SAFE FINAL SHUTDOWN AND DECOMMISSIONING OF BASIC NUCLEAR INSTALLATIONS

CHAPTER 15

SAFE FINAL SHUTDOWN AND DECOMMISSIONING OF BASIC NUCLEAR INSTALLATIONS

Upon completion of their operating period, basic nuclear installations (BNIs) undergo a series of clean-out and transformation operations allowing final shutdown prior to decommissioning. The Nuclear Safety Authority (ASN) requires that all the work done leads to delicensing of the installations in compliance with regulations concerning nuclear installations. The buildings or land cleaned up may be returned to the public domain (for purposes that may sometimes be limited) subject to appropriate constraints (ou encumbrance). The work done in this way may also lead to delicensing of the BNIs, while conserving one or more Installation Classified on Environmental Protection Grounds (ICPEs) subject to licensing or notification, once identified as such at the time the decommissioning application is submitted by the licensee. In the past, certain reactors were also converted into BNIs for storage of their own waste, pending the creation of an appropriate disposal channel.

The first steps following final shutdown of the BNI correspond to the removal of fuel or nuclear materials from the installation, and clean-out of the installation, helping to reduce the level of risk in terms of nuclear safety, in particular with regard to evacuation of the after-power from the reactors. During this same time, there is an increase in the risks linked to human radiation protection and to conventional safety, owing to operations carried out in close proximity to residual nuclear material and the numerous handling operations involved in waste removal, requiring particularly close attention.

Decommissioning is also accompanied by considerable changes in the way work is organised and in day to day risks. ASN aims to ensure that these changes are regulated and managed.

ASN encourages complete decommissioning either immediately or after slight postponement, provided that upstream of the regulatory processes, the licensee is able to present and justify the chosen decommissioning scenario, from the final cessation of production up to final decommissioning of the installation. The administrative practices involved in BNI decommissioning operations were updated at the beginning of 2003. They were the forerunners of regulations that will be adopted on the basis of the TSN law of 13 June 2006.

ASN considers the current decommissioning operations as test cases, providing an opportunity for the licensees, on the one hand, to define and implement a decommissioning strategy (decommissioning level to be reached, detailed operating schedule), and, on the other hand, a management policy for the large amounts of radioactive waste that will be generated (notably the very low level waste). If carried through to their conclusion, they would also constitute examples demonstrating the technical and financial feasibilities of an entire decommissioning operation.

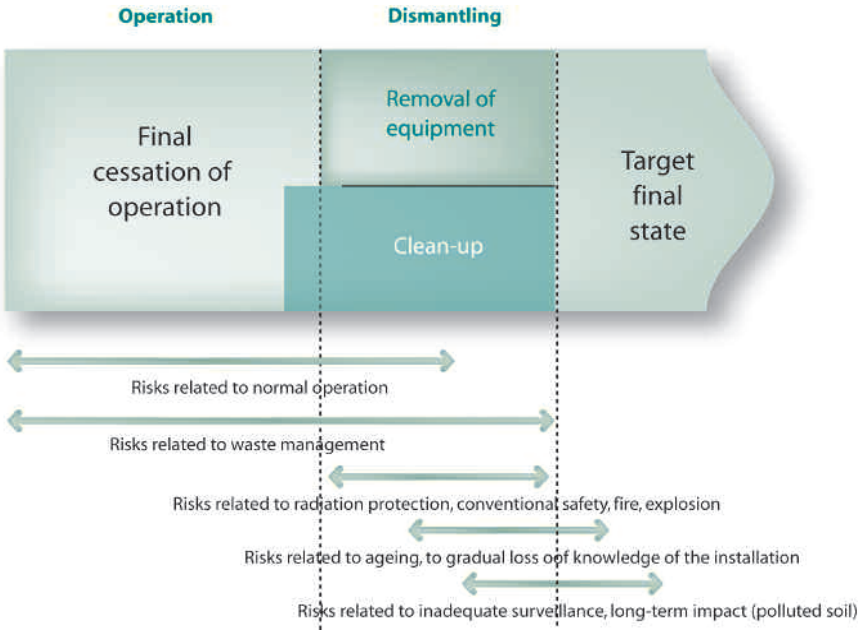
ASN now strives to integrate relevant experience feedback from past decommissioning projects in France and abroad.

1 TECHNICAL AND ADMINISTRATIVE PROVISIONS

The applicable regulations

The technical provisions applicable to installations to be decommissioned and decommissioned must obviously be in compliance with general safety and radiation protection rules, notably regarding worker external and internal exposure to ionising radiation, criticality, the production of radioactive waste, discharge to the environment of radioactive effluents and measures designed to reduce the risk of accidents and mitigate their consequences.

Safety issues, in other words protection of persons and the environment, can be significant, during active clean-out or decommissioning operations, and must never be neglected, including during passive surveillance phases. The rapidly changing nature of the installation being decommissioned is an additional risk factor in that it is harder than for an operating installation to guarantee that all potential risks have been consistently and exhaustively taken into account.



Risks

The above figure presents the main risks encountered when decommissioning an installation and the periods during which these risks are highest.

The risks related to waste management and which concern safety (increasing numbers of interim waste storage sites) or radiation protection (interim storage of irradiating waste) are present throughout all phases producing large quantities of waste.

As decommissioning progresses, the risks identified during operation of the installation tend to change more into radiation protection and conventional safety risks: some decommissioning operations for example take place in premises which are not usually occupied during operation.

New risks appear, in particular risks linked to the technologies employed for disassembling and cutting up structures, often involving hot-spot cutting technologies which entail a risk of fire or explosion.

The risks linked to the problem of the stability of partially dismantled structures also need to be considered, along with the risks linked to equipment obsolescence.

For complex nuclear installations such as nuclear power plant reactors, decommissioning work can last for more than a decade and often follows several decades of operation. There is thus a considerable risk of knowledge of the design and operation of the installation being lost, especially if the former licensees have left the installation. Collecting and thoroughly documenting the knowledge and memories of the personnel involved during these phases is therefore essential, all the more so as the traceability of the design and operation of former installations is sometimes random or unreliable.

As decommissioning proceeds, there arises the question of the adequacy at all times between the surveillance of the state of the installation and the risks it presents. The operational surveillance systems often need to be replaced by other means of surveillance, whether temporary or permanent: radiological monitoring, fire detection located close to the risks, in place of centralised control systems. Constantly checking the adequacy of surveillance for the rapidly and significantly

changing status of the installation is a difficult exercise, and there is a very real risk of failing to detect the onset of a hazardous situation.

Once the installation has reached its final state after dismantling, there is still a risk that pollution that has been inadequately identified, or not identified at all, or poorly characterised, will have a significant long-term impact on the site or its environment.

