# NUCLEAR FUEL CYCLE INSTALLATIONS



CHAPTER 13

France opted for the reprocessing of its nuclear fuel in the late 1960s, when nuclear power generation first began. Today, France, the United Kingdom and Japan are the only countries that reprocess nuclear fuel on an industrial scale.

The fuel cycle involves all the fuel manufacturing, reprocessing and recycling facilities. Recycling is achieved by using fuel based on a mixture of uranium oxide and plutonium, the plutonium having been generated when the fuel based on natural enriched uranium passes through the power reactors.

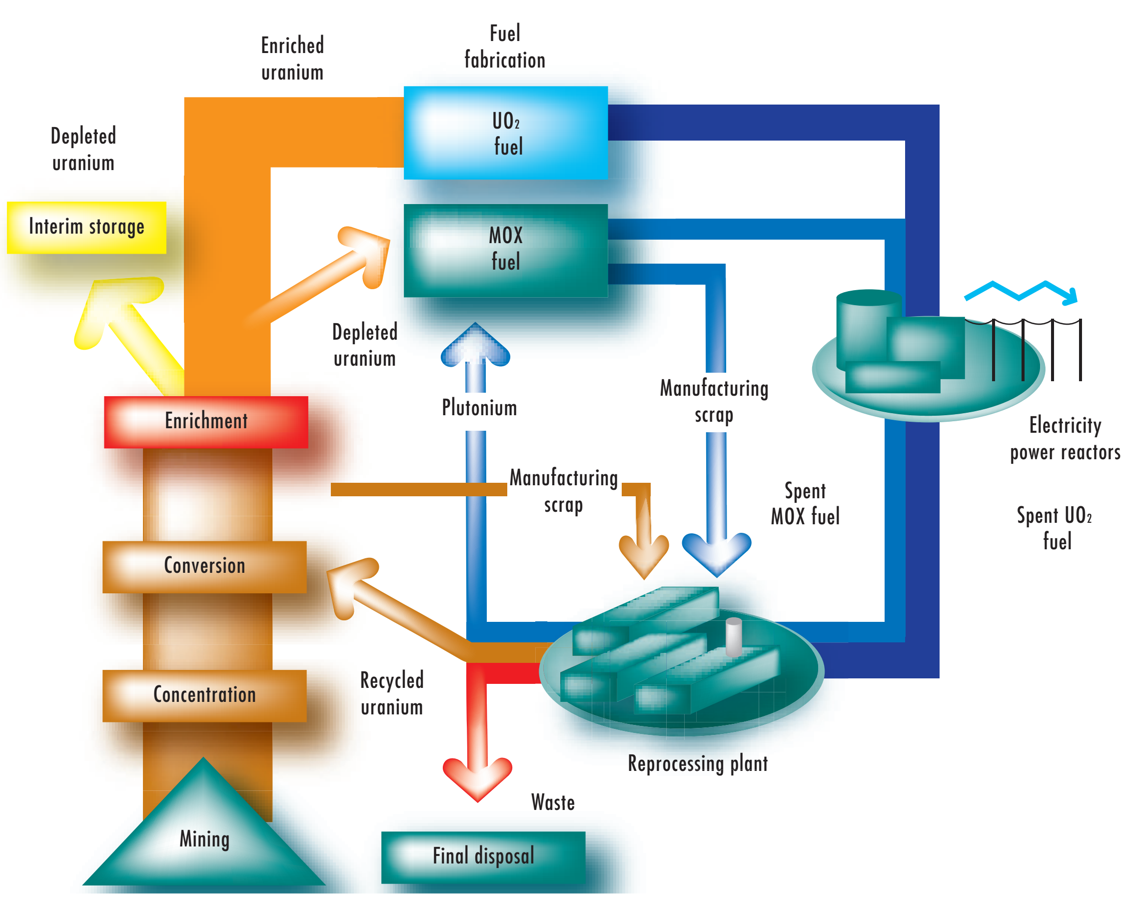
Historically, ASN has monitored these industrial facilities independently. Today its objective is to monitor a fleet of facilities having common basis in terms of safety and radiation protection. The creation of the AREVA Group was a determining factor in this respect, as was the desire to address these safety issues in international forum.

Today, ASN expects from AREVA a very high Level of safety and radiation protection management, corresponding to the ambitions stated by the Group; this must be based on an integrated vision of safety, shared by all the Group's stakeholders.

The fuel cycle comprises the fabrication of the fuel and its subsequent reprocessing after it has been used in the nuclear reactors (NPPs). However, conventionally 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 (UF6) in the conversion operation. The raw material for enrichment is fabricated by COMURHEX in Malvési (Aude *département*[1]) and Pierrelatte (Drôme *département*). The facilities in question – which are not regulated as basic nuclear installations (BNIs) but as classified installations – use natural uranium in which the uranium 235 content is around 0.7%.

## The fuel cycle




1. Administrative region headed by a *préfet*.

Most of the world's NPPs 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 this proportion from 0.7% to between 3 and 5% is the role of the EURODIF plant in Tricastin, which separates the UF6 by means of a twin-stream gaseous diffusion process, with one stream becoming enriched in uranium 235 while the other becomes depleted in the course of the process. The ultracentrifuging process currently entering service in the Georges Besse II plant will ultimately replace the gaseous diffusion process.

The process used in the FBFC plant at Romans-sur-Isère transforms the enriched $UF_6$ 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, firstly 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 it is low-level waste, otherwise it is placed in interim storage pending a final disposal solution.

The plutonium resulting from reprocessing is 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 particular in the French 900 MWe PWR reactors.

The main plants of the fuel cycle – COMURHEX, AREVA NC Pierrelatte (TU5/W), EURODIF, GB II, FBFC, MÉLOX, AREVA NC La Hague – belong to the AREVA Group.

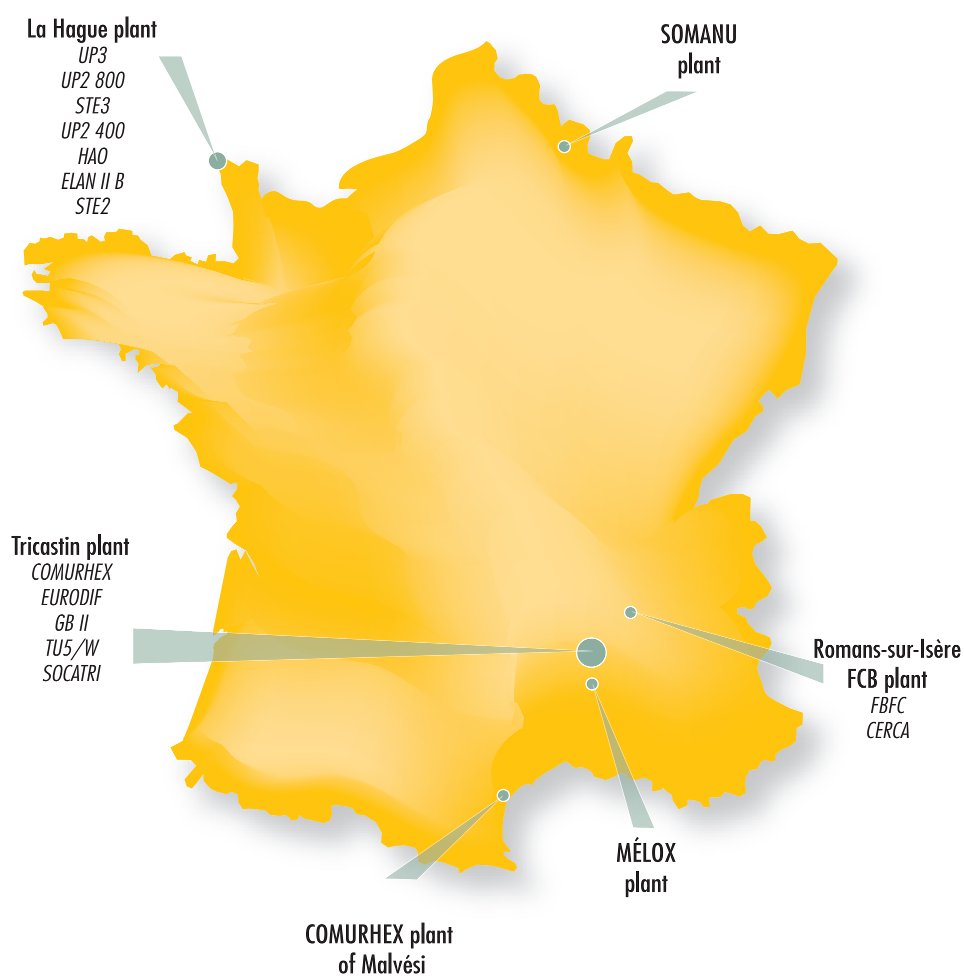


Table 1: Fuel cycle industry movements(1)

