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INTRODUCTION

1. General introduction

1.1 Purpose of the report

The Convention on Nuclear Safety, hereinafter referred to as “the Convention”, is one of the results of international discussions initiated in 1992 with the aim of proposing binding international obligations regarding nuclear safety. France signed the Convention on 20 September 1994, the date on which it was opened for signature during the IAEA’s General Conference, and approved it on 13 September 1995. The Convention entered into force on 24 October 1996.

For many years France has been participating actively in international initiatives to enhance nuclear safety, and it considers the Convention on Nuclear Safety to be an important instrument for achieving this aim. The areas covered by the Convention have long been part of the French approach to nuclear safety.

This report, the fourth of its kind, is issued in compliance with Article 5 of the Convention on Nuclear Safety and presents the measures taken by France to fulfil each of the obligations of the Convention.

1.2 Facilities concerned

As such, the Convention on Nuclear Safety applies to nuclear power reactors, and so most of this report deals with measures taken to ensure their safety. However, in this fourth report, as in the third, France has decided to include the measures taken concerning all research reactors, with a graded approach tailored to their size where appropriate.

First of all, research reactors are subject to the same general regulations as nuclear power reactors with regard to nuclear safety and radiation protection. Furthermore, the most powerful research reactor also generates electricity. Secondly, in the reports under the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, to which France is a party, the measures taken for research reactors in these areas have been described. Finally, in March 2004 the IAEA Board of Governors, on which France has a seat, approved the Code of Conduct on the Safety of Research Reactors, which incorporates most of the stipulations of the present Convention.

1.3 Report authors

This report was produced by ASN, the French nuclear safety authority, which coordinated the work on it, with contributions from IRSN (Institute for Radiation Protection and Nuclear Safety) and from nuclear reactor licensees, Électricité de France (EDF), the Atomic Energy Commission (CEA) and the Laue-Langevin institute (ILL). The final version was completed in July 2007 after consultation with the French parties concerned.

1.4 Structure of the report

For this report, France has taken account of the experience acquired with the three previous editions: it is a stand-alone report based mainly on existing documents and reflecting the viewpoints of the various stakeholders (regulatory authority and licensees). Thus, for each of the chapters in which the regulatory authority is not the only party to express its point of view, a three-part structure has been adopted: first a description of the regulations by the regulatory authority, followed by a presentation by the licensees of the steps taken to comply with the regulations, and finally an analysis by the regulatory authority of the steps taken by the licensees.

The report is structured according to the guidelines for national reports, as modified during the 2002 peer review meeting. The presentation is made “article by article”, each being the subject of a separate chapter, at the beginning of which the corresponding text of the Convention article is reproduced in a shadow box. This introduction presents the main changes since the third national report and France’s nuclear power policy. Part A deals with the general provisions (articles 4 to 6). Part B summarises the legislation and regulations (articles 7 to 9). Part C is devoted to general safety considerations (articles 10 to 16). Part D discusses the safety of the installations (articles 17 to 19). The conclusion outlines future trends in the field of nuclear safety in France, including measures for international cooperation. The report is supplemented by a number of appendices.

The main changes between this report and the previous one are summarised for each chapter in chapter 2 of this report.

1.5 Publication of the report

The Convention on Nuclear Safety does not stipulate any obligation regarding public communication of the report stipulated in article 5. Nonetheless, as part of its mission to inform the public and in its continuous effort to improve the transparency of its activities, ASN has decided to make the report accessible to any interested person. Consequently, this report is available on ASN’s website (*www.asn.fr*), in French and in English.

2. Main changes since the third French report

2.1 Changes in nuclear safety regulation in 2006

Since the last review meeting, the act of 13 June 2006 on transparency and security in the nuclear field has provided a legislative basis for the regulation of nuclear safety and radiation protection in France: it introduced an appropriate penalty system and transformed ASN into an administrative authority independent of the government. All the personnel of the former ASN have been transferred to the new entity. Initially this allows relative continuity, but substantial changes can be expected over the next few years. The description of the regulatory framework at chapter 7, and of the regulatory body, at chapter 8, therefore presents the current situation.

2.2 Changes in the content of the fourth report with respect to the third report

In drafting this report, the decision was made to retain the previous chapter organisation, with the answers to questions raised by certain paragraphs during the third review meeting being included in the paragraphs concerned. Moreover, in this report as in the previous one, France has chosen voluntarily to include the measures taken to ensure the safety of research reactors, even if they are not intended to generate electricity. The main changes compared with the previous report are summarised below.

This chapter 2, which mainly contains topical safety issues, is almost entirely new in relation to chapter 2 of the third report. Chapter 3 has been updated to take account of changes in the regulatory framework. Chapters 4 and 5 are unchanged. Chapter 6, on the main measures taken to improve reactor safety in France, has been updated.

Chapter 7, on safety legislation and regulations, and chapter 8, on the regulatory body, have been completely rewritten to describe the act of 13 June 2006 on transparency and security in the nuclear field and its consequences on the regulations and on ASN. Chapter 8 also reports on the IRRS mission received by ASN in November 2006. Chapter 9 has also been updated to take account of the new act.

