# 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 oxides and plutonium, the plutonium having been generated when the fuel based on natural enriched uranium gets irradiated in the power reactors.

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

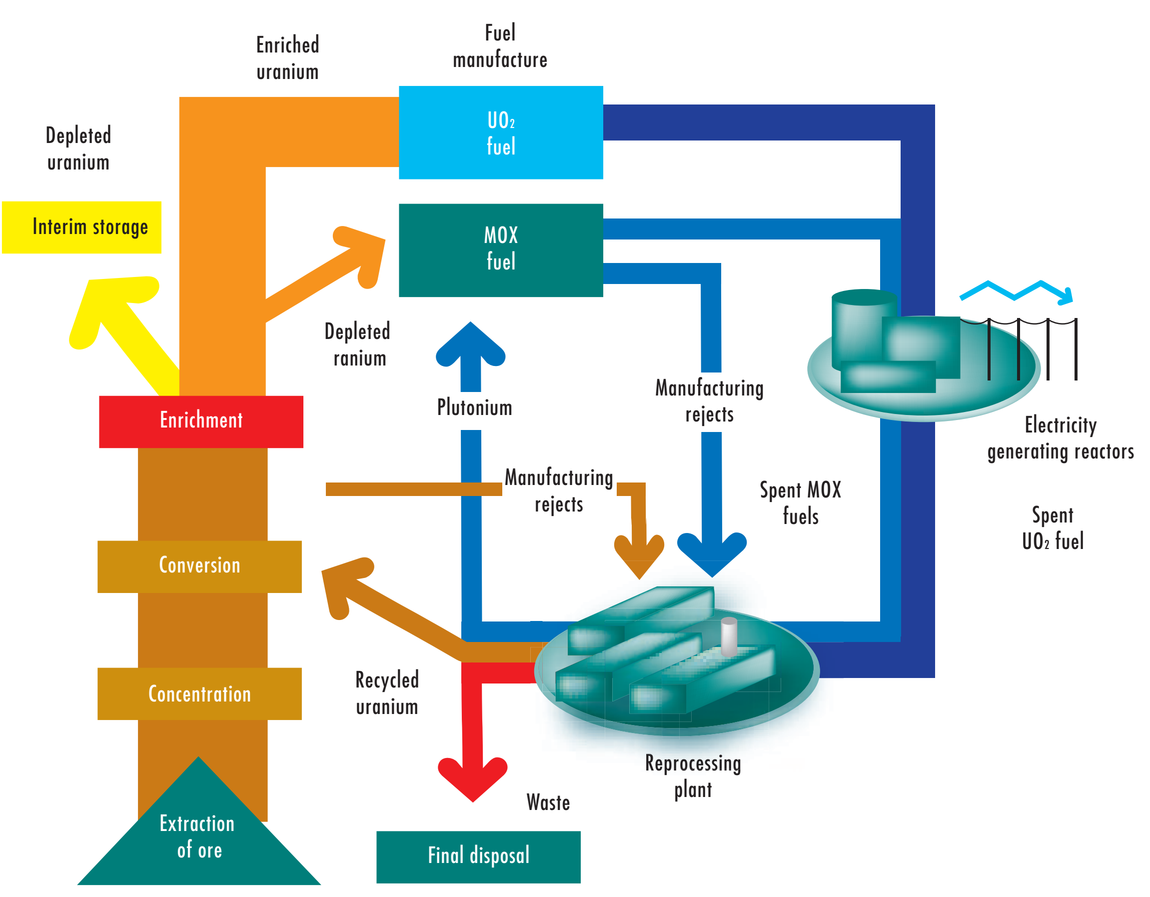
ASN regulates these industrial facilities independently with a view to monitoring a fleet of installations where safety and radiation protection must be managed along common lines. Today ASN expects AREVA to ensure high-quality management of safety and radiation protection in its facilities, rooted in the daily and on-ground activities of all the group's players, commensurate with AREVA's stated ambitions.

The fuel cycle chiefly comprises the fabrication of the fuel and its subsequent reprocessing after it has been used in the nuclear reactors. 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 ($UF_6$) in the conversion operation. The raw material which will subsequently be enriched is fabricated by the COMURHEX plants in Malvési (Aude *département*[1]) and Pierrelatte (Drôme *département*). The facilities in question - which are not regulated under the legislation for basic nuclear installations (BNIs) but under that for installations classified on environmental protection grounds (ICPEs) - use natural uraniumin which the uranium 235 content is around 0.7%.

The existence of nuclear facilities whose activity is necessary for the operation of the BNIs mentioned above must also be noted, such as SOCATRI which ensures the maintenance and decommissioning of nuclear equipment, and the processing of nuclear and

## The fuel cycle




1. Administrative region headed by a *Préfet*

industrial effluent from the AREVA companies in Tricastin, or SOMANU in Maubeuge, which ensures the servicing and repair of certain nuclear components outside their original facility.

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 of uranium 235 from 0.7% to between 3 and 5% is ensured by the EURODIF plant in Tricastin, which separates the uranium hexafluoride ($UF_6$) using a twin-stream gaseous diffusion process, with one stream becoming enriched in uranium 235 while the other becomes depleted during 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 pool, 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 either to manufacture fuel for fast neutron reactors (as was done in the ATPu in Cadarache), or, in the MELOX plant in Marcoule, to manufacture the MOX fuel (mixture of uranium and plutonium oxides) used in particular in the French 900 MWe PWR reactors.

