EDF DECOMMISSIONING PROGRAMME - A PREREQUISITE FOR THE ERECTION OF NEW NUCLEAR POWER PLANTS IN FRANCE

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ABSTRACT

Nowadays, decommissioning of nuclear power plants has become a key issue for nuclear industry in Europe. The phasing out of nuclear energy in Germany, Belgium and Sweden, as well as the early closure of nuclear units in applicant countries in the frame of EU enlargement, has largely contributed to consider decommissioning as the next challenge to face.

The situation is slightly different in France where nuclear energy is still considered as a safe, cost-effective and environment friendly energy source. Electricité de France (EDF) is working on the development of a new generation of reactor to replace the existing one and erection of a new nuclear power plant could start in the next few years. Nevertheless, to achieve this objective, it will be necessary to get the support of political decision-makers and the acceptance of public opinion. Due to the growing concern of these stakeholders for environmental issues, their support can only be obtained if it is possible to demonstrate that nuclear energy industry will not leave behind unsolved issues that will be a burden to the next generations. In this context decommissioning of the first generation of EDF NPPs constitutes a prerequisite for the erection of a new type of nuclear power plant. This paper will present the programme defined by EDF for the decommissioning of its nine already shutdown reactors. The reasons of the recent evolution of EDF decommissioning strategy will be explained and the key issues that will contribute to the successful implementation of this programme will be addressed. Finally, what has been achieved on sites so far and major planned activities will be described.

INTRODUCTION

EDF has nine of its nuclear power plants which have been definitively shutdown and which are currently under decommissioning. Most of them are first generation units which started operating in the 60s and were definitively shutdown at the end of the 80s or at the beginning of the 90s mainly for economical reasons. They were not competitive against the new type of reactors under erection at this time (PWR 1300 MW and N4 series).

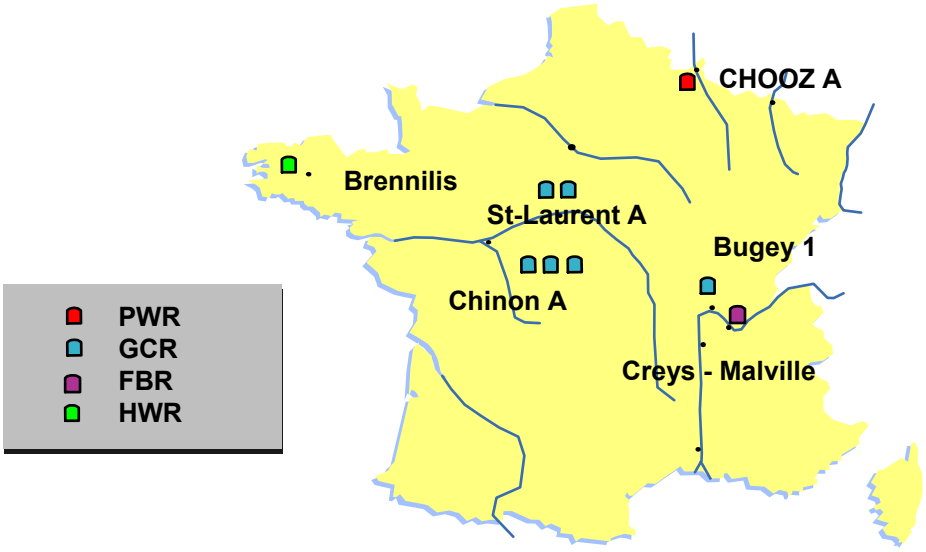

Fig. 1 Localisation of definitely shutdown NPPs in France

Table I Operation characteristics of EDF's shutdown units

Unit	Reactor type	Capacity	Operation Life
Brennilis	HWR	70 MW	1967/1985
Chinon A1	GCR	70 MW	1963/1973
Chinon A2	GCR	200 MW	1965/1985
Chinon A3	GCR	480 MW	1966/1990
St Laurent A1	GCR	480 MW	1971/1992
St Laurent A2	GCR	515 MW	1972/1994
Bugey 1	GCR	540 MW	1971/1992
Chooz A	PWR	300 MW	1967/1991
Creys-Malville (Superphenix)	FBR	1240 MW	1986/1996

EDF DECOMMISSIONING STRATEGY

Until January 2001, EDF's policy regarding the dismantling of its decommissioned nuclear power plants was to reach "level 2" (release of non-nuclear facilities) about 10 years after final shutdown and to postpone final dismantling for another 30-40 years to take advantage of radioactive decay. This strategy was satisfying 3 categories of stakeholders:

- The owner, because expenses were deferred,
- The operator, because there is still some activity on site
- The regulatory body because decision about final storage solutions could be postponed

Only public opinion was suspicious about the real possibility to return to green fields in a reasonable timeframe.
Today, EDF considers that, if the nuclear option is to remain open, it is necessary to deal with increasing public opinion concerns for environmental and waste management issues. EDF and the nuclear industry have thus to demonstrate their ability to control the back end of nuclear power plants life cycle. Therefore, EDF decided in 2001 **to achieve total dismantling of all nine already shutdown reactors in the next 25 years**. This new strategy will provide the tangible demonstration of the feasibility of dismantling, from the industrial, waste disposal and financial (adequate funding) points of view.