Chapters 10 to 20 are updates of the same chapters in the third report.

2.3 Topical safety issues in France in 2007

Since the review meeting of the previous report (April 2005), no major event related to nuclear safety has occurred in France. Two generic incidents on power reactors have been rated at INES level 2 over the same period. During these years ASN has continued its work to anticipate long-term nuclear safety and radiation protection issues and develop measures to deal with them, focusing on the points discussed below.

2.3.1 Safety and economic competitiveness

Act of 10 February 2000 on modernisation and development of the public electricity service has fundamentally changed the electricity market in France, in particular by placing EDF in a situation of competition for the generation and supply of electricity. In 2004 EDF changed status, becoming a public limited company. At the end of 2005 the company was partially privatised, the State retaining an 86% shareholding. The act stipulates that the State cannot hold less than 70% of the capital and of the voting rights.

The concern with cost control is now stressed to a greater extent by the licensee in its dealings with ASN. ASN has adapted its regulation to this new context, developing its actions in three areas.

The first area concerns the tracking tools developed for early detection of any drift and the reinforcement of oversight by the implementation in 2006 of inspections on the topic of “safety and competitiveness”, which pay particular attention to the licensee’s budget arbitration processes. In addition, ASN has asked its technical support organisation, IRSN (Institute for Radiation Protection and Nuclear Safety), to assess EDF’s safety management system in a context of competition; in 2008 this assessment will be the subject of a meeting of the committee for nuclear reactors (GPR). The second area of work concerns the establishment of a more frank and responsible dialogue with EDF on its economic issues, including through the use of safety cost-benefit analyses. The third area consists in developing international exchanges, including within WENRA, to harmonise safety requirements, given the internationalisation of licensees and the advent of a competitive electricity market.

Finally, it should be noted that most research installations are operated by major public-sector bodies, a large proportion of whose resources come from the budget of the State, itself subject to a context of restriction. ASN must make sure that such budget constraints have no detrimental consequences on safety or radiation protection in the operation of these installations.

2.3.2 The importance of human and organisational factors

People and organisations are fundamental factors in safety and radiation protection. Although 80% of incidents on reactors in operation have at least one cause linked directly to human and organisational factors (HOF), it must be emphasised that, in daily operation, people and organisations make an essential positive contribution to the safety of installations. Organisations have a crucial role to play in establishing and guaranteeing conditions conducive to the improvement of human performance and in reinforcing human and organisational lines of defence at all stages of installation lifetimes.

Through means including inspections, ASN monitors the arrangements made by the licensees, in particular for personnel training and skills management, organisation definition and operation, inclusion of human aspects in analysis of feedback from experience, and safety management.

This monitoring starts at the design stage of a new installation. In 2004, ASN and its technical support organisation conducted an assessment of the computerised control of the EPR reactor. Similarly, the HOF aspects of the proposed Jules Horowitz research reactor have been examined.

The monitoring also covers safety-related modifications implemented by the licensee to an existing installation. In 2004 ASN, together with IRSN, assessed the methodology adopted by EDF to include HOFs in the incorporation of technical and documentation changes in its NPPs. Similarly, at the request of ASN, the studies for the periodic safety review of CEA’s Masurca critical mock-up take HOFs into account.

Finally, the monitoring covers operation. The inspections conducted in 2006 examined the organisation, the resources, the operation improvement actions targeting individuals (skills, work environment and tools, human performance) and larger units (operational communication, interfaces between teams or departments), and the inclusion of HOFs in the analysis of experience feedback.

ASN considers that HOFs provide potential for safety improvement and plans to continue developing its monitoring actions in this area.

2.3.3 Internal authorisations

Certain operations on operating reactors are subject to prior ASN authorisation; this procedure has been imposed on the licensee in certain cases following significant incidents. ASN nevertheless considers that such arrangements must remain limited to the cases that necessitate them, in order to comply with the principle of prime responsibility of the licensee with regard to nuclear safety. ASN has decided to authorise the setting-up of “internal authorisation” systems, subject to quality criteria, replacing certain authorisations delivered previously by ASN. This procedure enables the licensee to carry out operations that do not compromise the safety demonstration without requesting prior authorisation from ASN. ASN has conducted inspections to confirm that these systems work properly. Their scope is still limited, but could be extended in 2007.

2.3.4 Periodic safety reviews and monitoring of ageing of nuclear power reactors

From a strictly regulatory standpoint, in France there is no limit on the time that a NPP is authorised to operate. Conversely, the licensee is required to conduct a safety review of each nuclear installation every ten years. These periodic safety reviews have two main objectives.

- The first is to compare the safety level of the installations with their initial safety reference system in order to identify any deterioration over time, along with any shortcomings or weaknesses in the safety analysis. This is the conformity review.
- The second is to compare the safety of the installations with the most recent standards in order to identify changes likely to improve the safety level and establish a new “safety reference system”. These safety improvements can be implemented during ten-year reactor outages.

