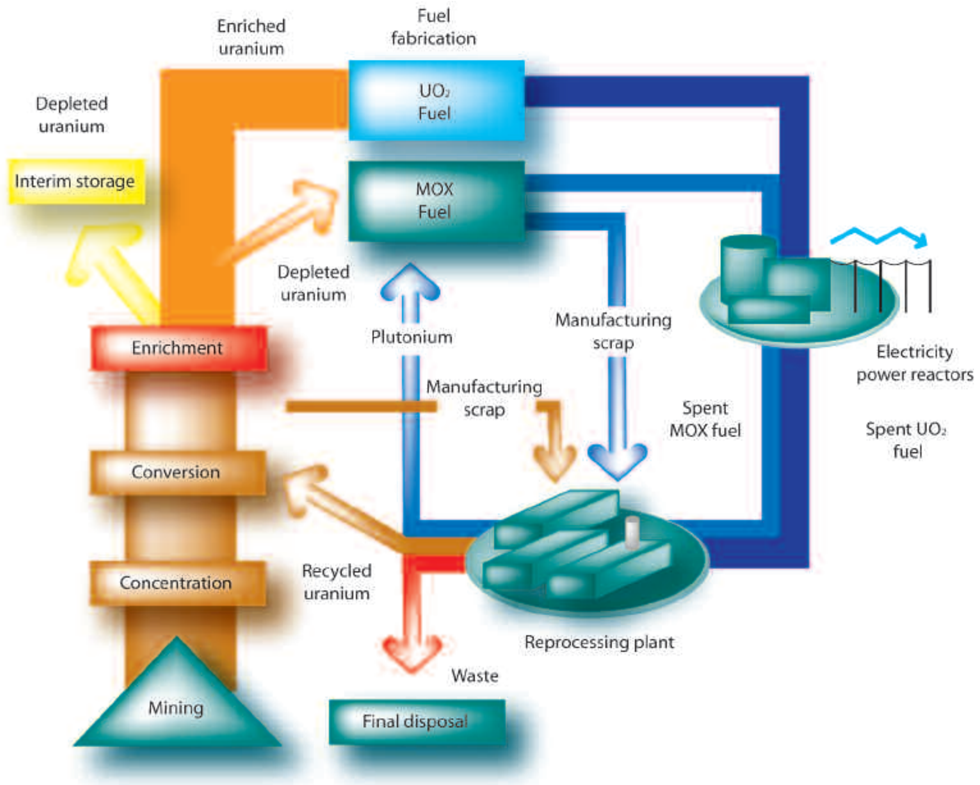
NUCLEAR FUEL CYCLE INSTALLATIONS

CHAPTER 13

Fuel cycle



Manufacture of the fuel and its subsequent reprocessing after it has passed through the nuclear reactors constitute the fuel cycle. The cycle begins with extraction of the uranium ore and ends with disposal of a range of radioactive waste streams arising from the spent fuel.

The uranium ore is extracted, then purified and concentrated into "yellow cake" on the mining sites. The solid yellow cake is then converted into uranium hexafluoride gas during the conversion operation. This is done in the Comurhex facilities in Malvési (Aude *département*) and Pierrelatte (Drôme *département*) and is the essential first step in the enrichment process. The installations involved - which are not regulated as basic nuclear installations (BNIs) - use natural uranium whose uranium 235 content is about 0.7%.

Most of the world's reactors use uranium which is slightly enriched with uranium 235. For example, the pressurised water reactor (PWR) series requires uranium enriched to between 3 and 5% with isotope 235. The uranium must therefore be enriched with isotope 235, in other words have its content increased from 0.7 to 3-5%. In the Eurodif plant at Tricastin, the uranium hexafluoride is separated using a dual flow gaseous diffusion process, one of which becomes enriched with uranium 235 while the other becomes depleted during the course of the process.

The enriched uranium hexafluoride is then converted into uranium oxide to allow manufacture of fuel assemblies in the FBFC and CERCA plants at Romans-sur-Isère. The assemblies are then placed in the reactor core where they release power by fission of the uranium 235 nuclei.

After about three years, the spent fuel is removed from the reactor and cooled in a pond, first of all on the plant site and then in the COGEMA reprocessing plant at La Hague.

In this plant, the uranium and plutonium from the spent fuels are separated from the fission products and the other actinides. The uranium and plutonium are packaged for interim storage before subsequent reuse. The radioactive waste is placed in a surface repository if low-level, or in interim storage pending an appropriate disposal solution.

The plutonium resulting from reprocessing can be used to manufacture fuel for fast neutron reactors (as was done in the ATPu in Cadarache). Alternatively, in the Marcoule Mélox plant, it can be used to manufacture the MOX fuel (mixture of uranium and plutonium oxides) used in the French 900 MWe PWR reactors.

The main plants in the fuel cycle belong to the AREVA group.

Fuel cycle industry throughput (1)

Installation	Material processed	Tonnage	Product obtained	Tonnage
Comurhex Pierrelatte	Uranyl nitrate (based on reprocessed uranium)		UF_4 UF_6 U_3O_8	0 0 466
COGEMA Pierrelatte TU5 facility	Uranyl nitrate (based on reprocessed uranium)	5 408	U_3O_8	1 629
COGEMA Pierrelatte W plan t	UF_6 (based on depleted uranium)	12 530	U_3O_8 produced (in tU) U_3O_8 stored (in tU)	9 999 8 960
Eurodif Pierrelatte	UF_6 (based on uranium) UF_6 (based on enriched uranium) UF_6 (based on depleted uranium)	14 042 1 184 1 037	UF_6 (natural uranium) UF_6 (depleted uranium) UF_6 (enriched uranium)	0 14 311 2 300
FBFC Romans	UF_6 based on enriched natural uranium) UF_6 (based on enriched reprocessed uranium)	850 19	UO_2 (powder) UO_2 (fuel elements) UO_2 (URE - fuel elements)	0 540 18
MELOX Marcoule	UO_2 (based on depleted uranium) PuO_2	162,9 12,0	MOX (fuel elements)	144,6 thm*
COGEMA La Hague	Reprocessed spent fuel elements UP3 UP2 800 UP2 400 Spent fuel elements unloaded into pon d	 698 317 0 1 265	NU produced PuO_2 produced Vitrified waste packages produced UP3 (number of containers) UP2 800 (number of containers)	921,8 11,8 499 485

(1) The table only deals with the movements inside fuel cycle BNIs, including those in the COGEMA W plant, which is an ICPE (installation classified on environmental protection grounds) located within the boundary of a BNI.
* Tons of heavy metal.