## Map showing the location of the fuel cycle plants

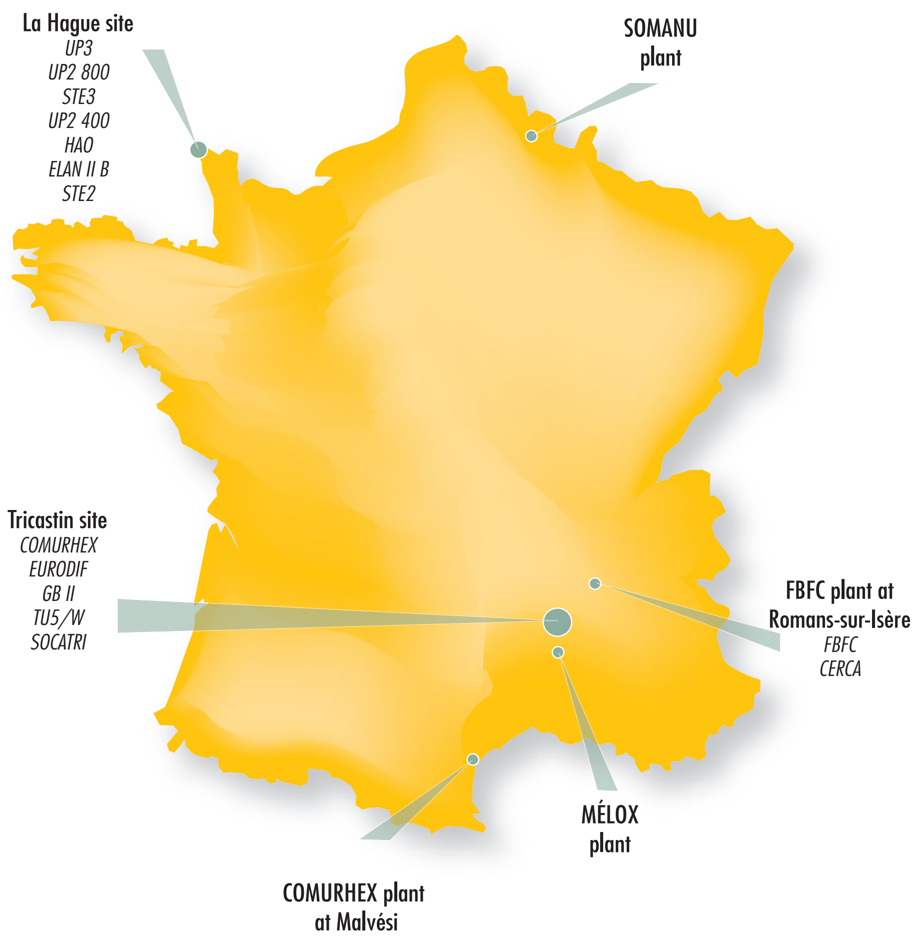


Table 1: fuel cycle industry movements in 2011

| Installation | Origins | Material processed | Tonnage (unless otherwise specified) | Product obtained | Tonnage (unless otherwise specified) | Destination | Tonnage (unless otherwise specified) |
|---|---|---|---|---|---|---|---|
| **COMURHEX** Pierrelatte[2] | Installation in shutdown status | $UO_2(NO_3)_2$ (derived from reprocessed uranium) | 0 | $UF_4$<br>$UF_6$<br>$U_3O_8$ | 0 | Installation in shutdown status | 0 |
| **AREVA NC** Pierrelatte TU5 plant | **AREVA NC** La Hague | $UO_2(NO_3)_2$ (derived from reprocessed uranium) | 2,801 | $U_3O_8$ | 837 | Interim storage TU5 | 837 |
| **AREVA NC** Pierrelatte W plant | **URENCO**<br>**EURODIF** | $UF_6$ (based on depleted uranium) | 11,181<br>8,205 | $U_3O_8$ | 8,917<br>6,552 | Interim storage W plant | 8,917<br>6,552 |
| **EURODIF** Pierrelatte | Converters and EURODIF Production | $UF_6$ (derived from natural and depleted uranium) | 6,420 | $UF_6$ (depleted uranium) | 5,636 | Defluorination and re-enrichment of tailings | 7,281 |
| | Re-enrichment of tails | $UF_6$ (based on enriched uranium) | 184 | $UF_6$ (enriched uranium) | 956 | Fuel manufacturers | 983 |
| **FBFC** Romans | **EURODIF**<br>**TENEX**<br>**URENCO** | $UF_6$ (based on enriched natural uranium) | 632 | $UO_2$ (powder) | 194 | FBFC, Dessel (Belgium) | 194 |
| | | | | Fuel elements | 387 | EDF | 387 |
| | | | | | 52 | Tihange+Doel (Belgium) | 52 |
| | **COMURHEX** | $UF_6$ (based on natural uranium) | 4.5 | | 30 | KOEBERG (South Africa) | 30 |
| | **AREVA NC** | $UF_6$ (based on enriched natural uranium) | 74 | Fuel elements | 72 | EDF | 72 |
| | **EURODIF** | $UF_6$ (based on depleted uranium) | 6 | Models | 0.5 | AREVA | 0.5 |
| **MÉLOX** Marcoule | **AREVA NC** Pierrelatte | $UO_2$ (based on depleted uranium) | 134.4 ML[3] | MOX fuel elements | 138.6 ML[3] | CNPE EDF | 118.1 ML[3] |
| | | | | | | FBFC-Dessel | 12.8 ML[3] |
| | **AREVA NC** La Hague | $PuO_2$ | 12.6 ML[3] | | | AREVA NC La Hague (Japan)[3] | 1.7 ML[3] |
| **AREVA NC** La Hague | EDF BORSELLE reactors | Spent fuel elements UOX + MOX $(U+Pu)_{init}$ on UP3 | 550.35 | Vitrified waste | 339 CSD-V packages | Interim storage La Hague | 38 CSD-V packages |
| | BR2 MOL | Reprocessed spent fuel elements $(U+Pu)_{init}$ sur UP3 | 0.03 | Vitrified waste | | Germany | 301 CSD-V packages |
| | EDF reactors $(U+Pu)_{init}$ on UP2 800 | Spent fuel elements UOX + MOX | 494.63 | Vitrified waste | 272 CSD-V packages (including 76 CSD-B packages) | Interim storage La Hague | 272 CSD-V packages (including 76 CSD-B packages) |
| | All origins | Spent fuel elements on UP3 et UP2 800 | | $UO_2(NO_3)_2$ | 809.97 | AREVA NC Pierrelatte | 809.97 |
| | | | | $PuO_2$ | 12.30 | MELOX | 150.08 |
| | | | | Compacted waste | 1,342 CSDC packages | Interim storage La Hague | 1,038 CSD-C packages |
| | | | | | | Belgium, Holland, Switzerland | 304 CSD-C packages |
| | EDF, TRINO BORSELLE reactors | Spent fuel elements UOX/MOX $(U+Pu)_{init}$ | | | | Elements unloaded into pool | 1243.75 |
| | CELESTINS, OSIRIS et ILL | Reprocessed spent fuel elements RTR $(U+Pu)_{init}$ | | | | | |

(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 2011.
(3) Heavy metal.

# 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 ($UF_6$), the form in which it is enriched. These operations are mainly carried out on the Tricastin site, also known as Pierrelatte.

All the BNIs on the site underwent a complementary safety assessment (CSA) in 2011 further to the ASN decision of 5 May 2011 (see point 5).

Following the joint review of these CSAs by the Advisory committee of experts for laboratories and plants, the IRSN (Institute of radiation protection and nuclear safety) and ASN, ASN will issue requirements relative to 1) the creation of a hard core of structures, systems and components that must be reinforced beyond the current design basis, 2) the development of the operating baseline standard, 3) emergency management, 4) reduction of the scale of a chemical accident, and 5) complements to the submitted CSAs.

