficult to maintain and transfer knowledge across different generations. Orano has managed to keep the know-how on both operations and engineering groups. This paper describes a recent example when a team of nearly 100 engineers and operators from several Business Units within Orano worked with the supply chain to design and execute a maintenance operation in the R1 unit.

La Hague "R1" is the front-end unit of the UP2-800 reprocessing plant, designed to process up to 800 T of standard PWR and BWR fuels with different degrees of burn-ups.The first step of reprocessing consists in shearing the fuel bundle to solve the fuel in concentrated nitric acid. To reach industrial throughputs, the dissolver was designed for continuous operation. It has a rotating bucket carrier (dissolver wheel). The lower half of the wheel is immersed in the acid contained in a tank (Figure 2). The fuel will solve and stay in the liquid that will be further processed while the bundles are carried away by the buckets of the wheel.

As per the initial design, the dissolver tank is made of zirconium to resist corrosion by nitric acid whilst the wheel is made of stainless steels and is thus subject to corrosion. Both equipments as well as the entire cell are regularly inspected during scheduled maintenance operations.

MAIN CONSTRAINTS

Given the presence of waste fuel, the dissolution cell is one of the most irradiating zones of the facility (~1 Gy/h).; hence, the replacement operation had to be performed remotely. This is not a minor issue considering that the wheel is 3.92 m in diameter and weighs 3.7 T.

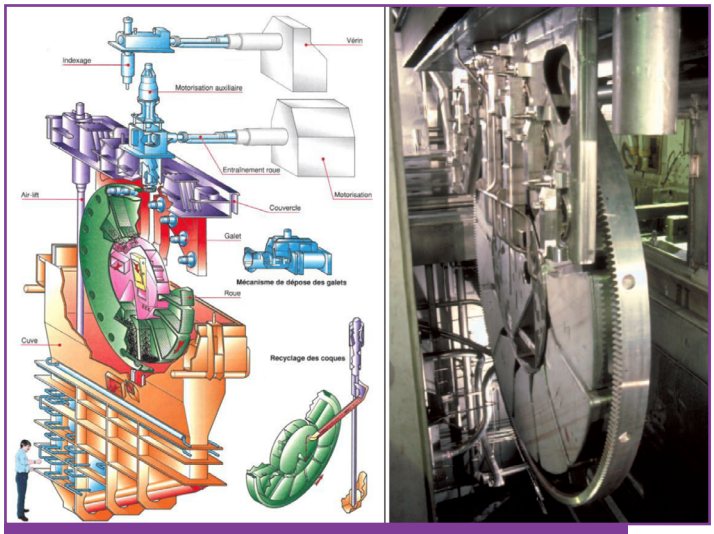

Figure 1. Left: Solving Wheel (in green), solving tank (orange) and associated equipment. Right: picture of the actual equipment [1].

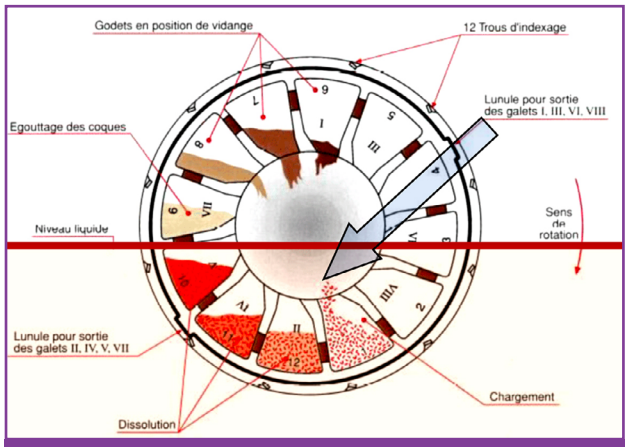

Figure 2. Operating principle; red arrow indicates the feed location, the red line is the liquid level. The fuel after being in contact with the acid stays in solution. The cask will drop when the bucket is located on top of the wheel (upside down).