There are several benefits to this more aggressive strategy:

- It will allow addressing safety- and environment-related issues as yet unresolved.
- The cost of dismantling first generation units will already have been met when comes the time to invest in the renewal of the operating PWR units.
- Last, it will also provide the opportunity for structuring the industrial organization and preparedness (engineering and industrial) on which to rely for the final dismantling of the existing PWR units beyond 2020 (32 units).

To implement this strategy, EDF decided in 2001 to set up an new Engineering Department, CIDEN (French acronym for Decommissioning and Environment Engineering Department), with 2/3 of the activity of its 400 employees dedicated to decommissioning.

EDF DECOMMISSIONING PROGRAMME

An overall programme has been established by EDF for the decommissioning of the 9 EDF units already shutdown with the objective to provide a global and optimized approach on important issues such as waste management and resources allocation (financing, engineering and work capacity). It has to be completed in 2025 and comprises two stages:

1. The first stage includes:
   - Final dismantling of Brennilis (green fields) in 2015
   - A dismantling demonstration of a PWR reactor building (Chooz A) before starting replacing the population of PWRs currently in operation
   - Final dismantling of reactor containment of a GCR (Bugey 1) as a first of its kind
2. The second stage includes:
   - Dismantling of following 5 GCR units (Saint-Laurent A1&A2, Chinon A1,A2 & A3)
   - Final dismantling of Chooz A and Bugey 1 in 2025

3 billions Euros will be invested by EDF in the next 25 years to implement this programme. Figure 2 below shows the programme cost breakdown according to the main categories of expenditures.

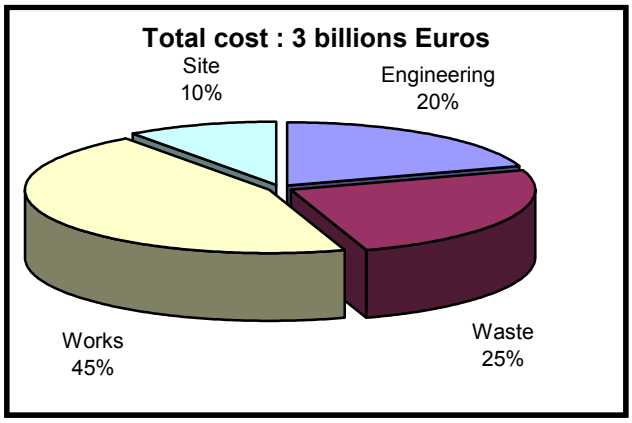

Fig. 2 Programme cost breakdown

Figure 3 shows the quantity of waste generated by the programme. Very Low Level Wastes (VLLW) are mostly concrete coming from the demolition of the nuclear buildings.

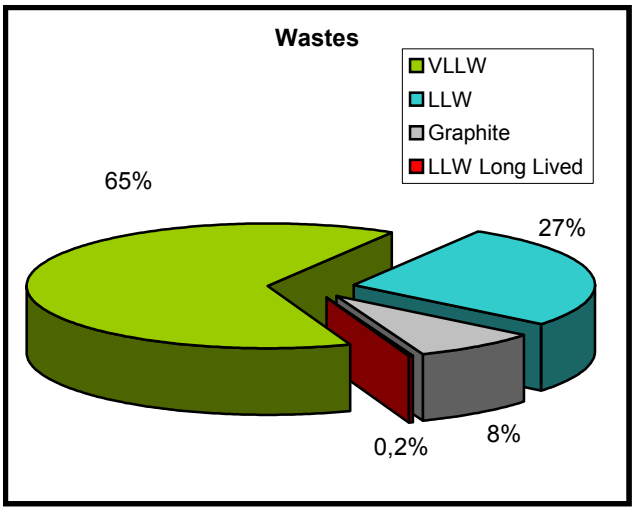

Fig. 3 Wastes generated

The successful implementation of this programme relies on:

- The simplification of regulatory processes and procedures
- The availability of treatment, conditioning and disposal facilities for specific categories of wastes (graphite, sodium, long-lived, …)
- An effective nuclear industry (contractors and suppliers) that will ensure the technical, cost and schedule aspects of this programme.