The decommissioning scenario (immediate or deferred) is selected by the licensee on a case by case basis, generally in the light of comparative studies. The strategies today adopted by EDF or CEA are presented in points 2|1 and 2|2.

Administration and regulation

The various technical provisions chosen for each stage in decommissioning of a nuclear installation are chosen by the licensee on a case by case basis. However, to avoid splitting up the decommissioning projects and to improve overall consistency, ASN asks that as of final shutdown of an installation, a file be submitted, explicitly presenting all the various works envisaged from final shutdown until the target final state is reached, and demonstrating at each step the nature and scale of the risk presented by the installation and the steps taken to control it. The decommissioning phase is generally preceded by a final shutdown phase carried out under the initial operating license, enabling most of the radioactive material to be removed from the installation.

Furthermore, in the current context of managing industrial sites being decommissioned, the need became apparent for conservation of a trace of the past existence of a BNI on a site, along with any utilisation restrictions appropriate to the condition of the site. The procedures for delicensing after clean-out are mentioned in chapter 16.

ASN reviews the applications for final shutdown and decommissioning submitted by the nuclear licensees; these operations are authorised by means of a decree. ASN therefore specified the regulations for the decommissioning of BNIs in guide SD3-DEM-01 of 17 February 2003 entitled: "regulatory procedures for the decommissioning of BNIs", subsequent to extensive work to clarify and simplify the administrative procedures, while improving how safety and radiation protection were taken into account. This guide is available on the ASN website and will be updated in order to incorporate the regulatory changes arising from publication of law 2006-686 of 13 June 2006 concerning nuclear transparency and safety, as well as the work done by the WENRA association (see chapter 16 point 1|3).

Practical procedures are now therefore imposed in order to:
- clarify the definition of the leading technical and administrative stages in decommissioning to ensure that they are better tailored to the diversity of nuclear installations;
- encourage complete decommissioning either immediately or after slight postponement;
- encourage presentation and justification by the licensee of the decommissioning scenario chosen before initiating the regulation process, from the decision to cease operations up to complete decommissioning;
- clarify the administrative notion of delicensing of a BNI and the related criteria.

This revision leads to a clearer definition of the two main phases in the life of an installation, each of which is associated with a single authorisation decree, the authorisation decree for the operating phase and the final shutdown and decommissioning decree for the decommissioning phase. This creates a more balanced picture, both technically and administratively, between the importance given to the decommissioning phase and that given to the operating phase.

2 THE SITUATION OF NUCLEAR INSTALLATIONS BEING DECOMMISSIONED IN 2006

2 | 1

EDF nuclear power plants

Since April 2001, EDF has decided for all its decommissioned nuclear installations (Brennilis, Bugey 1, Saint-Laurent A, Chinon A, Chooz A and Superphénix) to adopt this new decommissioning strategy, based on complete and decommissioning of the reactors, with no standby period. It thus foresees complete decommissioning of these reactors by 2025.

This new strategy was reviewed by the relevant advisory committee of experts in March 2004. ASN considers that there is nothing to compromise the feasibility of the complete decommissioning scenarios envisaged. In 2006, complete decommissioning of the Brennilis plant was authorised by decree 2006-147 and that of the Superphénix reactor by decree 2006-321. These decrees are the result of revision of the practical procedures for application of the decree of 11 December 1963 decided in 2002. This revision leads to a clearer definition of the two main phases in the life of an installation, each of which is associated with a single authorisation decree, the authorisation decree for the operating phase and the decommissioning decree for the decommissioning phase. Through this single decree, ASN sets the regulations for the decommissioning operations to be performed, specifies the check points required for supervision of the process and enables EDF to assume its responsibilities as nuclear licensee, by means of internal authorisation of operations with no major installation safety issues.

2 | 1 | 1

Internal authorisations

In a letter dated 9 February 2004, ASN authorised EDF to set up a system of internal authorisations for the installations concerned by the decommissioning programme. This approach is primarily designed to meet a strong demand for constant updating of the safety case of an installation. Setting up such a system therefore enables the licensee to make changes to the safety case which do not compromise the safety demonstration.

ASN considers that the working of the internal authorisations system is on the whole satisfactory. ASN nonetheless considers that EDF should pay particular attention to the interaction between the national and local internal authorisation systems, in particular to ensure that the recommendations from the decommissioning safety committee, which is a key body reviewing the internal authorisation files, are taken into account when carrying out the operations concerned.

2 | 1 | 2

Monts d'Arrée plant

The EL4 nuclear reactor, which was commissioned on 23 December 1966, finally ceased all production of electricity on 13 July 1985. This reactor was an industrial prototype, built and operated jointly by CEA and EDF. As part of the partial decommissioning process for this installation, the 31 October 1996 decree authorised modification of the existing installation, converting it into a facility for interim storage of its own equipment left on the site and thus created a new BNI called EL4-D. On the basis of a study defining the various possible options for final decommissioning earlier than planned, EDF on 22 July 2003 submitted an application for final shutdown and decommissioning of the EL4-D installation. Complete decommissioning of the EL4-D installation was authorised by decree 2006-147, published in the Official Gazette on 12 February 2006.

Brennilis – renovation of the ventilation system

The first EDF proposals concerning bulding post-operational clean-out and delicensing of the nuclear buildings at the Brennilis NPP were submitted in 1999. The various delicensing dossiers were reviewed and the pilot worksite carried out at the same time as guide SD3-DEM-02 was drafted. Its contents are specified in chapter 16 point 2.2. In 2006, ASN authorised delicensing of the spent fuel building (BCI) on the basis of the dossiers transmitted in accordance with the SD3-DEM-02 guide and the results of the joint analysis conducted by IRSN on random concrete samples. ASN considers that the organisation put into place by EDF for the clean-out operations is satisfactory. ASN considers that EDF must take full account of the lessons learned from clean-out of the BCI, in particular with regard to the clean-out methodology, the arduous nature of the clean-out work, the qualification of measuring instruments used and the compilation of delicensing dossiers, with a view to the future clean-out of large-scale buildings.

2 | 1 | 3

Gas cooled reactors (GCR)

Completion of the decommissioning programme in accordance with the schedule reviewed during the 2004 advisory committee meeting is based on the availability of waste disposal channels. ASN ensures that no decommissioning operation is undertaken until the licensee has proposed sustainable management of the waste resulting from the operation. Therefore, opening of the GCR compartments is dependent on commissioning of the activated waste interim storage facility and the graphite disposal centre. The 28 June 2006 act on the sustainable management of radioactive materials is therefore key to the correct performance of the decommissioning programme, as it provides for opening of this graphite repository in 2013, a timeframe compatible with the decommissioning programme as initially proposed by EDF. However, ASN remains vigilant on compliance with the timeframe associated with the decommissioning strategy. ASN asked EDF to assume its responsibility as waste producer, by immediately starting work on packaging of graphite waste that is acceptable for the future graphite repository, in close collaboration with ANDRA.