KEY ELEMENTS OF SUCCESS

There are three key elements of success: 1/ the collaboration highly skilled teams, 2/ design's provisions that were included and 3/ the use of modern technologies to assess potential differences, validate the procedures and train the operational team.

Collaborating Teams

Teams include key stakeholders from within Orano organization and the Supply Chain.

Management: The decision to go ahead with the wheel replacing option arrived early in the project. The sponsors decided to execute the project in Fast track. A Project director was appointed to manage two project managers: one for the Operations group and the other for the Project group.

The communication plan included diverse stakeholders like unions, journalists and safety regulators. It was important to reassure stakeholders that the decision was made while the teams were still working on the yearly maintenance shut-down and that the impact on production would be minimal.

Operations & Maintenance teams focused on the remote handling operations and providing enough information to help the project team to design the tools needed to complete the operation. Technologies like laser scanning were used (paragraph §3.3) to determine the exact dimensions of equipment and facilities, as well as the inventory and location of existing equipment in the hot cells.

Projects: Completed the required design review of the existent and designed the equipment and tools. It is important to notice that the Projects teams are located close to the operating facilities. They represent the legacy of the engineering group that designed and commissioned La Hague. Currently they execute yearly projects to maintain operations budgeted to nearly M200€ and are continuously communicating with operations.

Supply Chain: There is a cluster of suppliers whose main work is done for La Hague. As an example, there are companies like ACE ("chariot de chargement"), ACPP ("Charriot de manutention) and TEMIS (robot in Figure 3 b). Their manufacturing work is a key element of success for Operations and Projects. They were engages since early stages in the projects.

Design's provisions

"Start with the end in mind"; F. Covey

Almost 30 years ago, the Engineering company in charge of designing the facilities chose the material for the wheel to be steel instead of zirconium. The Engineering knew that the corrosion will require the wheel to be replaced in the future. Therefore, they: fabricated a spare wheel, designed the required tools and allocate provisions to maintain and access the equipment.

The replacement operation was tested and validated during the startup of the operations 25 years ago in T1, a twin facility. The Engineering group trusted both facilities were the same.

However, since then, the route for introducing and removing the wheel has been simplified mostly due to the absence of contamination and to reduce the risk of mishandling. For this reason, the first steps during the development of the operation helped to verify the as-built matches the existent layout. As a result, the project team found that the current accessibility allowance was much tighter with, in some instances, a mere 3-cm gap.

New Tools and Techniques

All the required tooling for the introduction, supporting, and evacuation of the wheel had been studied and built for the T1 test. Based on this favorable result, no test or tools had been made for R1. However, some differences exist between the two units therefore, new tools and equipment had to be fabricated. This difference also imposed the necessity to remove completely the dissolver cover (in blue Figure 3.a), which is normally left during maintenance operations, to prevent any risk of collision during the exchange operation.

New Equipment and Tools

The major equipment designed and built for the operation included:

- A wheel's **Exchange Cart** made in two parts and assembled in-cell (Figure 3 a).
- A wheel's **Transfer Cart** and a **mock up wheel** for replacement tests (Figure 3 d).
- A wheel's **Tilting Tool** (Figure c).
- Tools for handling and removing the dissolver cover.

New Techniques

The operation mobilized a series of modern techniques:

- Remotely operated 3D laser-scan of all the areas along the way to introduce the equipment into the cell.
- 3D models of the facility integrating the information from the laser scan and the newly designed tools and equipment.
- Virtual Reality (VR) was used to validate the replacement scenarios from the mechanical point of view as well as training the operators (Figure 4 a).
- Programmable robotic arm (Figure 4 b) designed to remove the bearings