### 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 $UF_6$ 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.

The TU5 facility on the Tricastin site

The dry radioactive material recycling unit was put into service in June 2011, which improves the safety of the storage sites.

### 1|1|2 The gaseous diffusion enrichment 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 $UF_6$ through porous barriers. These barriers allow preferential passage to the uranium 235 isotope 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.

The licensee plans stopping plant operation in mid-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-General for Energy and Climate (DGEC) on 23 April 2010. The decommissioning operations must be planned for (inventories, characteristics) given the masses of materials to be recovered – the diffusers, for example, represent 150,000 tonnes of steel – in order to optimise the treatments, dismantling operations, transport and disposal routes.

In the first quarter of 2011 the licensee submitted 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. These operations gave rise to a public inquiry from 19 December 2011 to 20 January 2012.

To technically underpin its application for cascade rinsing and to optimise the operations as a whole, the licensee - with the agreement of ASN – conducted several air venting tests of various diffusion units. The efficiencies were improved.

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

In 2010 ASN conducted an inspection on the subject of outside contractor monitoring that revealed deficiencies. The licensee implemented a plan of action that ASN monitored attentively in 2011.

Further to the experience feedback from the SOCATRI incident of July 2008, the licensee had undertaken a plan of action at the request of ASN. Although substantial measures were

ASN inspection on the EURODIF plant site – March 2010

External view of the REC II facility under construction at the GEORGES BESSE II plant – October 2011

undertaken to bring the retention areas into conformity, ASN observed defects in the ground surfacing finish beneath the overhead pipes conveying chlorinated solvents. ASN asked the licensee to rapidly establish a periodic inspection programme for the retention areas, and this is continuing today.

The year 2011 was marked by three significant events which had no impact on safety but were each rated level 1 on the INES scale:
- an upwelling of liquid $UF_6$ in a crystalliser due to the simultaneous pouring of two crystallisers in the same unit;
- non-compliance with a container docking procedure in a depleted $UF_6$ emission oven, leading to a rise in the container pressure;
- non-locking, due to a technical failure, of a protective cover on the valve of a liquid $UF_6$ container stored in an outside yard; this finding was made by an ASN inspector.

These events revealed organisational deficiencies, for which the remedial measures taken will be monitored by ASN in 2012.

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

The GBII plant (BNI 168) operated by the *Société d'Enrichissement du Tricastin* (SET), uses the ultracentrifugation process and will ultimately replace the EURODIF plant. The principle of this process involves injecting uranium hexafluoride ($UF_6$) into a cylindrical bowl rotating 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 quantities of nuclear material present in the cascades and centrifuges are reduced and 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 a support facility (REC II), was authorised by a decree on 27 April 2007.

The review carried out by ASN and its technical support organisations - IRSN and the Advisory Committee for laboratories and plants - revealed that the low level of $UF_6$ 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 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 authorisation is dependent on a number of requirements governing the start-up and operating conditions of the centrifugation plant.

In March 2010, ASN supplemented this framework with a decision whereby it prescribes a set of conditions relative to the safety tests prior to the first introduction of $UF_6$ into the plant. The plant commissioning process continued in 2011 in this framework with, at the end of the year, entry into production of a complete plant unit of the South unit, which represents 25% of this unit's production capacity.

Besides this, in January 2008 SET filed an application to modify the GBII BNI creation decree to allow the use of uranium resulting from spent fuel recycling in the REC II support facility, and the adaptation of the perimeter of the installation.

The ensuing procedure included a public inquiry that ran from 22 December 2008 to 30 January 2009. The results of this inquiry led to the production of a draft decree which was submitted to the petitioner for comments, in accordance with the regulatory provisions. Acting on referral from the ministers, and considering the remarks of the applicant, ASN gave a favourable opinion for this project on 28 July 2011.

## 1|2 Nuclear fuel fabrication plants in Romans-sur-Isère and Marcoule

On completion of 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. In the FBFC plant, this powder is used to fabricate pellets which will be made into fuel rods, which in turn will be grouped to form fuel assemblies. As for experimental reactors, some of them use highly enriched uranium in metal form. These fuels are manufactured by FBFC in the CERCA plant at Romans-sur-Isère.

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

The FBFC and MELOX plants underwent a complementary safety assessment in 2011 further to the ASN decision of 5 May 2011 (see point 5).

The CERCA plant will undergo a complementary safety assessment in 2012.

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

CERCA and FBFC, the two BNIs located on the Romans-sur-Isère site, are operated by FBFC, a company in the AREVA group. As far as the regulations are concerned, FBFC is the sole nuclear licensee for the site.

*FBFC nuclear fuel fabrication facility*

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

Operation of this plant is regulated by a decree authorising its creation, dating from 1978 and modified in 2006 to allow an increase in production capacity.

The renewal of the facility's industrial plant, which began in 2005, is now completed.

The year 2011 was marked by the discovery – at several points in the fuel manufacturing process (ventilation filters, pneumatic transfer system for uranium powder, uranium powder storage cylinders) – of a larger mass of uranium-containing materials than was expected. None of these events presented a criticality risk as the masses of uranium in question were low. Each of these discoveries resulted in a significant event notification, of level 1 for the filters and 0 for the others. Corrective measures were immediately applied, but the analysis of the root causes is still to be carried out. The licensee has undertaken an in-depth examination of the human and organisational causes that led to these incidents.

*CERCA fuel element fabrication plant*

The CERCA plant comprises a series of facilities for the manufacture of highly enriched uranium based fuel for experimental reactors.

The CERCA plant, one of France's oldest nuclear installations, was put into service before the BNI regulations were introduced. The Government was therefore simply notified of this installation in 1967.

To improve the regulatory framework governing the activities carried out in the facility, the drafting of instructions - provided for by Act 2006-686 of 13 June 2006 (now codified in books I and V of the environment code by Order 2012-6 of 5 January 2012) has been started. These technical instructions were finalised in 2011. They have been examined by the ASN commission and forwarded to the licensee for observations.

The year 2011 was marked by CERCA receiving formal notice from the Defence and Security High Official on 11 May 2011. The subject of this formal notice was the transfer of the highly enriched uranium-containing materials stored on the Romans site to a place where the civil engineering is more robust and the access better protected than the place used at present. The measures for conforming to this formal notice were taken during the summer of 2011. This transfer appreciably improves not only the security of the stored materials but also the safety of storage (better earthquake resistance).

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

The MÉLOX plant located in Marcoule is today the only French nuclear installation producing MOX fuel, which consists of a mixture of uranium and plutonium oxides.

In a decree of 20 March 2007, the MÉLOX plant was authorised to raise the production level 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.

