NUCLEAR FUEL CYCLE INSTALLATIONS

CHAPTER 13

Manufacture of the fuel and its subsequent reprocessing after it has passed through the nuclear reactors constitute the fuel cycle. However, by convention, the cycle begins with extraction of the uranium ore and ends with disposal of a range of radioactive wastes arising from the spent fuel.

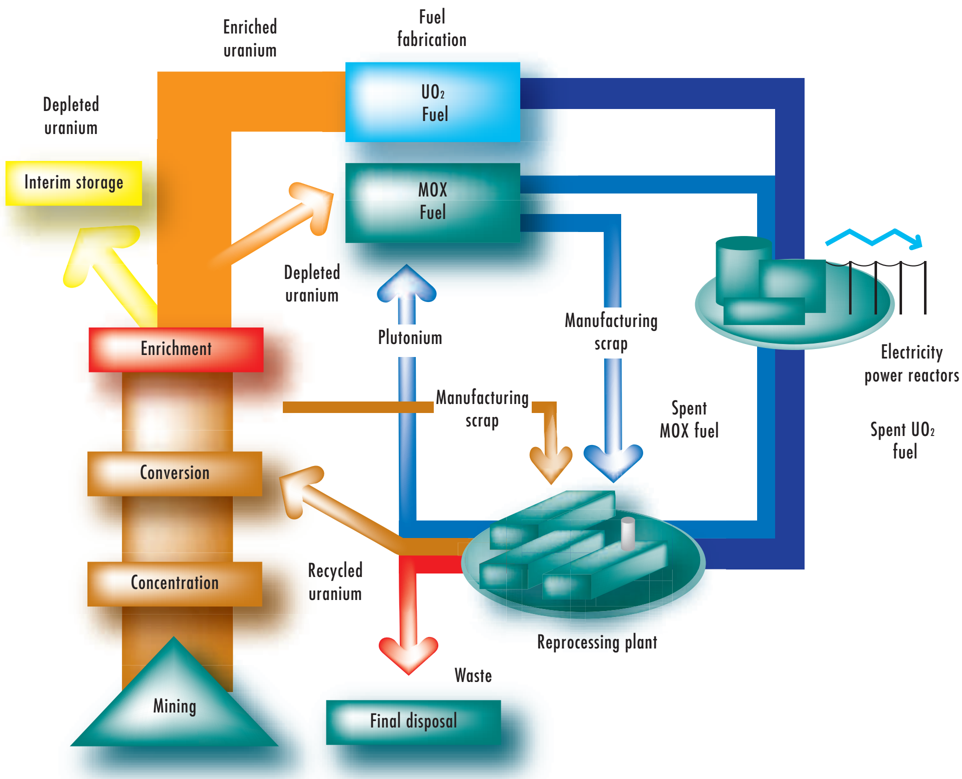
The uranium ore is extracted, then purified and concentrated into "yellow cake" on the mining sites. The solid yellow cake is then converted into uranium hexafluoride gas during the conversion operation. This fabrication of the raw material for enrichment is carried out by COMURHEX in Malvési (Aude *département**) and Pierrelatte (Drôme *département*). 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. Raising the isotopic content of uranium 235 from 0.7% to between 3 and 5% is the role of the EURODIF plant in Tricastin, which separates the uranium hexafluoride by means of a twin-stream gaseous diffusion process, with one stream becoming enriched in uranium 235, while the other becomes depleted during the course of the process.

The process used in the FBFC plant at Romans-sur-Isère transforms the enriched uranium hexafluoride into uranium oxide powder. The fuel pellets manufactured with this oxide are clad to make up the fuel rods, which are then combined to form the fuel assemblies. These assemblies are then placed in the reactor core where they release power by fission of the uranium 235 nuclei.

After about three to five 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 AREVA NC 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 and then stored for subsequent reuse. The radioactive waste produced by these operations is disposed of in a surface repository if low-level, or in storage pending a final disposal solution.



Fuel cycle

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 involved in the fuel cycle – COMURHEX, AREVA NC Pierrelatte, EURODIF, FBFC, MÉLOX, AREVA NC La Hague – are part of the AREVA group.

