Control and maintenance of the Superphenix knowledge and its specific sodium skills through an innovative partnership between EDF and AREVA

Thomas CALAIS[a*], Jean-Claude RAUBER[b]

[a]*AREVA NP, 10, rue Juliette Récamier, 69006 Lyon, France*

[b]*EDF DP2D, 154 avenue Thiers, 69009 Lyon, France*

**corresponding author: thomas.calais@areva.com*

Keywords: decommissioning, Superphenix, sodium, partnership, alliancing.

1) Background

Superphenix is a 1200 MWe sodium cooled Fast Breeder Reactor (FBR) located in Creys-Malville (France). Its grid coupling occurred in 1986 and its final shutdown pronounced through a decree, 12 years later, in 1998.

Figure 1: General view of Superphenix nuclear plant (EDF)

This Superphenix final shutdown decision marked a new stage in the life of the nuclear plant. Decommissioning activities were highly challenging due to the following:

- Non recurrent and first-of-a-kind (FOAK) characteristics
- Environment constraints: radiation level, high temperatures, presence of argon, sodium, NaK, soda, hydrogen, etc.
- Complexity of the primary vessel internal structures
- Numerous interfaces to manage

- Numerous technical uncertainties due to the difficulty in anticipating the effective state of components (sodium and aerosols retentions, tritium concentration, NaK alteration, etc.)

2) Approach

At the end of 1998, exchanges took place between EDF as « Superphenix nuclear operator » and AREVA as « Superphenix Nuclear Steam System Supply (NSSS) designer » in order to find the best way to meet the new challenge of decommissioning Superphenix. A key ingredient to achieving success was to ensure that existing local and specific sodium skills were controlled and maintained.

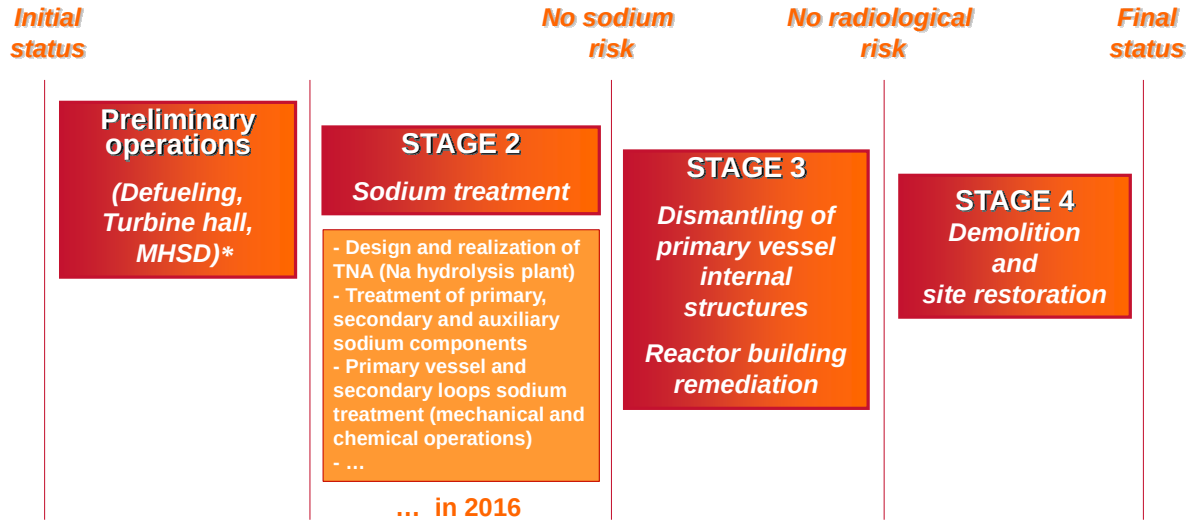
AREVA was selected by EDF as its industrial partner for the sodium activities on this project being entrusted with the following missions:

- Maintaining and adapting a strong EDF / AREVA partnership within the project duration
- Supplying support as the « NSSS Designer »
- Rolling-out multidisciplinary skills from the design to the on-site operations
- Relying on its best technical experts to solve each technical challenge
- Developing and adapting durable specific skills of its technical team (sodium, mechanical, process, I&C, statutory, etc.) following each stage of the decommissioning

3) Development of the Works

This EDF / AREVA partnership on the sodium activities has taken different forms according to the different stages of the project.