Incorporation of changes identified by the 20-year safety review of the 900 Mwe reactors, which began in 1990, continued in 2006 and will be completed in 2010.

At the end of 2004 and in the first half of 2005, ASN consulted the GPR on the priorities of the thirty-year safety review of the 900 Mwe reactors. Incorporation of the changes identified by this review is planned from 2009 to 2020.

On completion of the twenty-year safety review of the 1300 Mwe reactors, ASN confirmed the continuation of the operation of these reactors until their third ten-year outage. Incorporation of the changes identified by this review has begun and will continue until 2014.

2.3.5 Changes in nuclear power reactor fuel and its management

Changes in the fuels used in nuclear power reactors have implications for the plants in which they are produced or reprocessed, the installations in which they are stored and the transport of radioactive materials. It is necessary to make sure that these changes are consistent, in technical terms, with the safety of the corresponding operations and, in regulatory terms, with the authorisation decrees, the liquid and gaseous discharge and water intake authorisations, the technical requirements and the regulations on the transport of radioactive materials.

In 1999 ASN asked EDF to undertake a forward-looking assessment, in liaison with the fuel cycle companies, to provide information concerning compatibility between changes in fuel characteristics or spent fuel management and fuel cycle installations. It supplemented and clarified its request in 2006.

The information supplied and reviewed provides substantial clarification of the operation of the fuel cycle and of the safety issues; in particular, it enables the identification of technical and regulatory limits which could be modified as a consequence of changes in fuel management, once appropriate supporting documentation has been provided.

In order to maintain an overview of the fuel cycle, ASN has asked EDF to update this information periodically.

ASN aims in particular to prevent the saturation of NPP interim storage capacities as observed in other countries, and to avoid the licensees using older installations, for which the regulatory and technical framework for authorisation is less stringent, as a palliative measure.

2.3.6 New reactor projects and construction monitoring

Because of the age of the research reactors currently in service in Europe and their shutdown in the long or medium term, CEA, supported by several European partners, deemed necessary the construction of a new reactor dedicated to irradiation. The licence application for the construction of the Jules Horowitz reactor (RJH) was submitted in March 2006. At the request of ASN, the GPR will examine the preliminary safety report of this installation.

With regard to nuclear power reactors, in 1993 the French and German nuclear safety authorities jointly defined more stringent safety objectives for the EPR (European Pressurized water Reactor) project. On 28 September 2004, the French authorities informed EDF that they considered that the selected safety provisions meet the objective of safety improvement over present reactors. Following the national public debate, held from 19 October 2005 to 18 February 2006, EDF submitted a licence application for the construction of an EPR reactor at Flamanville on 9 May 2006. On 16 February 2007 ASN issued a favourable opinion on this application to the government. The authorisation decree was signed on 10 April 2007.

The EPR project is an opportunity to harmonise safety approaches between different countries. From the start, the French and German nuclear safety authorities have worked in close cooperation to define the safety requirements of the project and review the proposed design options. Following the authorisation by the Finnish government, in early 2005, of the construction of an EPR reactor by the company TVO, the Finnish and French nuclear safety authorities have strengthened their collaboration on this topic. Finally, the United States nuclear safety authority, which has been undertaking an assessment of the EPR design since 2006, wanted to benefit from the work done by ASN; a protocol was signed in June 2006 between the two safety authorities, and cooperation has started within the more general framework of the MDEP (Multinational Design Evaluation Program).

2.3.7 The recirculation sump filter clogging risk

In the event of a pipe break accident on the primary system inside the reactor building, the safety injection system (RIS) and the containment spray system (EAS) are started up automatically to cool the reactor core. The pumps of these systems initially draw water from the PTR tank. When the tank is empty, they are connected to the reactor building sumps, where the EAS spray water is collected, together with the water flowing from the primary system break.

Studies have shown that, in certain highly-improbable accident situations involving a major break in the primary system, sump filter clogging cannot be excluded, but can be dismissed for smaller breaks. All French nuclear reactors are concerned to various extents, with the older ones apparently being the most prone to this phenomenon, as their filtration surface areas are smaller. Given its potential impact on safety, this incident was rated at level 2 on the INES scale in 2003.

To avoid such an incident, EDF has decided to replace the sump filters, increasing the filtration areas significantly. This change was incorporated into three 900 MWe reactors in 2005 and twelve reactors in 2006; it will be incorporated into all the reactors before the end of 2009.

In addition, ASN has asked EDF to take all necessary measures to “practically eliminate” the risk of clogging of the water intakes of the safety injection, containment spray and corium catcher cooling systems of the EPR.

2.3.8 Legionella

Following an outbreak of legionellosis in France in late 2003 near an industrial plant with cooling towers, prevention of this risk at NPPs with similar towers has been reinforced. Technical discussions with the health authorities and EDF led ASN, in January 2005, to set limits for EDF on *Legionella* concentrations in NPP cooling systems, along with installation monitoring requirements.

