NUCLEAR RESEARCH FACILITIES AND VARIOUS NUCLEAR INSTALLATIONS

CHAPTER 14

Nuclear research facilities and installations not directly linked to the nuclear electricity generating industry cover all the basic nuclear installations of the civil part of the French Atomic Energy Commission, the basic nuclear installations of other research organisations, and a few other basic nuclear installations (BNIs) which are neither power reactors, nor which take part in the nuclear fuel cycle.

1 ATOMIC ENERGY COMMISSION INSTALLATIONS

The facilities of the Atomic Energy Commission (CEA) Centres include various BNIs (experimental reactors, laboratories). Research is focused notably on the lifetime of operating plants, future reactors, fuel performance and nuclear waste.

The constant changes made to these installations, due to their research functions, require particularly attentive regulation and frequent updating of the relevant safety files. The action of the Nuclear Safety Authority (ASN) may be considered at several levels:
- working with the General Administrator, ASN verifies CEA's compliance with its main undertakings, in particular with regard to planned new installations, upgrading older installations and waste management, especially in terms of compliance with the specified time-frames and handling of the safety and radiation protection issues;
- working with the Directorate for Nuclear Protection and Safety, reporting to CEA's general administrator, ASN develops a national overall approach to "generic" subjects concerning several installations or several sites;
- working with CEA Centres, ASN reviews the safety documents specific to each of CEA's BNIs, as and when necessary. The main contacts are the centre manager and the head of the installation concerned.

Point 1|1 below lists the generic subjects which marked the year 2006. Point 1|2 describes topical events in the various CEA installations currently operating. The installations currently undergoing clean-out or decommissioning are dealt with in chapter 15 and those devoted specifically to the interim storage of waste and spent fuel are covered in chapter 16.

1 | 1 Generic subjects

Through inspection campaigns and analysis of the lessons learned from the life of the installations, ASN identifies generic topics on which it queries CEA. These topics can lead to requests on the part of ASN and possibly to a stance being adopted following review of a dossier. The subjects which particularly attracted the attention of ASN in 2006 were the way in which the criticality risk was handled, as well as the methodology and the scheduling of the periodic safety reviews of CEA's BNIs.

1 | 1 | 1 Increased CEA responsibility as a nuclear licensee

In 2002, ASN felt that it was possible to enable CEA centre managers, with the assistance of the centre's safety units and as applicable safety commissions, to authorise a number of minor operations which did not compromise the installations' safety cases, without ASN having to issue formal authorisation. In two guides (SD3-CEA-01 and SD3-CEA-02), ASN specified rules for using this system of internal authorisations and the procedures for updating the safety documentation for the installations concerned.

This system offers a faster response to requests for changes to the installations to meet CEA research requirements, in that these requests can be rapidly managed internally and are not delayed by the time needed for review by the Institute for Radiation Protection and Nuclear Safety (IRSN), ASN's technical support organisation. This system also returns responsibility for the safety of the installations to the licensee. Finally, it enables ASN and its, IRSN, to focus on the major safety issues of these installations.

Since this system was introduced, ASN inspections carried out revealed no major functional problems. However, ASN does consider that in the files it submits, CEA should pay particular attention to proving that the envisaged operations are still covered by the installation's safety case. CEA should also remain attentive to updating the safety documents after each of these operations. With this in mind, ASN undertook the revision of CEA internal authorisation guides, in order to simplify the documentary reference system and clarify what was expected in terms of justifying compliance with the safety case.

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Periodic safety reviews of CEA installations

Many current CEA installations began operating at the beginning of the 1960s. These installations, designed to meet former requirements, contain timeworn equipment. They have also undergone modifications on various occasions, sometimes without overall review from the safety standpoint. A schedule of periodic safety reviews for the coming 6 years has been approved by ASN.

Moreover, in 2002, ASN informed the licensees that it considered a review of the safety of the older installations to be necessary approximately every 10 years. This provision is now contained in the law of 13 June 2006 on transparency and safety in the nuclear field. In 2005, ASN detailed its expectations with regard to the safety reviews of CEA installations, in terms of responsibility, content and schedule, in the form of an ASN guide (SD3-CEA-05). These provisions are being applied by CEA for the first time in the periodic safety review of the Orphée reactor in CEA's Saclay centre, for presentation to the Advisory Committee for nuclear reactors in 2008.

Generally speaking, the licensee is the first to conduct a diagnosis of the condition of its installation and state its position regarding the future of the installation. Should it decide to maintain operation of an installation, it will have to be upgraded to comply with current safety rules, standards, codes and practices. If the licensee presents a schedule for scaling down activities and closure of the installation within the next 10 years, a programme of compensatory measures will be requested on a case by case basis.

It may prove necessary to replace older installations by new ones. The MAGENTA and CEDRA interim storage projects and the AGATE and STELLA effluent treatment station projects are examples of this type of operation (see chapter 16).

The latest CEA installation safety reviews concerned the LECI (spent fuel testing laboratory) and the LEFCA (Laboratory for research and experimental fabrication of advanced nuclear fuels) in 2004. As regards the LEFCA, ASN authorised continued operation of the installation for 10 years in February 2004. As regards the LECI, ASN in June 2004 authorised commissioning of an extension, subject to the performance of tests and the completion of the technical files linked to the safety review of the old building. Partial start-up of this extension was authorised in October 2005. The complete start-up license was granted in July 2006, with authorisation to continue with operation of the old building.

The periodic safety review on the CABRI experimental reactor on the Cadarache site and modification of its experimental loop were presented to the Advisory Committee for nuclear reactors in January and May 2004. In July 2004, ASN informed the licensee that it did not object to its project continuing, subject to compliance with its undertakings concerning the quality of construction of the experimental loop and the upgrading of its installation. Work is in progress and the upgraded installation will once again be presented to the Advisory Committee for nuclear reactors in 2008. In March 2006, the periodic safety review file for the MASURCA critical mock-up was reviewed by the Advisory Committee for nuclear reactors. In June 2006, ASN authorised the licensee to continue with renovation of its installation in accordance with the presented methodology.

These safety reviews entail extensive upgrading work in areas where the regulations have changed significantly, in particular compliance with seismic loading requirements, fire protection and containment. ASN supervises all the work and the subsequent re qualification procedures, in accordance with principles and a schedule that it itself approves.

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Monitoring of sub-criticality at CEA

Following the incident that occurred in Saclay on 15 September 2004, and the inadequacies observed during the 2005 inspections on the subject of “criticality”, as well as the shortcomings found in the “criticality” related files transmitted by the various centres, ASN asked CEA in 2005 to conduct a rigorous CEA-wide assessment of the organisation in place to control the criticality risk.