· Chinon A1D, A2D and A3D reactors

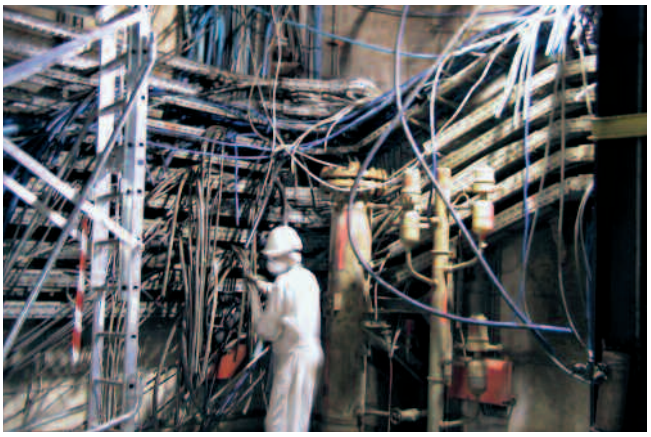
The old Chinon A1, Chinon A2 and Chinon A3 reactors were partially decommissioned and transformed into storage facilities for their own equipment. These operations were authorised by the decrees of 11 October 1982, 7 February 1991 and 27 August 1996, respectively. These installations are currently in the care and maintenance phase.

On 29 September 2006, EDF submitted an application for authorisation for final shutdown and complete decommissioning of the Chinon A3 installation.

· Saint-Laurent-des-Eaux A1 and A2 reactors

The decree authorising final shutdown operations for the two reactors was signed on 11 April 1994.

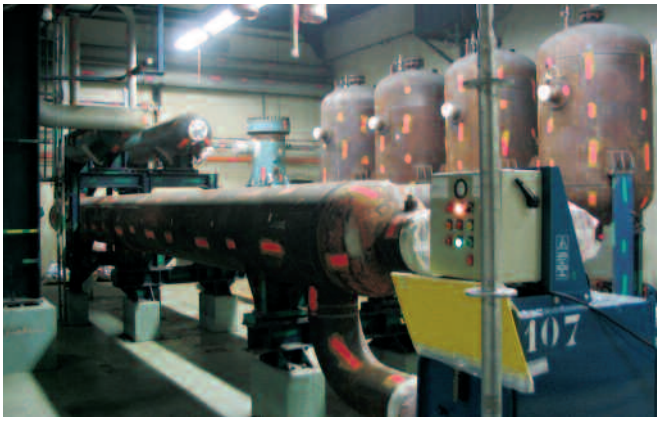
On 11 October 2006, EDF submitted an application for authorisation for final shutdown and complete decommissioning of the Saint-Laurent A1 and A2 installations.



Saint-Laurent – cable removal worksite

ASN is unhappy with the delay in the operation to recover the sludges stored at the bottom of the K tanks. In 2006, ASN observed a general lack of contractor surveillance and supervision on the Saint-Laurent A site. ASN considers that EDF will need to be particularly vigilant regarding management of the operations in 2007.

· Bugey 1 reactor



Bugey 1 – CO_2 local

The decree authorising final shutdown operations was signed on 30 August 1996. In 2006, EDF completed the dossier enclosed with the application for authorisation for complete decommissioning submitted in 2005. Decommissioning of the Bugey 1 reactor is the first of the GCR decommissioning operations. ASN will therefore adopt a stance on this dossier after submitting all the documents transmitted by EDF to the advisory committee for plants, so that it can review them.

2 | 1 | 4

Chooz A D reactor (Ardennes nuclear power plant)

The Ardennes nuclear power plant, which was coupled to the grid on 4 April 1967, finally ceased all electricity production on 30 October 1991. This reactor was the first PWR built in France. As part of the reactor partial decommissioning process, the 19 March 1999 decree authorised modification of the existing installation so that it could be converted into an interim storage facility for its own equipment left on the site, thereby creating a new BNI called CNA-D. Owing to the change in its decommissioning strategy, EDF submitted an application on 30 November 2004 for final shutdown and complete decommissioning of the CNA-D installation.

ASN therefore prepared a draft decree authorising final shutdown and complete decommissioning of the reactor. This project was reviewed by the interministerial commission on BNIs on 8 December 2006.

Chooz A – decommissioning of ventilation flue

2 | 1 | 5

Superphénix reactor

The Superphénix fast neutron reactor, a sodium-cooled industrial prototype, is located at Creys-Malville. In accordance with the Government decision of February 1998, this reactor, with its rated thermal power of 3000 MW and net electrical output of 1200 MWe, is currently in its final shutdown stage. This installation is associated with another BNI, the on-site spent fuel storage unit (APEC), consisting mainly of an interim storage pool for fuel removed from the reactor vessel.

Final shutdown of the reactor was authorised by decree 98-1305 of 30 December 1998.

Superphénix dome

In early 2003, all the fuel assemblies had been removed from the reactor and stored in the APEC. At present, the reactor vessel only contains special assemblies and the lateral neutron protections which present no criticality risk. The final decommissioning operations continued and the turbine hall is now completely empty. To allow treatment of the sodium contained in the reactor's systems and decommissioning of the reactor installations, EDF in 2003 submitted an application for authorisation for complete decommissioning of the reactor. It also submitted an application for a water intake and effluent discharge licence for the site. In 2004, these various applications were the subject of an administrative procedure, a technical investigation and a public inquiry. The last stage in final shutdown and complete decommissioning of Superphénix were authorised by decree 2006-321 of 20 March 2006.

This facility was commissioned on 25 July 2000 by the Ministers for Industry and the Environment. Spent fuel removed from the Superphénix reactor and washed is placed in the APEC pool.

In 2003, EDF submitted an application for modification of the installation's authorisation decree to allow storage of unused Superphénix fuel and storage within the boundary of this BNI of the blocks of sodium-impregnated concrete resulting from the treatment of sodium in this same reactor. The APEC modification was authorised by decree 2006-319 of 20 March 2006.

2 | 2

CEA installations

Following a request from ASN, CEA in June 2004 forwarded several documents enabling ASN to assess the overall decommissioning strategy for its civil installations, particularly with respect to consistency and management of the corresponding waste. These documents were completed in 2005 with respect to ranking of the safety and radiation protection priorities. ASN referred the matter to the advisory committees for plants and for waste, which approved the relevance of the CEA installations clean-out and decommissioning plan on 6 December 2006.

2 | 2 | 1

The Fontenay-aux-Roses centre

The CEA research centre is located in the town of Fontenay-aux-Roses, bordering on the towns of Châtillon and Plessis-Robinson, in the Hauts-de-Seine *département*[1]. It covers an area of 13.8 hectares.