Availability on time of waste solutions is of the utmost importance. Among them, the main critical issues are:

- Opening of a Very Low Level Wastes disposal in 2003 (130 000 tons)
- Opening of a new disposal for graphite wastes (17 000 tons) in 2010
- Opening in 2007-2008 of a centralised interim storage facility for long-lived Medium Level Wastes (500 tons including filters, control rods, reactor internals for example)

Spent fuel storage is not an issue for the implementation of EDF decommissioning programme because, except for CREYS-MALVILLE where an interim storage is already in operation, all the spent fuel produced by the unit under decommissioning has been reprocessed.

In order to secure the execution of the decommissioning programme EDF is considering the possibility to erect "buffer" storage facilities on site to mitigate the impact of potential delay in the licensing and commissioning of the new facilities.

Regarding the closely concerned and related issue, namely disposal of high-level radioactive waste (HLW), the so-called "1991 Bataille Law" defined three prospective investigations that were to be carried out before 2006. Waste transmutation (CEA mission with assistance from EDF), sub-surface storage and deep geological repository (under ANDRA responsibility).These possibilities are all open and under investigation and EDF intends to be active in all issues.

Because its responsibility as nuclear operator is at stakes, but also because it will have to bear the cost of waste disposal, EDF is becoming more and more involved in these projects.

The regulatory process has recently been simplified. When 3 authorisations were needed to cover all the decommissioning process, now only one decree is required. To obtain this decree, a safety case has to be elaborated and submitted to the Safety Authority. It comprises the following documents:

- Justification of final state of the site and main steps of the dismantling process
- Safety Analysis Report
- Operating rules for monitoring and maintenance
- Emergency plan
- Environmental Impact Assessment
- Waste management studies

To avoid to apply for a new decree when minor modifications are required, which will undoubtedly occur within such a long and complex process, an internal organisation has been set up by EDF and accepted by the French Regulatory Body to deliver internal authorisations for modification of the Safety Analysis Report and the operating rules as far as they remain in accordance with the safety case submitted for the issue of the decree. For each modification a safety analysis has to be documented and reviewed by an internal committee whose members are not involved in the operation of the plant. The authorisation is delivered by the operator of the plant taking into account the recommendations of the committee. French Safety Authority have to be informed after the authorisation has been delivered and they can audit this committee.

ACHIEVEMENTS AND CURRENT ACTIVITIES ON SITES – NEXT STEPS

BRENNILIS – HWR

BRENNILIS will be the first EDF NPP to be fully dismantled with a definite release of the site.

Dismantling activities started in 1997 with the dismantling of electromechanical equipment from auxiliary buildings and the conditioning of dismantling wastes. These wastes are now shipped to a final repository operated by ANDRA (Centre de Stockage de l'Aube) or to a melting and incineration facility (CENTRACO).

The remediation and demolition of auxiliary buildings started in 2000 and will be finished in 2004. In order to reduce the volume of radwastes to be treated, the contamination is removed from concrete walls by hands-on or remote techniques. Thus the remaining structures can be considered as conventional wastes. The buildings are then demolished with conventional techniques and the rubbles are unconditionally released. The French Safety Authority has approved this procedure and a first nuclear building has been demolished in April 2002.

The studies for the final dismantling of the reactor building have started this year and will be finished in 2004. The objective is to start the dismantling of the rector vessel in 2007 and to complete it in 2012. After remediation of the reactor building, its demolition will start in 2015. At this time the site will be cleared from any nuclear regulation and will be rehabilitated