1 MAIN TOPICS COMMON TO ALL INSTALLATIONS

1 | 1

Fuel cycle consistency

ASN regulates the overall safety-related and regulatory consistency of the industrial choices made with regard to fuel management. The question of the long-term management of spent fuel, mining residues and depleted uranium cannot be ignored, and the risks and uncertainties surrounding these industrial choices must be taken into account.

EDF was asked to undertake a forward-looking study in cooperation with the fuel cycle companies, presenting elements concerning compatibility between changes in fuel characteristics or spent fuel management systems and fuel cycle installation developments.

The data presented by EDF and reviewed to date provide significant clarification of how the fuel cycle operates and the safety issues involved, in particular how changes to fuel management policies may result in changes to the technical and regulatory limits, subject to adequate justification.

In order to maintain an overview of the fuel cycle, the data will have to be periodically updated. For any new fuel management system, EDF will be required to present a feasibility study, together with a revision of the "nuclear fuel cycle" dossier, specifying and justifying any modifications and deviations.

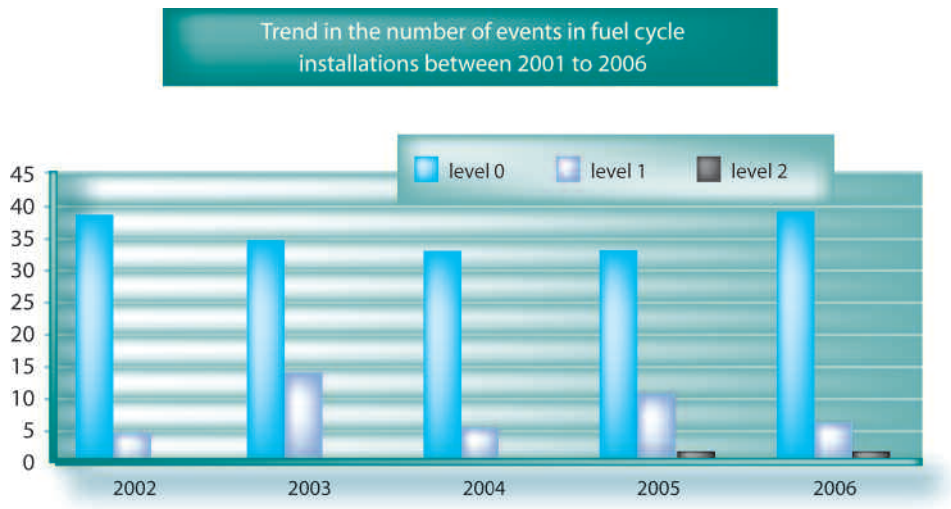
One of ASN's aims is to anticipate and hence avoid saturation of the nuclear power plant interim storage capacity that has happened in other countries, and to prevent the licensees from using older installations as a palliative interim solution, given that the regulatory and technical requirements to obtain authorisation are less stringent for older facilities.

1 | 2

Event management and operating feedback

The detection and processing of significant events that have occurred during operation of the installations play a fundamental safety role. The lessons learned from these events lead to new requirements applicable to safety-related items and to new operating rules. Licensees must therefore set up reliable systems for detecting, correcting and learning lessons from all safety-related events.

The following graph presents the trend in the number of significant events reported by fuel cycle installations.



ASN's monitoring of these events and how they are managed by the licensees in particular enables it to identify:
- events recurring on the same installation;
- events requiring operating feedback to other installations to confirm or invalidate their generic nature, in other words affecting or likely to affect several installations belonging to one or more licensees.

1 | 3

Licensee responsibility

Nuclear installation safety is primarily based on the supervision carried out by the licensee itself. In this respect, for each installation, ASN checks that the organisation and resources deployed by the licensee enable it to assume this responsibility.

The restructuring of the AREVA group has led ASN to exercise increased vigilance in this area, in particular with respect to the small installations. It is important that the fact of centralising resources, particularly financial resources, enables each nuclear licensee to continue to assume its responsibility as licensee. It is important that centralised resources, particularly finance resources, do not constrain site licensee ability to discharge its responsibilities as a licensee

Moreover, to further increase licensee accountability and rationalise its regulatory actions, ASN asked COGEMA to propose a system of internal authorisations for changes to installations or safety reference frameworks which do not compromise the safety case. Only operations which do not fall outside the scope of the authorisation decree or the technical specifications of the installation could be dealt with using this process. Significant modifications will still be submitted to ASN for approval. 2006 was an opportunity to further review with the licensee the practicalities of using this system on the La Hague units in the final shutdown phase.