In April 2006, CEA transmitted the results of its assessment and concluded that the organisation put into place to prevent the criticality risk was satisfactory and guaranteed the long-term performance of the functions defined by CEA in its internal circular on the subject of criticality.

However, further to the significant event that occurred in Saclay on 10 March 2006 and its analysis, ASN noted that the existing arrangements for the transfer of fissile materials between the installations concerned at CEA were not able to guarantee complete reliability of such transfers. Considering that the significant event that occurred in Saclay was generic in nature, ASN asked CEA to evaluate the transfer arrangements for all the BNIs concerned.

To conclude, ASN considered that the criticality organisation implemented at CEA was not yet proven to be sufficiently robust.

1 | 1 | 4

Management of sealed sources of ionising radiation at CEA

Since 2002, CEA has no longer enjoyed its traditional waiver of the need to obtain a licence to possess and use sources of ionising radiation. In order to ensure a transition towards an ordinary law regime, ASN asked CEA in 2002 to clarify the measures it intended to take to ensure implementation of the requirements of the Public Health Code. During the course of 2003, CEA submitted to ASN proposed arrangements for ionising radiation source management. ASN accepted the general principles of these arrangements.

As of 2004, CEA gradually applied these arrangements in its centres. CEA thus sent ASN a number of “pilot” files requesting a licence for possession and use of sources, and these are currently under review. Other more generic files are currently being finalised and in particular concern regularisation of registration of ionising radiation sources with IRSN and regularisation of the possession of sources more than 10 years old in use at CEA. In addition, during the course of 2005 and 2006, ASN carried out a number of source management inspections in CEA’s BNIs. These inspections enabled ASN to conduct an on site assessment of compliance with the regulations applicable to sources of ionising radiation.

1 | 1 | 5

Revision of water intake and discharge licences

CEA's effluent discharge and water intake licence revision process is continuing, under application of decree 95-540 of 4 May 1995 concerning gaseous and liquid effluent discharge and water intake by BNIs.

Water intake and effluent discharges from CEA's Grenoble site are regulated by the order of 25 May 2004.

Those on the Cadarache site are covered by 3 interministerial orders of 25 April 2006 and *préfets'*[1] orders of 12 August and 12 September 2005 allowing consistent regulation of all radioactive and chemical discharges from the centre.

The Saclay site submitted a file applying for renewal of the water intake and effluent discharge licence in August 2006, which could lead to revision of the orders regulating its discharges at the end of 2007.

Other applications concerning individual BNIs are also being reviewed, either for installations being created or for modifications to the existing operating conditions.

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Assessment of seismic hazards

On the occasion of the LEFCA installation periodic safety review in 2004, ASN submitted a number of requests concerning the seismic risk, particularly to take account of the particular effects on the Cadarache site. In 2005, CEA presented a study programme designed to supplement knowledge of seismic hazards on the site. The programme will be the subject of annual reports under the aegis of a steering committee comprising experts in this field. CEA's aim is to provide substantial data in 2008.

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Experimental reactor cores and devices

One particularity of many experimental reactors is the frequent modification of the reactor core configuration and the sometimes only very temporary introduction of experimental irradiation devices into the reactor core.

ASN pays particular attention to these operations, owing to the related risks, in particular concerning reactivity control (chain reaction) and the hazard constituted by the fuel elements.

A guide (SD3-CEA-04) dealing with the design, construction and licensing of these devices was produced by ASN and came into force in July 2004. It in particular requires the performance of periodic safety reviews on all experimental devices every 10 years. In 2006, ASN undertook the updating of this guide in order to incorporate experience gained during its first two years of implementation.

1 | 1 | 8

Research reactor maintenance outages

In 2004, ASN undertook to improve monitoring of installations undergoing a prolonged outage for maintenance or renovation work. This led to the production of a draft ASN guide, which was submitted to the licensees.

1 | 2

Topical events in CEA research facilities

This section deals only with research facilities currently operating. Installations currently undergoing clean-out and decommissioning are dealt with in chapter 15 while those devoted primarily to interim storage of waste and spent fuel are covered in chapter 16.

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CEA sites

a) Cadarache Centre

The Cadarache Centre is located at Saint-Paul-lez-Durance, in the Bouches-du-Rhône *département*[2]. It covers an area of 1,600 hectares. The main purpose of the units installed there is the industrial application of research and development in the fields of power reactors and uranium or plutonium-based fuel. It is for this reason that this Centre comprises about twenty BNIs operated by CEA, some of which (Cabri and Phébus reactors) are used by IRSN for its research work on safety. The site also comprises a secret BNI.

In CEA's medium and long-term strategy, this Centre was identified as a "nuclear power" centre of excellence and will thus be home to the main nuclear installation projects for the programmes of the future. For the time being, it houses the Jules Horowitz experimental reactor and the ITER international facility.

ASN believes that the following points in particular will need to be supervised at the Cadarache Centre:
- upgrading of the old installations;
- completion of new projects (replacement or creation of installations);
- inclusion of new civil engineering seismic strength requirements, including the particular site effects.

b) Saclay Centre

The Saclay Centre is located about 20km from Paris in the Essonne *département*. It occupies an area of 223 hectares, including the Orme des Merisiers annex.

This Centre was recently identified as being a centre of excellence devoted to material sciences. The responsibility of nuclear licensee was transferred to the DANS (department delegated for nuclear activities at Saclay) in mid-2005, with the Director of the Centre being responsible for the centre of excellence.

The Centre's activities range from fundamental research to applied research in a wide variety of fields and disciplines, such as physics, metallurgy, electronics, biology, climatology, simulation, chemistry and ecology. The purpose of nuclear applied research is to optimise the operation and safety of the French nuclear power plants and to develop future nuclear systems.

The Centre also houses an office of the National Institute for Nuclear Science and Techniques (INSTN), whose role is teaching, and two industrial companies: Technicatome, which designs nuclear reactors for naval propulsion systems, and CIS-bio international, specialising in medical technologies, especially radioactive marking of molecules, manufacturing of products used in nuclear medicine for therapy and imaging, as well as in-vitro medical diagnosis and molecular screening.

ASN considers that the following points in particular would need to be supervised in the Saclay Centre:
• maintaining the nuclear safety performance of the BNIs in a centre focused primarily on non-nuclear activities,
• including nuclear safety in the decisions taken concerning the development of future activities in the Centre.

c) Rhone Valley Centre

The Rhone Valley Centre administratively groups the sites of Marcoule (Gard *département*) and Pierrelatte (Drôme *département*). Non-secret installations represent only a fraction of the installations on these sites.