In parallel, in 2004 ASN asked AFSSET, the French Environmental and Labour Health Safety Agency, for an opinion on the health and environmental risks related to the presence of *Legionella* in NPP cooling systems. On the basis of an initial expert assessment by AFSSET in April 2006, ASN asked EDF for a more thorough analysis of several points, including the reinforcement of the monitoring arrangements, the means used to reduce *Legionella* growth in the cooling systems and the use of the results of epidemiological studies.

2.3.9 Steam generator clogging

The steam generators of several EDF power reactors are affected by substantial clogging of their suppport plates. This problem concerns a number of 900 Mwe and 1300 MWe series reactors whose secondary systems conditioning is at low pH. The clogging consists of deposits gradually filling the openings between the tubes and the support plates for water circulation.

This situation was revealed during the investigations following a major primary-secondary leak which occurred in February 2006 on the Cruas 4 reactor: a crack formed in a steam generator tube and extended within a few months, probably through vibration fatigue. Clogging of the upper support plates of the steam generators appeared to be the probable predominant factor at the origin of this damage. In inspections following this discovery, unanticipated high clogging levels of up to 80% were observed in several reactors. The estimated rate of increase of the clogging is 5% per year.

This clogging phenomenon has major safety consequences:

- It is probably the determining parameter resulting in excess vibrations of tubes in some areas of the steam generators, which can lead to rapid development of cracks. EDF has plugged an area of 58 tubes as a preventive measure.
- It generates high mechanical forces on the steam generator internals, particularly in some incident situations.
- It leads to a reduced rate of water circulation in the steam generators and thus, for a given water level, a reduced water inventory available inside the steam generator. Oscillatory phenomena may appear in the steam generators.

ASN has asked EDF to carry out more thorough studies to obtain a better understanding of the clogging levels and the consequences of this phenomenon. For the units with the highest levels, EDF plans to implement a chemical cleaning process of the steam generators. Due to the environmental aspects of this operation and its potential impacts on equipment, an authorisation from ASN is necessary. ASN has asked EDF to optimise the chemical cleaning process so as to minimise its consequences.

In the longer term, EDF is considering changing the operating conditions of the units in order to prevent the clogging phenomenon.

3. National nuclear policy

3.1 General policy

The first French government decision on nuclear energy was the establishment in 1945 of the *Commissariat à l'énergie atomique* (CEA), the Atomic Energy Commission, a public research organisation. The first French experimental nuclear reactor went critical in December 1948, paving the way for the construction of other research reactors and subsequently nuclear power reactors.

The French nuclear power reactors within the scope of the Convention were built and are operated by a single licensee, Électricité de France (EDF). The research reactors currently operating, including the Phénix power reactor, were built and are operated by CEA, with one exception, which is operated by the Laue-Langevin Institute.

French energy policy is defined by the government and is supervised by the Ministry for Ecolgy and Sustainable Development.

The government defines the general regulations applicable to nuclear activities by decree or by order. It takes the few major individual decisions required concerning major nuclear installations, including the plant and dismantling authorisations.

Regulation of nuclear safety and radiation protection by ASN is described in chapter 8.

3.2 Nuclear power plants

As all the fuel has been unloaded from the first generation of natural uranium graphite-moderated gas-cooled and heavy water power reactors, as well as from the first pressurised water reactor and from the Superphénix fast breeder reactor, they are not within the scope of this Convention.

The present nuclear power reactor fleet covered by the Convention comprises 58 pressurised water reactors (PWR), which were connected to the grid between 1977 and 1999 and are currently all in operation.

In 2006 the PWR reactors supplied approximately 80% of the electricity generated in France. They are located at 19 nuclear power plants (NPPs), which are generally similar. All have two to six reactors of the same type (pressurised water reactors), giving a total of 58 reactors, built by the same company, Framatome (now AREVA-NP). The following reactor series are usually identified (refer to the location map in appendix 1):

- thirty-four 900 MWe reactors:
  - the CP0 series, comprising the two reactors at Fessenheim and the four reactors at Le Bugey (units 2 to 5),
  - the CPY series, comprising the other 900 MWe reactors, subdivided into CP1 (18 reactors at Dampierre, Gravelines, le Blayais and Tricastin) and CP2 (10 reactors at Chinon, Cruas and Saint-Laurent-des-Eaux),
- twenty 1300 MWe reactors:
  - the P4 series, comprising eight reactors at Paluel, Flamanville and Saint-Alban,
  - the P'4 series, comprising 12 reactors at Belleville, Cattenom, Golfech, Nogent and Penly,
- the N4 series, comprising four 1450 MWe reactors: two at Chooz and two at Civaux.

In addition, in 2007 the construction of an EPR reactor was started at Flamanville.

Despite the overall standardisation of the French nuclear power reactor fleet, certain technological innovations were introduced as design and construction of the reactors proceeded.

The CPY series differs from the CP0 series (reactors at Le Bugey and Fessenheim) in building design and the addition of an intermediate cooling system between that used for containment spraying in the event of an accident and that containing river water.