Fuel cycle industry movements(1)

Installation	Origins	Material processed	Tonnage	Product obtained	Destination	Tonnage (unless otherwise specified)
COMURHEX Pierrelatte	Marcoule INBS **AREVA NC** Pierrelatte Comurhex Pierrelatte	$UO_2(NO_3)_2$ (derived from reprocessed uranium)	469 4	UF_4 UF_6 U_3O_8	/ / INBS	0 0 537
AREVA NC Pierrelatte TU5 facility	**CEA** Marcoule **AREVA NC** La Hague	$UO_2(NO_3)_2$ (derived from reprocessed uranium)	3,667	U_3O_8	Storage	1,097
AREVA NC Pierrelatte W plant	**URENCO** **EURODIF**	UF_6 (derived from depleted uranium)	8,315	U_3O_8	Storage	6,393
EURODIF Pierrelatte	Converters and **EURODIF** Production Re-enrichment of tails	UF_6 (derived from natural and depleted uranium) UF_6 (derived from enriched uranium)	17,382 1,006	UF_6 (depleted uranium) UF_6 (enriched uranium)	Defluorination and re-enrichment of tails Fuel manufacturers	16,542 2,098
FBFC Romans	**EURODIF** Pierrelatte	UF_6 (derived from enriched natural uranium)	819.026	UO_2 (powder) Fuel elements derived from enriched natural uranium	FBFC, Dessel, NFI, ENUSA EDF KOEBERG	291.887 526.8
MELOX Marcoule	**AREVA NC** Pierrelatte **AREVA NC** La Hague	UO_2 (derived from depleted uranium) PuO_2	124.8 9.8	MOX fuel elements	PNPE EDF FBFC-Dessel	124.3
AREVA NC La Hague	*ND*	Reprocessed spent fuel elements UP3 UP2 800 UP2 400 Spent fuel elements unloaded into pond	 698.13 317.06 0 1 264.69	$UO_2(NO_3)_2$ PuO_2 Vitrified waste packages produced in UP3 Vitrified waste packages produced in UP2 800	*ND*	921.8 11.769 499 containers 485 containers

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

1 PRINCIPAL AREAS OF INSTALLATION REGULATION

1 | 1 Ensuring the consistency of the cycle

ASN ensures 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 submitted 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 require 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 type of fuel management, EDF will be required to submit a feasibility dossier for this new management process, specifying and justifying any deviations from the "fuel cycle" dossier previously submitted.

An overall revision of this dossier is expected in 2008.

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

1 | 2 Checking licensee organisation

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 minor installations. It is important that the fact of centralising resources, particularly financial resources, enables each nuclear licensee declared as such to continue to fully assume its responsibility as licensee.

2007 was an opportunity for ASN to measure initial progress in this respect on the Tricastin site. The work being done to manage the site's flooding risk, the project to create a management centre for non-specific industrial waste common to all group licensees and the implementation of internal general transport rules, all demonstrate the determination of the AREVA group to improve coordination between the various licensees on the Tricastin site.

The deployment of the ORCADE project on the La Hague site dedicated to decommissioning installations no longer in use, is also seen by ASN as a positive step towards improving operational consistency.

Finally, when reviewing new projects, ASN pays particular attention to the financial and technical capacity of the licensees and the organisation put in place to ensure that safety is guaranteed from startup to decommissioning of the installations.

1 | 3 Promoting operating experience 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.

Graph 1 (following page) presents the trend in the number of significant events reported by fuel cycle installations.

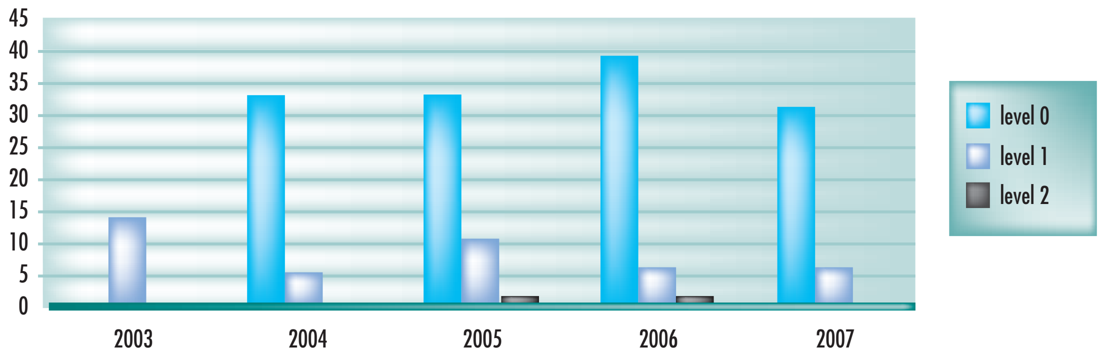
ASN's monitoring of these events and how they are managed by the licensees in particular enables it to identify:

– events recurring on the same installation;

– events requiring operating experience 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.

In terms of operating experience feedback, in a letter dated 17 January 2007, ASN drew the attention of all licensees to two outbreaks of fire caused by a reaction between nitric acid and organic material. ASN asked the various licensees to review the technical and organisational measures implemented to deal with this risk.

Graph 1: evolution of the number of events in fuel cycle installations from 2003 to 2007



2 MAJOR INSTALLATIONS IN OPERATION

2|1 The uranium conversion, processing and enrichment plants in operation at Tricastin

To allow production of fuels usable in the French reactors, uranium ore first has to be converted into UF_6 and then enriched. These operations take place mainly on the Tricastin site, also known as Pierrelatte.