| Installation | Origins | Material processed | Tonnage (unless otherwise specified) | Product obtained | Tonnage (unless otherwise specified) | Destination | Tonnage (unless otherwise specified) |
|---|---|---|---|---|---|---|---|
| **COMURHEX** Pierrelatte(2) | | U02(NO3)2 (derived from reprocessed uranium) | | $UF_4$<br>$UF_6$<br>$U_3O_8$ | | | |
| **AREVA NC** Pierrelatte TU5 facility | **AREVA NC** La Hague | $UO_2(NO_3)_2$ (derived from reprocessed uranium) | 3949 | $U_3O_8$ | 1163 | Interim storage TU5 | 1163 |
| **AREVA NC** Pierrelatte W plant | **URENCO**<br>**EURODIF** | $UF_6$ (based on depleted uranium) | 9070<br>8926 | $U_3O_8$ | 7237<br>7065 | Interim storage Plant W | 7237<br>7065 |
| **EURODIF** Pierrelatte | Converters and EURODIF Production | $UF_6$ (derived from natural and depleted uranium) | 11896 | $UF_6$ (depleted uranium) | 10888 | Defluorination and re-enrichment of tailings | 11976 |
| | Re-enrichment of tailings | $UF_6$ (based on enriched uranium) | 1387 | $UF_6$ (enriched uranium) | 2430 | Fuel manufacturers | 1997 |
| **FBFC** Romans | **EURODIF**<br>**TENEX**<br>**URENCO** | $UF_6$ (based on enriched natural uranium) (ML(3)) | 624.827 | $UO_2$ (powder) | 204.478 | FBFC, Dessel (Belgium) | |
| | | | | Fuel elements derived from enriched natural uranium | 271.079<br>71.995<br>44.739 | EDF, Tihange + Doel (Belgium), KOEBERG (South Africa) | |
| | **AREVA NC** | $UF_6$ (based on enriched natural uranium) (ML(3)) | 95.913 | $UO_2$ (powder) | | | |
| | | | | Fuel elements derived from enriched natural uranium | 92.426 | EDF | |
| **MÉLOX** Marcoule | **AREVA NC** Pierrelatte<br><br>**AREVA NC** La Hague | $UO_2$ (based on depleted uranium) (ML(3))<br>$PuO_2$ (ML(3)) | 123.4<br><br>11.4 | MOX fuel elements (ML(3)) | 124 | CNPE EDF<br>FBFC-Dessel<br>AREVA NC La Hague<br>(Japan)(9) | |
| **AREVA NC** La Hague | UOX and MOX: EDF, CAORSO | Reprocessed irradiated fuel elements: UP3 $(U+Pu)_{init}$ | 453.73 | $UO_2(NO_3)_2$ (tonne of U) | 997.71(8) | | |
| | RTR: BR2 MOL | Reprocessed irradiated fuel elements: UP3 $(U+Pu)_{init}$ | 0.08 | $PuO_2$ (tonne of $PuO_2$) | 13.70(5) | | |
| | UOX and MOX: EDF | Reprocessed irradiated fuel elements: UP2 800 UP3 $(U+Pu)_{init}$ | 595.11 | Quantity of vitrified waste products in UP3 | 383 CSD-V | Interim storage La Hague | 455 CSD-V |
| | | Reprocessed irradiated fuel elements: UP2 400 | | Quantity of vitrified waste products in UP2 800 | 380 CSD-V | | |
| | | | | Quantity of compacted waste products | 1472 CSD-C | Interim storage La Hague | 1260 CSD-C(7) |
| | UOX: EDF and CAORSO<br>UOX and CELESTINS for RTR | | | | | Irradiated fuel elements unloaded into a pool $(U+Pu)_{init}$ | 1120.99 |

(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.
(2) The installations are in final shutdown status. They did not receive, ship or convert any material in 2010. Production ceased in January 2008.
(3) Heavy metal.
(4) Value which includes the production from 2008 but which was accepted in 2009.
(5) Production of PuO2 in 2010: 13.70 tonnes of PuO2 and 1.7 kg of samples. In 2010, AREVA NC shipped 12.17 tonnes to MELOX (the samples are not shipped to MELOX).
(6) In 2010, AREVA NC shipped 308 packages of waste produced between 2002 and 2006 to Germany.
(7) In 2010, AREVA NC shipped 212 packages of compacted waste to Switzerland, Belgium and the Netherlands.
(8) In 2010, AREVA NC shipped all the uranyl nitrate produced to the Pierrelatte TU5 plant.
(9) Products fabricated in the MELOX plant and leaving it as assemblies or rods.

# 1 MAIN INSTALLATIONS IN OPERATION

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

To produce fuels that can be used in the reactors, the uranium ore must undergo a number of chemical transformations, from the preparation of the "yellow cake" through to conversion into uranium hexafluoride (UF6), the form in which it is enriched. These operations are mainly carried out on the Tricastin site, also known as Pierrelatte.

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

On the Pierrelatte site, AREVA NC operates:

– the TU5 facility (BNI) for conversion of uranyl nitrate ($UO_2(NO_3)_2$), produced by reprocessing spent fuel into uranium sesquioxide ($U_3O_8$).

– the W plant (ICPE within the BNI perimeter) for conversion of depleted UF6 into $U_3O_8$, a solid compound which offers safer storage conditions and recycling of the hydrofluoric acid.

The installation TU5 can handle up to 2,000 tonnes 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 and reuse in the fuel cycle.


Storage of depleted uranium on the Tricastin site

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

The isotope separation process used in the Georges Besse I (GBI) plant of EURODIF is based on gaseous diffusion. The plant comprises 1,400 cascaded enrichment modules, divided into 70 sets of 20 modules grouped in leak-tight rooms.

The principle of gaseous enrichment consists in repeatedly diffusing the gaseous UF6 through porous barriers. These barriers allow preferential passage to the uranium 235 isotope containing the gas, thereby increasing the proportion of this fissile isotope in the UF6 at each passage. The UF6 is introduced in the middle of the cascade, with the enriched product drawn off at one end and the depleted residue at the other.

The licensee has announced that plant operation will stop in 2012. The final shutdown and decommissioning operations should take about ten years. The EURODIF plant will be replaced by the Georges Besse II plant (GBII), in which the enrichment process is based on ultracentrifuging technology.

ASN regularly examines the licensee's studies on the EURODIF shutdown conditions and took a stance on the safety issues associated with plant shutdown in a letter addressed to the director of the DGEC (General Directorate for Energy and Climate) on 23 April 2010. Given the masses involved – 150,000 tonnes of steel for the diffusers for example – it is important to anticipate the inventory and characteristics of the equipment in order to optimise processing, disassembly, transport and disposal. The licensee should thus shortly submit an application for a modification to its creation authorisation decree corresponding to the PRISME operations (Project for intensive rinsing followed by EURODIF venting) which will consist in repeatedly rinsing the barriers with chlorine trifluoride (ClF3) to recover virtually all the deposited uranium and enable the metal to be recycled in nuclear routes. A public inquiry will be held for these operations.

Following the PRISME operations, the licensee will submit a final shutdown and decommissioning decree application (MAD-DEM) for the installation, a procedure that also entails a public inquiry.

At the end of October 2008, the licensee had submitted an application for a modification to the EURODIF plant's creation authorisation decree. This application concerned an increase in the maximum quantity of UF6 present in the facility and a number of operations on behalf of the site licensees concerning the reception, shipment and monitoring of the UF6. This application also concerned sorting and packaging of non-radioactive waste. The perimeter of the facility was to be modified in order to include the chlorine trifluoride (ClF3) disposal facility, which is an installation classified on environmental protection grounds (ICPE). The licensee withdrew its application at the end of 2009 in order to include the PRISME operations in it; the licensee also indicated to ASN that the quantity of UF6 present in the facility would remain below the authorised limit (50,000 tonnes) in the coming years and that it would not maintain its request to increase the quantity. The other requests will be unchanged.