The design of the 1300 Mwe reactor primary and secondary systems, core protection systems and plant buildings differs considerably from that of the CPY series. The power increase is matched by the addition of a fourth steam generator, providing greater cooling capacity than for the 900 MWe reactors equipped with three steam generators. Moreover, the reactor containment has a double concrete wall instead of the single wall with steel liner adopted for the 900 MWe series.

The P'4 series differs slightly from the P4 series, particularly with regard to the fuel building and the primary and secondary systems.

Finally, the N4 series differs from the previous series in the more compact steam generator design and the primary pump design, and in the computerised instrumentation and control system.

3.3 Nuclear research reactors

This report also describes the steps taken concerning the safety of research reactors, as they are subject to the same regulations as nuclear power reactors in France, even though they are not formally within the scope of this Convention.

There are 11 research reactors of various types in operation in France, with thermal powers ranging from 0.100 kWth to 350 kWth, commissioned between 1964 and 1978. The largest of them, the Phénix reactor, is a fast breeder reactor located at the CEA Valrhô centre in Marcoule. Designed for a thermal power of 563 MWth, it has been running at 350 MWth since 1993.

Nine of the other research reactors are operated by the CEA at its centres in Cadarache and Saclay. The Laue-Langevin Institute (ILL) High Flux Reactor (RHF) (refer to appendix A.3.3) is located near the CEA centre in Grenoble.

3.4 Regulatory framework

Before 1963, the safety of nuclear reactors, all of which were research reactors, was regulated by CEA.

In 1963, shortly before the commissioning of the first nuclear reactor designed for electricity generation, the decree which defined the organisation of nuclear safety regulation in France until 2006 was published. At the same time, an interministerial commission for BNIs was also established; this commission had to be consulted by the competent ministries on applications for the construction, modification or final shutdown of such installations.

A Central Nuclear Installations Safety was established in 1973; in 1991 it became the Nuclear installations Safety Service directorate. For civil nuclear installations, it was tasked with drafting regulations, monitoring their application, managing authorisation procedures and setting up an emergency response organisation in the event of incidents or accidents. In 1976, the CEA departments dealing with nuclear safety and radiation protection were merged into an Institute for Nuclear Safety and Protection, with a degree of autonomy within CEA, which acted as a technical support organisation for the nuclear safety authority.

In addition, a central department for protection against ionising radiation was set up in 1966; in 1994 it became the Office for Protection Against Ionising Radiation. It was tasked with performing all measurements, analyses and controls for determination of the amount of radioactivity or ionising radiation in various environments where their occurrence could present a hazard for the health of the public or workers, and with monitoring compliance with the regulatory requirements for radiation protection.

February 2002 saw the establishment of the General Directorate for Nuclear Safety and Radiation Protection which, with the support of the Nuclear Safety and Radiation Protection Divisions within the Regional Directorates for Industry, Research and the Environment, was responsible for nuclear safety and radiation protection. At the same time the former technical support organisations of the authorities for nuclear safety (IPSN) and radiation protection (OPRI) were merged into a single entity responsible for technical assessment and research: the Institute for Radiation Protection and Nuclear Safety (IRSN).

The act of 13 June 2006 on transparency and security in the nuclear field fundamentally recasts the legislative framework applicable to nuclear activities and their regulation. It sets out the fundamental principle of the prime responsibility of the licensee for the safety of its installation. It confirms that four major principles apply to nuclear activities: prevention, precaution, polluter pays, and public participation. It also reaffirms the major principles of radiation protection: justification, optimisation and limitation.

The act establishes a nuclear safety authority (ASN), an independent administrative authority with responsibility for regulating nuclear safety and radiation protection and informing the public in these areas. ASN is managed by a commission of five commissioners appointed for six-year terms; it reports to Parliament, to which it submits its annual report.

The French legislation is now among the most comprehensive in the world.

A. GENERAL PROVISIONS

4. Article 4: Implementing measures

Each Contracting Party shall take, within the framework of its national law, the legislative, regulatory and administrative measures and other steps necessary for implementing its obligations under this Convention.

This report presents the legislative, regulatory and administrative measures and other steps taken by France to implement its obligations under the Convention.

5. Article 5: Reporting

Each Contracting Party shall submit for review, prior to each meeting referred to in Article 20, a report on the measures it has taken to implement each of the obligations of this Convention.

This report is the fourth French report submitted for review in compliance with article 5 of the Convention.

6. Article 6: Existing nuclear installations

Each Contracting Party shall take the appropriate steps to ensure that the safety of nuclear installations existing at the time the Convention enters into force for that Contracting Party is reviewed as soon as possible. When necessary in the context of this Convention, the Contracting Party shall ensure that all reasonably practicable improvements are made as a matter of urgency to upgrade the safety of the nuclear installation. If such upgrading cannot be achieved, plans should be implemented to shut down the nuclear installation as soon as practically possible. The timing of the shut-down may take into account the whole energy context and possible alternatives as well as the social, environmental and economic impact.