The application filed in 2008 to transfer the status of nuclear licensee - hitherto held by AREVA NC - to MELOX SA, was examined and approved by ASN, with the publication of the decree in the *Official Journal* 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.

Fuel rod fabrication line in the FBFC plant at Romans-sur-Isère

Through this decision, ASN confirms that the licensee has indeed complied 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 taken into consideration in the facility's periodic safety review, instituted in article 29 of the TSN act, continued in 2010, culminating in the transmission of the facility's safety review file in October 2011. ASN referred the appraisal of this document to the IRSN.

With regard to safety, the event of 28 June 2011 which was rated level 1 on the INES scale (see point 3) must be borne in mind.

During a fuel rod assembly operation performed in manual mode on a bench, five rods impacted a mechanical part of the bench, leading to their rupture. The shop in which the operation was being carried out was contaminated, along with several adjacent rooms. The decontamination work was started immediately and continued until the end of October 2011.

The analysis of the causes of this event - in relation with the non-routine nature of the manual mode – revealed the need to improve the ergonomics of this drawing bench and to reinforce the safety system. The shortcomings implicating the human and organisational factors that were brought to light will lead the licensee to review the operating procedures for this production station. This event, through its duration (the assembly and interim storage shops were out of service for several weeks), falls into the category of contingencies that can affect the fuel cycle (see point 3|2).

Moreover, further to ASN's various findings (deficiencies in the computerised production management system, inconsistencies between the authorised baseline standard and practices on the ground) relative 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 these topics within the facility in June 2010 and examined the plans of action developed by the licensee to address these points. The implementation of this plan continued in 2011.

ASN observes a more pronounced commitment of plant senior management to the management of organisational and human factors within the plant, which has led to substantial modification efforts since 2010. They aim at increasing the presence of engineers on the ground and improving operating team responsiveness to unplanned situations. Nevertheless, although things are moving in the right direction, ASN considers that the means deployed today still fall short of the stated objectives of plant management.


Backup control panel in the MELOX plant. The "utilities" operations supervisor supervises the periodic inspections and tests

## 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 put into service from 1986 (reception and storage of spent fuel) to 1994 (vitrification facility), with most of the process facilities entering in service 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).

The plants of the AREVA NC La Hague site form part of the installations examined in 2011 as part of the experience feedback from the Japanese nuclear accident of Fukushima Daiichi in March 2011 (see point 5).

#### *Operations carried out in the plant*

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

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 pool, or dry in a leak-tight shielded cell. The fuel is then stored in the pools.

### 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 pools:* | *Pools 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:* | *Waste transit area* |
| *EDS:* | *Solid waste storage area* |
| *D/E EDS:* | *Storage/removal from storage of solid waste* |
| *ECC:* | *Storage and recovery facilities for technological waste and conditioned structures* |
| *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 pool* |
| *C pool:* | *Pool 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:** | *STE3 facility: effluent recovery and treatment and storage of bituminised packages* |
| *D/E EB:* | *Storage of alpha waste* |
| *MDS/b:* | *Mineralisation of solvent waste* |

After shearing the rods, the spent fuel is separated from its metal cladding by dissolution 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, calcined 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 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 those of 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.

Aerial view of the spent fuel reprocessing plant at La Hague

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.

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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.

On this account, in 2011 the licensee returned standard compacted waste containers (CSD-C) to Switzerland, Belgium and the Netherlands, and standard containers of vitrified waste to Germany.

## 1|3|2 Plant modifications

### *The plant authorised operating framework*

The creation authorisation decrees of 12 May 1981 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.

### *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.

By its decision of 14 June 2011, ASN authorised the cold crucible to be supplied with fission product solutions containing molybdenum from legacy waste, which will enable significant progress to be made in the recovery of legacy waste (RCD) from the site (see point 2|1|1).

*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. 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 safety-related equipment.

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 of experts for laboratories and plants from mid-2012 to 2014. 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 is 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 (CEDAI).

ASN has verified the operation of this system during specially dedicated inspections. Once a year it examines the forward-looking programme of operations that are authorised by this system.

*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. In this context, by a decision dated 16 June 2011, ASN has required the installation of thermocouples for monitoring the temperature of each well of the envisaged storage extension.

*The new facilities planned*

With the current growth in material recycling activities, the AREVA NC La Hague site reprocesses non-irradiated plutonium-containing materials existing as fuel assemblies, pellets or powder. As the reprocessing capacities of the units in service may not be compatible with the needs of the coming years, AREVA NC envisages putting into service a "plutonium-containing material reprocessing" unit (TMP) in the T4 facility.

Construction site of the glass storage building extension on the La Hague site (EEVLH)

Glove box in the R4 facility at La Hague

The licensee submitted the corresponding safety options file to ASN in 2009, the examination of which was completed in 2010.

This addition will form the subject of an application to modify the creation authorisation decree for BNI 116, and the file will be subject to a public inquiry.

Besides this, AREVA has submitted the safety file for the development project to enable the R4 facility to perform oxalic acid co-precipitation of uranium and plutonium. This new process will directly give a powder of mixed uranium and plutonium powder for use in the manufacture of MOX fuel. The R4 facility civil engineering modification work began in 2011 with a view to starting industrial operation in 2012; this will give rise to prescriptions and is subject to ASN authorisation due to its impact on the interests protected by the TSN Act. A draft decision was communicated to the licensee in November 2011, and the licensee has two months to submit its remarks to ASN. Decision 2012-DC-0262, requiring prior ASN agreement for certain operations relative to the implementation of a uranium and plutonium coprecipitation process in the R4 facility of the UP2 800 plant (BNI 117) on the AREVA NC site in La Hague, was signed by the ASN commission on 21 February 2012.

In the framework of the recovery of the sludge stored in the STE2 facility (see point 2|1|2), AREVA NC envisages integrating a new unit for conditioning this sludge by drying then compacting as pellets conditioned in a package filled with an inert material such as sand (C5 package). This project will necessitate a modification of the creation authorisation decree for BNI 118 (STE3) and the file will be subject to a public inquiry. AREVA envisages submitting its application file at the beginning of 2012.

AREVA NC has submitted to ASN a project for the complete renewal of the fleet of boilers that produce the energy necessary for operation of the La Hague plants. AREVA NC plans to replace them with one wood biomass boiler and two new oil-burning boilers. These installations are subject to licensing as individual ICPEs, and to notification as equipment items necessary for the operation of a BNI. AREVA effectively indicated in its file that the oil-burning boilers were sufficient to provide the energy necessary for safe operation of the plants, and that in the event of failure of the biomass boiler, the oil-burning boilers would immediately take over.