Lastly, and in order to make a decision on the continuation of operation of GBI for a limited period of time, ASN is examining the licensee's report on thirty years of operating experience feedback from the plant; it is also examining the current operational, management and human factor integration aspects that will give foresight on plant shutdown.

Aerial view of EURODIF, uranium isotopes gaseous diffusion separation plant on the Tricastin site

In 2009, an ASN inspection on waste management led to notification of an incident rated Level 1 on the INES scale. This event concerned significant deficiencies in criticality risk prevention during storage of fissile materials in waste areas not specifically designed for this purpose. The licensee rapidly took remedial action with respect to the criticality risk, which gave satisfactory results. However, ASN conducted an inspection of the subcontractor in 2010 that revealed deficiencies. The licensee has engaged a plan of action.

With regard to the plan of action engaged following the operating experience feedback from the Socatri incident of July 2008, although major work has been undertaken on the retention areas to bring them up to standard, ASN has found defects in the floor coverings beneath the overhead chlorinated solvent pipes. ASN has asked the licensee to establish a periodic inspection programme for the retention areas.

### 1|1|3 The Georges Besse II ultracentrifugation enrichment plant project

The ultracentrifugation process should eventually replace gaseous diffusion. This process, which will be operated by the Société d'Enrichissement du Tricastin (SET), consists in rotating a cylindrical bowl containing uranium hexafluoride (UF6) 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 major advantages over the gaseous diffusion process currently used by EURODIF: it consumes substantially less energy (75 MW compared with 3,000 MW for an equivalent level of production) and it is safer. This is because the mass of nuclear material present in the cascades and centrifuges is reduced, and is used in gaseous form at a pressure 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.

The review carried out by ASN, its technical support organisations IRSN, and the Advisory Committee for laboratories and plants, revealed that the low level of UF6 stocks in the enrichment modules and the operating conditions of the centrifugation process contribute to a high level of control of the risk of radioactive and chemical material dissemination. ASN also considers that the licensee has adopted satisfactory measures to control the risks associated with maintenance work being performed alongside normal operations, owing to the modular design of the plant.

ASN considered that the safety and radiation protection arrangements presented by the licensee for commissioning of the South facility are satisfactory and in early 2009 it authorised commissioning of the facility. This commissioning is dependent on a number of technical requirements, explaining the centrifugation plant's start-up and operating conditions. In March 2010, ASN supplemented this framework with a decision in which it prescribes a set of conditions relative to the safety tests prior to the first introduction of UF6 into the plant. The UF6 was introduced at the end of 2010 and the plant will start functioning in 2011.

Furthermore, in January 2008, SET submitted a modification application for the GBII basic nuclear installation (BNI) creation decree (168), more specifically to allow the use of reprocessed uranium (URT) in the REC II support shop. The public inquiry on this matter took place from 22 December 2008 to 30 January 2009 and the coordinating *préfet*[2] approved the modification. The amending decree is currently being drafted.

## 1|2 Nuclear fuel fabrication plants in Romans-sur-Isère 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 fabrication of fuels for electricity generating reactors implies transforming $UF_6$ into uranium oxide powder. This powder is used to fabricate pellets which are made into fuel rods, which in turn are grouped to form fuel assemblies. As for experimental reactors, some of them use highly enriched uranium in metal form. These fuels are fabricated by FBFC in Romans-sur-Isère.

The MÉLOX plant in Marcoule is specialised in the fabrication of MOX (mixed oxide) fuels.

2. In a *département*, representative of the State appointed by the President

ASN commissioners visit the Georges Besse II plant – July 2010

## 1|2|1 The FBFC and CERCA uranium-based fuel fabrication plants

The two BNIs located on the Romans-sur-Isère site belong to the CERCA and FBFC companies respectively. These two companies are now an integral part of the AREVA Group. As far as the regulations are concerned, FBFC 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.

The FBFC plant production, consisting of uranium oxide powder or fuel assemblies, is intended solely for light water reactors (PWRs or BWRs).

During 2010, the licensee renovated the uraniferous (i.e. containing uranium) effluent networks further to the incident of 12 October 2009, in which part of the site's stormwater drainage network and one stormwater tank were found to be contaminated with uranium due to uncontrolled connections. The renovation work separated the uraniferous effluent networks from the stormwater drainage networks.


**Robotic welding in the FBFC plant of Romans-sur-Isère**

*FBFC nuclear fuel fabrication facility*

By a decree of 20 March 2006, FBFC was authorised to raise annual capacity to:
– 1,800 tons for the conversion unit;
– 1,400 tons for the pelletizing, rod fabrication and assembly lines.

However, pending the end of the work to renew and modernise the industrial plant, ASN restricted the capacity of the pelletizing lines to 1,000 tons per year. The industrial plant renewal and modernisation work continued in 2010. Adjustment of the new uranium pellet sintering[3] furnaces is finished.

*CERCA fuel element fabrication plant*

The CERCA plant, one of France's oldest nuclear installations, predates the BNI regulations. The Government was therefore simply notified of this installation in 1967.

In order to improve regulation of the activities carried out in the installation, work on drafting the requirements stipulated in act 2006-686 of 13 June 2006 has been started. These technical requirements will be finalised in the first quarter of 2011.

In this context and in accordance with the conclusions of the periodic safety review carried out on this installation in 2006, ASN is particularly vigilant to human factors being considered in the routine operation of the units and in handling of the waste produced by the site's activities.

## 1|2|2 The MÉLOX uranium and plutonium-based fuel fabrication 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.

As this increase does not entail any significant modifications to the industrial plant, ASN remains particularly attentive to ensuring that the organisation adopted for operation is appropriate and sufficient and that radiation protection optimisation measures are reinforced.

In 2008, pursuant to the requirements of article 29 of decree 2007-1557 of 2 November 2007, the CEO of the MÉLOX SA company submitted an application for the transfer of nuclear licensee status from AREVA NC to MÉLOX SA.

ASN reviewed this application in 2009; the decree was published in the Official Gazette on 3 September 2010.

The ASN decision enabling this authorisation to become effective was made on 7 December 2010 under the conditions set out in article 29 of the decree of 2 November 2007. Through this decision, ASN confirms that the licensee has indeed complied

3. Sintering is a very high-temperature baking operation which transforms the compacted "raw" uranium pellets into pellets with a composition similar to that of a ceramic.

with the obligations of article 20 of the "Waste Act" of 28 June 2006, concerning the provision of guarantees to cover the financial cost of decommissioning nuclear facilities and the management of radioactive waste.

The process for defining the elements to be considered in the periodic safety review of the facility, as defined in article 29 of the TSN Act, continued in 2010: the review file is to be submitted to ASN in mid-2011.

2010 was marked by the event on 9 February 2009 which was classified as Level 1 on the INES scale (see point 3). During a maintenance operation using a glove box, the rotation of a mechanical wheel driven by a motor functioning intermittently caused a containment break by tearing the glove used by an operator, resulting in internal contamination of the operator's forearm.

Analysis of the causes of this event revealed a number of failings involving human and organisational factors in both the preparation and the performance of this intervention. The licensee decided to review the work authorisation procedure, analysing the human factor in greater depth. The conclusions of the working group responsible for this review will be applied to all the plant units.

Further to ASN's various findings (deficiencies in the computerised production management system, inconsistencies between the authorised requirements and practices on the ground) related to prevention of criticality and the notification of about ten significant events concerning criticality and organisational aspects in less than two years, ASN organised an in-depth inspection on this topic within the facility in June 2010 (see point 3.3.4).

ASN notes that managers of the plant have now made a strong commitment to better managing organisational and human factors on the site. Modifications are in progress to increase the presence of engineers on the ground and to improve operating team responsiveness to unplanned situations. Nevertheless, although things are moving in the right direction, the means deployed today still fall short of the stated objectives of plant management.

Loading fuel assemblies in the MÉLOX plant

## 1 | 3 AREVA NC reprocessing plants at La Hague

### 1 | 3 | 1 Presentation

The La Hague plant for reprocessing fuels irradiated in the power reactors (UNGG GCRs, then PWRs) is operated by AREVA NC.

The various facilities of the UP3 and UP2 800 plants and of the effluent treatment station STE3 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 per year.

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

The reprocessing of irradiated fuels in plant UP2 400 has been stopped since 1 January 2004 (see point 2).

*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, purification of the uranium and plutonium and effluent treatment.