6.1 Nuclear installations in France

The 58 pressurised water reactors (PWR) used to generate electricity, together with the EPR reactor under construction, lie at the heart of the nuclear industry in France. These reactors are all operated by a single licensee, *Électricité de France* (EDF). Another feature specific to France is the standardisation of the fleet, with a large number of technically similar reactors, justifying a “generic” presentation. One fast neutron reactor, used for research and producing electricity, is operated by CEA. Nine other research reactors are operated by CEA and one is operated by the Laue-Langevin Institute. A list of nuclear reactors in operation in France, both power reactors and research reactors, is given in Appendix 1, together with a map showing their locations.

The principles of the Convention have been applied to the safety of these installations since their design stage.

6.2 Safety assessments

Before a nuclear reactor is commissioned, ASN reviews all the safety assessments carried out by the licensee at the various stages of installation design, construction and pre-commissioning testing, in accordance with the regulations described in chapters 7 and 17 to 19. Moreover, in order to guarantee that safety is maintained or even improved, taking into account new knowledge, safety reassessments are regularly performed by the licensees of nuclear reactors, as is the case for all nuclear installations, at the request of ASN, as stipulated in the regulations in force in France (decree 63-1228 of December 11, 1963, article 5, section II). The safety reassessment process is described in chapter 14. The main safety improvements made to the nuclear reactors since France's previous report are summarised in the following paragraphs.

6.3 Main safety improvements to nuclear power plants

6.3.1 Main equipment/procedure modifications

The unit safety review process, based around periodic reviews or specific issues, leads in certain cases to unit modifications. Such modifications are generally grouped into batches, each batch initially being implemented in a lead unit, which serves as a prototype, before being rolled out to all units in the series concerned. Grouping modifications in this way allows more effective industrial-scale implementation by simplifying scheduling, document updating, operator training, etc. Batches of modifications are generally implemented during ten-yearly outages to minimize the impact on availability. The main projects during the period 2004-2006 concerned the thirty-four 900 MWe units (third ten-yearly outage) and the four 1450 MWe units (first ten-yearly outage).

6.3.1.1 Third ten-yearly outages of 900 MWe units (VD3 900)

The scope of the safety review for 900 MWe units was defined on the basis of national and international experience feedback, and comparison with the most recent reactor designs, including the EPR project. The aim of the third ten-yearly outages is to ensure that the units are able to continue operating up to a service lifetime of 40 years, while retaining the possibility, as a precaution, of extending unit lifetimes beyond 40 years when the time comes, subject to the implementation of appropriate provisions. In 2003, ASN validated the main lines of the review programme proposed by EDF, while also requesting some changes. In mid-2005, following a review of the topics of the safety review by the advisory committee for nuclear reactors (GPR), EDF presented the result of the verification studies and the list of modifications to be implemented (document changes, equipment modifications and operation modifications) to ASN. The main modifications resulting from the integration of the VD3 900 safety reference system include:

- enhanced seismic resistance (mainly concerns the Le Bugey plant);
- improved consideration of risks associated with explosive gases (principally hydrogen). Premises in which there is a risk of an explosive atmosphere have been fitted with hydrogen detectors and/or explosion-proof equipment;
- improved robustness of sites in respect of natural external hazards, mainly by enhancing the long-term reliability of emergency diesel generators;
- consideration of the risk of rapid draindown of spent fuel storage pools. The modifications to be implemented are aimed at increasing the time available for operators to return fuel assemblies in the process of being handled to a safe position (automatic shutdown of fuel pool pumps at low-low level, and measurement of draindown rate);
- improved management of severe accidents, notably by enhancing the reliability of the system for depressurizing the primary system using the pressuriser relief valves, even in case of severe accidents caused by a loss of electrical power supplies;
- a series of modifications aimed at reducing personnel radiation dosimetry, improving unit performance, and resolving issues of obsolescence of instrumentation and control (I&C) equipment in respect of the upgrading of certain equipment items that are unable to continue in service for 40 years.

6.3.1.2 Second ten-yearly outages of 1300 MWe units (VD2 1300)

The first VD2 1300 outage incorporating the review conclusions was that of Paluel 2 in 2005. Experience feedback from this lead unit enabled validation of the batch of modifications for the entire series.

6.3.1.3 First ten-yearly outages of 1450 Mwe (N4) units (VD1)

Given the recent approval of the reference system for 1450 MWe units, which dates from the start up of Civaux 2 in 2005, it was decided that the safety review would focus on bringing the 1450 Mwe series into conformity with changes in the reference system that have been introduced since unit connection, and which were not included in the initial safety analysis report.

The conclusions of the VD2 1300 and VD3 900 safety reviews that can be transposed to N4 units were also integrated into the 1450 Mwe safety review. Modifications are scheduled to be implemented in batches at Chooz B2, the lead unit, in March 2009. Roll-out to the remaining N4 units is planned to be completed by 2012.