Since 2006, the Marcoule site has been the responsibility of CEA and was thus identified as a centre of excellence for the back-end nuclear fuel cycle and in particular radioactive waste. It is playing a major role in the research being conducted pursuant to the Bataille law of 1991 and the programme law of 23 June 2006 on the sustainable management of radioactive materials and waste. Its two main installations, Atalante (for separation) and Phenix (for transmutation), were extensively used for these purposes.

ASN considers that the following points in particular would need to be supervised for this Centre:
• the continued safety of Phénix, on the one hand to allow completion of its research programme and on the other to prepare for the activities linked to shutdown of the installation in 2009,
• consistent and safe management of the "waste" activities for CEA as a whole.

d) Fontenay-aux-Roses Centre

This Centre is currently undergoing decommissioning and clean-out (see chapter 15).

e) Grenoble Centre

This Centre is currently undergoing decommissioning and clean-out (see chapter 15).

1 | 2 | 2

Research reactors

Experimental nuclear reactors make an essential contribution to scientific and technological research and to supporting operation of the country's nuclear power plants. Each of them is an individual case to which ASN regulation must be tailored, while ensuring that safety practices and rules are improved.

In this respect, a more generic approach has in recent years been adopted to the safety of these installations, based on the rules applicable to power reactors and in particular through the inclusion of operating situations and the classification of the associated equipment, which has led to considerable progress being made in terms of safety. This approach was in particular used for the CABRI and MASURCA periodic safety reviews (2004 and 2006).

a) Critical mock-ups

• MASURCA reactor (Cadarache)

The MASURCA reactor was built for neutronic studies of fast neutron reactor cores. It also took part in minor actinide transmutation research, having been coupled with a particle accelerator, GÉNÉPI.

As early as February 2000, ASN informed CEA that it was necessary to conduct a safety review of the reactor, the previous such review dating back to 1988 and several reactor items now being obsolescent. Renovation work was carried out as a priority in 2005. The Advisory Committee for nuclear reactors reviewed the measures envisaged to allow long-term operation of the MASURCA reactor in March 2006, following which, ASN indicated that it had no objection to renovation of the installation and continuation of the safety review in accordance with the guidelines presented. ASN also undertook revision of the authorisation decree, dating back to the 1960s, to bring it into line with current MASURCA operations. ASN will make known its standpoint on restart of the upgraded installation in 2009.

· ÉOLE and MINERVE reactors (Cadarache)

The ÉOLE reactor is a host structure for LWR experimental cores. It consists of a reactor block with biological shielding compatible with high neutron flux operation, in which is installed a cylindrical vessel designed to contain different types of core and associated structures.

The MINERVE reactor, located in the same bay, is used for cross-section measurement by oscillation of samples.

As a result of its 2005 strategic analysis of programmes and safety, CEA informed ASN in 2006 of its wish to continue with long-term operation of the ÉOLE and MINERVE installations. The safety review guidelines file was reviewed by ASN.

MASURCA reactor in Cadarache

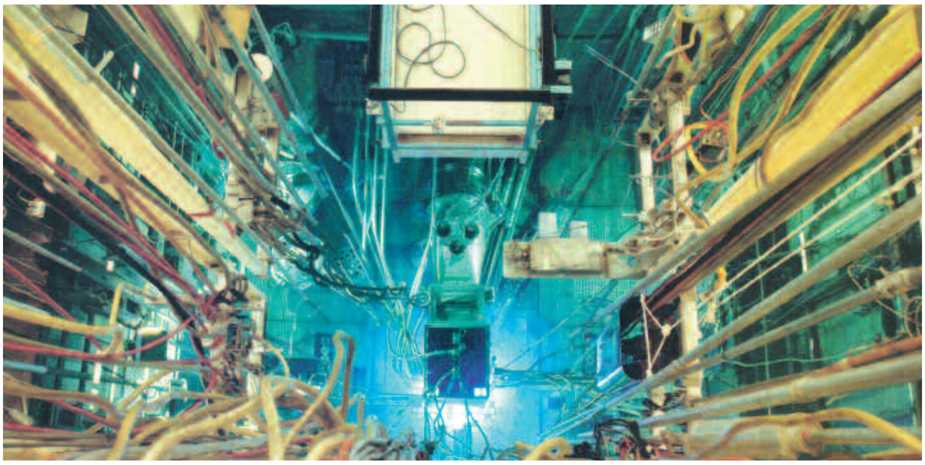
b) Irradiation reactors

· The OSIRIS reactor and its ISIS critical mock-up (Saclay)

The 70 MWth pool-type reactor OSIRIS is mainly used for technological irradiation tests on structural materials and fuels for various types of power reactor (notably PWRs), for the production of radioelements and doped silicon and for the irradiation of specimens for activation analysis. Since the end of 1996, the reactor core has consisted entirely of a new type of low-enrichment U3Si2Al fuel, in order to comply with the IAEA's non-proliferation requirements.

A programme of work to renovate the OSIRIS installation, in order to guarantee safe operation for the coming years, was proposed by CEA. ASN considers that in the light of its old design, operation of the installation could not be envisaged beyond a few years. Depending on the nature of the work undertaken, a date for shutdown of the installation will be determined.

The ISIS reactor is a mock-up of the OSIRIS core. Its power is limited to 700 kWh and it is designed for neutronic measurements and dose metering; it is also used for neutron radiography of various objects. Following the shutdown of the ULYSSE reactor, ISIS will as of 2007 be used for training purposes. 2006 was marked by the commissioning of a new instrumentation and control system for the ISIS mock-up.



View of the OSIRIS reactor pool

· The RJH (Jules Horowitz reactor) project (Cadarache)

With the support of a number of European partners, CEA deemed it necessary to build a new reactor owing to the age of the European irradiation reactors currently in service and their imminent or medium-term shutdown. The first objective of the reactor, which is scheduled for start-up in 2014, is irradiation of materials and fuels to support the French and European nuclear power programmes. This reactor will also be able to produce artificial radionuclides used for medical purposes and for doping silicon for the electronics industry.

The authorisation decree application (DAC), together with the water intake and effluent discharge licence application (DARPE) and the preliminary safety report for the future installation, were sent to ASN at the end of March 2006. After reviewing them, ASN transmitted the DAC and DARPE files to the Bouches-du-Rhône *préfet*'s offices so that they could undergo the public inquiry process (from 20 November to 21 December 2006). At the same time, ASN also referred the matter to the Advisory Committee for nuclear reactors, so that it could meet in mid-2007 and rule on the preliminary safety report.

RJH reactor project in Cadarache

c) Neutron source reactors

• ORPHÉE reactor (Saclay)

LThe 14 MWth ORPHÉE reactor is a pool-type research reactor, equipped with nine horizontal fuel channels, tangential to the core, enabling the use of 20 neutron beams. These beams are used by the Léon Brillouin Laboratory (CEA and CNRS, the French national centre for scientific research) to perform experiments in fields such as physics, biology or physico-chemistry.