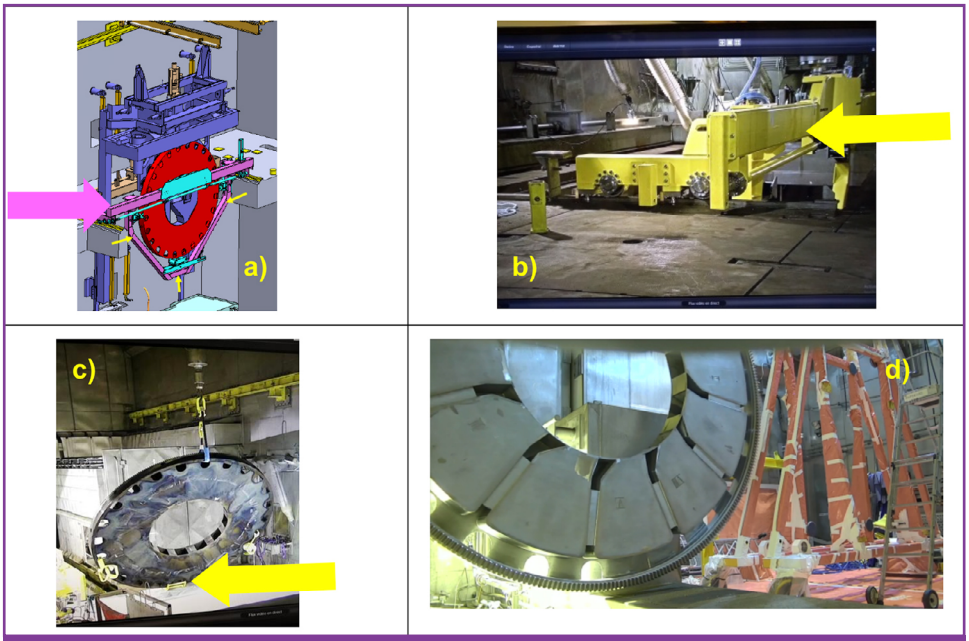

Figure 3. The various tools used to handle the wheels
a) Exchange cart (in pink). b) the WEC in yellow. c) Tilting tool (WTT) for the old wheel. d) Transfert Cart WTC – New Techniques.

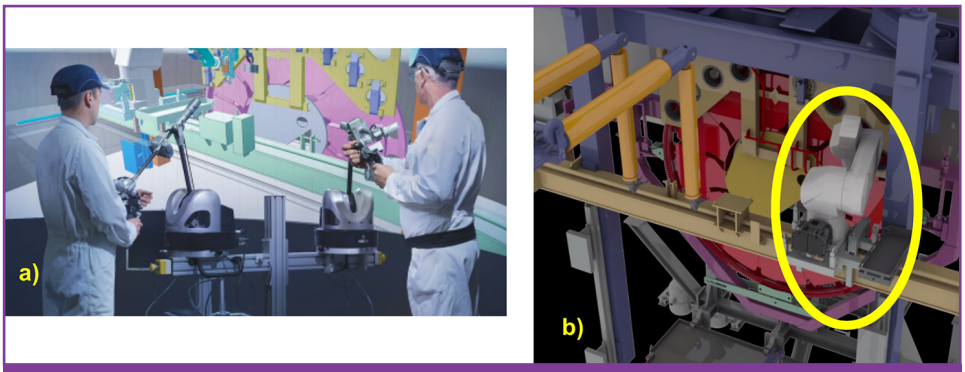

Figure 4. a) Operator training to the remote operations using VR; b) New robotic arm.

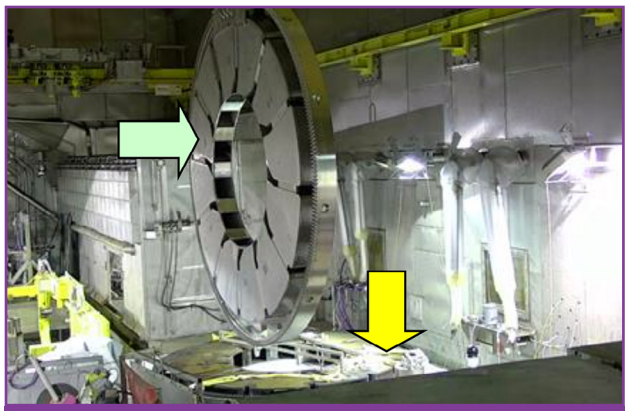

Figure 5. The used wheel (on the floor, see yellow arrow) and the new wheel (vertical, see green arrow) crossed paths during the exchange operation.