2 MAIN INSTALLATIONS

2 | 1

Uranium conversion and processing plants

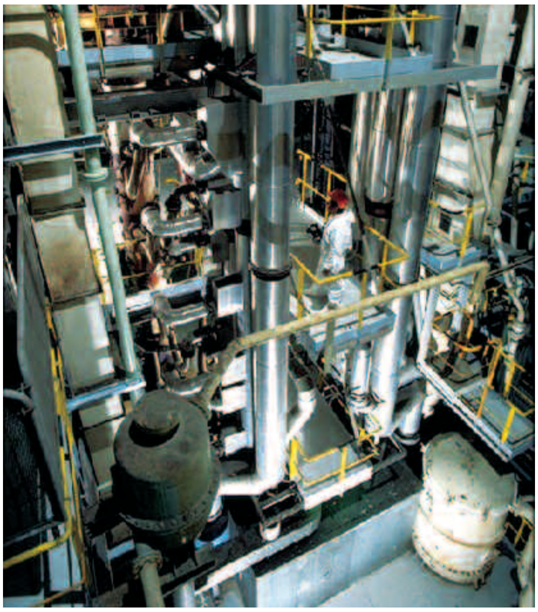
To allow production of fuels usable in the French reactors, uranium ore first has to be converted into UF_6 and then enriched.

2 | 1 | 1

Comurhex uranium hexafluoride preparation plant

The Comurhex plant in Pierrelatte is designed to manufacture uranium hexafluoride.

This production uses natural uranium in the ICPE part of the plant, or reprocessed uranium in the BNI part of the plant. The latter plant consists of two facilities:
- the 2000 facility, which converts uranyl nitrate from the reprocessing plants into UF_4 or into U_3O_8;
- the 2450 facility, which converts the UF_4 (whose uranium 235 content is between 1 and 2.5%) from the 2000 facility into UF_6. This UF_6 will be used to enrich the reprocessed uranium for recycling in the reactor.



Comurhex plant at Pierrelatte

Structure 2450 was shut down by the licensee in 2002.

Since then, 235U levels have been limited to strictly lower than 1% for all activities in the Comurhex BNI, which could enable the licensee to benefit from downgrading to an ICPE rather than a basic nuclear installation.

In 2004, the licensee also notified ASN of its intention to close down the 2000 facility and decommission the entire BNI no later than 31 December 2008.

2 | 1 | 2

COGEMA TU5 facility and W plant

On the Pierrelatte site, COGEMA operates:

- the TU5 facility (BNI) for conversion of uranyl nitrate (UO_2 $(NO_3)_2$), produced by reprocessing spent fuel, into uranium tetrafluoride (UF_4) or into uranium oxide (U_3O_8). However, the current technical configuration of the installation is not compatible with the production of UF_4. The installation can handle up to 2000 (ou 20,000?) metric tons of uranium per year;

TU5 – drying of concentrate on belt filter in TU5 facility

- the W plant (ICPE within the BNI boundary) for conversion of depleted uranium hexafluoride (UF_6) into uranium oxide (U_3O_8), which is a solid component offering safer storage conditions.

The uranium from reprocessing is partly placed in interim storage on the COGEMA Pierrelatte site and partly sent abroad for enrichment.

2 | 2

Uranium enrichment plants

2 | 2 | 1

The uranium isotopes gaseous diffusion separation plant (Eurodif)

The isotope separation process used in the plant is based on gaseous diffusion. The plant comprises 1,400 cascaded enrichment modules, split into 70 sets of 20 modules grouped in leak-tight rooms.

The gaseous enrichment principle consists in repeatedly diffusing UF_6 gases through porous walls called “barriers”. These barriers give preferential passage to the uranium isotope 235 contained in the gas, thereby increasing the proportion of this fissile isotope in the UF_6 at each passage.

Each enrichment module has a compressor for raising the UF_6 gas to the required pressure, an exchanger removing the heat produced by compression and the actual diffuser containing the barriers.

The 235U enriched diffused gas flow is routed to the next higher module. The depleted, non-diffused flow is routed to the lower module. These modules or stages, grouped in four gaseous diffusion plants, constitute the enrichment cascade.

The UF_6 is introduced in the middle of the cascade, with the enriched product drawn off at one end and the depleted residue at the other.

This plant will be closed shortly after 2010.

2 | 2 | 2

The GBII ultracentrifugation enrichment plant project

The ultracentrifugation process should eventually replace gaseous diffusion. This process involves rotating a cylindrical bowl containing uranium hexafluoride (UF_6) at very high speed. The centrifugal force concentrates the heavier molecules (containing uranium 238) on the periphery, while the lighter ones (containing uranium 235) migrate towards the centre.

The future licensee, the Société d’enrichissement du Tricastin (SET), envisages start-up of two production units between 2007 and 2013.

These plans for a new plant were the subject of:

- a public debate in autumn 2004;
- a public enquiry from 12 June to 21 July 2006.

They were also presented to the interministerial commission for basic nuclear installations at the end of 2006.

As none of the consultations led to any form of opposition, the installation should receive its authorisation decree in 2007.

GBII – installation worksite

2 | 3

Nuclear fuel fabrication plants

After the uranium enrichment process, the nuclear fuel is made in different installations, depending on its final destination. The UF_6 is converted into uranium oxide powder so that after processing it can be made up into fuel rods, themselves subsequently assembled to form fuel assemblies.

Depending on whether the fuel is intended for PWRs, fast reactors or experimental reactors, and depending on the fissile material it contains, it is manufactured in one of the following establishments: FBFC at Romans-sur-Isère or Mélox at Marcoule, this latter plant being designed to produce fuel containing plutonium.

2 | 3 | 1

The FBFC and CERCA uranium-based fuel fabrication plants

The two basic nuclear installations located on the Romans-sur-Isère site, where they share a number of common facilities, belong to the CERCA and FBFC companies respectively. These two companies are now part of the AREVA group's fuel sector. Under the terms of decree 63-1228 of 11 December 1963, as amended, concerning nuclear installations, the FBFC company is the site's sole nuclear licensee.