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 the rods, the spent fuel is separated from its metal cladding by being dissolved 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 solution separation phase consists in separating the uranium and plutonium from the fission products and other transuranium elements, then separating the uranium from the plutonium.

After purification, the uranium, in the form of uranyl nitrate ($UO_2(NO_3)_2$), 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 production operations, from shearing through to the finished products, use chemical processes and generate gaseous and liquid effluents. These operations also generate the so-called "structure" waste.

## The installations at La Hague

| | |
|---|---|
| • **BNI 80:** | *High activity fuel* |
| *HAO/North:* | *Facility for underwater unloading and spent fuel storage* |
| *HAO/South:* | *Facility for shearing and dissolving of spent fuel elements* |
| • **BNI 33:** | *UP2 400 plant, the first reprocessing facility* |
| *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:* | *central product quality control laboratory* |
| • **BNI 38:** | *STE2 facility: collection, treatment of effluents and storage of precipitation sludge, and 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/interim 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-piece compaction facilities* |
| *AD2:* | *Technological waste packaging facility* |
| *ADT – EDS – D/E EDS ECC:* | *Packaged technological and structure waste storage and recovery facilities* |
| *E/EV South East (EEVLH extension):* | *Vitrified waste storage facility* |
| • **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:* | *Fuel elements shearing, dissolving and resulting solutions clarification facility (including the URP: plutonium re-dissolution facility)* |
| *R2:* | *Uranium, plutonium and fission product separation, and fission product solution concentration facility (including the UCD: alpha waste centralised processing unit)* |
| *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 product vitrification* |
| *AML – AMEC:* | *Packaging reception and maintenance facilities* |
| • **BNI 118:** | *STE 3 facility: effluent recovery and treatment and storage of bituminised packages* |

View of the spent fuel reprocessing plant in La Hague

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. Residual radioactive gases, in particular krypton and tritium, are checked before being released into the atmosphere.

The liquid effluents are processed and generally recycled. Certain radionuclides, such as iodine and less active products are checked, then directed to the off-shore marine discharge pipe. The others are sent to facilities for encapsulation in a solid matrix (glass or bitumen).

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

The solid radioactive waste from irradiated fuel from French reactors is sent to the low-and intermediate-level, short-lived waste repository at Soulaines (see 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 was approved by order of the minister responsible for energy on 2 October 2008. In 2009, the licensee thus shipped standard containers of compacted waste (CSD-C) back to the Netherlands and in 2010 to Germany.

## 1|3|2 Plant modifications

### *The plant authorised operating framework*

The creation authorisation decrees for the nuclear installations on the La Hague site were revised in 2003, particularly to allow changes in installation activities to be made under satisfactory conditions of safety and environmental protection.

ASN decisions now authorise broadening of the nature and origin of the materials and substances brought in for treatment from other installations, while remaining within the domain defined by the decrees.

### *Adaptation of the industrial plant*

Environmental protection concerns and new market trends require the licensee to modify its industrial plant.

### *The cold crucible project*

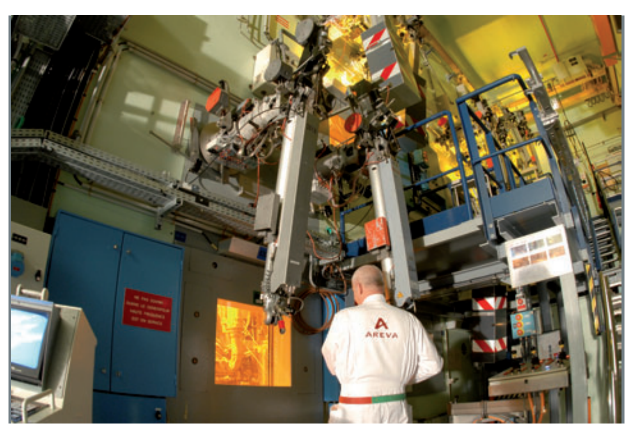
Between 1966 and 1985, the processing of UNGG (Uranium Naturel Graphite Gas) GCR (Gas Cooled Reactor) fuels of type UMo (alloy of uranium and molybdenum) and UMoSnAl (alloy of uranium, molybdenum, tin and aluminium) generated fission product concentrates with a high concentration of molybdenum and phosphorus, elements which are hard to incorporate into an aluminoborosilicate vitreous matrix. The concentrates were stored in tanks in the SPF2 unit, pending possible incorporation into a glass matrix. AREVA NC research into a packaging process led to the development of a vitroceramic type aluminosilicophosphate matrix which would be able to incorporate a large mass of molybdenum oxide ($MoO_3$) while offering good resistance to leaching. This glass is 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.

By decision of 22 December 2009 and subject to compliance with its prescriptions, ASN authorised use of the cold crucible vitrification process on Line B of the R7 unit. The line configured accordingly was put into operation on 17 June 2010. Authorisation to supply the cold crucible with solutions of fission products containing molybdenum originating from legacy waste is currently being examined by ASN.

### *Periodic safety reviews*

Article 29 of Act 2006-686 on transparency and security in the nuclear field requires the licensee to conduct a safety review of its BNIs every ten years, taking account of the best international practices.

In 2008, ASN examined the conclusions of the periodic safety review for BNI 118, which includes the effluent treatment station (STE3), the solvent mineralisation facility (MDS-B) and the sea discharge outfall pipe. ASN is paying particularly close attention to the schedule for the licensee's implementation of the commitments it undertook during this periodic safety review.



Cold crucible vitrification process in the AREVA plant in La Hague

ASN observes that, on the whole, the licensee has fallen behind in its initial undertakings regarding both the response times and their implementation, particularly in performing the installation conformity reviews and the treatment of legacy waste.

In 2010, the licensee completed the periodic safety review of BNI 116 (UP3 plant) and started that of BNI 117 (UP2 800 plant). When it established the periodic safety review guideline document, ASN specified the main requirements pursuant to decree 2007-1557 of 2 November 2007. The periodic safety reviews of the La Hague plants will focus more particularly on the verification of installation conformity and the identification and complete inventorying of elements important for safety.

ASN has asked its technical support organisation, IRSN, to examine the relevance and quality of the licensee's periodic safety review of the UP3 plant. The result of IRSN's appraisal will be presented to the Advisory Committee for laboratories and plants from the end of 2011 to 2013. The result will be communicated in an ASN report to the ministers in charge of nuclear safety and radiation protection.

### *Internal authorisation systems for minor modifications*

The licensee requested the setting up of an internal authorisations system in 2008, as provided for by article 27 of decree 2007-1557 of 2 November 2007. ASN approved this system by its decision of 14 December 2010, which will be applicable as of 1 January 2011. This system provides for two internal authorisation levels, depending on the extent of the operations and the associated radiation protection and safety implications. Before a planned operation or modification is authorised, it is assessed - depending on its assigned level - by either a safety specialist independent of the requesting operating unit, or, for the most extensive operations, an internal authorisations assessment committee (CDAI).

### *Construction of an extension to a vitrified waste package storage facility*

The production programmes for standard vitrified waste containers (CSD-V) and the end of the returning of containers attributed to AREVA NC's foreign customers (contracts signed before 2001) mean that the storage capacity on the La Hague site (R7, T7 and EEVSE) will become saturated by the first half of 2012.

AREVA NC therefore decided to build an extension to the EEVSE storage facility called the "glass storage building extension on the La Hague site" (EEVLH), in order to increase the storage capacity of the existing facility. The extension reuses the main design options of the EEVSE facility.

Further to ASN's decision of 15 June 2010, AREVA NC sent ASN the safety report for the construction and commissioning of this storage facility. The file is currently being reviewed and will give rise to prescriptions from ASN.

### *The new facilities planned*

To face up the increases in plutonium recycling flows of the coming years, AREVA NC is envisaging putting a "plutoniferous material treatment" (TMP) unit into service in the T4 facility. The licensee submitted the corresponding safety options file to ASN in 2009, and this is currently being reviewed.

This addition will be subject to a modification of the BNI 116 creation authorisation decree, with a prior public inquiry.

AREVA NC has submitted to ASN a project for the complete renewal of the fleet of boilers that produce the heat necessary for operation of the La Hague plant. AREVA NC plans to replace them with one wood biomass boiler room and two new oil-burning boilers.

Construction of an extension to the fission product interim storage hall (CSD-V)

# 2 INSTALLATIONS IN CLOSURE PHASE

## 2 | 1 Older AREVA NC La Hague installations

### 2 | 1 | 1 Recovery of legacy waste

This point is also covered in chapter 16.