6.3.1.3.1 Modifications specific to N4 plants

- Completion of equipment upgrades associated with qualification for post-accident environmental conditions.
- Improved reliability of primary pump trip under degraded environmental conditions, and seismic classification of the control rod drive mechanism (CRDM) cooling system.
- Integration of experience feedback from an equipment modification concerning the positioners and electro-pneumatic converters of atmospheric steam dump valves.
- Reduction of fuel damage probability by taking action in respect of sequences highlighted by probabilistic safety analyses.

6.3.1.3.2 Modifications implemented as a result of experience feedback from all reactor series

Modifications implemented with short lead times following events occurred in the NPP fleet include the following:

- in early 2006, modifications to all safety injection pumps and containment spray pumps to improve their resistance to vibrations in the long-term phases of accidents;
- the program of modifications to recirculation sump filters described in Section 2.3.7.

6.3.2 Protection against climate-related external hazards

Following the flooding of the Le Blayais site in December 1999, EDF embarked on an initiative aimed at re-assessing and protecting sites in respect of the risk of external flooding. This re-assessment was based on a specific analysis for each site, and encompasses the following:

- revision of the design-basis flood level[1];
- additional hazards that could lead to flooding of sites, such as heavy rain, failure of water storage tanks, rise in water table, etc.;
- reactor operation procedures, which take account of the work which will have been carried out to provide protection against a design-basis flood as well as other hazards.

[1] **Design-basis flood level:** This is the water level that must be taken into consideration for protection feature design capacity, depending on the site location. The design assumptions applied for the most part are a thousand-year flood plus 15% for riverside sites, and a tide coefficient of 120 combined with a 120-km/hour wind for coastal sites.

On the basis of these studies, EDF has defined additional protection features where necessary. This concerns three sites; studies are under way in respect of a further three sites (scheduled completion date: end of 2007).

The protection measures adopted for all sites are as follows: prevention of water ingress into below-ground structures (to be completed by the end of 2007), implementation of appropriate alert and operation procedures, and establishment of a local and national emergency response organisation.

The implementation of the methodology defined in 2001 as well as the adequacy of the protection measures were approved by the GPR on 21 and 22 March 2007. Additional provisions are currently under investigation with a view to integrating experience feedback from an incident of turbine hall flooding by the circulating water system at a plant.

In the summer of 2003, the whole of France experienced exceptionally high temperatures. A further period of hot weather occurred in summer 2006. These severe hot weather conditions led to high air temperatures, high heat-sink temperatures, and, toward the end of the summer, low watercourse flow rates. These parameters affect the performance of safety-related auxiliaries (ventilation systems and backup heat sink) and energy production auxiliaries (main generator, condenser), as well as impacting authorised thermal release conditions.

EDF initially implemented short-term corrective actions in late 2003 and in 2004 to deal with the most sensitive vulnerabilities identified during the summer 2003 severe hot weather period. These included the implementation of appropriate alert and operation procedures and establishment of a local and national emergency response organisation (at all sites), as well as equipment-related measures such as the use of additional chiller units (every year since 2004) and an increase in the heat-exchange capacity of backup heat sinks at the most sensitive sites.

In the longer term, the robustness of units in respect of high temperature conditions is the subject of a re-assessment along the same lines as that described above for external flooding risk. This involves compiling a safety reference system on the basis of a classification of hazards in light of changes in climatic conditions, followed by study of the additional protection measures required to enable installations to withstand these hazards. The re-assessment concerns all three reactor series, and is scheduled for completion by the end of 2008, to enable roll-out of measures to the sites from 2010.

6.3.3 Protection against seismic events

Changes in methods for considering seismic movements led to the initiation of a study programme encompassing all reactor series. The programme concluded that some civil engineering structures, as well as equipment at the Le Bugey plant, required reinforcement.

In addition, the safety rule relating to the aseismic design of civil engineering structures has been updated.

6.3.4 Environmental protection

The interministerial order of 31 December 1999, amended in January 2006, stipulates the general requirements to be met by BNIs as regards environmental protection. It supplements the texts specific to each installation on this subject (discharge licences and operating licenses for installations classified on environmental protection grounds on the sites).

More specifically, the order stipulates, in addition to general rules pertaining to incident and accident prevention (staff training, safety instructions, installation maintenance, etc.), objectives to be attained in areas such as fire protection, and protection against lightning, noise and accidental water pollution. Major work has been carried out on the installations, and all NPPs achieved compliance with the order by the deadline of 15 February 2006.

On a much broader level in terms of efforts to improve environmental performance, EDF embarked on an initiative to obtain ISO 14001 certification. The EDF Group was certified to ISO 14001 in April 2002, and all entities of EDF's Nuclear Power Generation Division have been certified since 2004. Certification was renewed in July 2006 (according to the 2004 version of the standard).

6.3.5 Fire protection

In terms of nuclear safety, EDF considers fire to be the most likely initiating event for a nuclear accident, in which it is no longer possible to cool the nuclear fuel, as a result of which core damage occurs.