From 1998 to 2005, AREVA was involved in strategic and feasibility studies on various technical subjects. EDF identified these subjects and AREVA was entrusted with the preliminary studies relying on a dedicated engineering team located in its Lyon office. An initial dismantling plan was drawn up on the basis of these studies results.



*MHSD = Decommissioning

Figure 2: *Superphenix decommissioning schedule in 4 stages*

From 2006 to 2012, the partnership consisted of a common structure, combining skills from both parties into an integrated team located in the EDF offices in Lyon. This team conducted the high level strategic engineering studies and managed the support workforce, while relying on the technical skills of specialists. The purpose of this organization was to efficiently develop the general decommissioning strategy and the main technical guidelines which would be adopted during these seven years.

At the same time, in 2009, volume of field work exceeded the one of engineering activities due to the physical progress of the project. The center of gravity of these activities shifted from Lyon to Creys-Malville, where the nuclear plant is located. Then, the partnership was complemented with an integrated team office located on plant site from 2009 to 2014. This team followed up operations studies and associated operations and managed technical and operational exchanges between the on-site EDF and AREVA teams. The development plan for primary sodium draining is an example of the integrated team outpost coordination activities.

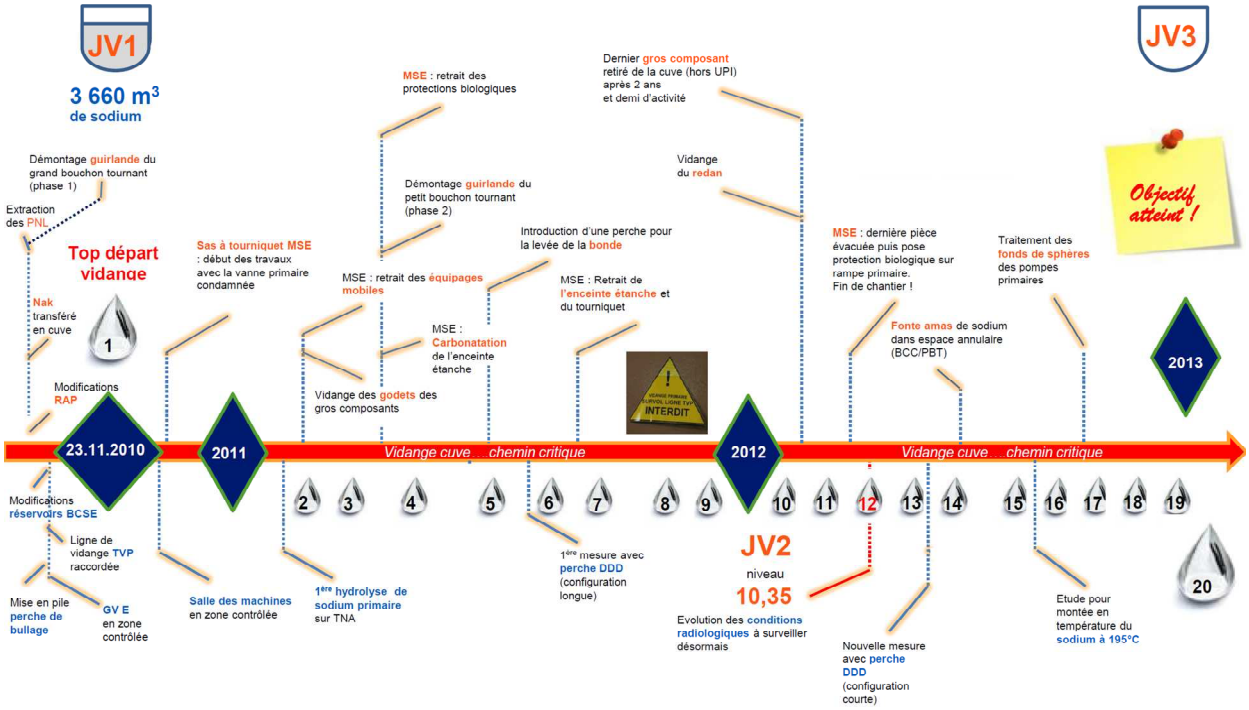