Recovery of legacy waste from the La Hague site is monitored particularly closely by ASN, mainly due to the strong safety and radiation protection implications associated with it. Furthermore, recovery of the site's legacy waste is one of the AREVA group's major commitments, taken in the framework of the ministerial authorisations to start up new treatment plants (UP3 and UP2 800) in the 1990s; this waste recovery is not necessarily easy, as it involves major technical difficulties and high costs. But in spite of this, the deadlines must no longer be pushed back, because the buildings in which this legacy waste is stored are aging and no longer comply with current safety standards. Lastly, disposal routes or new interim storage solutions must be decided upon, because their deployment represents long-term projects: pushing them further back would jeopardise compliance with the deadlines set by the act of 28 June 2006, learing on "radioactive waste and spent fuel management".

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.

Further to the November 2005 review of the waste management policy for the La Hague site by the Advisory Committee for laboratories and plants and for waste, ASN confirmed the need to undertake as rapidly as possible the recovery of the sludge stored in the STE2 silos, the wastes from the HAO silo and the silo of Building 130, and the drums of predominantly alpha waste stored in Building 118 of BNI 38, whose safety level does not meet current safety requirements.

#### *STE2 sludge*

In recent years, processing of STE2 sludge has been the subject of research and development work, in particular with a view to determining the methods for recovery and transfer required prior to any packaging. The process then chosen consisted in bituminisation of the sludge using a process employed in the STE3 facility.

Following on from these experiments and the December 2007 review of the proposed packaging process by the Advisory Committee for laboratories and plants, ASN issued a decision on 2 September 2008 prohibiting the bituminisation of STE2 sludge in the STE3 facility.

Pursuant to this decision, the licensee submitted a preliminary safety analysis report on 1 January 2010 corresponding to the modifications necessary for implementation of a new STE2 sludge packaging process, along with the characteristics of the corresponding waste package. Recovery of this sludge should be completed no later than 31 December 2030.

STE2 sludge storage silo

#### *HAO silo*

The HAO silo contains various wastes 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. Decommissioning of this silo requires prior dismantling of the equipment installed on the silo slab, construction of the recovery cell and qualification of the equipment to be used. The initial dismantling work has already been done.

The detailed preliminary decommissioning studies were reviewed by ASN in 2007. In 2010, the licensee optimised its initial scenario: waste recovery from the SOC (optimised hull storage) should be carried out at the same time as waste recovery from the HAO silo. The hulls and end-pieces from the HAO silo will be packaged then stored in the D/E EDS facility before being compacted in the ACC facility. ASN continues to pay particular attention to the effective implementation times of the waste recovery and packaging operations.

#### *Silo 130*

Following the announced postponement in the setting up of a graphite waste disposal route, the licensee stated that its strategy would have to change, but that whatever the case, it still aimed to recover the waste from Silo 130. The operations will therefore require interim storage of the recovered waste.

The project submitted by the licensee to achieve this comprises four phases. The first is to transfer the GCR waste before storage in the D/E EDS facility. The second phase is to drain and treat the water in the silo, in the STE3 installations. The last two phases will enable the waste to be recovered from the bottom of the silo, along with the rubble.

In 2008, ASN approved the preliminary preparatory work, in particular installation of the silo waste recovery and evacuation cells.

Unfortunately, the licensee announced in early 2009 that the start of the waste recovery operations was postponed to a later date. Considering the old design of this silo and the uncertainties as to the way its civil engineering structure would evolve over time, ASN enacted requirements on 29 June 2010 obliging the licensee to take compensatory safety measures and submit a detailed file on the waste recovery preparation and actual recovery operations. ASN has set 1 July 2016 as the deadline for starting the recovery and packaging operations for all the wastes, and the end of 2014 as the deadline for submitting the approval application file for the package for packaging waste containing graphite.

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

To package fission products from reprocessing of French gas-cooled reactor fuel, in particular containing molybdenum, the licensee has opted for cold crucible vitrification (see point 1.3.2).

It is planned to put the cold crucible into service with these old solutions in 2011, with the aim of packaging the solutions between 2011 and 2017.

### *Removal from storage in Building 119 of 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 and process in the D/E EB facility in BNI 118, the drums of alpha waste from the French MOX fuel manufacturing plants. This authorisation was supplemented in 2008 to allow the reception, storage and treatment in the D/E EB facility in BNI 118 of the drums of alpha waste from the plants on the La Hague site.

In 2009, and in 2010 but at a slower pace due to an incident that affected the installations, verification and transfer for processing to the alpha waste conditioning unit (UCD) in the R2 facility continued. This conditioning will enable said waste to be disposed via existing disposal routes.

The processing capacity of the UCD will be entirely devoted to Building 119, which will enable this facility to be closed down earlier, as it no longer meets current safety requirements.

A new compacting unit capable of handling a large volume of alpha waste is currently being studied.

## 2|1|2 Final shutdown of the UP2 400 plants, the STE2 facilities and the Elan IIB unit

On 1 January 1967, the UP2 400 plant for reprocessing the spent fuels from the GCR reactors entered into industrial operation jointly with the effluent treatment station STE2 for purifying the liquid effluents before their discharge into the sea. In 1974, UP2 400 was licensed to reprocess fuels from the light water reactors.

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 was accompanied by a file presenting the operations planned in the phase of preparation for final shutdown (MAD) of the various units in this plant, and the associated effluent treatment station. The Elan IIB facility dedicated to the fabrication of caesium 137 and strontium 90 sources between 1970 and 1973 has also been shut down since 1973.

During the course of 2009, the licensee integrated the ORCADE project, which is responsible for final shutdown of the UP2 400 units and the legacy waste recovery programmes, into an entity on the site under the responsibility of the AREVA value development business unit. This unit, created at the end of 2008, handles all the group's decommissioning projects and promotes sharing of operating experience feedback between the various AREVA facilities (UP1 plant in Marcoule, ATPu in the CEA/Cadarache centre, SICN in Veurey - Voroise).

The year 2010 was marked by the reclassification to Level 2 on the INES scale of an incident involving plutonium contamination of a worker wearing a leak-tight suit during a dust removal operation in a cell of the MAU facility of the UP2 400 plant (see point 3.4.1).

At the end of 2008, AREVA NC submitted a final shutdown and decommissioning (MAD/DEM) safety file for the BNIs corresponding to the UP2 400 plant, the STE2 facility and the Elan IIB facility, i.e. BNIs 33, 38 and 47. The public inquiry was held in October 2010 (see chapter 15).

The MAD/DEM safety file of the HAO facility (high oxide activity: old facility for receiving, shearing and dissolving spent fuels in the UP2 400 plant) was subject to a public inquiry in November 2008 and received a favourable opinion. Final shutdown and decommissioning decree 2009-961 for BNI 80 was published on 31 July 2009 (see chapter 15).

The north section of the HAO facility will nevertheless continue to receive the fuels that cannot be received in the head workshops of the UP3 and UP2 800 plants.

## 2|2 COMURHEX uranium hexafluoride preparation plant

COMURHEX, a 100% subsidiary of the AREVA Group, has been established on the Tricastin site since 1961, where it mainly produces the uranium hexafluoride ($UF_6$) for nuclear fuel fabrication needs. Alongside this main activity, COMURHEX produces various fluorinate products such as chlorine trifluoride (ClF3).

This production activity uses the excess fluorine resulting from the hydrolysis of hydrofluoric acid (HF).

Production of $UF_6$ uses natural uranium in the ICPE part of the plant, or reprocessed uranium in the BNI part of the plant. This latter part, BNI 105, chiefly consists of two facilities:
– the 2000 unit, which transforms reprocessed uranyl nitrate ($UO_2(NO_3)_2$) into uranium tetrafluoride ($UF_4$) or uranium sesquioxide ($U_3O_8$);
– the 2450 unit, which converts the $UF_4$ (whose uranium 235 content is between 1 and 2.5%) from the 2000 unit into $UF_6$. This $UF_6$ will be used to enrich the reprocessed uranium for recycling in the reactor.