This centre currently comprises four BNIs, which pursued research activities in the fields of chemical engineering, analytical chemistry, storage of radioactive waste and transuranic elements. The laboratory for plutonium-based fuel studies (RM2 - BNI 59) and the plutonium chemistry laboratory (LCPu - BNI 57) are currently being cleaned-out. Only the radioactive liquid effluent and solid waste treatment station (BNI 34) and the interim storage facility for radioactive solid waste (BNI 73) are still operating.

With the aim of delicensing and cleaning out the centre, which should be completed in about 2015, CEA decided to group the nuclear activities in the "Fort" area, which required a modification of the existing BNI perimeter, thereby creating two new BNIs in place of the four original BNIs mentioned above. The two decrees authorising the creation of the two new BNIs, the Process BNI (BNI 165) and the Support BNI (BNI 166) in place of BNIs 34, 57, 59 and 73, and authorising the final shutdown and decommissioning of these installations, were published in the Official Gazette of 2 July 2006. These decrees will become applicable during the course of 2007, as soon as the buildings outside the perimeter of BNIs 34, 57, 59 and 73 have been delicensed and removed from the current perimeters.

The activities of the centre are moving away from nuclear activities to research in life sciences.

ASN considers that BNI clean-out operations are on the whole taking place satisfactorily. The building clean-out methodologies leading to delicensing are in the process of being drafted by the licensee and will be reviewed by ASN, which will thus be required to also adopt a stance on the overall radiological status of the site, for which the licensee has undertaken major work to identify radiological traces arising from past experimentation and to rehabilitate the soil.

1. *département*: administrative region.

ASN inspection of the CEA site at Fontenay-aux-Roses on 8 September 2006

Radioactive effluent and solid waste treatment station and solid waste interim storage station (also see chapter 16)

Despite the shutdown of some activities (incineration, evaporation), the radioactive effluent and solid waste treatment station (BNI 34) continues to evacuate radioactive effluent from the site and to treat solid waste, in particular as part of the site post-operational clean-out operations. BNI 34 is also storing legacy effluent pending removal to other CEA centres. The solid waste interim storage station (BNI 73) stores irradiating drums in decay pits, pending removal, and provides interim storage of low and very low level waste drums waiting for transport to a repository. BNI 73 is carrying on the removal of the irradiating drums of solid waste from the decay pits. Shutdown of these BNIs is taken into account in the decommissioning of the CEA Fontenay-aux-Roses site.

Plutonium chemistry laboratory

Until July 1995, the plutonium chemistry laboratory (LCPu) at the CEA centre in Fontenay-aux-Roses was used for research and development work on spent fuel reprocessing and waste treatment methods.

The final shutdown operations for this installation began in July 1995 and are continuing. This will involve recovering, processing and removing the radioactive materials present in the installation.

The Petrus high-level tanks were characterised in June 2004, confirming that their content was indeed liquid. The operation to empty tank B was authorised by ASN in October 2006. These operations will take place in 2007.

ASN asked the licensee to take better account of the chemical risks when decommissioning this installation, particularly owing to the age of this waste and effluent resulting from past experiments carried out in support of the reprocessing plants.

Laboratory for plutonium-based fuel studies

This radio-metallurgical laboratory, located on the CEA site at Fontenay-aux-Roses, comprised two units, RM1 and RM2, located in two separate buildings. The activities of the spent fuel analysis laboratory ended in 1984.

Clean-out operations took place from 1991 to 1995.

In 1999, CEA provided an end-of-clean-out report for the RM1 part and a more detailed decontamination plan for the RM2 part. CEA sent ASN a clean-out report concerning the floor in the filters room as experience feedback. Decommissioning will be covered by the decommissioning order for the CEA site at Fontenay-aux-Roses (see beginning of section).

2 | 2 | 2

The Grenoble centre

The Grenoble research centre (Isère) is located in an industrial zone north-west of the town, at the confluence of the Drac and the Isère rivers. It covers an area of 128 hectares.

This centre, whose activities were initially devoted to developing nuclear reactor technologies, now focuses on non-nuclear fundamental and applied research (condensed state physics, biology, electronics and materials). The centre also houses a unit of the INSTN (National Teaching Institute for Nuclear Science and Techniques).

ASN considers that the clean-out and decommissioning operations in the Grenoble centre installations are running correctly. ASN nonetheless drew the CEA's attention to verifiable compliance with procedures when drawing up internal authorisations in the centre, as the Grenoble centre benefits

from the internal authorisations system for all its BNIs and ASN must be able at all times to check the conditions in which responsibility has been delegated.

Effluent and solid waste treatment station and decay storage

The effluent and solid waste treatment station (STEDS – BNI 36) is continuing with gradual shutdown of its activities, aiming for completion of decommissioning in 2012. The solid waste and liquid effluent treatment and packaging functions have ceased. The STEDS is still taking in and providing interim storage for waste, primarily that resulting from clean-out of the BNIs in the centre, before taking them away to alternative disposal routes. The removal from storage of the high-level bins in the decay storage installation (BNI 79) continued in 2006, as did recovery of the high-level packages stored in radioactive decay pits, for sorting and optimisation of the package contents prior to repackaging. This will enable some of the packages to be sent to ANDRA's Aube repository or to the CEDRA BNI for waste with sufficiently decayed radioactivity levels. For packages for which the level is still too high for removal through the above-mentioned channels, CEA envisages storing them in ventilated pits in BNI 72 (STED at CEA Saclay).

CEA presented its final shutdown and decommissioning dossier for this installation in 2006.

Active material analysis laboratory (LAMA - BNI 61)

This laboratory ended its scientific research duties in 2002. It was used to receive experimental fuels with no further purpose, taken from the Siloé and Mélusine reactors following their shutdown. It takes part in the clean-out operations for the STED and is engaged in its own clean-out work.

CEA presented its final shutdown and decommissioning dossier for this installation in 2006.

Siloette reactor

Siloette is a pool-type 100 kWth reactor, primarily used to train operational personnel for the nuclear power generating plants. The decree authorising final shutdown and decommissioning of the reactor was signed on 26 January 2005. This reactor is in the final stages of decommissioning and could be delicensed at the end of 2007.

Mélusine and Siloé reactors

Mélusine is a pool reactor operated by CEA at its Grenoble centre. Final shutdown was declared in 1994. The decree authorising CEA to modify the Mélusine reactor prior to its decommissioning and delicensing was published in the Official Gazette in January 2004. The clean-out and decommissioning work on the premises continued in 2006 and pool decommissioning is in progress.

The Siloé reactor, located on the CEA site in Grenoble, has been shut down since 23 December 1997. The decree authorising final shutdown and decommissioning of the reactor was signed on 26 January 2005. Decommissioning operations are continuing. The pool liner removal operations began at the end of 2006 and will continue in 2007.