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 transforms reprocessed uranyl nitrate ($UO_2(NO_3)_2$) into uranium tetrafluoride (UF_4) or uranium oxide (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.

Facility 2450 was shut down by the licensee in 2002.

Since then, ^{235}U 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 made known its intention to close down the 2000 facility and decommission the entire BNI no later than 31 December 2008.

The site of the present plant should in the next few years be used for the construction of a new installation classified on environmental protection grounds, comprising the fluorine production and fluorination units. If reprocessed uranium were to be used, this would, as in the past, entail classification of part of these installations as a new basic nuclear installation.

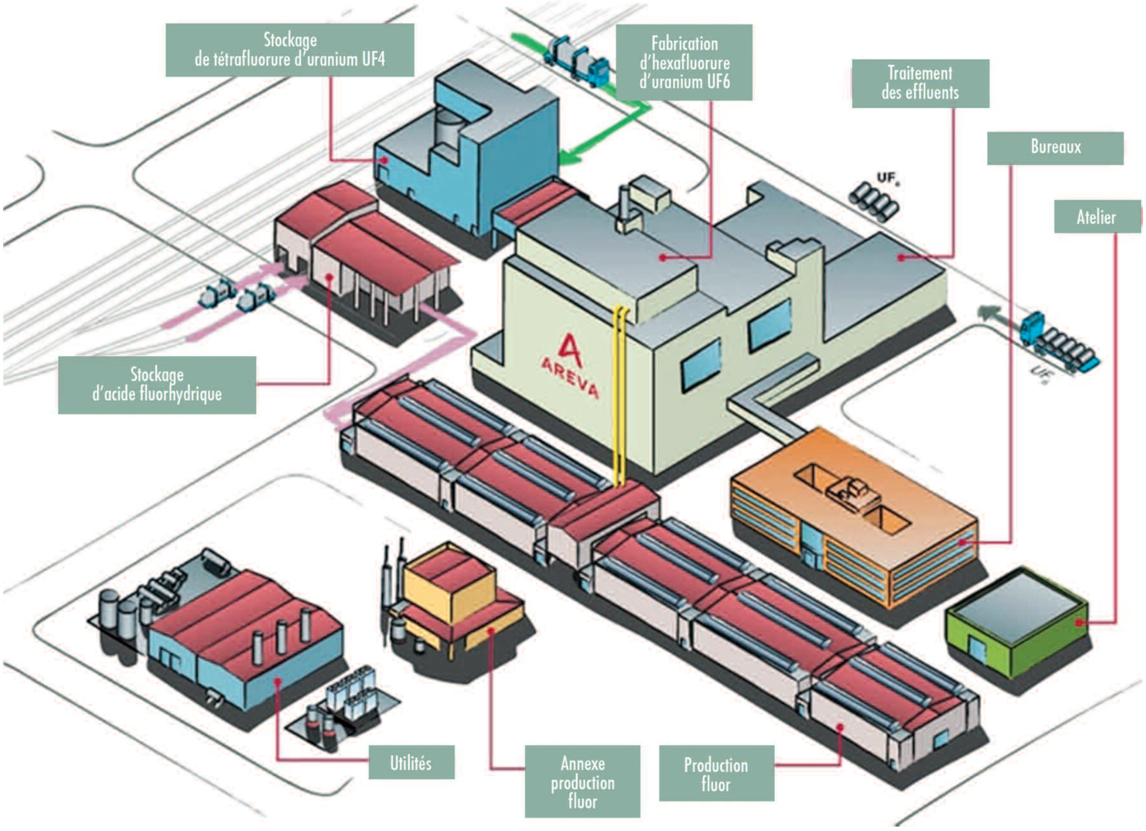
2|1|2 AREVA NC TU5 facility and W plant

On the Pierrelatte site, AREVA NC operates:
– the TU5 facility (BNI) for conversion of $UO_2(NO_3)_2$, produced by reprocessing spent fuel, into UF_4 or into U_3O_8. However, the current technical configuration of the installation is not compatible with the production of UF_4;
– the W plant (ICPE within the BNI perimeter) for conversion of depleted UF_6 into U_3O_8, a solid compound which offers safer storage conditions and can be used to produce hydrofluoric acid.

The installation can handle up to 2,000 metric tons of uranium per year.