# 2 INSTALLATIONS IN CLOSURE PHASE

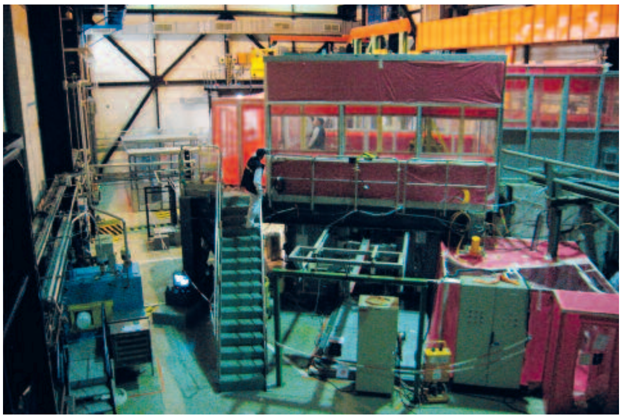
## 2|1 Older AREVA NC La Hague installations

The older plants of the AREVA NC La Hague site form part of the installations examined in 2011 as part of the experience feedback from the Japanese nuclear accident of Fukushima Daiichi in March 2011 (see point 5).

### 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 because of 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 involves major technical difficulties and induces high costs. Work has therefore fallen behind the initial schedule. 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, the solutions for elimination routes or new intermediate storages must be definitively decided upon, because their implementation involves large-scale projects: further postponement would jeopardise compliance with the deadlines set by the "waste" act of 28 June 2006, which states that the owners of medium-activity long-lived waste produced before 2015 must package it by 2030 at the latest.



Decommissioning of the HAO/North facility – September 2011

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 difficulties associated with the age of the waste, in particular its characterisation prior to any recovery and reprocessing, confirm ASN's approach which, for any project, requires the licensees to 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 of experts for laboratories and plants (GPU) and for waste (GPD), ASN confirmed the need to undertake as rapidly as possible the recovery of the sludges stored in the STE2 silos, the wastes from the HAO (high activity oxide) silo and the Building 130 silo, and the drums of predominantly alpha waste stored in Building 119 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 experiments and the GPU's review in December 2007 of the proposed packaging process, ASN issued a decision on 2 September 2008, banning the bituminisation of STE2 sludges 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, called the C5 package. In June 2011, ASN gave its agreement on the dismantling of the unused bituminisation line so that the new process can be installed in its place later on. Pursuant to the provisions of the "waste" law of 28 June 2006, recovery of these sludges must be completed no later than 31 December 2030.

### *HAO silo*

The HAO silo contains various wastes comprising hulls, end-pieces, fine dust coming mainly from the 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 optimised hull storage (SOC) 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 hulls and end-pieces compaction facility (ACC). ASN remains attentive to the effective implementation times of the waste recovery and packaging operations which must be completed by 31 December 2022 at the latest, in accordance with the provision of decree 2009-961 concerning the final shutdown and decommissioning of the HAO facility.

### *Silo 130*

Further to the licensee's postponement of waste recovery from the silo because of its outdated design and uncertainties as to the resistance of its structure over time, ASN issued requirements on 29 June 2010 imposing compensatory safety measures on the licensee, to be implemented before mid-2012 along with the submittal of a file detailing the waste preparation and recovery operations.

The project submitted by the licensee 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 effluents 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.

These files were submitted to ASN in December 2010 and are currently being examined. 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 GCR (gas-cooled reactor) fuel, in particular containing molybdenum, the licensee has opted for cold crucible vitrification (see point 1|3|2).

Entry of the cold crucible into operation with these old solutions was authorised by ASN decision of 20 June 2011, and began in June 2011, with the objective of packaging the solutions between 2011 and 2017.

### *Removal from storage in Building 119 of BNI 38*

The licensee has implemented an overall strategy to treat in priority the drums of alpha waste that are still stored in building 119, a building that does not meet current safety requirements.

These drums are reconditioned before being transferred for treatment in the alpha waste conditioning unit (UCD) of the R2 facility. This treatment consists firstly in mechanical sorting of the alpha waste to identify the waste fraction for which chemical leaching – another step in the treatment - to recover the plutonium, is appropriate.

The rate of chemical treatment of the alpha drums has dropped considerably since 2009, due to an incident that affected the facility, and to operating difficulties. This being said, the transfers from building 119 to the alpha waste conditioning unit (UCD) of the R2 facility continued with the aim of treating and removing all the stored waste from building 119 by the end of 2013, in accordance with the commitment taken by AREVA.

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

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

On 30th December 2003, the licensee notified its decision to stop processing spent fuel in the UP2 400 facility as of 1st 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 entrusted the ORCADE project relative to the final shutdown operations of the UP2 400 units and the legacy waste recovery programmes, to 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 the sharing of operating experience feedback between the various AREVA facilities (UP1 plant in Marcoule, ATPu in the CEA/Cadarache centre, SICN in Veurey-Voroise).

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 final shutdown and decommissioning decree no. 2009-961 for the HAO (high activity oxide: the former facility for fuel reception, shearing and dissolution of the UP2 400 plant), which corresponds to BNI 80, was published on 31 July 2009 (see chapter 15). The north section of the HAO facility will nevertheless continue, to receive, until 2015, the fuels that cannot be received in the head workshops of the UP3 and UP2 800 plants.

## 2|2 COMURHEX uranium hexafluoride fabrication 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 fluorinated products such as chlorine trifluoride (ClF3). This production activity uses the excess fluorine resulting from the hydrolysis of hydrofluoric acid (HF).

$UF_6$ is produced from natural uranium in a part of the plant that constitutes an ICPE; the $UF_6$ production from reprocessed uranium in a part of the plant constituting a BNI was stopped in 2003.

This latter part, BNI 105, chiefly comprises two facilities:
– the 2000 unit, which transformed reprocessed uranyl nitrate $UO_2(NO_3)_2$ into uranium tetrafluoride ($UF_4$) or uranium sesquioxide ($U_3O_8$) ;
– the 2450 unit, which transformed the l'$UF_4$ (whose uranium 235 content is between 1 and 2.5%) from the 2000 unit into $UF_6$. This $UF_6$ was used to enrich the reprocessed uranium for recycling in the reactor.

On 13 October 2008, the licensee notified ASN of final shutdown of 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 postponed submission of the final shutdown and decommissioning decree application file, initially announced for mid-2010, until May 2011. ASN considered the file incomplete due to significant shortcomings in the impact study.