The CERCA plant comprises a series of facilities for the manufacture of highly enriched uranium fuel for experimental reactors. FBFC plant production, consisting of uranium oxide powder or fuel assemblies, is intended solely for light water reactors (PWR or BWR).

FBFC fuel elements fabrication plant

In 2002, the licensee submitted a request for an increase in the annual production capacity and an extension of the plant's perimeter. The licensee's production target is an annual capacity raised to:
- 1,800 tons for the conversion facility;
- 1,400 tons for the rod, pellet and assembly lines.

Authorisation was given in the decree of 20 March 2006.

At the same time, further to the periodic safety review carried out in 2003, the licensee proposed renewing and modernising its industrial tool. This project was accepted by ASN. The resulting site modernisation process should run until 2008.

FBFC – new autoclaves

CERCA plant

The CERCA company plant, one of the oldest French nuclear sites, predates publication of the above-mentioned 1963 decree. This installation was therefore simply declared after publication of this decree.

ASN wishes to see the requirements applicable to operation of this plant covered by a decree, as is the case with the FBFC company's fuel fabrication plant. The procedure could be started when the application is submitted for modification of the installations and could be based on the safety review for this plant currently in progress.

In accordance with its program of periodic safety reviews on the installations under its authority, and following that on the FBFC plant in 2003, ASN carried out an overall assessment of safety in CERCA facilities. The conclusions of this assessment were presented to the Advisory Committee for laboratories and plants on 29 November 2006.

2 | 3 | 2

The Mélox uranium and plutonium-based fuel fabrication plant

With the cessation of industrial production in the Cadarache ATPu facility, Mélox is now the only French nuclear installation producing MOX fuel, consisting of a mixture of uranium and plutonium oxides.

Following the decree authorising the plant's annual production capacity to be raised from 101 tons of heavy metal (or 115 tons of oxide) to 145 tons of heavy metal, to absorb the ATPu's order book, the licensee in August 2004 presented a further application to increase the production capacity to 195

Melox – preparation for loading an MX8 packaging

tons of heavy metal. The licensee's latest application was submitted to a public enquiry from 18 April to 17 June 2006.

It was also presented to the interministerial commission on basic nuclear installations at the end of 2006.

As none of these consultations led to any form of opposition, the requested modification should be authorised by decree in 2007.

In the context of the above-mentioned capacity increase, ASN is particularly attentive to ensuring that the licensee continues with and reinforces actions to optimise radiation protection.

2 | 4

COGEMA reprocessing plants at La Hague

2 | 4 | 1

Site description

The La Hague plant, designed for reprocessing of fuel irradiated in the power reactors (GCR then PWR) is operated by the Compagnie générale des matières nucléaires (COGEMA), which replaced CEA as nuclear licensee under the terms of a decree of 9 August 1978.

The various facilities in the UP3, UP2 800 and STE 3 were commissioned from 1986 (reception and interim storage of spent fuel) to 1994 (vitrification facility), with most of the process facilities becoming active in 1989/1990.

The decrees of 10 January 2003 set the individual capacity of each of the two plants at 1,000 tons per year of initial metal (U or Pu), and limit the total capacity of the two plants to 1,700 tons.

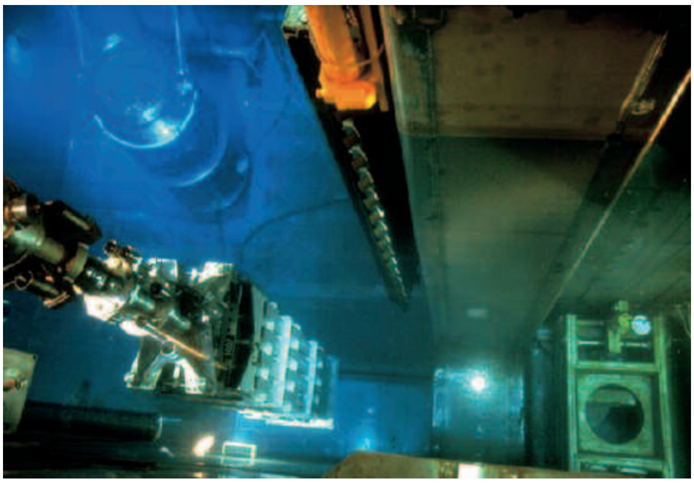
COGEMA La Hague – general view

The COGEMA La Hague site thus houses the following installations:
- BNI 33 covering the UP2 400 plant, which was the first reprocessing unit;
- BNI 38 covering effluent treatment station no. 2 (STE 2) and AT1, a prototype installation currently being decommissioned;
- BNI 47 covering the Élan II B facility, a CEA research facility currently being decommissioned;
- BNI 80 covering the HAO facility, the first PWR fuel reprocessing unit;
- BNI 116 comprising the UP3 plant;
- BNI 117 comprising the UP2 800 plant; and
- BNI 118 comprising effluent treatment station no. 3 (STE 3).

Spent fuel reprocessing in the UP2-400 plant has now stopped. The production facilities in the UP2 400 plant have all been shut down. (see point 3).

Operations carried out in the plant

The main processing chain of these facilities comprises reception and interim storage installations for spent fuel, plus facilities for shearing and dissolving it, chemical separation of fission products, final purification of the uranium and plutonium and waste treatment.



COGEMA La Hague – underwater unloading

First operations at the plant consist in delivery of transport packages and interim storage of spent fuel. Upon arrival at the reprocessing plant, the packages are unloaded, either underwater, in a pond, or dry, in a leak-tight shielded cell. The fuel is then stored in pools.

After shearing of the rods, the spent fuel is separated from its metal cladding by dissolving in nitric acid. The pieces of cladding, which are insoluble in nitric acid, are removed from the dissolver, rinsed in acid and then water and transferred to a packaging unit. The solutions taken from the dissolver are then clarified by centrifugation.