2 | 2 | 3 The Cadarache centre installations being decommissioned

ASN considers that the clean-out and decommissioning operations on the Cadarache centre installations are running satisfactorily; ASN nonetheless drew the licensee's attention to management of the waste resulting from the future decommissioning of certain installations, in particular Rapsodie (sodium and NaK waste). ASN is in fact opposed to long-term storage of this waste in the BNIs being decommissioned and CEA will either have to dedicate interim storage capacity pending treatment of it, or design and create the units necessary for this treatment.

Rapsodie reactor and Fuel assembly shearing laboratory (LDAC)

Rapsodie, a fast neutron experimental reactor, was shut down on 15 April 1983. Final shutdown was declared on 28 May 1985. As from 1987, this installation has been undergoing work, which led to its partial decommissioning. This work was interrupted in 1994, further to a fatal accident which occurred during the cleaning of a sodium tank. This accident, which emphasizes the risks involved in decommissioning operations, necessitated rehabilitation and partial cleanup processes, which were completed by the end of 1997. Since then, clean-out and decommissioning work limited to certain equipment items has been resumed, along with waste removal. Renovation and refurbishment work has also been carried out.

The LDAC, located within the same BNI as the Rapsodie reactor, was designed for inspection and examination of spent fuel from the Rapsodie reactor or other fast neutron reactors. This laboratory has been shut down since 1997. It has been cleaned-out, is under surveillance and awaiting decommissioning.

In 2002 and 2003, CEA sent ASN the updated General Operating Rules (RGEs) and an updated safety case which covered the Rapsodie reactor, the LDAC and the neutron radiography reactor in a single document. The 2005 review of these documents found that the justifications were insufficient, in particular with respect to the forthcoming clean-out operations. A revised version of the installation's safety case, transmitted to ASN at the beginning of 2006 and covering final shutdown operations, is currently being reviewed. 2006 was also marked by a change in licensee strategy concerning installation decommissioning. The strategy involving deferred decommissioning of the reactor core, after a surveillance phase lasting until 2020, was abandoned in favour of immediate decommissioning, scheduled to start in 2009.

Harmonie reactor

Operation of the Harmonie reactor ceased in 1996. It was a calibrated neutron source used primarily for calibrating detectors and studying the properties of certain materials. Operations finally ceased on 18 December 1997, and the decree authorising CEA to carry out final shutdown and decommissioning was published on 8 January 2004. Following the operations to cut up the reactor block and take away the waste generated by decommissioning in 2005, the reactor slab, which had been activated by the neutron flux during operations, was subject to complete clean-out in 2006. The final target state for the licensee included demolition of the building, which should take place in 2007. This demolition is a precursor to administrative delicensing of the installation.

Reactor hall with reactor block cutting hatch – Harmonie

Enriched uranium processing facilities (ATUE)

The ATUE at the CEA Cadarache centre provided conversion into sinterable oxide of the uranium hexafluoride from the isotopic enrichment plants. They were also used for the chemical reprocessing of fuel element fabrication scraps to recover the enriched uranium they contain. The facility was also equipped with a low level organic liquid incinerator. Production in the facilities ended in July 1995 and the incinerator was shut down at the end of 1997.

In 1998, CEA submitted a final shutdown and decommissioning application for this BNI, which was updated in 2003 and led to publication of the final shutdown and decommissioning authorisation decree in February 2006. The year 2006 saw the completion of the first phase (disassembly of process equipment) and initiation of the second phase (disassembly of common structures and infrastructures) of the decommissioning process. The licensee transmitted a document presenting the complete clean-out methodology for the installation, which will be implemented during the third phase of the operations.

Cadarache irradiator (IRCA)

The Cadarache irradiation installation was designed to test the resistance of PWR safety-related electrical equipment to gamma radiation.

The decree authorising CEA to proceed with final shutdown and decommissioning was published on 8 January 2004. The operations covered by this decree were carried out during the course of 2004, and all the waste resulting from the decommissioning operations was taken away. Following these operations, CEA sent ASN a request for delicensing of the BNI, backed up by an environmental residual impact assessment. The decision for delicensing was signed in September 2006, along with the constraint (or encumbrance) act. The installation was therefore removed from the list of BNIs on 22 September 2006.

2 | 2 | 4

The Saclay centre installations being decommissioned

ASN considers that the clean-out and decommissioning operations leading to delicensing of the two Saclay particle accelerators were carried out in compliance with satisfactory methodology and regulations, which should be extended to the other installations, particularly old installations or parts of installations, the decommissioning of which had been postponed for a considerable time.

High activity laboratory (LHA)

The high activity laboratory (LHA) comprises several units equipped for research and production assignments on various radionuclides.

CEA transmitted a final shutdown and decommissioning dossier in April 2006 in order to obtain decommissioning authorisation in 2008 with the end of decommissioning scheduled for 2012. Clean-out work is in progress in three cells. Two cells are still active and the others are empty.

CELIMENE cell

The CELIMENE cell, adjoining the EL3 reactor, was commissioned in 1965 for review of the fuel from this reactor. This cell is now attached to the spent fuel analysis laboratory (LECI). The last fuel rods were removed in 1995 and a number of partial clean-out operations conducted until 1998. Decommissioning of the installation, currently under surveillance, is not planned before about 2010. In 2006, ASN asked CEA to update the safety analysis report for the CELIMENE cell.

Saclay linear accelerator (ALS)

The Saclay linear accelerator is located on the Orme des Merisiers site on the Saclay plateau. It was operated by CEA.

ALS before decommissioning

ALS after decommissioning

The decree authorising CEA to carry out the shutdown and decommissioning operations on the ALS installation was published in January 2004. The operations covered by this decree ended in March 2004. The results of final shutdown and decommissioning were sent to ASN. All the radioactive waste resulting from decommissioning was sent to the authorised channels. The act of constraint on behalf of the State, whereby in the event of sale of the land occupied by the BNI, the buyer must be informed that a BNI previously occupied this land, was signed in August 2006. The installation was consequently removed from the list of BNIs on 13 September 2006.

2|3 The La Hague installations being decommissioned

UP2 400 spent fuel reprocessing plant and associated facilities

The former UP2 400 reprocessing plant and the associated facilities (BNIs 33, 38, 47 and 80) is slated for decommissioning. The situation of UP2-400 is described in chapter 13, point 3|2|2. ASN strongly urges COGEMA to rapidly submit the decommissioning application dossiers for the UP2-400 plant installations which have been shut down for a long time. The decommissioning application dossiers submitted by the licensee will then undergo a public inquiry.

In addition to the facilities operated by COGEMA since 1976, there are two other facilities that were operated by CEA: AT1 and Elan IIB. These facilities are now under the responsibility of COGEMA and should be incorporated into the decommissioning authorisation application for the former reprocessing plant.