This reactor is jointly funded by CEA and CNRS. Owing to the budget restrictions imposed on CNRS in 2003, the installation had to opt for limited operation, mainly involving shorter operating cycles of 3 weeks instead of 100 days. In 2006, at the request of CEA, ASN authorised return to "long cycle" operation.

With a view to long-term operation of the reactor, ASN asked for studies to be carried out for a safety review of the installation, which should lead to a meeting of the Advisory Committee for nuclear reactors in 2008.

d) Test reactors

• CABRI reactor (Cadarache)

The Cabri pool-type reactor is mainly used for experimental programmes aimed at better understanding nuclear fuel behaviour in the event of reactivity accidents. The reactor is operated by CEA for the test programmes designed by IRSN.

For the purposes of a new research programme, work is under way to replace the reactor's sodium loop by a water loop. The "CABRI water loop" programme is designed to determine the behaviour of high burnup fuels in accident situations representative of the conditions encountered in a PWR. The decree authorising modification of the installation appeared in March 2006.

CEA also conducted a safety review of its entire installation in order to define the work needed to bring it into conformity with current requirements, with a view to continuing reactor operations for about a further twenty years.

Arrival of the water loop caisson in the CABRI reactor

ASN will issue its standpoint on the safety of this installation in 2008, after review of the provisional safety case by the Advisory Committee for nuclear reactors, and prior to start-up of the modified reactor. ASN noted that at the end of 2006, CEA was already two years late in its schedule of work, indicative of inadequate project management, which could be prejudicial both to the project and to safety.

• PHÉBUS reactor (Cadarache)

The PHÉBUS reactor is one of CEA's tools for the study of possible PWR accidents.

The latest test in the "fission products" experimental programme, the purpose of which was to study the behaviour and the transport of fission products from the PWR fuel to the environment, in the event of core meltdown, took place at the end of 2004. Test data are currently being analysed by IRSN. At the same time, work to clean out and decommission the experimental systems should continue until 2009.

In 2005, CEA announced its intention to continue operating the installation at reduced levels, pending the results of the work by the International Expert Group set up to look at future programmes in the installation and their funding. These results are expected by the end of 2006. This operating mode will be the subject of a specific licence from ASN.

Overview of the PHÉBUS reactor

e) Teaching reactors

• ULYSSE reactor (Saclay)

The 100 kWth ULYSSE reactor is mainly used for teaching purposes and practical applications. CEA informed ASN of its decision to finally shut down reactor operations in February 2007 and enter the decommissioning phase. Training activities will be transferred to the ISIS reactor.

f) Prototype reactors

• PHÉNIX reactor (Marcoule)

The PHÉNIX reactor, built and operated by CEA jointly with EDF, is a fast neutron demonstration reactor. It is located in Marcoule (Gard *département*). Its construction began in 1968 and first criticality occurred on 31 August 1973. Its rated power is 563 MWth.

The characteristics and performance of this installation are such that it is considered by CEA to be an indispensable tool for the completion of research programmes on plutonium combustion

PHÉNIX reactor platform

(CAPRA programme) and actinide incineration (SPIN programme). These research programmes come under articles L.542-1 to L.542-14 of the Environment Code concerning radioactive waste research.

In 2002, following major reactor renovation work, ASN informed CEA that it considered the answers provided on subjects concerning the installation periodic safety review to be satisfactory and that it had no objection to reactor operations resuming at partial power of 350 MWth, for the 6 burn-up cycles still to be carried out (i.e. 720 EFPD). 2006 was devoted to continuing with the experimental irradiation programme.

In 2005 and 2006, CEA also presented its programme for final shutdown and decommissioning of the reactor, now scheduled for 2009. This programme will include the use of installations for processing the sodium from PHÉNIX and possibly other CEA installations. ASN considers that the licensee will need to be particularly attentive to the ageing of installation components and to the place given to human and organisational factors in reactor operations.

1 | 2 | 3

Laboratories

a) The irradiated materials and spent fuel assessment laboratories

These laboratories, also known as “hot laboratories”, are major assessment tools for present and future programmes developed by the main licensees. There used to be a large number of these laboratories but they are now concentrated in two centres: one, in Saclay, devoted to irradiated materials and the other, in Cadarache, dealing with fuel. From the safety viewpoint, these installations must meet the standards and rules of the large fuel cycle nuclear installations, but this approach has to be adapted on a case by case basis.

ASN asked CEA to conduct a safety review of all its installations in which major upgrade work had been initiated. It considers that this effort needs to be maintained over the long term in order to ensure that the installations are rapidly in a condition to meet the needs of future programmes in complete safety.

· Active fuel examination laboratory (LECA)

The LECA is a laboratory carrying out destructive and non-destructive testing on spent fuel taken from various types of nuclear power or experimental reactors and on irradiated structures and equipment from these technologies. Its safety review started in 2000 and led to a major six-phase upgrade programme, with each phase requiring a licence.

Renovation of the LECA in particular includes civil engineering operations to improve its seismic resistance. After the transfer of activities from the “UO2” building in 2006, clean-out and dismantling work will reduce the interaction between buildings should en earthquake occur. The work should be completed in August 2008.

Given the scale and the progress of the renovation work initiated, ASN stated that it had no objection to continued operation of the installation until 2015. CEA also stated its intention of extending the LECA's operating lifetime beyond this date by carrying out additional anti-seismic reinforcement work. This option will be examined at the next safety review scheduled for 2011.

· The LECA's treatment, clean-out and reconditioning station (STAR) (Cadarache)

The STAR installation, designed to stabilise and recondition GCR spent fuel, also carries out destructive and non-destructive testing of PWR type spent fuel. In May 2006, ASN authorised extension of the STAR's operating framework to include reception, reprocessing and packaging of fuels which could not be reprocessed as-is. The installation's safety review file should be transmitted to ASN in 2007.

· Laboratory for research and experimental fabrication of advanced nuclear fuels (LEFCA)

The LEFCA is a laboratory responsible for performing basic engineering studies on plutonium, uranium, actinides and their compounds in all forms (alloys, ceramics or composites) with a view to application to nuclear reactors, the performance of ex-pile studies necessary for the interpretation and understanding of fuel behaviour in the reactor and at the various stages in the cycle, and the manufacture of irradiation test capsules or experimental assemblies.

In 2005, following the installation safety review, ASN stated that it had no objection to continued operation of the LEFCA for a further ten years and the licensee was sent new technical requirements.

The licensee forwarded an updated safety case taking account of the requirements and commitments resulting from the safety review. Technical investigation is currently under way into the building reinforcement work (in particular an innovative process involving bonding strips of carbon fibre fabric to the items to be reinforced), and into the feasibility of a radiating drainage well aimed at preventing the risk of liquefaction.