The separation phase consists of initial separation of the fission products and the transuranic elements from the uranium and plutonium contained in the solutions, and then of the uranium from the plutonium.

After purification, the uranium, in the form of uranyl nitrate, is concentrated and stored. This uranyl nitrate is intended for conversion into a solid compound (U_3O_8) in the Pierrelatte TU5 installation.

After purification and concentration, the plutonium is precipitated by oxalic acid, dried, calcinated into plutonium oxide, packaged in sealed boxes and placed in interim storage. The plutonium can be used in the fabrication of MOX fuel. The plutonium from foreign fuel is returned to the licensees in the country of origin.

The La Hague plant facilities

• UP2 400 plant

HAO/North:	underwater unloading and spent fuel interim storage;
HAO/South:	shearing and dissolving of spent fuel elements;
HA/DE:	separation of uranium and plutonium from fission products;
HAPF/SPF (1 to 3):	fission product concentration and interim storage;
MAU:	uranium and plutonium separation, uranium purification and interim storage in the form of uranyl nitrate;
MAPu:	purification, conversion to oxide and initial packaging of plutonium oxide;
LCC:	product central quality control laboratory.

• STE 2 Installation: collection, treatment of effluent and interim storage of precipitation sludges.

• UP2 800 plant

NPH:	underwater unloading and interim storage of spent fuel elements in pond;
C pond:	pond for interim storage of spent fuel elements;
R1:	shearing of fuel elements, dissolving and clarification of solutions obtained;
R2:	separation of uranium, plutonium and fission products (FP), and concentration of FP solutions;
R4:	purification, conversion to oxide and first packaging of plutonium oxide;
SPF (4, 5, 6):	interim storage of fission products;
BST1:	secondary packaging and interim storage of plutonium oxide;
R7:	fission products vitrification.

• UP3 plant

T0 facility:	dry unloading of spent fuel elements;
D and E ponds:	ponds for interim storage of spent fuel elements;
T1:	shearing of fuel elements, dissolving and clarification of solutions obtained;
T2:	separation of uranium, plutonium and fission products, and concentration/interim storage of FP solutions;
T3/T5:	purification and interim storage of uranyl nitrate;
T4:	purification, conversion to oxide and packaging of plutonium;
T7:	vitrification of fission products;
BSI:	plutonium oxide interim storage;
BC:	plant control room, reagent distribution facility and process control laboratories;
ACC:	hull and end-pieces compacting facilities.

• STE 3 facility: effluent recovery and treatment and interim storage of bituminised packages.

The production operations, from shearing up to the finished products, use chemical processes and generate gaseous and liquid effluent. These operations also generate what is called "structural" waste.

The gaseous effluent is given off mainly during cladding shearing and during the boiling dissolving operation. These discharges are processed by washing in a gas treatment unit. Certain residual radioactive gases, in particular krypton, are checked before being discharged into the atmosphere.

The liquid effluent is processed and generally recycled. Certain radionuclides, such as iodine and less active products are, after checking, sent to the marine discharge pipe. The others are sent to facilities for encapsulation (glass or bitumen).

Solid waste is packaged on the site. Two methods are used: compacting and encapsulation in cement.

In accordance with article L. 542-2 of the Environment Code concerning radioactive waste management, radioactive waste from irradiated fuels of foreign origin must be shipped back to its owners. Radioactive waste from irradiated fuels of French reactors is sent to the Soulaines (Aube) repository or stored pending a final disposal solution.

Interim storage pond for spent fuel from nuclear power plants

2 | 4 | 2

Scope of plants operations authorisations

The revision of the La Hague site nuclear installations authorisation decrees, which was completed on 10 January 2003, is a technical decision designed to allow changes to the activities in the installations in satisfactory conditions of safety and environmental protection, and in conformity with the regulations.

The reference fuel elements for which reprocessing was envisaged at the time of publication of the old decrees are relatively unrepresentative of the fuel elements currently loaded into the reactors, a difference that will be accentuated in the future. This revision was therefore necessary to allow management of today's fuel movements. The authorised modifications also combine improved nuclear safety with greater environmental protection, through the use of the best available techniques.

Furthermore, the greater diversity in the nature and origin of the materials and substances to be processed, exploiting the potential of each of the UP2 800, UP3 and STE 3 facilities for recycling, processing, packaging or storing radioactive substances (effluent, waste, scrap, etc.) and nuclear materials (uranium, plutonium, new fuels) from other facilities, could prove to be of benefit during decommissioning or when retrieving legacy waste.

The decrees published on 11 January 2003 in the Official Gazette define a new operating framework for the facilities and article 5 requires that any extension of the current operating framework within this new framework, receive specific authorisation issued by interministerial order. The actual operations to process the fuels, substances and materials authorised by interministerial orders must, as now, be the subject of an operational agreement from ASN for each particular processing campaign outside the previously authorised framework. Given the time that elapses between the framework extension authorisation and the actual performance of processing, this will allow a check that the performance conditions envisaged by the operator are compatible with the safety of the facilities and with human and environmental protection.

In 2001, environmental protection associations also took legal action against COGEMA for the alleged illegal import, disposal and reprocessing of spent nuclear fuel from the Australian ANSTO research reactor. Claiming that reprocessing would have taken too long, the plaintiffs asked that the assemblies be returned to the country of origin, on the grounds that they should be regarded as waste. In a decision of 12 April 2005, the Caen court of appeal partially overturned a judgement of the Cherbourg court of first instance dated 3 February 2003 and considered that the nuclear fuel in question did constitute radioactive waste under the terms of the Environment Code, and ordered COGEMA La Hague to produce and to communicate to the plaintiff organisations the operational authorisation for reprocessing the stock of fuel, failing which COGEMA should terminate the presence of all of these materials on French soil. Reprocessing of the assemblies concerned began on 9 June 2005. The above-mentioned order by the Caen court of appeal was confirmed by the Cour de Cassation (supreme court of appeal) on 7 December 2005.