Moreover, the coexistence on the same site of a BNI and various ICPEs housed in highly interspersed buildings, with associated risks and possessing a number of common equipment items, considerably complicates administrative tracking and regulation of the facilities, currently ensured by the DREAL (regional directorate for the environment, planning and housing) for the ICPEs, and ASN for the BNI. In addition, this situation is not in conformity with the TSN act, which in such situations provides for all the facilities to be included within the perimeter of the BNI and regulated by ASN. Consequently, ASN proposed by deliberation 2001-DL-0026 of 22 November 2011, a draft decree to the ministers responsible for nuclear safety, modifying the perimeter of BNI 105 in order to include all the site's facilities in it.

In the second half of 2010, the licensee sent an updated version of its safety baseline standard, better suited to the current status of the facilities. ASN validated this in June 2011, subject to certain reservations, which the licensee has now taken into consideration.

The COMURHEX plant at Tricastin

Besides this, at the end of 2008 COMURHEX lodged an application file for a license to operate a new installation, COMURHEX II, regulated by the ICPE system. This project consists in replacing the existing conversion units, also classified as ICPEs, 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 currently in operation, which will be shut down, and those in the course of construction.

The COMURHEX installations are included among those examined in 2011 as part of the experience feedback from the Japanese nuclear accident of Fukushima Daiichi in March 2011 (see point 5).

# 3 REGULATING THE NUCLEAR FUEL CYCLE FACILITIES

ASN regulates the fuel cycle facilities at different levels. It regulates:
– the main steps in the life of nuclear facilities;
– the organisation of the licensees through inspections conducted on the ground;
– the fuel cycle consistency;
– the operating experience feedback from the fuel cycle BNIs other than the NPPs.

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

### *Examining the licensing or modification applications for installations in operation*

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 2011, introduction of uranium reprocessing in the REC II facility of GBII, PRISME project 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, produced in particular for the commissioning of GBII, are ultimately to be extended to all the facilities of the AREVA Group. ASN has thus prepared a draft prescription for the CERCA facility. The licensee has been consulted and can submit its comments before the decision is finalised.

ASN inspection on the La Hague site – September 2011

ASN also reviews the safety files specific 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 appropriately to all these facilities and that they are regularly updated, particularly on the occasion of the ten-year periodic safety reviews.

### *Examination of the periodic safety review files*

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 examinations focused more particularly on the organisation of the reviews, in order to give them their full weight as vectors for improving safety, for taking account of the aging of the facilities, and for identifying and listing the safety-related equipment.

The periodic safety review file for MÉLOX, prepared along these lines, was submitted in October 2011, while that for La Hague underwent additions concerning the updates of the unit safety reports. The SOMANU orientation file (DOR) has been finalised and the licensee submitted the safety review file at the end of 2011. In 2010, the SOCATRI file had undergone an admissibility review by ASN and IRSN. The content of the safety review file had been considered insufficient; it was supplemented, particularly with regard to the facility's 10-year development prospects and its resistance to external hazards. Analyses of the civil engineering structure resistance remain to be submitted.

All these files shall be presented to the GPU between 2012 and 2014.

### *Regulating the conditions of final shutdown of the facilities*

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 led ASN to clarify its expectations on this subject.

*Examining the measures taken by the head office departments in terms of safety*

ASN's regulatory action also covers 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 2011, the main subjects concerned the development of the CSAs required by ASN decision further to the Fukushima Daiichi accident.

*Particular regulatory actions conducted in consultation with the Defence nuclear safety authority (ASND)*

With the prospect of ASN taking over responsibility for regulation and inspection of the entire Pierrelatte site in the medium term, ASN and the Defence Nuclear Safety Authority (ASND) are focusing on maintaining complete coherence in the application of the safety and radiation protection requirements to facilities for which each of them is responsible on the Tricastin site. Most of the facilities under the responsibility of ASND have been shut down 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. In a joint letter dated 29 September 2011, ASN and ASND asked the Chairman of the AREVA board of directors to propose a substitute project for the Tricastin waste treatment station, currently situated on the secret basic nuclear installation (BNIs), as an alternative to the planned relocating of its activities in a former civil facility that does not meet the safety requirements.

ASN and ASND have set up a working group to clarify the steps of ASN's takeover of the regulation of the safety of activities on this site. It has been decided that the takeover would take place progressively, as and when the regulatory situation of each facility is clarified, after its periodic safety review. The working group reported its conclusions to the two regulatory bodies at the end of 2010. The delicensing process has been started for the first step. This process should end by the year 2018.

## 3|2 Monitoring the organisation of the licensees of the cycle nuclear installations other than nuclear power plants

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 points examined in this context concern, for example, the possible under-staffing of certain departments that play a key role in safety, or the balance between duties and available resources in other departments. These situations can make it difficult for them to accomplish their duties, and can result in production requirements taking priority over other considerations, notably in terms of safety.

Given this context, ASN initiated a safety management review process within the AREVA Group, for the BNIs operated by the Group. AREVA submitted its review results file in January 2010; it was examined by the GPU in December 2011, and ASN is currently drafting its opinion on it.

## 3|3 Ensuring the consistency of the cycle

ASN monitors the overall consistency of the industrial choices made with regard to fuel management, from both the safety and the regulatory aspects. 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 terms, ASN intends ensuring that saturation of the spent fuel storage capacities in the NPPs - as has been observed in other countries - is foreseen and prevented, so that the licensees do not use old facilities with lower safety standards as a remedial solution. ASN is assisted in this approach by the ministry in charge of energy, which it consults in particular to obtain information relative to 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 and reviewed to date provide a clarification of how the fuel cycle operates and the safety issues involved, indicating the technical and regulatory limits that could be modified - subject to adequate justification - by the changes in fuel management policies.

In order to maintain an overall and constantly appropriate view of the fuel cycle, these data must be periodically updated. For any new utilisation of the fuel, 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 “Impact Cycle” file was submitted in 2008. This file was examined on 30 June 2010 by the GPU and GPD on the basis of a report presented by the IRSN. The DGEC (General Directorate for Energy and Climate) and members of the Advisory Committees of experts for nuclear reactors (GPR) and for transport (GPT) took part in this analysis.

On completion of this review, ASN tightened the monitoring of the coherence of the fuel cycle and its changes, by demanding biennial update reports and requiring EDF to submit an updated "cycle" file by 2016. ASN underlined four major points in its letter of 5 May 2011:
– the need to carry out a true sensitivity study, to take into account, among other things, the variability of the electricity grid power demands;
– the need to assess the margins in the underwater spent fuel storage capacity, until the year 2020 and beyond;
– the development of EDF’s fuel management strategies, particularly after the virtually complete abandoning of “high combustion rate” fuel management options;
– the change in the radiological content of the materials used, when they come from the reprocessing of spent fuel.