During its inspections in 2008 and 2009, ASN observed irregularities affecting the means of prevention of chemical or radiological pollution risks. On 20 November 2009, the licensee had informed the authorities of a leak in which about 17 $m^3$ of liquid acid effluents had infiltrated the water table of the River Rhône. For operating reasons, the licensee had decided to drain the part of a tank containing acid effluents into its retention structure, but this structure was not leak-tight. The DREAL (Regional Directorate for the Environment, Planning and Housing), in collaboration with ASN, gave the COMURHEX site formal notice to bring the retention structure of its liquid effluent treatment facility into conformity.

At the request of ASN, the licensee implemented a plan of actions aiming to check the conformity of all the retention structures on the site (BNI and ICPE), and carry out the repair work where necessary. The Tricastin site underwent a tightened inspection on 9 June 2010 that confirmed the monitoring of this plan of action and the one put in place following the operating experience feedback from the SICATRI incident of July 2008. The inspectors observed that all the actions were in progress or completed.

On 13 October 2008, the licensee notified ASN of final shutdown of its BNI 105 on 31 December 2008. At the end of July 2009, in accordance with article 37 of decree 2007-1557 of 2 November 2007, it also transmitted the decommissioning plan for this facility. ASN judged the file incomplete and asked the licensee to supplement it by including in particular the clean-out and final state of the floors of the BNI and the ICPE and of the adjacent grounds.

The licensee has postponed submission of the final shutdown and decommissioning decree application file, initially announced for mid-2010, to the first quarter 2011. ASN considers this postponement prejudicial because it will push back decommissioning operations that must be started as soon as possible. Furthermore, the safety baseline of the installation shut down under its operating baseline is still not satisfactory; ASN has asked the licensee to complete it. Pending application authorisation, the licensee, at the request of ASN, has communicated the list of operations it wants to carry out on the installation and which are compatible with the currently authorised baseline.

As regards the ICPE, at the end of 2008 COMURHEX submitted an application file for a license to operate a new installation, COMURHEX II. This project consists in replacing the existing conversion units which will then be shut down and decommissioned. The file was the subject of a public inquiry and a joint review by ASN and the Rhône-Alpes DREAL, which led to prefectural order 10-3095 of 23 July 2010 licensing the ICPEs in operation and those in the course of construction.

**Fluorine electrolysis cells. COMURHEX Pierrelatte plant for converting UF4 to UF6, Tricastin site**

## 3 REGULATING THE NUCLEAR FUEL CYCLE FACILITIES

### 3|1 Regulating the main steps in the life of nuclear facilities

ASN works at several levels to regulate the AREVA group's nuclear facilities.

ASN is responsible for regulating the main steps in the life of these facilities when they are modified (in 2010, change of licensee operating MÉLOX, commissioning of GBII, preparation for shutdown of EURODIF) and proposes the decrees that accompany these changes to the Government; ASN also draws up the provisions that establish the regulatory framework for these major steps.

These provisions specify the technical requirements relative to safety as well as those relative to the safety and radiation protection policy and management of the BNIs. These provisions were produced for the first time for the commissioning of GBII and the aim is ultimately to issue them for all the facilities of the AREVA Group. In 2010, ASN produced drafts for the La Hague and CERCA facilities.

ASN reviews insofar as necessary the safety files for each BNI, paying attention to their integration in the broader framework of laboratory and plant safety. In this respect, it ensures that the safety requirements are applied uniformly to all these facilities and that they are regularly updated, particularly on the occasion of the ten-year safety reviews.

In 2009 and 2010, the orientation files (DOR) for the periodic safety reviews of the AREVA Group's facilities, and particularly those of the La Hague and MÉLOX, were examined. The DOR of SOMANU is practically finalised. The subjects of discussion concerned the organisation of the reviews as an activity directly affecting safety and its regulation and inspection, the consideration of ageing of the facilities, the identification and application of elements important for safety. All these files will be presented to the Advisory Committee for laboratories and plants between 2011 and 2013. In 2010, the SOCATRI file underwent an admissibility review by ASN and IRSN. The content of the periodic safety review file was considered insufficient and it must be supplemented, particularly regarding the facility's ten-year development prospects, in accordance with the requirements of the TSN Act.

At shutdown of the AREVA Group's industrial facilities, ASN also ensures that each of them complies with the requirements of decree 2007-1557 of 2 November 2007, with regard both to informing ASN about the dates of shutdown and to the quality of the files, particularly regarding the taking into account of the risks due to the operating changes. In 2009 and 2010, the shutdown files for EURODIF, UP2-400 and COMURHEX gave ASN the opportunity to clarify its expectations on this subject.

An operating experience feedback unit within ASN, specialised in laboratories and plants, examines all the incidents occurring in these facilities. It analyses their causes to detect deviations or events that could occur in other facilities. Where applicable, ASN informs the licensees of the lessons learned, or modifies the regulations (see section 3.4.1).


ASN inspection of EURODIF plant on the Tricastin site - March 2010

ASN's regulatory actions also cover the AREVA head office departments, which are responsible for the group's safety, radiation protection and environmental protection policy (D3SE). ASN looks at how they draft and facilitate the implementation of this policy in the various establishments within the group. In 2010, the main subjects were the production of internal authorisation systems and the more widespread consideration given to human and organisational factors (HOF), in particular through production of the "safety management in AREVA facilities" file. ASN also alerted the AREVA head office departments about the standardisation of practices relating to incident notifications and the drawing up of significant event reports. Defining the elements important for the safety of the group's facilities was also a key subject in 2010.

Finally, because ASN will be taking over responsibility for regulation and inspection of the Pierrelatte site in the medium term, ASN and the Defence Nuclear Safety Authority (ASND) are focusing on ensuring completely coherent application on the Tricastin site of the safety and radiation protection requirements for which each of them is responsible. Most of the facilities under the responsibility of ASND have been shutdown or are being decommissioned, and should shortly be considered to be civil facilities. The facilities that will not be decommissioned are those currently treating the effluents and wastes for the site as a whole, and all the uranium storage facilities. Some of these facilities are obsolete and must be replaced by new facilities which will then be placed under the authority of ASN.

ASN and ASND set up a working group to clarify the steps involved in ASN's taking over responsibility for regulating the safety of the activities performed on this site. This working group was opened up to the licensees in 2010 to establish the precise procedures involved in the change in regulatory body. It was decided that this would take place gradually as and when the regulatory situation of each facility is clarified (after periodic safety review, decommissioning under way or planned). The end of this process is scheduled for about 2018. The working group reported its conclusions to the two regulatory bodies at the end of 2010.

## 3|2 Ensuring the consistency of the cycle

ASN regulates the overall safety-related and regulatory consistency of the industrial choices made with regard to fuel management. The issue of long-term management of spent fuel, mining residues and depleted uranium is examined taking account of the unforeseen variables and uncertainties attached to these industrial choices. In the short and medium term, ASN particularly aims to anticipate and prevent saturation of the storage capacity of the NPPs, as has been seen in other countries, and to prevent the licensees from using former installations, for which the regulatory and technical licensing requirements are less strict, as an interim storage solution. ASN is assisted in this approach by the ministry in charge of energy, consulted to obtain information concerning movements of materials or industrial constraints that could have consequences on safety, for example.

EDF was asked to undertake a forward-looking study in cooperation with the fuel cycle companies, presenting elements demonstrating compatibility between changes in fuel characteristics and their management, and developments in fuel cycle installations.

The data presented by EDF and reviewed to date provide significant clarification of how the fuel cycle operates and the safety issues involved, and 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 policy, EDF must demonstrate that it has no unacceptable effect on the fuel cycle installations.

At the end of 2008, EDF reached an important agreement with AREVA for managing reprocessing-recycling traffic and, allowing for unforeseen variables, for developing a long-term vision for forward-looking management of the fuel cycle plants, including end-of-life operations.

An overall revision of the file was submitted in 2008. This file was reviewed on 30 June 2010 by the Advisory Committees for laboratories and plants, and for wastes, on the basis of a report presented by IRSN. The DGEC (General Directorate for Energy and Climate) and members of the Advisory Committees for nuclear reactors and for transport took part in the discussion.

On completion of this review, ASN enhances the monitoring of the cycle and its modifications through biennial updating reports, and requires that EDF communicate an updated "cycle" file by 2016. This monitoring system integrates more specific technical requests: they concern the management of new fuels, the way certain types of fuel evolve, and the spent fuel storage strategy.

## 3|3 Overseeing licensee organisation

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

It is not the role of ASN to impose a particular organisational model on the licensees. ASN can nevertheless express an opinion or give recommendations regarding the chosen organisation, and possibly directives on specific identified points if it considers that they present shortcomings in terms of internal inspection of safety and radiation protection, or that they are inappropriate.