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

An incident involving a hydrofluoric acid leak in the chilled water circuit of an exchanger in the W plant was



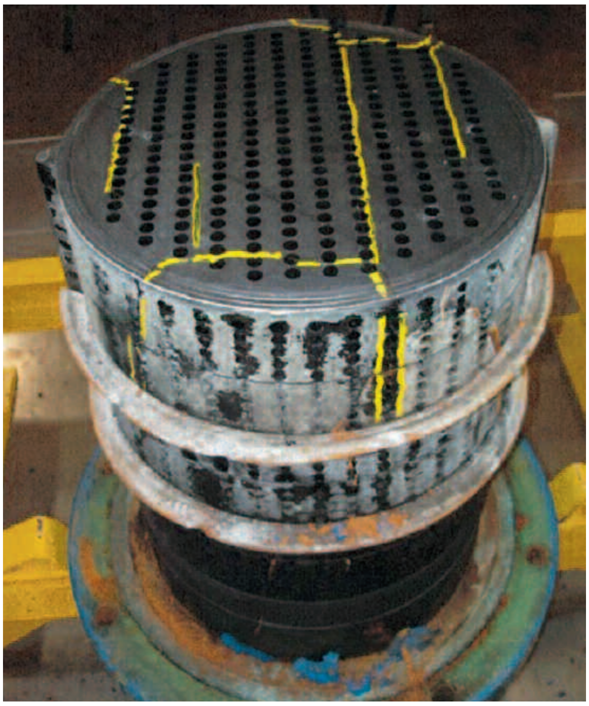
COMURHEX – General view

detected on 13 September 2007. The AREVA NC site installations supplied by the chilled water circuit were damaged by corrosion of the circuits, which were not designed to withstand solutions of hydrofluoric acid. Before the installations, in particular TU5 and W, were restarted, ASN ensured that the licensee had reviewed the risks arising from this incident.

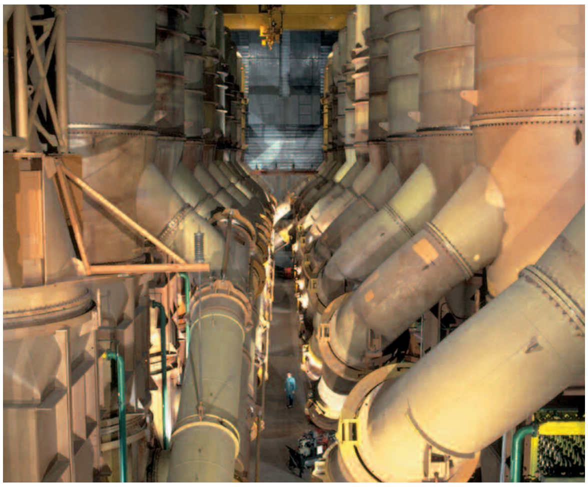
2 | 1 | 3 The uranium isotopes gaseous diffusion separation plant (EURODIF)

The isotope separation process used in the EURODIF 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.

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. These barriers give preferential passage to the uranium isotope 235



TU5 – Exchanger cracking



Eurodif – Group of diffusers

contained in the gas, thereby increasing the proportion of this fissile isotope in the UF_6 at each passage.

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.

In the light of the ageing design of this plant, it will be shut down shortly after 2010.

ASN is already monitoring the first studies undertaken by the licensee concerning the shutdown procedures. Given the masses involved – 150,000 tons of steel for the diffusers alone – it is important to anticipate the equipment inventories and characteristics in order to optimise the treatment, disassembly, transport and disposal processes.

Furthermore, to allow the creation of the Georges Besse II plant (see point 2|1|4), the authorisation decree for the EURODIF plant was modified on 27 April. ASN approved the signing of this text in its opinion 2007-AV-0012 of 1 February 2007.

2|1|4 The Georges Besse II 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) are recovered in the centre.

This process has two key advantages over the gaseous diffusion process currently used by EURODIF: on the one hand, it consumes far less energy (75 MW as opposed to 3,000 MW for equivalent production), and on the other, the design is safer (far less nuclear material in the cascades, plus centrifuges below atmospheric pressure).

Creation of the Georges Besse II plant (GBII), which comprises two separate enrichment facilities (South and North) and support facilities, was authorised by a decree on 27 April 2007. After examining the licensee's technical and financial capacity and the safety of the project, ASN approved the signing of this text in its opinion 2007-AV-0010 of 1 February 2007.

The nuclear licensee for this new installation is the Société d'Enrichissement du Tricastin (SET). Building work is continuing and is being monitored by ASN. At the same time, review of the safety cases is ongoing.

As part of its examination of the installation commissioning application, ASN will in particular look at those aspects enabling it to update its assessment of the licensee's technical and financial capacity.

The first cascade should be supplied in early 2009.

The arrangement envisaged by SET when the GBII project was launched, was to rely on a support facility called REC II – an integral part of the GBII BNI – and a TE facility operated by AREVA NC. AREVA decided to merge the TE and REC II functions. The resulting facility, incorporated into the GBII project, could provide services for licensees of other installations on the Pierrelatte site and would have shared resources with the GBII North unit, in particular the storage areas for UF6 containers and the control room.

In autumn 2007, SET therefore submitted an application for a modification to the GBII BNI licensing decree

GBII – Construction site at Tricastin

(168), which will be the subject of a public inquiry. This support installation should enter service by 2011.