ASN also wanted the following to be put into perspective:
– the storage capacities for depleted uranium (due to the increase in the enrichment capacity) and for reprocessed uranium, as the saturation of available surface areas is not totally excluded in this latter case;
– the availability of the different packages proposed for the transport of radioactive materials.

Furthermore, ASN considered that the first lessons had to be drawn from the Fukushima Daiichi NPP accident in March 2011, by asking EDF to specify whether any factors were likely to confirm - or make it modify - its spent fuel management strategy.

## 3|4 Promoting operating experience feedback from the fuel cycle BNIs other than the nuclear power plants

### 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 safety-related equipment and to new operating rules. Licensees must therefore set up reliable systems for detecting, correcting and integrating the experience feedback from safety-related events.

Examination of these events by ASN and their management by the licensees serve notably to identify:
– events recurring on the same installation;
– events necessitating integration of the experience feedback by other facilities, when the events are of a generic nature, that is to say affecting or likely to affect several facilities of one or more licensees.

After dropping in 2010, the number of significant events notified by the nuclear facilities other than the nuclear power plants has risen, reaching a total of 246 significant events. ASN does not think that there is any particular explanation linked to the facilities. This increase could be explained by the licensees being more attentive to the notification process and the integration of experience feedback, and greater vigilance on the part of ASN, particularly during inspections, on the detection and notification of significant events.

The year 2011 was marked by an incident that occurred on 12 September 2011 in the CENTRACO facility operated by Socodei. An explosion occurred in a smelting furnace that treats very-low-activity metals from nuclear facilities. This accident had severe human consequences, causing the death of one employee and injuring four others, one very seriously. The radiological consequences were very limited, since no radioactive releases were detected in the site environment. The accident was rated level 1 on the INES scale. Three investigations are under way further to this accident: a judicial inquiry and two administrative investigations, of which one is conducted by the labour inspectorate.

ASN was closely involved in the management of this accident, activating its emergency centre as soon as the alert was raised, and sending people to the site very rapidly after the accident. It thus followed the development of the situation, taking into account the information provided by the IRSN, the licensee and the specialist public fire-fighting services, to analyse its development and inform the public. In the exercise of its oversight responsibilities, ASN observed that the activity of the waste present in the furnace at the time of the accident had been underestimated, and asked the licensee to take the measures necessary to review its emergency management procedures in order to ensure that the data transmitted, especially the figures, are always verified beforehand. An inspection was conducted in this framework. ASN is analysing the possible causes of the accident with the other competent services (see chapter 16).

ASN has moreover taken a decision requiring the restarting of the activities of the smelting unit and the incineration unit to be subject to ASN authorisation in order to ensure that the necessary safety conditions are fulfilled. The following elements are required in particular:
– the results of the pre-restart verification operations, focussing in particular on the condition of the safety-related equipment of the incineration furnace;
– a report presenting the conclusions of a review of the situations introducing an explosion risk in the incineration unit, and the technical and organisational measures for preventing such situations from occurring.

On 31 December 2011, authorisation to restart operation had not been given.

### 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 for 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 as from 2008, which is when the Group's head office departments started employing HOF specialists. Since then, a national policy has been developed and is being gradually deployed among the group's licensees. ASN considers that this approach must be continued for it to fully bear fruit.

The various licensees within the AREVA Group are now staffed with persons competent in HOF. Nevertheless, ASN is still not sure that all the licensees are devoting sufficient resources to this subject.

Furthermore, the analysis of significant event reports and the technical files reviews indicate that fuller integration of the HOF is required. The specialists on the subject are not yet systematically consulted with regard to issues with strong implications in terms of human reliability or workstation ergonomics.

### 3|4|3 Controlling the fire risk in nuclear facilities

Controlling the fire risk is of major importance in the control of accidents that can affect the laboratories and plants. Indeed, widespread fire is often taken as a design-basis accident for these facilities.

Control of the fire risk is taken into account in the current regulations by the order of 31 December 1999, amended. The revision of the regulations undertaken in application of the TSN Act gave ASN the opportunity to take them to greater depth and update certain points. A working group was created, including representatives from ASND and the IRSN, with a view to developing a draft decision on controlling the fire risk, based on the best practices available.

### 3|4|4 Controlling the criticality risk in nuclear facilities other than nuclear power plants

In 2009, events had revealed significant deficiencies in prevention of the criticality risk[2] in several nuclear facilities of the AREVA Group.

Moreover, two events that occurred that year in the laboratories and plants and had been rated level 2 on the INES scale concerned the limitation of the mass of fissile materials:

Radiation protection inspection on the glove boxes in the cladding room in the MOX fuel manufacturing plant at Bagnols-sur-Cèze

2. Criticality: capacity of fissile materials to be able to trigger and sustain, under certain conditions, a nuclear reaction. Criticality 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).

– 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;
– an incorrect estimation in the ATPu (see chapter 15) of the residual masses of fissile materials in certain workstations (undetected accumulation of deposits during operation), that could have led to the maximum authorised mass being exceeded in several of those workstations.

ASN considers that it is important to check the measures taken, that they are appropriate for all the plausible situations, and that the requirements in terms of safety-criticality and operator training are met. 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 these events, ASN decided to revise the fundamental safety rule relative to the criticality risk, dating from 1984, in order to introduce the national and international experience feedback from 25 years of operation, the change in the dedicated calculation codes and the principle of defence in depth in the approach to this risk, and extend its application to the reactors outside the constituted cores. A working group comprising representatives from ASN, IRSN, the licensees' criticality engineers and a number of experts (IAEA) was set up in early 2011 to revise this text. This revision will lead to the joint drafting of an ASN guide on prevention of the criticality risk in the BNIs and in transport, and an enforceable decision. It will be presented to the GPU, the GPR, and the criticality-safety commission of ASND.

The firemen of the local security organisation (FLS) on the Tricastin site

## 4 INTERNATIONAL ACTION

Since June 2009, ASN has 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 public 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 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. The cooperation continued in 2011, particularly on the issues relating to waste and security.

In addition to this, ASN received the Canadian Nuclear Safety Commission (CNSC) in April 2011 to inform it of the changes in the French regulations pursuant to the TSN Act; ASN also explained the way in which the fuel cycle facilities, particularly those in the early stages of the cycle, similar to the facilities of this type in Canada, are regulated and monitored.

ASN also took part in a seminar in Russia in order to initiate the setting up of bilateral exchanges concerning the safety of the reactors and the plants in the fuel cycle (August 2011).