In 2003, environmental protection associations appealed to have the decrees of 10 January 2003 and the discharge license for the La Hague installations invalidated. The Council of State and the Caen administrative court rejected their pleas.

In 2006, an environmental protection association took COGEMA before the Court of first instance to ask for access to the documents concerning the Dutch spent fuel which had reached La Hague. In its judgement of 3 March 2006, the Court ordered COGEMA to provide said association with copies of the reprocessing contracts and a detailed calendar for the return of the waste, with penalties to be paid on a daily basis in the event of non-compliance, but rejected the association's request for release of a precise calendar of the reprocessing operations.

The main authorisations issued

In 2006, ASN issued COGEMA La Hague various authorisations, some of which are summarised below.

– by delegation of the Ministers for Industry and the Environment, the Director General for Nuclear Safety and Radiation Protection signed the interministerial order of 29 September 2006 authorising COGEMA La Hague to receive, store and reprocess drums of waste from French plants manufacturing mixed uranium and plutonium oxide based fuels, in the STE 3 plant's D/E EB facility.

ASN also issued the following operational approvals:

– on 9 August 2006, approval for reprocessing of the 21 tons of MOX fuel that had been taken from light water reactors for at least the past 7 years, and for which the specific burnup is between 30 GWd/t and 45.7 GWd/t and whose initial mass of plutonium and americium does not exceed 4.28%;

– on 2 November 2006, approval to extend the operational framework of the hulls and end-pieces compacting facility (ACC) to packaging of structural waste resulting from the reprocessing of fuel assemblies based on natural uranium with 4.5% enrichment of uranium 235 and for which the specific burnup is between 45 and 60 GWd/t.

2 | 4 | 3

Site discharges and environment monitoring

Discharges from the La Hague site, notably liquid discharges, have on the whole been decreasing over the last fifteen years, whilst reprocessing production has increased. This decrease was obtained through technical enhancements within the plants.

The effluent discharged from this type of facility differs from that from a nuclear reactor and the quantities are larger, as it must be remembered that:
– the La Hague plant reprocesses fuel from about a hundred nuclear reactors;
– this reprocessing involves spent fuel shearing, followed by nitric acid immersion, whereas maximum fuel containment is assured in a reactor. The processing of the radioactive materials contained in these fuels consequently produces different effluents.

The limits specified in the order of 10 January 2003 authorising COGEMA to continue with water intake and liquid and gaseous effluent discharge for operation of the La Hague nuclear site, already entail a significant reduction in the impact on the most exposed population groups: the maximum dose calculated for these groups has in fact been reduced to 0.02 mSv per year.

The order also includes targets for reducing the impact of chemical and radioactive materials, thus meeting the objectives of the 1998 Sintra declaration, as part of the OSPAR convention.

At the beginning of 2006, the licensee submitted a dossier justifying the means to be employed to further reduce discharges and optimise the impact of its activities. The discharge limits and conditions are currently being revised to take account of these analyses and the lessons learned from the first 3 years of implementation of the order.

In addition, the COGEMA La Hague complex publishes a quarterly record of results of measurements carried out in the context of environmental surveillance. This document is sent to the French and British authorities and to the special standing information committee for the COGEMA La Hague complex.

COGEMA La Hague – environmental checks

The 2006 discharges for 1,015 tons of reprocessed fuel are shown below:

Gaseous discharges (TBq per year)	Limits in order of 1984	Limits in order of 2003	2006 discharges	2007 forecast
Tritium	2,200	150	67.8	77.1
Iodine	0.11 (halogens)	0.02	0.00681	0.0055
Rare gases including krypton 85	480000 (gases other than tritium)	470,000	242,000	258,476
Carbon 14		28	14.2	17.18
Others β and γ emitters	0.074 (aerosols emitters α and β)	0.001	0.000106	0.0002
α emitters		0.000 01	0,00000173	0,0000018

Liquid discharges (TBq per year)	Limits in order of 1984	Limits in order of 2003	2006 discharges	2007 forecast
Tritium	37,000	18,500	11,100	13,122
Iodine	/	2.6	1.34	1.5
Carbon 14	/	42[1]	7.46	8.93
Strontium 90	220	12[2]	0.216	0.5
Caesium 137		8[3]	0.623	0.75
Ruthenium 106	/	15	4.80	5
Cobalt 60	/	1.5[4]	0.210	0,25
Caesium 134	/	2	0.0605	0.06
Others β and γ emitters	1700	60[5]	5.24	5.6
α emitters	1.7	0.17[6]	0.0250	0.25

1 This limit value takes account of total carbon 14 discharges in the liquid effluent, assuming elimination of all gaseous discharges.
2 The limit is 2 for normal discharges and 10 for discharges linked to shutdown and decommissioning (MAD) and recovery of legacy waste (RCD).
3 The limit is 2 for normal discharges and 6 for MAD and RCD discharges.
4 The limit is 1 for normal discharges and 0.5 for MAD and RCD discharges.
5 The limit is 30 for normal discharges and 30 for MAD and RCD discharges.
6 The limit is 0.1 for normal discharges and 0.07 for MAD and RCD discharges.

The following table evaluates the impact of the annual discharges, in terms of effective dose, on the "reference groups", in other words the groups of persons among the population for whom exposure from a given source is relatively uniform and who are representative of the persons who receive the highest doses from this source.