Figure 3: Convergence plan for primary sodium draining

The success of this partnership can be illustrated at each stage of the project; a number of technical challenges were addressed while maintaining the project deadlines.

This includes, for example:

- TNA sodium hydrolysis plant from design to the start of operations
- Primary vessel internal structures drilling
- Four secondary loops sodium carbonation
- Gas transfer lock dismantling
- Eighteen large components sodium carbonation

- Primary vessel main and complementary sodium draining
- Laser cuttings of several primary vessel internal sodium retentions as LIPOSO, primary pump skirt, primary vessel penetrations, …

Figure 4: Primary pump transfer to MDG workshop for dismantling after its sodium carbonation

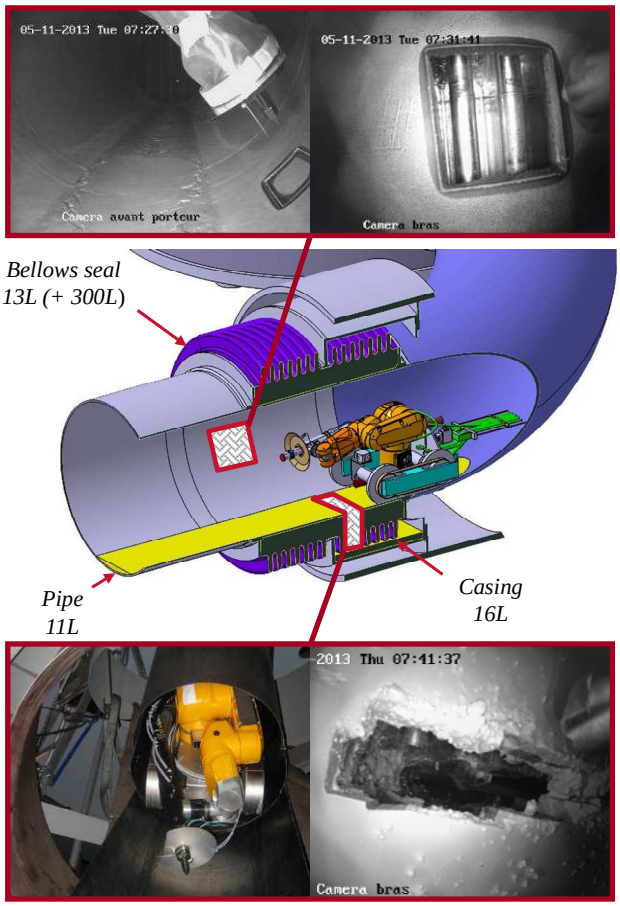


Figure 5: Laser cutting of the LIPOSO primary vessel internal structures with the « CHARLI » ROV

However, it was also necessary to tighten budget control as the field activities were ramping up, while keeping in mind, and coping with, the high level of uncertainties of such project, which is quite unusual in traditional reactors dismantling activities.

Thus, from the end of 2012, EDF and AREVA jointly developed and adapted specific contractual rules for this project in order to:

- Adopt “virtuous” contractual measures (Win/Win),
- encourage both parties to reduce costs and delivery time,
- work in total technical and financial transparency,
- limit contractual conflicts,
- allow a quick and open negotiation on all technical issues occurring during the project (in a partnership spirit).