AT1 pilot reprocessing facility

The AT1 pilot facility reprocessed fuel from the Rapsodie and Phénix fast breeder reactors from 1969 to 1979. It is part of BNI 38 (STE-2).

Clean-out of this installation began in 1982, and was completed in 2001. In 2001, ASN duly took note of the end of clean-out, exclusive of civil works, and of transition to the surveillance stage. This installation is not however delicensed as its complete decommissioning will be part of the decommissioning application for the UP2-400 plant as a whole.

Caesium 137 and strontium 90 source fabrication facility (Élan IIB)

The Élan IIB (BNI 47) facility manufactured caesium 137 and strontium 90 sources until 1973.

The initial decommissioning operations undertaken by the Technicatome firm ended in November 1991.

A large number of renovation and maintenance operations took place during 2002 and 2003 (upgrading of the ventilation system, radiological mapping, etc.) with a view to decommissioning operation resumption. All the installation upgrade work and the work preparatory to decommissioning of the installation was carried out during 2004 and 2005. Radiological reconnaissance work was carried out

in 2005 and the licensee sent ASN the final shutdown dossier at the end of 2005. The licensees provisional target is to complete decommissioning in 2013.

2 | 4

Other installations

2 | 4 | 1

The *Société Normande de Conserve et Stérilisation* (SNCS) irradiator

The SNCS ionisation plant, located at Osmanville (Calvados), authorised by decree on 17 October 1990, was used for the sterilization of foodstuffs and medico-surgical equipment.

In 1995, the cobalt 60 sealed sources contained in the installation were transferred to ionisers operated by the Ionisos company.

The licensee presented an application for final shutdown and decommissioning of the installation, with the ultimate aim of removing the installation from the list of BNIs. The corresponding decree was signed on 27 March 2002.

The decision to delicense the installation was signed in late 2002 by the Director General for Nuclear Safety and Radiation Protection. This decision was followed by signing of the conventional constraints on behalf of the State on 7 November 2006.

2 | 4 | 2

The Strasbourg University reactor

ASN inspection of a bunker installed for decommissioning work on the Strasbourg University reactor on 4 October 2006

Very similar in design and characteristics to the CEA Ulysse reactor at Saclay, the Strasbourg University reactor (RUS- BNI 44) at Louis Pasteur University was mainly used for experimental irradiations and the production of short-lived radioisotopes.

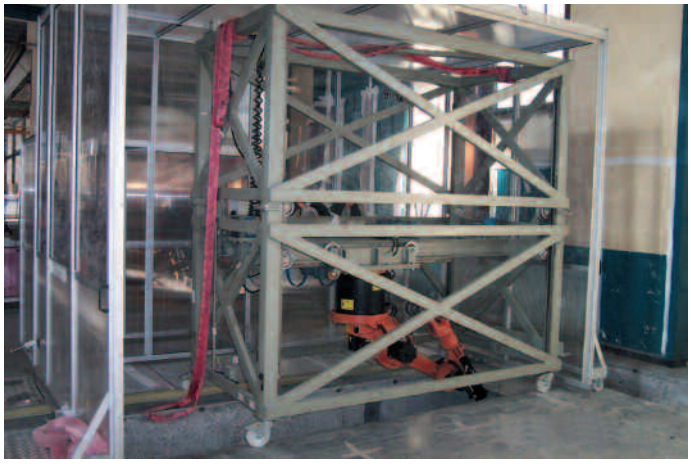
The decree authorising Louis Pasteur University in Strasbourg to proceed with final shutdown and decommissioning was published in the Official Gazette of 22 February 2006. The decommissioning work began in the second half of 2006 and should be completed at the beginning of 2008.

ASN considers that the work is progressing satisfactorily.

2 | 4 | 3

SICN plant in Veurey-Voroize

Two nuclear installations, BNIs 65 and 90, grouped together on the site of the SICN company (AREVA Group) in Veurey-Voroize, make up this establishment. Work involving the fuel elements used in experimental reactors and fabrication of fuel pellets with all enrichment levels has now finally ceased. Final shutdown operations took place between 2000 and the end of 2005. The decrees authorising final shutdown and decommissioning operations were published in February 2006, thus enabling the decommissioning work to begin. A pilot worksite, designed to define the techniques to be employed for cleaning-out the site buildings, started in 2005. Experience feedback from this site was integrated into the complete clean-out methodology for the installations, which was transmitted



Adjustment of a bush hammering robot (pilot worksite) – SICN

to ASN. Furthermore, a dossier presenting the management strategy for the site soil and earth, polluted by former activities, was also sent to ASN. This dossier underwent a review, after which ASN requested a certain amount of additional information, which should be transmitted in 2007.

ASN considers that the decommissioning work is progressing satisfactorily according to a methodology that it itself approved. However, ASN asked the licensee to exercise particular vigilance regarding disposal of the legacy materials and waste which could compromise the safety of these worksites.

2 | 4 | 4

The Miramas interim storage facility

The COGEMA Miramas establishment was created in 1983. It was a warehouse for solid and stable compounds of natural, enriched or depleted uranium and uranium hexafluoride (UF6). Store clearance operations took place from the end of 2002 to the end of 2003 and the warehouse was com-

pletely empty of nuclear materials by 1 January 2004. The decree authorising the final shutdown and decommissioning of the installation was published in February 2006, and enabled the licensee to proceed with cleaning and clean-out operations, which ended in September 2006.

3 THE FINANCING OF DECOMMISSIONING AND RADIOACTIVE WASTE MANAGEMENT

Financing the future cost of decommissioning nuclear installations and managing radioactive waste is an important subject for ASN. Performing the corresponding operations in good conditions of safety depends first of all on the availability of adequate resources as and when the time comes.

In its annual reports, ASN has emphasised the need to set up a system to guarantee that sufficient dedicated funds are available when the time comes, for financing decommissioning of the installations and managing the radioactive waste.

ASN in particular last year stressed the importance of the principles to be followed by the system to be set up, including with regard to regulation.

2005 and 2006, two key years

In January 2005, the Government audit office (*Cour des Comptes*) published a special report entitled "decommissioning of nuclear installations and management of radioactive waste". While recognising the progress made in recent years, this report contained a certain number of remarks and recommendations.

The Audit office monitored their progress and wrote it up in its annual report published in February 2006. In particular, in response to a comment by the Audit Office, EDF stated that it would be speeding up creation of the dedicated funds, in order to move on from the state referred to by the Office as "embryonic" to a level in 2010 corresponding to all of the commitments estimated by EDF.

The Office noted that the resources in the CEA's civil fund, partly based on the sale of Areva shares held by CEA, are severely restricted by the Government's decision not to sell off any more of the Areva capital beyond the current level of 4%.