Evaluation of annual impact of releases on the reference groups			
Limits in order of 1984	Limits in order of 2003	Actual 2006-2007 discharges	Discharge forecasts
0.120 mSv	0.020 mSv	0.010 mSv	0.009 mSv

3 INSTALLATIONS IN CLOSURE PHASE

3 | 1

Plutonium technology facility (ATPu) and chemical purification laboratory (LPC) at Cadarache

Owing to the fact that the resistance of these facilities to the seismic risk specific to the Cadarache site cannot be demonstrated and their incompatibility with current seismic design rules, COGEMA halted industrial activities in the ATPu in mid-July 2003. The effectiveness of this shutdown was confirmed by ASN inspectors during the course of an unannounced inspection on 1 August 2003.

This shutdown commits the ATPu and the LPC to a common shutdown and decommissioning process to be covered by a decree. Against this backdrop, the licensee submitted in 2006 a common dossier for each of the two installations, pursuant to article 6 ter of the decree of 11 December 1963, along with the impact assessment required by the Environment Code. These documents are currently being analysed by ASN.

Furthermore, in November 2006, a crusher in the ATPu was loaded twice, thus exceeding the maximum mass of nuclear material stipulated for this apparatus. Due to the safety margins designed into the crusher, this incident had no consequences, as the mass loaded into the machine remained far below the physical criticality threshold. Nonetheless, it was made possible by a sequence of human errors and shortcomings in the quality assurance process. This is why ASN decided to rate this incident 2 on the INES scale.

3 | 2

Former COGEMA La Hague installations

3 | 2 | 1

Retrieval of legacy waste

This point is also covered in chapter 16.

Unlike the new UP2 800 and UP3 plants, most of the waste produced during operation of the first plant, UP2 400, was placed in interim storage without packaging for disposal. The operations involved in recovering this waste are technically difficult and require the use of considerable resources. The problems linked to the age of the waste, in particular its characterisation prior to any recovery and reprocessing, confirm ASN's approach to the licensees which is to require that for all projects, they assess the corresponding production of waste and plan for processing and packaging as and when the waste is produced.

Following the November 2005 review of the waste management policy at the La Hague complex by the Advisory Committees for laboratories and plants and for waste, ASN confirmed the need for recovery as early as possible of the sludge stored in the STE 2 silos, the waste in the HAO silo and the silo waste from building 130.

STE 2 sludge

In recent years, processing of STE 2 sludge has been the subject of research and development work, in particular with a view to determining the methods for retrieval and transfer required prior to any packaging. These methods have now been determined and efforts are now being concentrated on the packaging itself.

The packaging system today adopted by COGEMA consists in bituminisation using a process employed in the STE 3 facility. In 2002, COGEMA was authorised to take samples from one of the silos. The result of the analysis conducted in 2003 by ASN and its technical support organisation showed that major developments were still needed before industrial retrieval of the sludge could take place.

In 2004, the licensee therefore forwarded additional justifications to enable packaging to start as of 2005. It also agreed to produce 3,000 drums in the first three years of operation, while continuing to investigate alternative solutions. ASN asked the licensee to validate the chosen scenarios, by carrying out a series of experiments. The feedback from these experiments is currently being reviewed by ASN. If the scenarios of the 2004 dossier are validated by these experimental results, operational approval could be given for industrial scale recovery.

The licensee is also continuing its research into alternative processes. The possibilities are vitrification, ceramisation, cementation and the DRYPAC dry process. The first two were ruled out owing to technical feasibility problems, while the last two require additional research into prior drying of the sludges.

HAO silo and SOC[1]

The HAO silo contains various waste comprising hulls, end-pieces, fines, resins and technological waste resulting from operation of the HAO facility since 1976. The hulls and end-pieces produced by fuel shearing and dissolving were placed in carriers, themselves taken away to their place of interim storage. From 1976 to 1987, the storage site was the HAO silo, which accepted the hulls, end-pieces and carrier lids in bulk. As of 1988, and until 1998, the carriers containing the hulls and end-pieces were exclusively stored in ponds S1, S2 and S3 of the SOC facility.

The decommissioning scenario, presented by the licensee in March 2005, comprises five phases. The first two consist in recovering and packaging the structural waste and the technological waste from the silo. The waste recovered in this way will be transferred to the ACC facility and packaged into CSD-C packages. The third phase involves recovery and packaging of fines and resins. The fourth phase, the last one concerning the silo, consists in recovering waste from the bottom of the silo by an appropriate mechanical system. The fifth phase comprises recovery of the carriers from the SOC, which will be emptied into shuttle drums for routing to the ACC facility.

Recovery requires prior dismantling of the equipment installed on the silo slab, construction of the recovery cell and qualification of the equipment to be used. Initial dismantling work began in 2006.

Silo 130

Following the announcement of postponement of the creation of a graphite waste disposal channel, the licensee stated that its strategy would have to change, but that in any case, the aim of recovering the waste from silo 130 was maintained. The operations will therefore require interim storage of the waste recovered.

The licensee’s current project therefore comprises four phases. The first is to transfer the GCR waste to ECE drums before interim storage in the D/E EDS facility. The second is to empty and treat the water from the silo in the STE installations. The final phases will enable the waste to be recovered from the bottom of the silo along with the rubble.

The first on-site tests are today scheduled for 2010.

Old fission product solutions stored in the SPF2 unit in the UP2 400 plant

To package waste containing fission products from reprocessing of gas-cooled reactor fuel, in particular waste containing molybdenum, the licensee has opted for vitrification with a specific glass for-

1. From the French “Stockage organisé des coques”, organised hull disposal)

mulation. Research focused on cold-crucible production of this glass. The particular advantage of this technique is that higher temperatures can be reached, enabling new glass formulations to be used. Sensitivity analysis of the reference formulation is still ongoing. ASN representatives also visited CEA's "cold-crucible" R&D facilities in Marcoule.