This « alliance » contractual model is now based on a « Target State » achievement for a « Target Amount ». The « Target State » matches the end of the sodium activities on site. The « Target Amount » is composed of:

- A target price without risks,
- a risks amount based on a risk-analysis approach shared by EDF and AREVA for each work order,
- a budget envelope covering technical scope variation needed to reach the « Target State ».

Such contractual mechanism encouraged EDF and AREVA to find optimization of funding allocations thus resulting in simplified technical solutions when possible in order to set more funds aside to cover contingencies. This contractual mechanism fosters a better and easier control on the final project cost.

These contractual arrangements include the financial incentives on:

- The labour cost of each work order,
- subcontracting cost of each work order,
- effective labour cost risks of each work order,
- project milestones and
- final project cost.

Finally, EDF has committed to share the potential savings on this project with AREVA in the form of adjustment activities. This last contractual mechanism is essential because it ensures a stable workload enabling the contractor to mobilize and manage specific skills in the best possible way until the end of the project.

4) Main results

Thanks to this strong partnership around the sodium activities, the Superphenix decommissioning project deadlines were met and the budget kept well under control from the beginning of the primary vessel sodium draining in November 2010 until today (i.e. 4,5 years), in spite of all the numerous issues and difficulties encountered which is quite unusual on decommissioning activities.

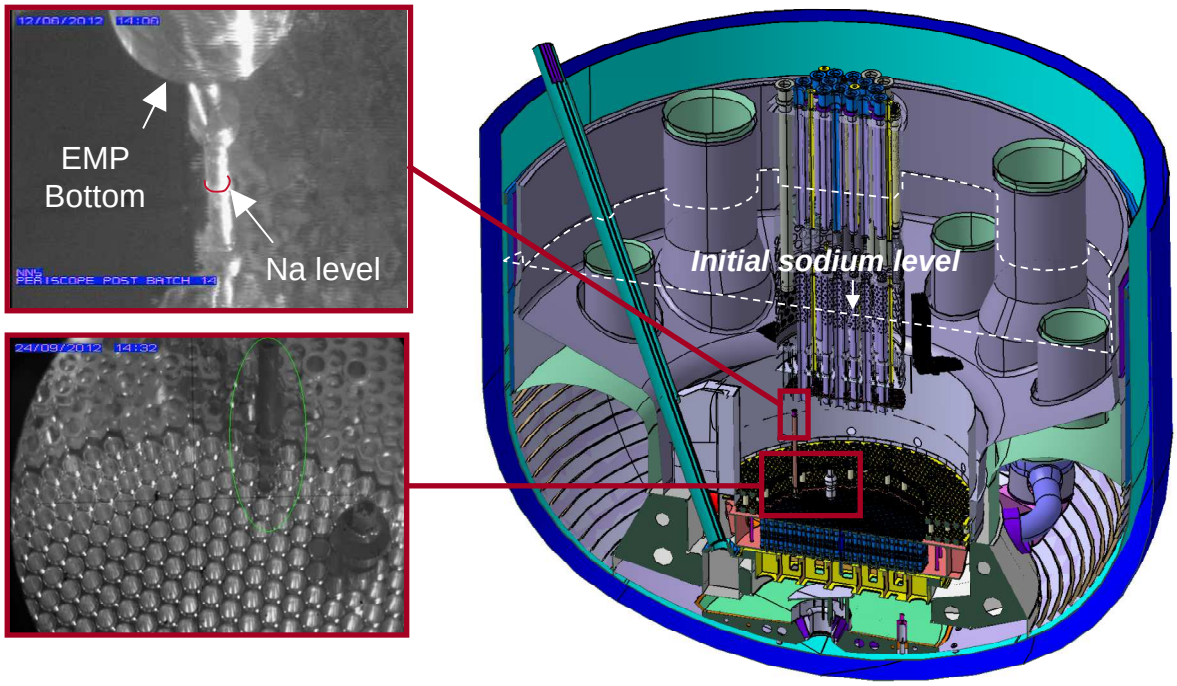


Figure 6: Primary vessel main sodium draining with electromagnetic pump

This successful result is based on an efficient optimization strategy shared by the stakeholders and a contract model focused on work site problem-solving, ontime delivery, and budget compliance.