Programme act 2006-739 of 28 June 2006 concerning the sustainable management of radioactive materials and waste contains an article devoted to the financial resources necessary for decommissioning nuclear installations and managing radioactive waste (article 20).

Furthermore, at European Union level, various actions have been carried out by the European Commission, Parliament and Council. These actions led in 2006 to a number at recommendations European level.

Article 20 of the 28 June 2006 act.

This article in particular stipulates the following points:
- The licensees of BNIs must make a prudent assessment of the cost of decommissioning their installations and of managing their spent fuels and radioactive waste.
- The licensees must set up reserves for these costs and ring-fence the assets needed to cover these reserves. No claim may be made on these assets, with the exception of the State in the exercise of its powers to compel the licensees to meet their obligations.
- Every three years, the licensees must submit a report to the administrative authority (assessment of costs, calculation methods, choices concerning the assets and their management) and must

update this report every year, immediately notifying the authority of any important events in this field. The licensees must transmit their first three-year report no later than mid-2007, including a plan for creation of the necessary assets.
– The administrative authority may prescribe the necessary measures for regularising an unsatisfactory situation.
– A national commission for assessing the financing of BNI decommissioning costs and spent fuel and radioactive waste management costs is set up to evaluate the supervision of the adequacy of the reserves for meeting future costs and of asset management. It must submit a report to Parliament and to the High Committee for Transparency and Information on Nuclear Safety. This report will be made public.

ASN observes that article 20 of the 28 June 2006 act is indeed in line with the principles mentioned in its 2005 annual report.

As in certain countries, ASN has to contribute to reviewing implementation. It will naturally be involved in defining scenarios and hypotheses and more generally in dealing with the various aspects of the estimation methodology.

4 Outlook

The regulations for operations linked to BNI decommissioning was redefined in 2003 after a revision process of several years, in order to encourage the licensees to carry out decommissioning of the closed installations as early as possible.

This process was considerably simplified by considering that the life of an installation was on the whole governed by two decrees, the first covering operations and the second covering the final shutdown and decommissioning of a BNI, whereas beforehand, several decrees had been necessary to regulate the various stages of decommissioning. These principles were also incorporated into the nuclear transparency and safety act of 13 June 2006 and will be included in the decrees implementing the act.

The licensees thus submitted numerous final shutdown and decommissioning applications for their installations. Since the first application was submitted, about twenty decrees have been published in the Official Gazette and a further twenty are currently under review.

Feedback from decommissioning either completed or in progress confirms the technical feasibility of complete decommissioning and places these complete decommissioning operations in a regulation that is both clear and flexible enough to adapt to the changing nature of decommissioning operations. This framework, which is enshrined in law, should lead the licensees to envisage all of the operations up to and including delicensing of the installation and each step in decommissioning can itself be the subject of particular authorisations under the terms of the decree.

Experience feedback from the first decrees also shows that it is possible to issue authorisations covering several decades, such as those intended for the decommissioning of Superphénix, or for periods of only a few years, such as those intended for smaller research facilities (the Strasbourg University reactor for example).

ASN ensures that these decommissioning operations conform at all times to an overall, coherent safety approach taking account of safety and radiation protection constraints both in the choice of scenarios and the main steps involved and in the criteria initiating decommissioning of each of the installations of the main nuclear licensees.

ASN also asked EDF, CEA and COGEMA to produce dossiers giving an overall description of the their strategy and schedule for decommissioning of the many shut down installations, giving safety and radiation protection justifications. In 2004, ASN concluded its review of EDF's overall decommissioning strategy for the first generation reactors and in 2007 and 2008 will adopt a stance on the overall decommissioning strategy for the CEA and COGEMA civil installations.

2006 was marked by numerous new applications for final shutdown and decommissioning decrees, in particular those for the Grenoble STED/STEL and the LAMA, clearly indicating that this CEA centre as a whole will soon be completely delicensed.

EDF also requested final shutdown and decommissioning of four older generation reactors: Bugey in the Lyons area, Saint Laurent A1 and A2 and Chinon A3 in the Centre region, meaning that 7 of the 9 reactors of this generation have now requested complete decommissioning.

ASN considers that initial experience feedback from the decommissioning carried out by the licensees, including the working of the internal authorisations system, is on the whole satisfactory.

The feasibility of total decommissioning nonetheless depends on the creation of appropriate channels for all the decommissioning waste produced, in particular the graphite waste, which remains a subject of concern for ASN (see chapter 16).

Finally, ASN is satisfied that the 28 June 2006 act on sustainable management of radioactive materials and waste, in particular its article 20, gives due consideration to the procedures for financing the management of radioactive waste and decommissioning. ASN will be involved in defining scenarios and hypotheses and more generally in dealing with the various aspects of the estimation methodology, which is satisfactory.

In 2007, ASN intends to further adapt the regulations to take account of experience feedback gained in previous years. The following are therefore planned:
- preparation of a regulation tailored to decommissioning, pursuant to the TSN act which implements the principles established in 2003;
- formalisation of the methodology and principles for assessing the safety of installations being decommissioned;
- formalisation of the procedures for delicensing BNIs following complete decommissioning;
- initiation of a process to look at the treatment of polluted soils in BNIs, based on experience feedback from licensee pilot worksites, consistent with the overall approach to non-BNI polluted soil treatment;
- evaluation of the processes leading to internal authorisations at the main licensees and incorporation of experience feedback into the corresponding review guides.

As early as possible, ASN also aims to review the decommissioning decree applications from the nuclear licensees, of which there are about ten for 2007-2008. Against this backdrop, regulation of the decommissioning of the UP2-400 plant in La Hague, which is a particularly large project, will be a priority.