2 | 2 Nuclear fuel manufacturing plants in Romans and Marcoule

After the uranium enrichment stage, the nuclear fuel is manufactured in various installations, depending on the type of reactor for which it is intended. 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.

This fuel, whether intended for PWRs or for fast or experimental reactors, is manufactured at FBFC in Romans-sur-Isère or MÉLOX in Marcoule, the latter installation being designed for the manufacture of fuels containing plutonium.

2 | 2 | 1 The FBFC and CERCA uranium-based fuel manufacturing 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 an integral part of the AREVA group. In the eyes of the regulations, the FBFC company is the sole nuclear licensee for the site.

The CERCA plant comprises a series of facilities for the manufacture of highly enriched uranium based 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 manufacturing plant

By a decree of 20 March 2006, FBFC was authorised to raise the plant's annual capacity to:

– 1,800 tons for the conversion facility;

– 1,400 tons for the rod, pellet and assembly lines.

At the same time, following the periodic safety review conducted in 2003, the licensee proposed a project to renew and modernise its industrial tool, which was accepted by ASN. This operation is now well under way and the work should continue until 2008.

CERCA plant

The CERCA plant, one of the oldest nuclear sites in France, pre-dates the BNI regulations. The Government was therefore simply notified of this installation in 1967.

FBFC – New autoclaves at Romans-sur-Isère

ASN would like to see the operations of this plant covered by a decree, as is the case with the FBFC fuel manufacturing plant. The procedure could be started on the occasion of an application for modification of the installations and be based on the results of the periodic safety review carried out for this plant.

The conclusions of the periodic safety review on the CERCA facilities were presented to the Advisory Committee for nuclear laboratories and plants in 2006.

Further to this review, ASN identified two areas for progress. The first area is the consideration given to human factors in day-to-day operations and the corresponding need for skills enhancement. The second concerns the storage areas for the waste arising from the site's activities, the organisation and management of which need to be improved.

The licensee must also review the criticality risk in certain facilities, in order to minimise as far as possible the potential consequences of an accident, in particular with regard to off-site exposure to radiation.

CERCA – General view of the facility at Romans-sur-Isère

2 | 2 | 2 The MÉLOX uranium and plutonium-based fuel manufacturing plant

The MÉLOX plant is today the only French nuclear installation producing MOX fuel, consisting of a mixture of uranium and plutonium oxides.

In a decree of 20 March 2007, MÉLOX was authorised to raise the production capacity of its Marcoule plant to 195 tons of heavy metal. After clarifying the relations between the nuclear licensee AREVA NC and the industrial operator, MÉLOX SA, ASN approved the signing of this text in its opinion 2007-AV-0011 of 26 January 2007.

In the context of this capacity increase, ASN is particularly attentive to ensuring that the licensee continues with and steps up actions to optimise radiation protection.

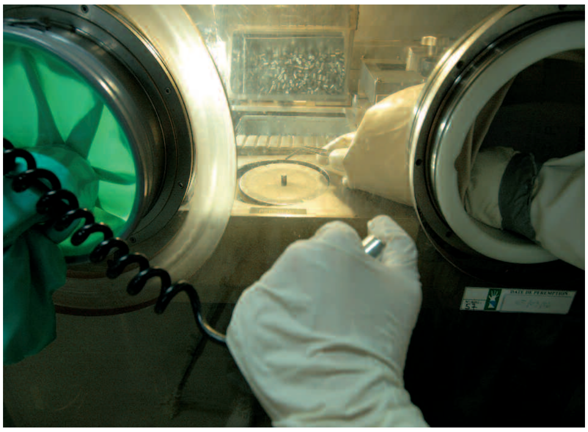
2 | 3 AREVA NC reprocessing plants at La Hague

2 | 3 | 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 (AREVA NC), 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 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 metal before passage in the reactor (U or Pu), and limit the total capacity of the two plants to 1,700 tons.



MELOX – Check on pellets in a glove box in Marcoule

The discharge limits and conditions were revised by the order of 8 January 2007.