REPLACEMENT EXECUTION

After designing and validating the operation in VR simulations, the various tools were built on a fast-track mode by the various suppliers. The tools were tested and the operation rehearsed with the mock up wheel.

At first, the dissolver cover was removed using the in-cell crane and transferred to a specific support in the General Maintenance Cell (GMC) above the dissolution cell.

The Exchange Cart was assembled, introduced into the GMC, and placed on the rails designed for this operation (in pink- Figure 3 a). The Cart was positioned below the used wheel in order to receive the wheel when dismounted. The bearings were removed using the programmable robotic arm (in white - Figure 4 b).The wheel was retrieved using the existing crane (operating in Figure 5) and tilted to a horizontal position using the Tilting Tool which, like the Transfert Cart, was an addition to the existing provisions forecasted for the test of the T1 unit.

The new wheel was introduced into the GMC following the itinerary and the operations that had been defined in the scenario, and then positioned on the Exchange Cart. The wheel was brought to position, the bearings were put back in and rotation was tested. The wheel with its cover was lowered into the dissolver successfully and the unit was then ready for operation.

The used wheel was dismantled and evacuated and the entire cell configuration restored for operation.

CONCLUSIONS

La Hague reprocessing plants have been designed and built with the objective of ensuring continued performance during the whole life of the facility. Specific emphasis has been placed during the design on enabling all forecasted maintenance operations according to the expected life of equipment, including equipment exchange. [3] The provisions included in the initial design almost 30 years ago (modular equipment design, in-cell handling tools, a spare wheel, crane, robotic arm, manipulators) were complemented by new tools designed and tested with a 3D model (updated via laser scan) and fabricated by a La Hague's cluster of suppliers in an agile mode.

Other key activities included the verification by trained operators of the whole scenario both in VR and in inactive conditions with a mock up wheel fabricated for the purpose.

One of the indicators of this success, other than the fact that the operation was completed in a record time, one month ahead schedule, while respecting strict dosimetry conditions and avoiding any heavy and lengthy modification to the facility, is given by the plant owner who is currently preparing to exchange the wheel of the twin unit "T1".

ACKNOWLEDGMENTS

This exceptional operation has only been possible thanks to the dedication of, and collaboration between, all Orano teams: Orano Cycle, the plant owner and operator, Orano Projects, the engineering team, the "HRB" development hall, Orano Temis, designer of the robotic arm, Orano Dismantling Services, together with all the suppliers: ACE, ACPP, AH Technometal, GM Technologie, MAINCO, Nuvia Process, Réel, Selca, who all contributed to this success by their dedication, creativity and expertise.

REFERENCES

[1]. Picture from «La prise en compte du credit burnup dans les études de criticité » ; IRSN Rapport scientifique et technique, 2005

[2]. CEA e-DEN Monograph, Treatment and recycling of spent nuclear fuel – Actinide partitioning – Application to waste management – Editions du Moniteur, Paris, France, 2008

[3]. C. BERNARD, F. CHENEVIER, *UP3 design concepts: maintenance in a commercial reprocessing facility*. Proc. ANS International Meeting on Fuel Reprocessing and Waste Management, Jackson Hole (USA), Aug. 25-29, 1984.

[4]. F. GEFFARD, Ph. GARREC, G. PIOLAIN, M.-A. BRUDIEU, J.-F. THRO, A. COUDRAY, E. LELANN, TAO 2000 V2 computer-assisted force feedback telemanipulators used as maintenance and production tools at the AREVA NC-La Hague recycling plant. J. of Field Robotics, Wiley, 2012, 29, pp 161-174. ■