ASN therefore primarily observes the working of the organisations put into place by the licensees through inspections, including those devoted to safety management. The main findings in this context concern the under-staffing of certain departments that play a key role in safety, or the balance between duties and available resources in other departments. This is liable to make it hard for them to perform the duties entrusted to them, with production demands often taking precedence over the other constraints.

ASN therefore initiated a safety management review within the AREVA Group, for the BNIs operated by the Group. The file on which this review is based was submitted by AREVA in January 2010; it is currently being examined and should be presented to the Advisory Committee for laboratories and plants in autumn 2011.

## 3|4 Promoting operating experience feedback

### 3|4|1 Dealing with incidents

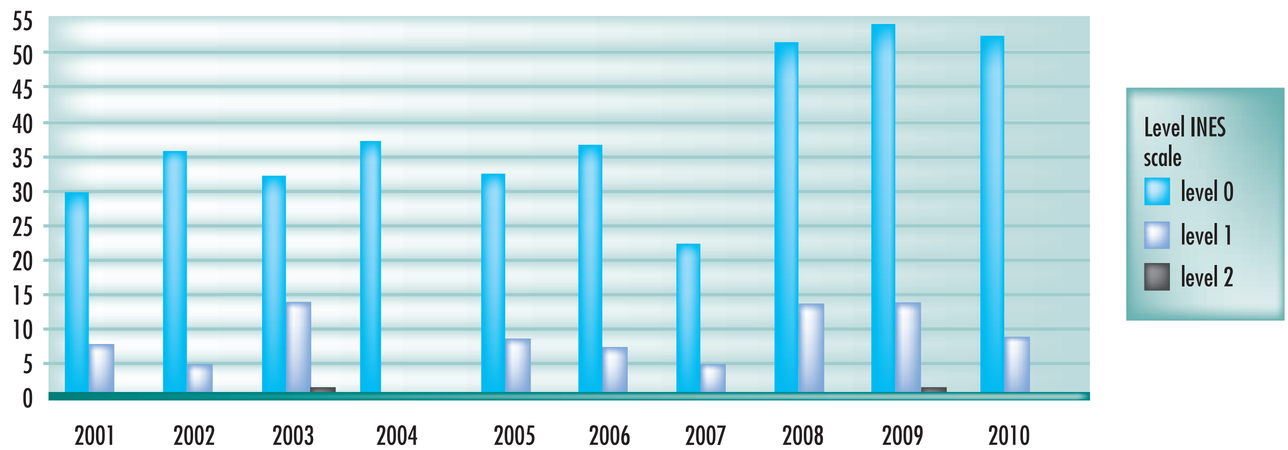
The detection and processing of significant events that have occurred during operation of the installations play a fundamental safety role. The lessons learned from these events lead to new requirements applicable to elements important for safety (EIS) and to new operating rules. Licensees must therefore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

The following graph shows the trend in the number of significant events notified in fuel cycle installations.

Examination these events by ASN and their management by the licensees serve notably 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.

The number of notified significant events has dropped, after having risen markedly for two years in succession. The drop is observed more particularly in the installations upstream of the cycle, namely the research laboratories and the installations undergoing decommissioning. These trends will be analysed in depth by ASN in 2011.

## Graph 1: Trend in the number of significant events in fuel cycle installations since 2001




The year 2010 was marked by the reclassification to Level 2 on the INES scale of a personnel contamination incident that occurred at the end of 2009 in the MAU (medium uranium activity) facility of the UP2 400 plant on the La Hague site.

2010 was also marked by the consequences of the significant event that occurred within the ATPu (Plutonium Technology facility) on the Cadarache site, declared on 6 October 2009 (see point 3.4.4). This event led ASN to send out generic requests to the licensees with the prime aim of getting them to verify the quantities of fissile materials[4] actually present in their facilities. The results of the first verifications were presented to the High Committee for nuclear safety transparency and information at the end of April 2010. As these verifications were incomplete, ASN asked the licensees for additional information in May 2010, chiefly relating to verifications to be carried out in poorly accessible systems, such as ventilation ducts or liquid effluent discharge networks. The results of these additional verifications are still to be communicated.

The inspections carried out in the AREVA Group's facilities in 2010 showed that, when they are detected, events are still not sufficiently analysed. ASN observed that even if abnormal situations are correctly detected, their analysis does not always provide the licensees with a common view of the safety issues at stake in the different facilities, enabling them to draw the relevant lessons from them. ASN expects continuing improvement in operating experience feedback based on significant events.

The facilities involved in the fuel cycle progressed in their assimilation of operating experience feedback in 2010: on the whole, they showed greater rigour in compliance with the notification criteria and event report submission times. Several incidents do however show that weaknesses persist in the organisation of safety and radiation protection in the AREVA Group's facilities, even if their overall number has decreased. ASN will remain vigilant on the licensees' implementation of measures to prevent their renewal.

### 3|4|2 Taking account of organisational and human factors

Formalisation of the way human and organisational factors (HOF) are taken into account actually began in 2005-2006

**TO BE NOTED**

#### Internal contamination of an employee of a subcontractor

*On 19 November 2009, an employee of a subcontractor company was contaminated, more specifically by plutonium, when removing dust from a cell in the MAU (medium uranium activity) facility. In the course of the operation, the right hand of the employee, who was wearing a leak-tight ventilated suit, hit a metal wire attaching an identification label to a pipe in the cell. The metal wire pierced the employee's protective gloves and pricked him, causing internal contamination. The licensee carried out a detailed analysis of the incident, which was examined by ASN. The licensee temporarily suspended this type of clean-out operation in the facility in order to redefine the working conditions and improve the conditions of use of personal protective equipment.*

*The results of the periodic complementary examinations of the contaminated employee led to the 50-year committed dose being estimated at between 20 mSv and 100 mSv. This dose was calculated by the occupational physicians and confirmed by IRSN. No disease has been observed to date as a consequence of this level of exposure.*

4. A fissile material is a material that can sustain a nuclear reaction, like that used in nuclear reactors to produce electricity.

within the fuel cycle installations, with the drafting of internal policies specific to each licensee. This approach began to be centrally applied within the AREVA Group in 2008, when the Group's head office departments employed a HOF specialist. Since then, a central policy has been drafted and is being gradually deployed among the Group's licensees. This approach will still take some time to bear full fruit.

The various licensees within the AREVA Group are now staffed with persons competent in HOF. Nonetheless, ASN wonders whether the resources of certain licensees are sufficient in this area.

The analysis of significant event reports or the review of the technical files would seem to indicate that assimilation of the HOF approach is still in progress. The specialists on the subject are not yet systematically consulted with regard to issues with high stakes in terms of human reliability or workstation ergonomics.

## 3|4|3 Maintenance

The elements important for safety (EIS) in a facility undergo maintenance with the aim of guaranteeing their long-term operation and their availability. Maintenance is said to be corrective when it is carried out at the initiative of the licensee after a failure. Preventive maintenance leads to maintenance programmes, usually annual, determined under the responsibility of the licensee. These programmes include the periodic checks and tests.

In the industrial environment, maintenance operations are to a very large extent subcontracted, with the licensee keeping its own personnel for the smaller-scale operations and those relating to the core activity.

ASN considers that, being responsible for the safety of the facility, the licensee must guarantee the quality of preventive maintenance operations, be familiar with its results and conduct in-depth analysis of the causes of any deviations and drift observed.

ASN thus attaches particular importance to the choice of contractors, to the way the licensee accomplishes its duty in monitoring them, to the quality of the analysis of their work, to the results of the second-level checks that the licensee must perform, and to any improvements it might have to make.

ASN calls a number of inspections on this topic every year. The campaign of inspections carried out in 2010 revealed inadequate monitoring of the contractors working for first-tier subcontractors.