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

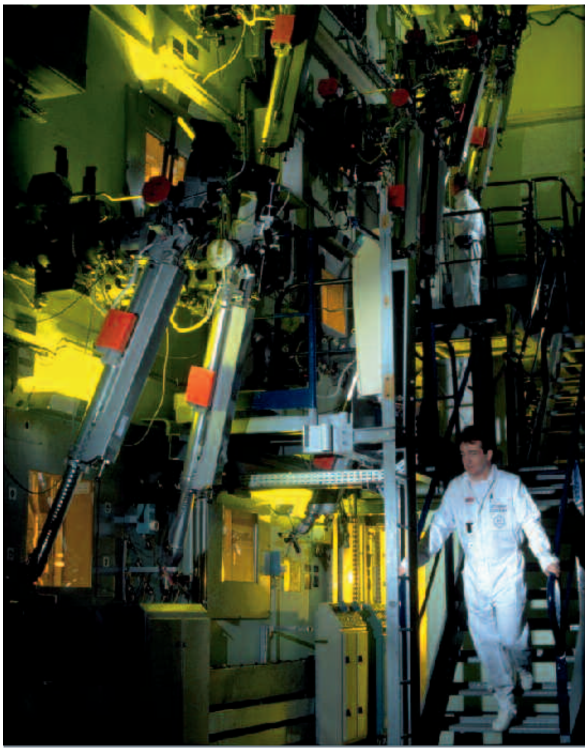
Operations carried out in the plant

The equipment in these facilities comprises the following in succession: reception and storage installations for spent fuel, then facilities for shearing and dissolving it, chemical separation of fission products, final purification of the uranium and plutonium and treatment of effluents.

The first operations to take place in the plant are reception of the transport containers and storage of the spent fuel. Upon arrival at the reprocessing plant, the containers are unloaded, either underwater, in a pond, or dry, in a leak-tight shielded cell. The fuel is then stored in the ponds.

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



AREVA NC La Hague – Remote-manipulator in the T7 vitrification facility

The installations at La Hague

• **INB 33:**	*UP2 400 plant, the first reprocessing facility*
HAO/North:	*facility for underwater unloading and spent fuel storage*
HAO/South:	*facility for shearing and dissolving of spent fuel elements*
HA/DE:	*facility for separation of uranium and plutonium from fission products*
HAPF/SPF (1 to 3):	*facility for fission product concentration and storage*
MAU:	*facility for uranium and plutonium separation, uranium purification and storage in the form of uranyl nitrate*
MAPu:	*facility for purification, conversion to oxide and initial packaging of plutonium oxide*
LCC:	*product central quality control laboratory*
• **BNI 38:**	*STE 2 installation: collection, treatment of effluents and storage of precipitation sludges in AT1 facility, prototype installation currently being decommissioned*
• **BNI 47:**	*Elan II B facility, CEA research installation currently being decommissioned*
• **BNI 116:**	*UP3 plant*
T0:	*facility for dry unloading of spent fuel elements*
D and E ponds:	*ponds for storage of spent fuel elements*
T1:	*facility for shearing of fuel elements, dissolving and clarification of solutions obtained*
T2:	*facility for separation of uranium, plutonium and fission products, and concentration/storage of fission products solutions*
T3/T5:	*facilities for purification and storage of uranyl nitrate*
T4:	*facility for purification, conversion to oxide and packaging of plutonium*
T7:	*facility for vitrification of fission products*
BSI:	*facility for plutonium oxide storage*
BC:	*plant control room, reagent distribution facility and process control laboratories*
ACC:	*hull and end-pieces compacting facilities*
• **BNI 117:**	*UP2 800 plant*
NPH:	*facility for underwater unloading and storage of spent fuel elements in pond*
C pond:	*pond for storage of spent fuel elements*
R1:	*facility for shearing of fuel elements, dissolving and clarification of solutions obtained*
R2:	*facility for separation of uranium, plutonium and fission products and concentration of fission products solutions*
R4:	*facility for purification, conversion to oxide and first packaging of plutonium oxide*
SPF (4, 5, 6):	*facilities for storage of fission products*
BST1:	*facility for secondary packaging and storage of plutonium oxide*
R7:	*facility for fission products vitrification*
• **BNI 118:**	*STE 3 facility: effluent recovery and treatment and storage of bituminised packages*

uranium and plutonium contained in the solutions, and then of the uranium from the plutonium.

After purification, the uranium, in $UO_2(NO_3)_2$ form, is concentrated and stored. It 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 storage. The plutonium can be used in the manufacturing of MOX fuel. The plutonium from foreign fuel is returned to the licensees in the country of origin.

AREVA NC La Hague – Aerial view

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

The gaseous effluents are 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 effluents are 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.

The spent fuel solid radioactive waste from French reactors is sent to the low and intermediate level, short-lived waste repository at Soulaines (see point 6|1|2 of chapter 16) or stored pending a final disposal solution.

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. In order to guarantee fair distribution of the waste among its various customers, the licensee proposed an accounting system for monitoring items entering and leaving the La Hague plant. This system is currently being examined by ASN, at the request of the General Directorate for Energy and Raw Materials (DGEMP).

2|3|2 Plant changes

The plant authorised operating framework

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

AREVA NC La Hague – Interim storage of waste drums in the ADT facility

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 (effluents, 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 therefore 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 decision of ASN.

Adaptation of the industrial tool

Environmental protection concerns and new market trends require the licensee to modify its industrial tool. A number of projects to that end were therefore examined in 2007 and are presented below.