5 List of basic nuclear installations delicensed as at 31.12.2006

Installation LOCATION	BNI	Type of installation	Com-missioned	Final shutdown	Final regulatory procedures	Current status
NÉRÉIDE FAR*	(former BNI 10)	Reactor (500 kWth)	1960	1981	1987: Removed from BNI list	Decommissioned
TRITON FAR*	(former BNI 10)	Reactor (6.5 MWth)	1959	1982	1987: Removed from BNI list and classified as ICPE	Decommissioned
ZOÉ FAR*	(former BNI 11)	Reactor (250 kWth)	1948	1975	1987: Removed from BNI list and classified as ICPE	Confined (museum)
MINERVE FAR*	(former BNI 12)	Reactor (0.1 kWth)	1959	1976	1977: Removed from BNI list	Dismantled at FAR and reassembled at Cadarache
EL 2 Saclay	(former BNI 13)	Reactor (2.8 MWth)	1952	1965	Removed from BNI list	Sealed source
EL 3 Saclay	(former BNI 14)	Reactor (18 MWth)	1957	1979	1988: Removed from BNI list and classified as ICPE	Partially decommission-ed, remaining parts confined
PEGGY Cadarache	(former BNI 23)	Reactor (1 kWth)	1961	1975	1976: Removed from BNI list	Decommissioned
CÉSAR Cadarache	(former BNI 26)	Reactor (10 kWth)	1964	1974	1978: Removed from BNI list	Decommissioned
MARIUS Cadarache	(former BNI 27)	Reactor (0.4 kWth)	1960 in Marcoule, 1964 in Cadarache	1983	1987: Removed from BNI list	Decommissioned
LE BOUCHET	(former BNI 30)	Ore processing	1953	1970	Removed from BNI list	Decommissioned
GUEUGNON	(former BNI 31)	Ore processing		1980	Removed from BNI list	Decommissioned
ALS	(former BNI 43)	Accelerator	1965	1996	2006: Removed from BNI list	Cleaned up-easements (***)
SATURNE	(former BNI 48)	Accelerator	1958	1997	2005: Removed from BNI list	Cleaned up-easements (***)
ATTILA** FAR*	57	Reprocessing pilot	1966	1975		Decommissioned
BAT 19 FAR*	(former BNI 58)	Plutonium metallurgy	1968	1984	1984: Removed from BNI list	Decommissioned
LCAC Grenoble	(former BNI 60)	Fuels analysis	1968	1984	1997: Removed from BNI list	Decommissioned
ARAC Saclay	(former BNI 81)	Fabrication of fuel assemblies	1975	1995	1999: Removed from BNI list	Cleaned up
IRCA	(former BNI 121)	Irradiator	1981	1996	2006: Removed from BNI list	Cleaned up-easements (***)
FBFC Pierrelatte	(former BNI 131)	Fuel fabrication	1983	1998	2003: Removed from BNI list	Cleaned up-easements (***)
SNCS Osmanville	(former BNI 152)	Ioniseur	1990	1995	2002: Removed from BNI list	Cleaned up

(*) Fontenay-aux-Roses - (**) Attila: Reprocessing pilots located in the BNI 57 cell - (***) Easements: conventional easements on behalf of the State were taken out on the plots concerned.

6 LIST OF BASIC NUCLEAR INSTALLATIONS FINALLY SHUTDOWN AS AT 31.12.2006

Installation LOCATION	BNI	Type of installation	Commissioned	Final shutdown	Final regulatory procedures	Current status
CHOOZ AD (FORMER CHOOZ A)	163 (former BNI 1, 2, 3)	REACTOR (1040 MWth)	1967	1991	1999: Partial decommissioning decree for Chooz A and creation of the Chooz AD interim storage BNI	Partially decommissioned, modified to BNI for interim storage of waste left on-site
CHINON A1D (FORMER CHINON A1)	133 (former BNI 5)	REACTOR (300 MWth)	1963	1973	1982: Chinon A1 confinement decree and creation of the Chinon A1D interim storage BNI	Partially decommissioned, modified to BNI for interim storage of waste left on-site (museum)
CHINON A2D (FORMER CHINON A2)	153 (former BNI 6)	REACTOR (865 MWth)	1965	1985	1991: Partial decommissioning decree for Chinon A2 and creation of the Chinon A2D interim storage BNI	Partially decommissioned, modified to BNI for interim storage of waste left on-site
CHINON A3D (FORMER CHINON A3)	161 (former BNI 7)	REACTOR (1360 MWth)	1966	1990	1996: Partial decommissioning decree for Chinon A3 and creation of the Chinon A3D interim storage BNI	Partially decommissioned, modified to BNI for interim storage of waste left on-site
MÉLUSINE GRENOBLE	19	REACTOR (8 MWth)	1958	1988	2004: Decommissioning authorisation decree	Decommissioning in progress
SILOÉ GRENOBLE	20	REACTOR (35 MWth)	1963	1997	2005: Decommissioning authorisation decree	Decommissioning in progress
SILOETTE GRENOBLE	21	REACTOR (100 kWth)	1964	2002	2005: Decommissioning authorisation decree	Decommissioning in progress
RAPSODIE CADARACHE	25	REACTOR (40 MWth)	1967	1983		Decommissioning in progress
EL 4D (FORMER EL4 BRENNILIS)	162 (former BNI 28)	REACTOR (250 MWth)	1966	1985	1996: Decree ordering decommissioning and creation of the EL-4D interim storage BNI	Decommissioning in progress
SPENT FUEL REPROCESSING PLANT (UP2) (LA HAGUE)	33	Transformation of radioactive materials	1694	2004	2003: Boundary change	In the process of being shutdown
EFFLUENT AND SOLID WASTE TREATMENT STATION (STE2) AND SPENT NUCLEAR FUELS REPROCESSING FACILITY (AT1) (LA HAGUE)	38	Reprocessing of fast fuels	1969	1979		Cleaned up

6 Liste des installations nucléaires de base arrêtées définitivement au 31.12.2006 (suite)

Installation LOCATION	BNI	Type of installation	Commissioned	Final shutdown	Final regulatory procedures	Current status
HARMONIE Cadarache	41	Reactor (1 kWth)	1965	1996	2004: Final shutdown and decommissioning decree	Decommissioning in progress
Strasbourg university reactor	44	Reactor (100 kWth)	1967	1997	2006: Final shutdown and decommissioning decree	Decommissioning in progress
BUGEY 1	45	Reactor (1920 MWth)	1972	1994	1996: Final shutdown decree	Final shutdown in progress
ST-LAURENT A1	46	Reactor (1662 MWth)	1969	1990	1994: Final shutdown decree	Final shutdown in progress
ST-LAURENT A2	46	Reactor (1801 MWth)	1971	1992	1994: Final shutdown decree	Final shutdown in progress
ÉLAN II B La Hague	47	Fabrication of Cs 137 sources	1970	1973		Decommissioning in progress
High Level Laboratory (LHA) Saclay	49	Laboratory	1960	1996		Final shutdown in progress – some cells still active
ATUE Cadarache	52	Uranium processing	1963	1997		Clean-up in progress
LCPu FAR*	57	Plutonium chemistry laboratory	1968	1995		Final shutdown in progress
RM2 FAR*	59	Radio-metallurgy	1968	1982		Decommissioning in progress
LAMA Grenoble	61	Laboratory	1668	2002		Final shutdown in progress
HAO (high level oxide) facility (La Hague)	80	Transformation of radioactive materials	1974	2004	2003: Boundary change	Final shutdown in progress
SUPERPHENIX Creys-Malville	91	Reactor (3000MWth)	1985	1997	1998: Final shutdown decree	Final shutdown in progress

(*) Fontenay-aux-Roses

CHAPTER 15

SAFE FINAL SHUTDOWN AND DECOMMISSIONING OF BASIC NUCLEAR INSTALLATIONS