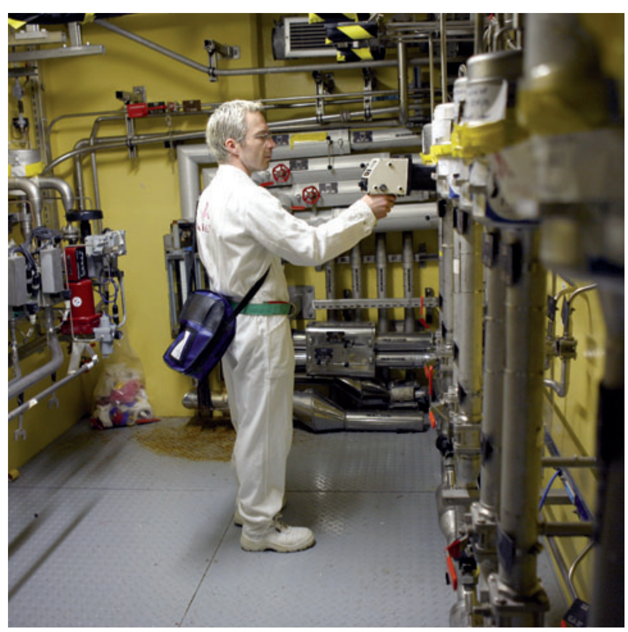
## 3|4|4 Controlling sub-criticality

In 2009, events had revealed significant deficiencies in prevention of the criticality risk[5] in several nuclear facilities of the AREVA Group.

Moreover, two events in the laboratories and plants had been classified as Level 2 on the INES scale and concerned the limitation of the mass of fissile materials:
– during an exceptional operation at MÉLOX, for which the use of the appropriate mass monitoring software was not planned, the introduction of a mass of fissile materials into a workstation led to the maximum authorised mass being exceeded;

5. Criticality: capacity of fissile materials to be able to trigger and sustain, under certain conditions, a nuclear reaction. Crticality depends on three main parameters: the quantity of fissile materials brought together in a given place, the geometry of that quantity of materials, and the presence of “moderator” materials (mainly materials that contain hydrogen atoms).

Maintenance intervention by AREVA on the core instrumentation of a nuclear power plant



Inspection in the radiation protection department of the spent fuel reprocessing plant in La Hague

– an incorrect estimation of the ATPu (see chapter 16) of the residual masses of fissile materials in some workstations (undetected accumulation of deposits during operation), that could have led to the maximum authorised mass being exceeded in several workstations. (see point 3.4.1).

Moreover, with regard to the MÉLOX facility, in June 2010 ASN carried out a review inspection on the theme "assimilation of the criticality risk and human and organisational factors". The inspectors noted improvements in awareness of the importance of current and future implications in terms of safety, criticality and human and organisational factors within the facility. Certain technical or organisational provisions for preventing the criticality risk, such as the procedure for managing inconsistencies of masses in material monitoring within the facility, must be subject to clarification and improvement. Lastly, the inspections and internal audits on the topic of criticality were still considered insufficient, even if they are developing within the MÉLOX facility.

It is therefore essential to check the arrangements taken, ensuring that they are appropriate for all plausible situations, that safety-criticality requirements are met and that the operators have been trained. It is also essential to underline the importance of the share of human and organisational factors in the events relative to the criticality risk, as many checks on the control of this risk require human interventions.

Further to this series of events, ASN decided that the fundamental safety rule in relation to criticality dating from 1984 would be revised in order to introduce 25 years of national and international operating experience feedback from the installations, the changes in the dedicated calculation codes, and the principle of "Defence in Depth" into the approach to this risk. A working group bringing together ASN, IRSN, licencees' criticality engineers and a number of experts (IAEA) will be tasked with revising this text. The revision will be presented to the Advisory Committee for the laboratories and plants and to the safety-criticality commission of ASND.

## 4 INTERNATIONAL ACTION

In June 2009, ASN launched a bilateral cooperation programme with the NRC (United States Nuclear Regulatory Commission) for nuclear fuel cycle facilities and more particularly those involved in reprocessing-recycling. The reason is that the United States, which opted a long time ago for an open cycle and final disposal of spent fuel without reprocessing, is now confronted with the population's opposition to the Yucca Mountain nuclear waste repository. The United States authorities are therefore currently examining the closed cycle option. This context has spurred NRC to initiate in advance the drafting of the regulations that would be applicable to future fuel reprocessing and recycling plants if the closed cycle option were to be adopted. It expressed its interest in having discussions with ASN on its operating experience feedback on the regulation of this type of installation. Seminars and visits to facilities were therefore organised during 2010. The subjects addressed included the regulatory licensing process, the risk analysis methodologies, the criteria for determining elements important for safety, management of safety, radiation protection and waste, and the transport of radioactive materials.

In March 2010, NRC visited the centrifuging plants to learn about France's operating experience feedback from the start-up of the GBII plant, given that NRC is responsible for the licensing process of two new plants in the U.S.

The NRC also met ASN and the licensees of the La Hague and MÉLOX plants in September 2010 to discuss topics associated with recycling. The question of research dedicated to recycling and waste was addressed at a meeting with the CEA (French Alternative Energies and Atomic Energy Commission). Over and beyond research topics, CEA gave a presentation – at the request of ASN – on the safety of the installations that carry out this research in France and which are BNIs (particularly ATALANTE in CEA's Marcoule centre).

In June 2010, ASN also took part in the annual public meeting to share experience about the fuel cycle which for the past 4 years has brought together licensees and associations at the NRC premises in Washington. These seminars, entitled FCIX "fuel cycle exchange information meetings" attract up to 300 people. ASN presented France's operating experience feedback concerning regulation of the nuclear fuel cycle and the main areas in which progress is expected.

Lastly, ASN took part in two seminars of the OECD /NEA in Vienna: firstly that of the WGFCF (Working Group for Fuel Cycle Facilities) on 9 October 2010 on the integration of operating experience feedback from fuel cycle facilities, and secondly the FINAS (Fuel Incident Notification and Analysis System) conference of 7 and 8 October 2010 (organised jointly by IAEA/NEA) during which it presented its appraisal of the incidents that occurred in the French laboratories and plants in the last year.

# 5 OUTLOOK

*Cross-disciplinary aspects*

In 2011, ASN will continue the actions undertaken in 2010 to better supervise the ongoing and future license applications and the planned periodic safety reviews.

ASN also initiated in September 2010 the overall review of the safety and radiation protection management process within the AREVA Group. ASN is closely monitoring this file, which should be presented to the Advisory Committees of Experts in November 2011.

The way the AREVA Group licensees integrate operating experience feedback will receive particular attention in 2011, as will the implementation of internal authorisation systems.

*Tricastin site*

Pollution prevention and progress with the projects concerning the effluent and waste treatment stations remain the major issues for this site in 2011.

ASN will ensure that all the projects planned by AREVA, whether to prepare for the EURODIF and COMURHEX plant shutdown operations or for the major changes in the existing plants (SOCATRI, GBII), are conducted in compliance with the TSN Act, particularly as regards informing the public.

*Romans-sur-Isère site*

In 2011 on the Romans-sur-Isère site, ASN will in 2011 closely monitor confirmation of the progress already achieved in terms of safety. It in particular expects improved management of the waste areas. It will also be focusing on the actions taken following the safety reassessment of the facilities belonging to the CERCA company.

*MÉLOX plant*

As regards the MÉLOX plant in Marcoule, ASN will remain vigilant on the organisation and means implemented to increase the production capacity of the industrial plant and accompany the change in the nature of the materials used with respect to the expected requirements in term of safety and radiation protection. Consequently, verification of dosimetry control and the capacity to prevent the risks associated with human and organisational factors and the criticality risk, will remain a priority.

The periodic safety review of the MÉLOX plant is scheduled in 2011. It will constitute a key step in the life of the facility, as it provides the opportunity to assess its conformity with the regulations and with its safety requirements, while at the same time establishing the safety improvement work programme for the next ten years. This review will also allow the fundamental questions concerning the choice of computerised production management system to be addressed. Today this system manages both criticality risk prevention and nuclear materials accounting.

*La Hague site*

ASN considers that efforts must be continued in the La Hague plants, particular in the integration of operating experience feedback and the notification of significant events. In the framework of the periodic safety reviews of the facilities, 2011 should see the completion of the identification of elements important for safety and the improvement of the general operating rules of these plants. Regarding the periodic safety reviews, ASN has asked IRSN to examine more particularly the conformity reviews of the UP3 plant and the effects of aging on the structures and equipment.

As regards the recovery of legacy waste, ASN will be attentive to ensure that turnarounds in industrial strategy do not significantly delay the recovery and disposal of the waste from Silo 130 or the sludge from STE2 and HAO. ASN has already taken measures to this end for Silo 130 in 2010, and will oversee the programme as a whole more closely in 2011.

Lastly, ASN will closely monitor the implementation of the system of internal authorisations at the La Hague plant.