The cold crucible project

Between 1966 and 1985, the reprocessing of Umo (molybdenum alloy) and MoSnAl (molybdenum, tin, aluminium alloy) GCR fuels generated fission product concentrates with a high concentration of molybdenum and phosphorus, which are hard to incorporate into an aluminoborosilicate vitreous matrix. They were stored in tanks in the SPF2 facility, pending possible incorporation into a glass matrix. The solutions stored must now be recovered and packaged. AREVA NC research into a packaging process has led to the development of a vitroceramic type aluminosilicophosphate matrix which would be able to incorporate a large mass of Mo03 while offering good resistance to leaching. This glass will be produced in a cold crucible. The glass poured into this crucible is induction heated, with the metal structure of the crucible being externally cooled, allowing the formation of a protective auto-crucible with high temperatures being obtained at its centre. The work necessary for installation of the cold crucible on line B in the R7 facility was authorised on 18 July 2007.

The cold crucible will also allow incorporation into a vitreous matrix of the sludges created by processing of the effluents from the rinsing involved in the legacy waste recovery operations.

The 3D project

The "3D" project is a range of operations involving removal from storage, cladding removal and dissolving prior to reprocessing of the non-irradiated MOX fuel materials. Implementation of this project required work in the HAO/North and T4 facilities. In 2007, ASN authorised startup of the pellets line and qualification of dissolution in the URP along with reprocessing of "KALKAR" materials packaged in the ESBB 210 container.

Adaptation of the vitrified residues storage removal facility (DRV)

AREVA NC requested authorisation to take delivery of and load TN 85 containers in the DRV so that foreign waste could be returned to Germany. The first TN 85 loads were carried out in the last quarter of 2007. Three high-level vitrified waste (CSD-V) shipments, each consisting of eleven TN 85 or CASTOR HAW 28 M containers, should take place by the end of 2010.

Safety review

Article 29 of Act 2006-686 on Transparency and Security in the Nuclear Field requires that every ten years, the licensee conduct a safety review of its Basic Nuclear Installations (BNIs), taking account of the best international practices. This review should allow an assessment of the compliance of the installation with the rules applicable to it, and an up-to-date evaluation of the risks or drawbacks presented by the installation in terms of security, public health and safety, or protection of nature and the environment, taking particular account of the condition of the installation, experience acquired during the course of operation, new knowledge and the rules applicable to similar installations.

At the request of ASN, AREVA NC in 2007 presented the safety review for BNI 118, which includes the effluent treatment station (STE3), the solvents mineralisation installation (MDS B) and the sea discharge outfall pipe. In 2008, ASN will issue an opinion on the determinations of this review.

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, AREVA NC 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 its support laboratory, the LPC, to a common final shutdown and decommissioning process to be authorised by 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 (see chapter 15, point 2|2|3).

3 | 2 Former AREVA NC 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 storage without packaging for disposal. The operations involved in recovering this waste are technically difficult and require the use of considerable resources. The issues 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.

Subsequent to the November 2005 review of the waste management policy in use at the La Hague establishment by the Advisory Committees for laboratories and plants and for waste, ASN confirmed the need for recovery as early as possible of the sludges stored in the STE 2 silos, the waste in the HAO silo and the waste in the building 130 silo, along with the primarily alpha waste drums stored in building 119 in BNI 38, which offer inadequate safety guarantees.

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 AREVA NC consists in bituminisation using a process employed in the STE 3 facility. In 2002, AREVA NC 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, IRSN, 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 in 2005 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 this campaign led the licensee to propose further modifications to the sludge encapsulation process. This was examined by ASN, which did not authorise production of the planned 3,000 drums, in the light of the modifications made. However, in order to gain new insights, ASN in June 2007 asked the licensee to carry out a further series of experiments (3 x 36 drums) in the latest encapsulation conditions defined.

The licensee is also continuing its research into alternative processes. Cement encapsulation and the drying process (DRYPAC) were identified as being technically suitable. However, prior drying of the sludge requires further additional research.

HAO silo and SOC1

The HAO silo contains various waste comprising hulls, end-pieces, fines (dust produced mainly by shearing), resins and technological waste resulting from operation of the HAO facility from 1976 to 1997.

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 in CSD-C packages. The third phase comprises the 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 SOC cursors before 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 has already been done. The detailed preliminary studies were extended into 2007 with the aim of simultaneous recovery of the fines and resins as well as the hulls and end-pieces.

Silo 130

Following the announcement of postponement of the creation of a graphite waste disposal route, 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 storage of the waste recovered.

The licensee's current project therefore comprises four phases. The first is to transfer the GCR waste before 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.

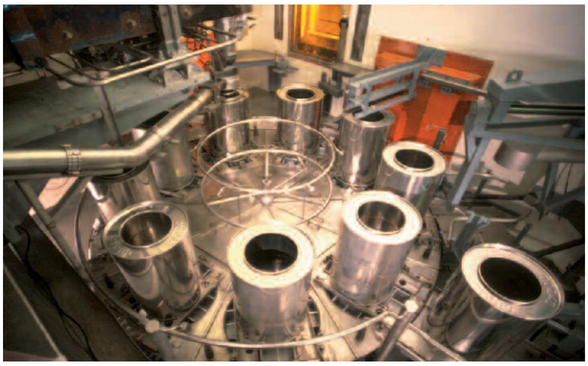
At the end of 2007, ASN undertook a review of the application for authorisation to carry out the preliminary development work, in particular the installation of silo waste recovery and removal cells.