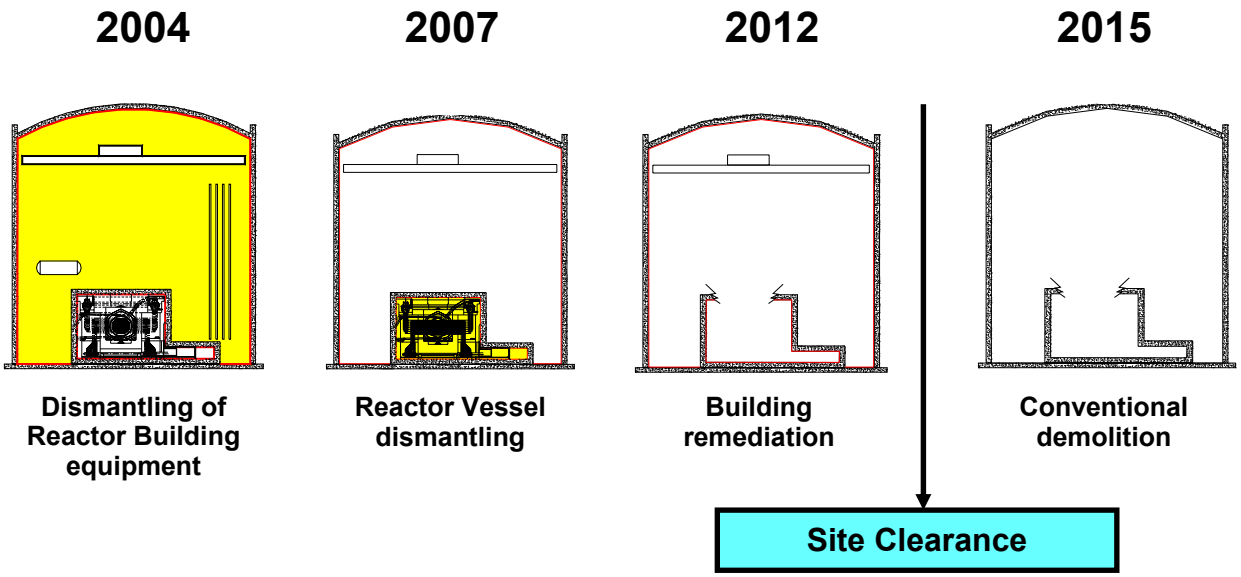

Fig. 4 The dismantling stages planned for the dismantling of BRENNILIS reactor building.

CHINON A 2 – GCR

As a result of EDF previous decommissioning strategy, CHINON A 2 has reached the level 2 of the decommissioning process defined by IAEA – i.e. Restricted Site Release. The conventional island has been demolished and most of the nuclear electromechanical equipment has been dismantled as to reduce the safe enclosure perimeter and surveillance activities. Only the reactor vessel and the heat exchangers are remaining. They will be dismantled after the dismantling of the BUGEY 1 reactor containment which will constitute a first of its kind for EDF GCRs. The graphite is temporally stored in the reactor vessel and some of the dismantled electromechanical equipment is temporally stored in the Safe Enclosure.

BUGEY 1 - GCR

Last of the graphite-moderated reactors built by EDF, Bugey 1 was shutdown in 1994. It is an integrated reactor where the heat exchangers are located under the core, both being integrated into a huge pre-stressed concrete block

whose walls are 7 meters thick. As a result of this particular design, most of the equipment outside this concrete block is not contaminated and has been dismantled.
Removal of graphite fuel cladding packages started in 2002 and partial dismantling involved with decommissioning work is expected to be completed by the end of this year. The studies for the dismantling of the reactor building started last year. Some samples were taken from inside the reactor concrete block and from the walls in order to characterize the contamination and activation of the materials. The dismantling works will start in 2008 to be completed in 2015.

CHOOZ A – PWR

The Chooz A NPP is located in the Ardennes region and was definitively shutdown in 1991. It is the first French PWR unit involved in a deconstruction program. A unique feature of this site is that the reactor and its auxiliaries are installed in two rock caves excavated in a hill.

The unloading of the reactor started immediately after final shutdown and removal of spent fuel from the site was completed by 1995. After that, the safety systems related to the cooling of spent fuel were decommissioned, the circuits were drained and the spent fuel pool was decontaminated. In 1999, EDF was authorized by the French regulatory body to start the activities leading to the transformation of the plant to a Safe Enclosure as requested by the previous decommissioning strategy. The primary circuit was disconnected from the remaining part of the installation so as to confine most of the radioactive materials. The Demolition of conventional island started in 2002 and dismantling work in nuclear auxiliary buildings located on the top of the hill was completed by the end of last year. After remediation, the buildings are considered as conventional buildings and will be demolished using conventional techniques.

As a result of EDF new strategy, studies for the dismantling of equipment located in the two rock caves were anticipated and started in 2003. Dismantling works of the reactor vessel will start in 2006 to be completed in 2014.

CONCLUSION

Three years after the decision was taken to accelerate the decommissioning programme of its definitely shutdown power plants, the first achievements make EDF confident that the conditions are favourably settled to implement this programme under satisfactory industrial conditions of safety, radioprotection, wastes management, economics.

The increasing mobilisation of EDF for the decommissioning of its already shutdown NPPs shows its willingness to demonstrate its capacity to control the nuclear life cycle from end to end. The successful implementation of its decommissioning programme will not mean the end of nuclear energy in France but it will constitute a pre-requisite for the erection of new nuclear power plants in France.