· Spent fuel test laboratory (LECI) (Saclay)

The spent fuel test laboratory is an installation designed to analyse the various components of the spent fuel from nuclear reactors (components of the radioactive material, components of the assembly cladding, etc.), in order to determine how they behave under irradiation.

In June 2004, ASN authorised pre-commissioning of the LECI extension, subject to compliance with a number of requests resulting from the conclusions of the extension project review by the Advisory Committee for laboratories and plants, which met in April 2004. In 2005, ASN authorised partial pre-commissioning of the LECI extension (limited to certain types of samples). In 2006, complete pre-commissioning of the LECI extension was authorised and new technical requirements were sent out.

b) Research and development laboratories

· Alpha facility and laboratory for transuranian elements analysis and reprocessing studies (ATALA NTE) (Marcoule)

ATALANTE primarily contains CEA's R&D facilities for high-level radioactive waste and reprocessing. These activities were previously distributed over three sites in Fontenay-aux-Roses, Grenoble and the Rhone Valley.

Owing to the numerous modifications made to the installation since its creation, ASN asked the licensee, prior to actual commissioning, to submit a safety review file for analysis by the Advisory Committee for laboratories and plants in May 2007.

Analysis of the incidents that have occurred in the installation in recent years revealed common causes linked to "human factors" and to the way operations are organised. ASN therefore sent the licensee a number of requests concerning the preparation of operations (in particular experiments), operational documents, workstation ergonomics and incident reports. Furthermore, following the incident which led to the contamination of five staff in 2004, specific corrective measures will need to be taken. Finally, ASN remains particularly vigilant regarding management of the project to increase the buildings' ability to withstand earthquakes.

• The CHICADE installation (Cadarache)

The CHICADE (chemistry, waste characterisation) installation carries out research and development work on low and intermediate level nuclear waste, primarily concerning:
- aqueous liquid waste treatment processes;
- decontamination processes;
- solid waste packaging methods;
- assessment and monitoring of waste packaged by the waste producers.

In 2006, the licensee began work to update the installation's safety case and general operating rules.

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Other facilities

• The central enriched uranium warehouse (MCMF) and the MAGENTA project (Cadarache)

The MCMF is a warehouse for storing enriched uranium and plutonium. Its main duties are reception, interim storage and shipment of non-irradiated fissile materials (U, Pu) pending reprocessing, whether intended for use in the fuel cycle or temporarily without any specific purpose.

In 2006, the licensee continued to remove from storage the fissile materials held in the facility, leading in particular to a 96% reduction in the total mass of plutonium-bearing materials initially stored there, with a view to ultimately closing the facility.

In March 2006, CEA also submitted an application for the decree authorising creation of the MAGENTA facility, which is to replace the MCMF by 2010. To support its application, CEA sent ASN the facility's preliminary safety case. This document will be reviewed by the Advisory Committee for laboratories and plants in March 2007.

• The CIS Bio International facility (Saclay)

CIS Bio International is a key player on the French market for radiopharmaceutical products used for both diagnosis and therapy. In May 2006, Schering S.A. – which had been the 100% owner of CIS Bio International since December 2001 – sold the company to the consortium consisting of IRE (Institut national des radioéléments, based in Fleurus, Belgium) and IBA (Ion Beam Applications S.A.). Through this acquisition, IRE and IBA obtained 80.1% and 19.9% shares in CIS Bio International respectively.

Given the context of the CIS Bio International acquisition by IRE-IBA, the renovation project ran out of steam in 2006. CIS Bio International was in particular unable to complete the safety review of the facility as promised. ASN considers that CIS Bio International will need to make additional efforts to complete the facility's safety review. In 2007, ASN will be particularly attentive to the adequacy of the means employed by CIS Bio International for pursuing the action taken to improve the safety of the facility.

After checking that the IRE-IBA consortium has the technical and financial capacity, in particular to continue the renovation project initiated by Schering S.A., ASN approved the change in licensee. The draft decree transferring the responsibility of nuclear licensee from CEA to CIS Bio International was reviewed by the interministerial commission for BNIs in December 2006.

• POSEÏDON irradiator (Saclay)

The operating principles of irradiators are explained in part 3.1 of this chapter. The POSEÏDON facility was initially under the ownership of CIS Bio International and was primarily used to study the strength of the materials used in nuclear power plants and fuel cycle plants. It is scheduled for return to the list of CEA's basic nuclear installations.

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Effluent and waste treatment facilities

CEA's radioactive effluent and waste treatment installations are distributed between the Fontenay-aux-Roses, Grenoble, Cadarache and Saclay sites. They are generally equipped with characterisation facilities to enable measurement-based checks on the declarations made by the waste producers and verification of the conformity of the waste packaged with respect to the specifications for acceptance prior to routing to the appropriate channel. The processing and packaging installations primarily handle the liquid and solid waste generated by the CEA centre on which they are located.

They occasionally process waste from outside nuclear sites (CEA or others) depending on their specific nature.

The installations devoted specifically to interim storage of waste and spent fuels are dealt with in chapter 16 (§ 7).

a) Cadarache Centre

The effluent and waste treatment station (STED) processes and packages liquid and solid radioactive waste from the Cadarache Centre.

Following the periodic safety review of this installation in 1988, ASN had authorised continued operation for a limited period. CEA then proposed creating three new installations with a view to carrying out the duties performed by the STED: the Rotonde, for sorting of solid waste, CEDRA, for treatment of a part of the solid waste and AGATE for treatment of liquid effluent.

The Rotonde sorting installation should be operational in 2007 and will primarily interface between the solid waste producers and treatment, storage and disposal installations. Since the closure of the STED's 250-ton compacting press at the end of 2004, the waste from this technology is directly routed to Andra's waste repository in the Aube *département*, which compacts the packages. At the beginning of 2007, CEA will be sending ASN a file about the long-term future of the STED's 500-ton press. This extension requires reinforcement of the installation against the effects of earthquakes. Finally, CEA has abandoned the incineration process which was to be employed in the CEDRA installation. This installation was to process the plutonium waste from the Pégase installation, which will instead be compacted.

Processing of liquid effluent contaminated with intermediate-level alpha emitters, referred to as "special" effluent, ceased on 1 July 2005. CEA is transferring this effluent to the liquid effluent treatment station on the Marcoule site (STEL).

In 2006, ASN authorised continued operation of the STED to process liquid effluent contaminated with beta-gamma emitters, until 1 March 2008. The decision to continue operations until commissioning of the AGATE installation will be taken on the basis of acceptance by the Defence Nuclear Safety and Radiation Protection Delegate (DSND), continued operation of the STEL in Marcoule and the progress of the AGATE project.