ASN also received the Norwegian Radiation Protection Authority (NRPA) in response to a question posed by the Norwegian government further to a WISE organisation publication concerning the storage of fission product solutions in the plants of the AREVA NC La Hague site, particularly the oldest ones. The Norwegian authority was able to visit the La Hague site plants, a visit which was followed by an ASN presentation of the licensing and regulation rules for these facilities and the waste produced in them. Bilateral exchanges and an accident information agreement are going to be established.

Lastly, in September 2011, ASN took part in the WGFCF (Working Group for Fuel Cycle Facilities) seminar of the OECD / NEA in Toronto (Canada), relative to the integration of operating experience feedback from fuel cycle facilities. The main subject addressed was how the feedback from the March 2011 accident on the Fukushima Daiichi nuclear site in Japan is integrated in each participant country, along with the question of the methodologies used to assess the safety of the fuel cycle facilities.

## 5 EXPERIENCE FEEDBACK FROM THE FUKUSHIMA DAIICHI ACCIDENT

At the end of the prioritisation process for the nuclear facilities other than nuclear reactors (see the pages devoted to Fukushima in the introduction to this report), it was decided that virtually all the sites and facilities operated by the AREVA group should provide complementary safety assessments (CSAs) for September 2011: all the facilities on the La Hague and Tricastin sites, the MELOX plant and the FBFC plant in Romans-sur-Isère.

AREVA submitted its methodology in June 2011. It was examined by the GPR and GPU on 6 July 2011. ASN considered that the methodology was globally satisfactory on condition that the licensee meets its commitments and replies to the questions formulated by ASN.

The CSAs required by the ASN decisions of 5 May 2011 were sent on 15 September 2011 in accordance with the terms of these decisions. They were examined by the Advisory committee of experts on 8, 9 and 10 November 2011. These Advisory committees, comprising French and foreign experts, submitted their opinion to ASN dated 10 November 2011.

On completion of the CSAs of the priority nuclear facilities, ASN considers that the level of safety of the facilities examined is sufficient for it not to demand the immediate shutdown of any one of them. At the same time, ASN considers that their continued operation does require that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible.

Consequently, at the beginning of the second quarter of 2012, ASN will impose on the licensees a set of measures comprising the following in particular:
– the establishing of a "hard core" of material and organisational measures to control the fundamental safety functions in extreme situations; the licensees will submit the content and specifications of the "hard core" for each facility to ASN before 30 June 2012;
– for the spent fuel pools of the different facilities: implementation of reinforced measures to reduce the risk of the fuel becoming exposed;
– for the La Hague site silos: feasibility studies with a view to setting up technical arrangements, such as geotechnical containment or having an equivalent effect, with the aim of protecting the underground and surface water in the event of a severe accident;
– for the Tricastin and Romans-sur-Isère sites operated by AREVA, ASN will ask the licensee to study and implement complementary means for mitigating the consequences of a toxic product leak (gaseous hydrogen fluoride, uranium hexafluoride, chlorine, chlorine trifluoride, etc.);
– measures relative to emergency management and organisational and human factors.

The experience feedback from the Fukushima accident will be taken into account in the following manner for the other facilities:
– the CERCA plant on the Romans-sur-Isère site must submit a complementary safety assessment in September 2012;
– the COMURHEX Malvési BNI, consisting of pools, shall be examined later;
– the SICN site, which is in the final phase of decommissioning, will not be concerned.

## 6 OUTLOOK

*Cross-disciplinary aspects*

In 2012, ASN will continue the work started in 2011, in particular to examine the license or major modification applications for the fuel cycle facilities, and to set the framework for these operations: application to modify the conditions of operation of the GBI plant with a view to its final shutdown, application to modify the conditions of operation of the La Hague installations (BNI 116 and 118). In addition, it will continue the analysis of the safety review files, particularly those concerning the La Hague facilities.

ASN also initiated in September 2010 the overall review of the safety and radiation protection management process within the AREVA Group. This file was presented to the Advisory groups of experts on 14 December 2011.

ASN notes that efforts must be made to implement the group's organisational and human factors policy in all the facilities, and to involve the outside contractors in this as a matter of course. ASN will demand tracking of the development of subcontracting data and closer monitoring of outside contractors. It will in particular demand improvements in the monitoring of project management, including when this is ensured by a subsidiary of the group.

National long-term management of all activities relating to safety and radiation protection comes out as an essential factor in safety management.

In addition, ASN considers that new more representative "safety" indicators must be developed and implemented within the AREVA group. Lastly, AREVA must present an assessment of the use of the new aids for processing events and experience feedback.

Continuing in line with the actions taken in 2011, ASN will be particularly attentive to the integration of experience feedback by the AREVA group licensees, and to the implementation of the internal authorisation systems.

Lastly, ASN will specifically monitor the implementation of the complementary safety measures required further to the CSAs, the submittal of the required complementary studies, and will examine them.

*Tricastin site*

Pollution prevention and progress with the projects concerning the site's effluent and waste treatment stations remain the major issues for this site in 2012. In the framework of the CSAs performed further to the Fukushima Daiichi accident, ASN will closely monitor the implementation of measures to reinforce the safety of the site facilities that handle large quantities of $UF_6$ and hydrofluoric acid, particularly the reinforcing of the earthquake resistance of certain ICPEs and the integration of the chemical risk in the emergency plans of the Tricastin site licensees.

*Romans-sur-Isère site*

In 2012 on the Romans-sur-Isère site, ASN will closely monitor confirmation of the progress already achieved in terms of safety. It more particularly expects to see better control of containment in certain premises, and of the fire risk in the FBFC plant. It will be attentive to the actions taken following the safety reassessment of the facilities belonging to the company CERCA. It will also be attentive to ensure the implementation of the improvements planned under the CSAs.

*MÉLOX plant*

ASN will be vigilant as to the means adopted to accompany the changes in materials used with regard to requirements in terms of safety and radiation protection. In this context, management of dosimetry and the ability to prevent organisational and human factor risks and the criticality risk will remain regulation and inspection priorities.

The periodic safety review file for the MÉLOX plant was handed over to the ministers and ASN in late September 2011. Its examination will be a key step in the life of the facility. It will enable the conformity of the facility with the applicable regulations and its baseline safety standard to be verified, while at the same time setting a safety improvement programme for the next ten years in the light of the best available practices. This safety review will also consider the important question of the role of the computerised production management system, which today ensures both prevention of the criticality risk and nuclear material accounting management.

*La Hague site*

ASN considers that efforts must be continued in the La Hague plants, particularly in the integration of operating experience feedback and the notification of significant events. In the framework of the periodic safety reviews of the facilities, 2012 should see the implementation of the safety-related equipment identification procedure 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 already gave instructions, to this end, in 2010 for silo 130 and will oversee the programme more closely in 2012.

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