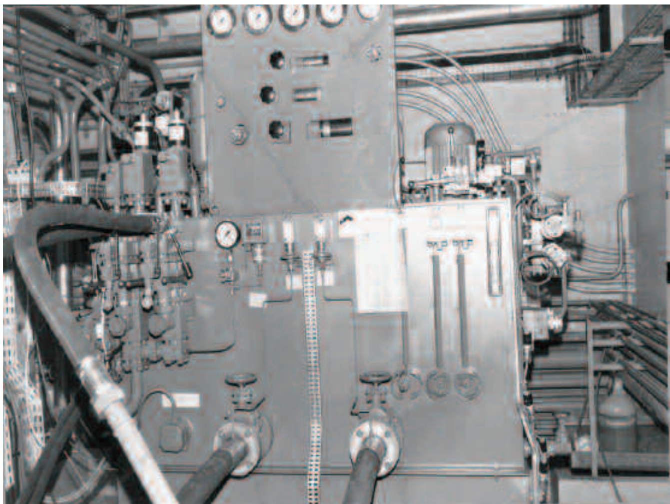
The first cold crucible should enter service on the La Hague site in 2011, for packaging of solutions between 2011 and 2017.

3 | 2 | 2

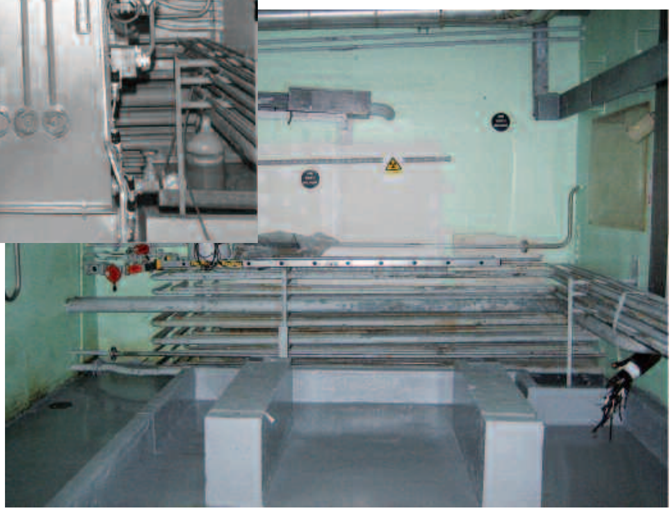
Final closure of the UP2 400 plant and the STE 2 installation

On 30 December 2003, the licensee notified its decision to stop as of 1 January 2004 processing of spent fuel in the UP2 400 facility. This notification came together with a dossier presenting the operations scheduled for the final closure (CDE) phase of the various facilities concerned in this plant and the corresponding effluent treatment station. The licensee took the necessary organisational measures, setting up the ORCADE project to manage the final closure operations for the UP2 400 facilities and the legacy waste recovery programmes.

The CDE phase enables the licensee to carry out certain operations to prepare the installation for the decommissioning phase. These operations must be either covered by the operational framework, or be authorised by ASN. In the case of the HAO/Sud and MAPu facilities, the licensee submitted the safety analysis files for dismantling of certain equipment (in particular gloveboxes and shears) which is no longer needed. Some of these operations began in 2005 and are continuing. In 2006, the licensee in particular focused its efforts on dismantling the equipment in pond 907 of the HAO/Sud facility and the dry process gloveboxes in the MAPu facility.



1976: plant in operation



2006: after disassembly work

COGEMA La Hague – disassembly of the hydraulic plant

ASN also firmly and repeatedly urged COGEMA to submit the final shutdown and decommissioning file (MAD/DEM) as rapidly as possible for the BNIs corresponding to the UP2 400 plant and the STE 2 installation, that is BNIs 33, 38 and 80. The licensee's current approach will involve the production of the MAD/DEM file in several stages. The licensee has therefore agreed to submit the files for BNI 80 in the first quarter of 2007 and those for the other BNIs at the end of the same year. BNI 80 will however continue to receive fuels that cannot be taken by the UP3 and UP2 800 plant facilities until such time as the necessary modifications are made to allow reception of this waste in one of the two plants, and will then carry out transfers to the UP3 and UP2 800 ponds.

4 OUTLOOK

Manufacture of the fuel and its subsequent reprocessing after it has passed through the nuclear reactors constitute the fuel cycle. In 2006, the fuel cycle installations experienced no significant safety problems. However, against a background of increasingly severe economic constraints, the Nuclear Safety Authority is ensuring that the technical solutions chosen by industry have and will continue to have no adverse impact on safety and radiation protection of the workers, the population and the environment.

Since all the licensees in the French nuclear fuel cycle were integrated into the AREVA group, the changes to the various installations are more consistent and efforts are being made to maintain a satisfactory level of safety.

In this respect, a turning point was reached on the Tricastin site in 2006, with the beginning of the procedures to create the new centrifugation enrichment plant and the announced shutdown of old installations such as the Comurhex BNI or Eurodif. ASN considers these changes to be positive and is monitoring correct performance of the corresponding procedures.

On the Romans site, ASN notes that progress has been made with regard to safety and operations and hopes that the production and management of the waste generated by the site will also follow this same trend. In any case, ASN will be attentive to ensuring that the progress achieved is sustainable.

At the Mélox plant in Marcoule, ASN has been particularly attentive to changes in dosimetry. Against the backdrop of the plant's capacity increase, the measures taken to ensure radiation protection and to maintain the quality of operation will be the focal points of ASN regulation over the coming years.

Finally, the efforts devoted every year to regulating the installations on the La Hague site confirm ASN's opinion of the licensee's rigour and responsibility. However, the recovery of legacy waste and the shutdown and decommissioning of a number of old facilities in the UP2 400 plant are among the top priorities and will receive close and sustained attention from ASN.