In the light of the planned reduction in the Cadarache Centre's needs with respect to the future production of liquid effluent, CEA presented a new strategy in 2005 which will limit the configuration of the AGATE project. According to CEA's strategy, AGATE would concentrate the effluent contaminated by beta-gamma emitters produced in the Cadarache Centre. The concentrates would then be transferred to the Marcoule STEL which would handle final processing. This strategy presupposes that the Marcoule STEL, for which the periodic safety review is scheduled for 2007, would pose no safety problems in the coming years. On this occasion, CEA envisages renovating the Marcoule STEL to take charge of the concentrates from Cadarache and the liquid effluent from Marcoule. The effluent bituminisation process would thus be replaced by a cement encapsulation process, like the process employed in the new STELLA installation at Saclay.

Finally, removal of the radioactive organic liquids (LOR) from the ZELORA building in the Cadarache STED, and their final treatment, remain a priority for ASN. A first shipment of LOR was thus made to the ATALANTE facility in 2006, for treatment by hydrothermal oxidation.

b) Saclay Centre

The solid waste management zone handles treatment and interim storage of solid radioactive residues produced in the Centre by the reactors, laboratories and workshops. This installation provides the interface between the waste producers on the Saclay site and the treatment, interim storage and disposal installations for this waste. It also recovers waste from the small producers (scintillation liquid sources, ion exchanger resins) and provides interim storage of radioactive sources.

In 2006, CEA continued the programme to recover from the fuel assembly blocks the spent fuel elements stored in the solid waste management zone. This programme consists in characterising old containers, stored in the fuel assembly block, so that they can be taken to the STAR installation in Cadarache for reconditioning before interim storage in CASCAD, pending a final solution (reprocessing or disposal).

CEA's current strategy is to reduce the source term present in the installation and primarily maintain the functions to provide the interface between the producers of solid waste and the appropriate disposal channels. ASN asked CEA to conduct a safety review of the solid waste management zone,

STELLA extension building

which will be assessed by the Advisory Committee for laboratories and plants, with ASN making its standpoint known in 2008.

The radioactive liquid effluent management zone (STE) collects, stores and reprocesses the low-level aqueous effluent and stores aqueous and organic effluent. The radioactive aqueous effluent is evaporated and stored in RESERVOIR tanks pending treatment. By a decree of 8 January 2004, CEA was authorised to modify the STE by adding the STELLA extension.

In 2007, ASN will issue a declaration on the safety of the part known as the "old plant" and on commissioning of the STELLA extension, after having had the entire file reviewed by the Advisory Committee for laboratories and plants.

The progress of the operations, first of all to recover stored legacy effluent awaiting treatment, and secondly to clean out the old installation buildings, are among the priorities that CEA must set for itself, along with commissioning of STELLA.

c) Fontenay-aux-Roses Centre

The main function of the radioactive effluent and solid waste treatment station (STED) is interim storage of solid and liquid waste prior to removal to the appropriate channels. As part of the site clean-out process, in addition to removal of the waste from storage, the STED will act as the support installation for managing the waste generated by decommissioning.

d) Grenoble Centre

The effluent and waste treatment station (STED) is continuing with removal of waste from storage and recovery of legacy waste, for complete decommissioning by 2010. This installation will from now on also be the support installation constituting the interim storage facility for the waste generated by decommissioning of the Grenoble site installations prior to removal to the appropriate disposal channels. The installation is also storing containers of sodium and a mixture of sodium and potassium, pending processing. In 2006, CEA submitted an application for authorisation to shut down and decommission the STED.

1 | 2 | 6

Installations being decommissioned

CEA has begun a process of shutting down and decommissioning certain installations it no longer wishes to use or which are located in the immediate vicinity of large cities (as is the case with Fontenay-aux-Roses and Grenoble).

ASN asked the Advisory Committee for laboratories and plants to review the decommissioning strategy for CEA installations in order to ensure that safety and radiation protection requirements are incorporated into this programme, and that they are ranked according to the safety problems encountered. These aspects are dealt with in chapter 15.

2 NON-CEA NUCLEAR RESEARCH INSTALLATIONS

2 | 1

Electromagnetic radiation laboratory (LURE)

The Electromagnetic radiation laboratory (LURE), in Orsay (Essonne *département*), is an installation producing synchroton radiation (high-power X-rays) for a wide variety of research applications.

In June 2002, the licensee announced its intention to cease operation of this positon accelerator at the end of 2003, apart from the autonomous use of the CLIO laser. The shutdown phase, which began in 2004, should be completed by the end of 2006. The licensee announced that by the end of 2006 it would provide ASN with the shutdown and decommissioning case for the facility. The facility's first ring (ACO ring), built in the 1960s, is now included on the "supplementary" list of industrial historical monuments.

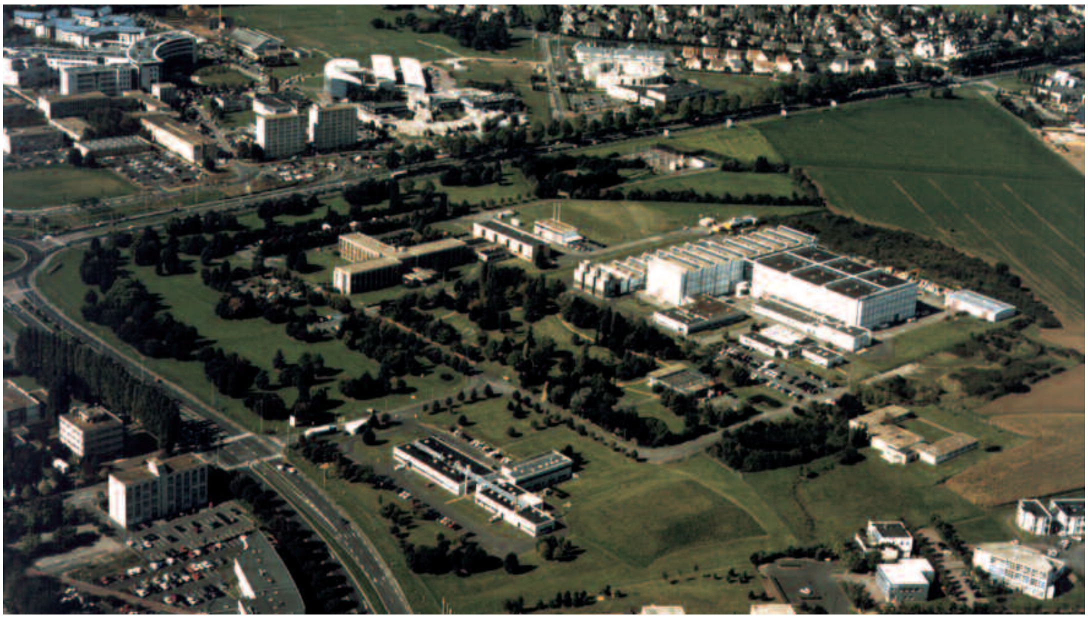
2 | 2

Large National Heavy Ion Accelerator (GANIL)

The GANIL, located in Caen (Calvados *département*) is designed to accelerate all heavy ions (from carbon to uranium) with a maximum energy of 100 MeV per nucleon.