These contractual rules are appropriate for:

- « FOAK » activities with high uncertainties (unsellable) and
- in an agreement and partnership context, introducing a commitment to achieving technical and commercial transparency.

This innovative contractual model, developed by EDF and AREVA for the Creys-Malville decommissioning project, is based on:

- A common interest for both parties to perform under the target price while sharing gain and pain and
- an improvement in stakeholder relations and flexibility.

5) Future works

The next steps in the Superphenix decommissioning program are the orbital laser cutting of 27 primary vessel penetrations from November, 2015, to March, 2016, and then the primary vessel carbonation, flooding and venting expected before the end of March, 2017. This last operation will mark the end of the sodium risk on site.

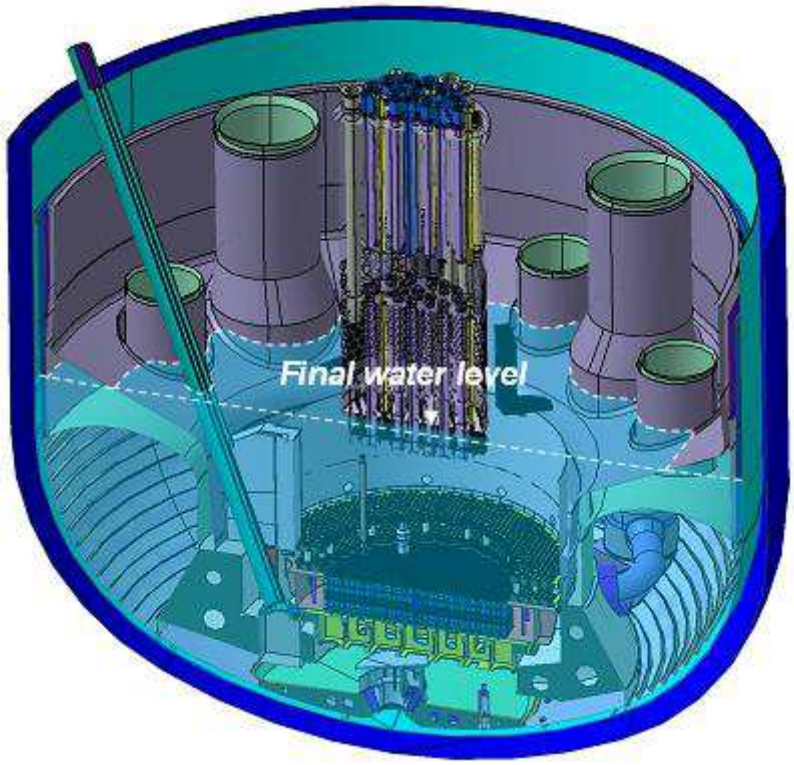


Figure 7: « Target State » of the Superphenix primary vessel

6) Conclusion

This partnership-based contractual model is most relevant with projects featuring complex operations and higher-than-usual risks and uncertainties. It is particularly adapted to situations where the project faces significant unknowns. In this case, traditional contracting models, such as lump-sum or cost-plus-fee could lead to significant overall overruns as both parties are not sufficiently incentivized to sharing the same goal. Equitably sharing the risks and opportunities as implemented with this partnership-based approach provides better control of the project through an increased understanding of the detailed situation and the actual risks. Finally, it facilitates the maintenance of key skills required for the project in the long term, in case of potential shortage (ex: technical expertise, engineering and fabrication, operation, specific knowledge including facilities configuration and history of past operations).