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

At the request of ASN, the licensee in 2007 forwarded a safety analysis study concerning the consequences and the management of a possible loss of containment of this silo.

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

To package fission products from reprocessing of gas-cooled reactor fuel, in particular containing molybdenum, the licensee has opted for cold crucible vitrification (see point 2|3|2).



AREVA NC La Hague – Drum filling equipment in the STE3 station

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

Emptying of building 119 in BNI 38

An overall strategy was implemented by the licensee for priority treatment of the existing drums of alpha waste, which are currently stored in building 119.

At the end of 2006, ASN thus authorised the licensee to receive, store in conditions of adequate safety and process in the D/E EB facility in BNI 118, the drums of alpha waste from the French MOX fuel manufacturing plants.

ASN examined an application made in July 2007 for extending this authorisation to cover drums of alpha waste produced at the La Hague site, so that the processing capacity be entirely dedicated to building 119, thus reducing the lifetime of this installation.

A further compacting facility, enabling a larger volume of alpha waste to be handled, will be commissioned in 2013.

3|2|2 Final closure of the UP2 400 plants in the STE 2 installation

On 30 December 2003, the licensee notified its decision to stop processing spent fuel in the UP2 400 facility as of 1 January 2004. 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/South and MAPu facilities, the licensee submitted the safety analysis dossiers for dismantling of certain types of equipment (in particular glove boxes and shears) which are no longer needed. Some of these operations were carried out in 2005 and 2006. For 2007, the licensee asked that equipment dismantling be continued, particularly of the shearing machine frame. The licensing application is currently being reviewed by ASN.

ASN also firmly and repeatedly urged AREVA NC to submit the final shutdown and decommissioning dossier

(MAD/DEM) as rapidly as possible for the BNIs corresponding to the UP2 400 plant and the STE 2 installation, i.e. BNIs 33, 38 and 80. The licensee's current approach will involve the production of the MAD/DEM dossier in several stages, and the licensee therefore submitted a provisional version of the dossiers for BNI 80 in May 2007; transmission of the dossiers for the other BNIs (33, 38 and 47) is scheduled for the first quarter of 2008. BNI 80 will however continue to receive fuels that cannot be accepted 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 2007, the fuel cycle installations experienced no significant safety problems. However, in a context in which economic pressures are being increasingly strongly felt, ASN makes sure that nuclear safety remains the number one priority of the licensees.

The incorporation into the AREVA group of all the French fuel cycle licensees has increased the degree of consistency between the various installations, a fact that can only improve safety.

In this respect, the AREVA group continued in 2007 to transfer its activities to the Tricastin site, with the announced shutdown of former installations such as BNI COMURHEX or EURODIF. This installation will be replaced by a new centrifugation enrichment plant which will significantly boost safety, in particular owing to a reduction in the quantities of UF_6. ASN considers these changes to be positive steps.

On the Romans-sur-Isère site, the year 2007 was marked by the continued commissioning of new equipment associated with the renovation of the FBFC company's plant and by the safety review conducted on the facilities of the CERCA company. ASN expects confirmation of the progress already achieved in terms of safety and improved management of the site's waste storage facilities. It will be particularly attentive to the satisfactory running of these programmes as well as to the improvements actually observed.

With regard to the MÉLOX plant at Marcoule, ASN will be focusing its attention on two points: dosimetry management and the ability to prevent risks related to human factors. ASN will here be taking account of both the rise in production capacity without significant modification to the industrial tool, and changes to the materials used. These two points for surveillance will be at the heart of ASN's regulatory action in the coming years.

Finally, the efforts devoted every year to checking the installations on the La Hague site confirm ASN's opinion of the professional way in which the site is operated. However, ASN would like to see the same degree of stringency applied to the quality of the dossiers submitted to it, in particular those relating to the installations periodic safety reviews. ASN will also be particularly attentive to licensee compliance with deadlines for the recovery of legacy waste and the return of foreign waste to its country of origin. The shutdown and decommissioning of a number of old facilities in the UP2 400 plant are among the top priorities that are and will continue to receive close and sustained attention from ASN. In this respect, at the request of ASN, the Advisory Committee for plants will shortly be examining the BNI 80 decommissioning operations selected by AREVA NC. The aim will be to identify on the one hand anything that is unacceptable in terms of safety, radiation protection or waste and effluent management, and on the other those operations which, before they can start, could require a specific safety review if stipulated in the decree authorising final shutdown and decommissioning.