The CIRIL6 radiobiology laboratory was started up in autumn 2003. In May 2004, the GANIL submitted the safety options file for the SPIRAL 2 project (creation of new experimentation rooms with a more powerful beam). In July 2005, ASN approved the safety options proposed by the GANIL, provided that a certain number of comments were taken into account. At the same time, ASN asked the GANIL to proceed with the periodic safety review of the installation.

ASN is remaining particularly vigilant with regard to the installation's upgrade schedule and the organisation that the licensee intends to put into place. Access management and fire protection are the key issues.



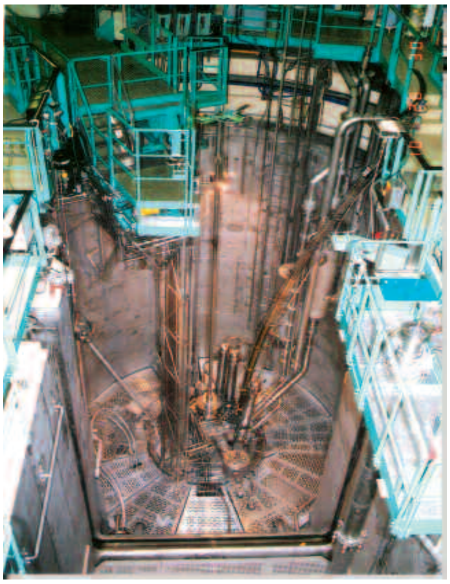
Aerial view of the GANIL accelerator

2 | 3

Laue-Langevin Institute high flux reactor

The high flux reactor (RHF) at the Laue-Langevin Institute in Grenoble constitutes a neutron source mainly used for experiments in the field of solid-state physics and nuclear physics. Maximum authorised power for this reactor is 58.3 MWth. The reactor core, cooled and moderated by heavy water, is placed at the centre of a reflector tank, immersed in a light water pool.

In 2002, ASN asked for seismic reinforcement work on the installation. This work is still in progress and should be finished by the end of 2006. The installation's liquid and gaseous effluent discharge authorisations are also being revised.



View of the RHF vessel, empty of water

2 | 4

European Organization for Nuclear Research (CERN) installations

The European Organization for Nuclear Research (CERN) is an intergovernmental organisation established on the basis of a treaty between States for the purpose of carrying out purely scientific and fundamental research concerning high energy particles. The CERN site is located near Geneva, on the Franco-Swiss frontier.

The CERN is currently working on setting up a hadron collider (Large Hadron Collider, LHC) which should enable progress to be made in particle physics research, notably by producing proton-proton collisions at a beam energy of 7 TeV. The LHC is installed in the tunnel of the Large Electron-Positon (LEP) which has been dismantled. The work on building the LHC is continuing. In 2006, CERN sent the necessary files to ASN so that it could make a decision on commissioning of the LHC, scheduled for 2007.

The safety of these installations is regulated by a convention binding the French Government and the CERN. The convention currently in force, which dates from July 2000, states that French legislation applicable to BNIs applies to the LHC and to the SPS, two rings which make up part of the CERN's installations. It also designates the Nuclear Installation Safety Directorate (DSIN, now ASN) as the French Government representative to deal with technical matters concerning the convention. ASN also has a seat on the CERN's radiation protection committee, in charge of all radiation protection problems on the site.

2 | 5

The ITER (International Thermonuclear Experimental Reactor) project

The ITER project is an experimental installation, the purpose of which is scientific and technical demonstration of controlled thermonuclear energy with a deuterium-tritium plasma magnetic confinement, during long-duration experiments with a significant power level (500 MW for 400 s). This project is an international one and enjoys financial support from China, South Korea, Japan, Russia, the European Union and the United States. After lengthy negotiations, Cadarache was finally chosen at the end of June 2005 to host the facility. The international treaty creating the international ILE

(ITER Legal Entity) was signed in May 2006. Its director general had been appointed in May 2005 and the deputy director general was appointed in April 2006.

The installation's preliminary safety case is currently being drafted by the designers and should be transmitted by the end of 2007 with a view to initiating the authorisation decree procedure. Technical dialogue is continuing (about ten or so meetings are scheduled to take place by mid-2007). It primarily concerns the extent to which French safety requirements have been taken on board by the designers, a point on which ASN is particularly vigilant.

ASN notes that the ITER's status as an international organisation, in particular the prerogatives linked to the privileges and immunities enjoyed by international organisations, create a degree of difficulty with respect to the responsibility of the nuclear licensee. ASN asked that, in the same way as for other French basic nuclear installations, no person could enjoy immunity and that no premises could be off-limits to nuclear safety and radiation protection inspections.

3 IONISERS, MAINTENANCE FACILITIES AND OTHER NUCLEAR INSTALLATIONS

3 | 1

Industrial ionisation installations

Industrial ionisation installations provide gamma-ray (mainly cobalt 60 sources) treatment for medical equipment (sterilisation) or foodstuffs. An ioniser consists of a concrete bunker inside which the ionisation processes take place. The sources are placed in a pool inside the bunker. They are remotely and automatically extracted from the pool during an ionisation operation. They are lowered into the pool after the operation and prior to any intervention by the operators in the bunker. There is thus no risk of irradiation inside the bunker. Installations of this type exist in Pouzauges (Vendée), Marseille (Bouches-du-Rhône), Sablé-sur-Sarthe (Sarthe) and Dagneux (Ain).

The safety problems mainly concern access management, a point on which ASN is extremely attentive, in particular on the basis of the experience feedback from the operation of similar installations in Europe.

In a letter of 30 June 2006, the ISOTRON France company submitted an application for authorisation to create a basic nuclear installation, called GAMMATEC, on the Marcoule site. This new installation would be the second one in France for the ISOTRON group, the first being at present operated in Marseille. The main vocation of this installation, which would use cobalt 60 sealed sources, would be ionisation treatment of medical equipment.

3 | 2

Maintenance facilities

Three basic nuclear installations specifically handle nuclear maintenance activities in France:
- the SOMANU (*Société de maintenance nucléaire*) facility in Maubeuge (Nord département), which specialises in the repair, maintenance and evaluation of equipment taken mainly from PWR main primary systems and their auxiliaries, with the exception of fuel elements;

– the clean-out and uranium recovery installation of the Société auxiliaire du Tricastin (SOCATRI) in Bollène (Vaucluse *département*) which handles maintenance, interim storage and clean-out of equipment from the nuclear industry and storage of waste on behalf of ANDRA;
– the Tricastin operational hot unit (BCOT), also in Bollène, which carries out maintenance and interim storage of contaminated PWR equipment, except for fuel elements.

The surface treatment shop, located in the non-nuclear part of the SOCATRI installation in Bollène, gave rise to groundwater pollution by hexavalent chromium in 1998. The clean-out operations, required by order of the *préfet* on 26 November 1998 and consisting in pumping the groundwater for depollution by ion exchange resin treatment, are still proceeding, until the thresholds set by the above-mentioned order are reached.

3 | 3

Chinon irradiated material facility (AMI)

This installation, located on the Chinon nuclear site (Indre-et-Loire *département*), is operated by EDF. Its main purpose is to carry out review and assessment of activated or contaminated materials from PWR reactors.

2006 was marked by a change in strategy on the part of the licensee with regard to the future of the installation. ASN considered that the renovation project presented by EDF in 2004 would be unable to allow long-term operation and had asked EDF for its stance with regard to the long-term future of the installation, before this work began. EDF's new strategy concerning the irradiated material facility is based on 2 main aspects: definition of new objectives concerning the processing and future of waste for which there is no disposal technology, and the final shutdown of the installation no later than 2015. The construction of a new assessment laboratory is also being envisaged.

The procedures for implementation of this new strategy will be reviewed by ASN, with the aim of guaranteeing a high level of safety until the installation is decommissioned.

All unused fuel stored in the installation was removed in mid-2006.

3 | 4

Inter-regional fuel warehouses (MIR)

EDF has two inter-regional fuel warehouses, on the Bugey site in the Ain *département* and at Chinon in Indre-et-Loire. EDF uses them to store nuclear fuel assemblies (only those made of uranium oxide) pending loading into the reactor. Accessibility considerations and a just-in-time fuel management policy have led EDF to indicate that it intends to close down the Chinon warehouse in the near future.

3 | 5

CENTRACO waste incineration and melting facility

The CENTRACO low-level waste processing and packaging centre, located in Codolet near the Marcoule site (Gard *département*), is operated by SOCODEI.

SOCODEI has begun to look at ways of expanding its scope of operations, given the need to reposition itself in the low-level waste management sector, particularly since ANDRA's very low-level waste repository opened. This strategy requires modification of the creation authorisation, revision of the SOCODEI water intake and effluent discharge licence (ARPE) and ASN approval of the new safety reference system. CENTRACO submitted an application for modification of its creation authorisation and effluent discharge and water intake licence in 2006 and the files were sent for public inquiry.

4 OUTLOOK

The research and other installations dealt with in this chapter are extremely diverse and in particular comprise experimental reactors, hot laboratories, accelerators and irradiators. In addition to CEA, there are a large number of licensees which operate a small number of installations.

2006 was an opportunity for CEA to position itself with respect to the priority areas for development of its activities.

Definition by CEA of dedicated centres of excellence (life sciences in Fontenay-aux-Roses, material sciences in Saclay, nuclear energy in Cadarache, radioactive waste in Marcoule, and so on) has led to ASN issuing recommendations to the highest level of CEA, to ensure that nuclear safety and radiation protection remain the licensee's primary concern, including in those centres whose activities are mainly non-nuclear.

CEA is aware of the need to develop a true overall policy for the safety of its installations, even though this was anything but a foregone conclusion given that the forty or so BNIs at CEA were all special cases which needed a graded safety approach (in the words of the IAEA). However, there are a number of clear installation categories:

- Research reactors, for which high safety levels have always been demanded. ASN considers that experience feedback is satisfactory, in particular with regard to the periodic safety reviews. An important point concerns the Phénix reactor, for which final shutdown operations are currently being prepared: ASN asked the licensee in particular to take account of the importance of human and organisational factors for an installation in closure phase.
- Laboratories and other facilities: ASN considers that CEA has to ensure strict compliance with its commitments with regard to upgrading of its older facilities. A particular point concerns the ATALANTE facility which contains all the R&D resources for the back end of the nuclear fuel cycle: ASN asked the licensee to pay particular attention to human and organisational factors in its facility following the incidents involving the interfaces between the experimentation staff and the licensee.
- Waste and effluent treatment facilities: these facilities, which are mostly of older design, are lagging far behind current safety standards and some will need to be replaced. ASN has observed that several projects concerning these facilities have been called into question or postponed and wants to see a rapid change in this situation, leading to a credible strategy for the management channels.
- Facilities being decommissioned, of which there are about ten or so today: ASN considers that the particularities of decommissioning are on the whole dealt with satisfactorily in these facilities (see chapter 15).

In 2006, CEA transmitted a three-year (2002-2004) review of safety and radiation protection proposing areas for progress in the future. ASN considers that this review is a good practice that should be continued, while stressing that it should be possible to quantify the attainment of certain major objectives. On the basis of this review, CEA extended its 3-year 2006-2008 action plan for improving security at CEA to include nuclear safety. ASN feels that this plan, which is satisfactory in principle, should define precise safety objectives and means of achieving them. It should also be associated with a set of indicators for assessing the progress made.

ASN also believes that CEA should continue to develop its system of internal authorisations for minor operations which do not compromise the installation's safety case. This system has been in use since 2002 and experience feedback is satisfactory, leading to improved safety appraisal skills within CEA. However, this system at present only concerns half of CEA's installations. ASN would like to see this system generalised to all CEA installations, with CEA acquiring the corresponding necessary resources.

To conclude, ASN considers that CEA has made progress in the field of safety, albeit unevenly, with emphasis on research tools to the detriment of installations supporting this activity, in particular effluent and waste treatment facilities. ASN considers that CEA needs to rapidly implement a true safety and radiation protection policy and strategy that is legible and transparent to the Safety Authority, together with a management tool enabling it to ensure that its undertakings are met, thereby fully assuming its responsibility as nuclear licensee.

In 2007, ASN will particularly focus on:
- creation of an overall safety policy at the highest decision-making level of CEA;
- supervision of the main commitments made in recent years, in particular with regard to waste and effluent treatment installations;
- consideration of human and organisational factors;
- ensuring that the new projects progress on time, particularly AGATE and MAGENTA, designed to replace the installations that no longer meet current safety standards;
- developing and completing ASN guides for research installations, in particular to formalise the methodologies applied to these installations.

Chapter 14

NUCLEAR RESEARCH FACILITIES AND VARIOUS NUCLEAR INSTALLATIONS