As part of the investigations carried out in 1992 for changes to the fire protection process at operating PWR units, EDF embarked on an overall re-assessment of fire protection. This led to the compilation of a new design and operation reference system, after which work was carried out as part of the fire action plan (PAI) to bring the units into conformity with the new reference system. The key component of the plan is fire zoning of the premises. Its implementation was completed in late 2006 in all 900 Mwe and 1300 MWe units. The new reference system was incorporated into 1450 Mwe plants during construction.

In addition to this work, ASN also requested that, within the scope of the third ten-yearly safety review of 900 MWe reactors (and subsequently the 1300 MWe series), EDF make further improvements in fire protection of the reactors by identifying and correcting residual weaknesses through:

- use of the results of a probabilistic fire safety analysis to supplement the deterministic approach used up to now;
- re-evaluation of existing margins between the qualification of installed fire-barrier components and foreseeable fire durations in the premises.

Consideration of fire risk in plant design has thus been significantly enhanced at all nuclear sites. On the operational side, EDF additionally launched a robust programme of actions in 2004, with the following aims:

- strengthening fire prevention in operation, and developing a "fire prevention" culture at nuclear sites;
- boosting the effectiveness of firefighting by enhancing organisations, strengthening internal skills, and improving effective response by offsite emergency services, in order to provide an overall system that is sufficiently robust to cope with any kind of event. Effectiveness is assessed by ASN, in particular via an increased number of fire exercises carried out during inspections, in some cases unannounced;
- improving the reliability of fire detection, and preventing risks of obsolescence;
- enhancing the protection of the non-nuclear parts of installations.

All these provisions ensure compliance with the order of 31 December 1999, which applies specifically to BNIs. The order was amended in 2006 to take account of experience feedback from its application and provide a clearer specification of the content of fire risk studies.

6.3.6 Control of criticality risks

Experience feedback from cases in which a fuel assembly is placed in a position in the reactor that is not compliant with the core loading plan has led to the definition of procedures to limit the consequences of a possible error, such as "snake-mode" refuelling[2]. Additional monitoring provisions are also in place at the NPPs to reduce the risk of such errors.

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[2] **"Snake-mode" refueling:** involves loading the reactor core in successive alternate diagonals.

In June 2005, monitoring of uniform dilution in refuelling outage and maintenance outage conditions was reviewed. Provisions relating to the monitoring of boron concentration during refuelling outages were reinforced. New conditions for the use of source-range channels in CPY-series 900 Mwe PWRs were proposed in early 2007. The boron concentration inside the reactor under cold shutdown conditions with the core fully loaded has been increased, and new source-range channel threshold settings were introduced in October 2005.

An event that occurred in an individual reactor on reaching criticality for plant restart in October 2004 led EDF to rewrite operations procedures for achieving criticality. The associated training programme was also revised. Since September 2006, all EDF sites have used the same procedures, founded on best practice. The effectiveness of the new approach has been monitored during simulator training exercises and under real approach-to-criticality conditions.

Two further events that occurred in the second half of 2006 highlighted the difficulty of controlling very low power levels in the reactor during certain operating transients. In accordance with the recommendations of a letter sent to reactor licensees by WANO, an in-depth analysis was initiated in respect of the events concerned in early 2007, in order to learn any relevant lessons.

6.3.7 Safety of spent fuel storage

Changes in operating practices tend to increase the residual heat of fuel stored in the spent fuel decay pool, thereby reducing the time available for taking action in the event of total loss of cooling. This situation has led EDF and ASN to re-assess the safety of fuel storage in fuel buildings. The file submitted by EDF to ASN for approval covers the various problems associated with loss of cooling or loss of water inventory as a result of an incident, notably:

- the resistance of the various components the temperature and humidity conditions resulting from pool boiling, with verification of the possibility of restart following repair;
- the feasibility of supplying makeup water to the pool, taking account of access possibilities, to eliminate the possibility of fuel assembly uncovery;
- the ability to manage a situation involving rapid draindown of the pool.

This review led to the definition of modifications that have been integrated into the ten-yearly reviews.

6.4 Main safety improvements to nuclear research reactors

6.4.1 The Phénix reactor

Phénix is a prototype reactor built and operated by the French Atomic Energy Commission (CEA) in association with EDF, using the fast-neutron technology. It is sited at Marcoule (Gard). Its construction started in 1968 and it first went critical on 31 August 1973. Its design power is 563 MWth (250 MWe).

It has run for over 20 years, and in 1995 ASN requested that its safety status be generally reviewed. The safety reassessment included:

- carrying out significant renovation work, so that the installation could operate in future with enhanced levels of safety and availability;
- implementing technical solutions to reduce risks (sodium fire, pipework movement, mechanical re-sizing and seismic retrofit of the buildings);
- modifications to the systems after the safety analysis;

- carrying out non-destructive testing in the core, on the primary and secondary systems, to obtain the maximum amount of information about the behaviour and ageing of the structural components of the core and the various installation systems, and to estimate their impact on the reactor lifetime.

All the work has been monitored by ASN, and its technical support organisation has analysed all the documents presented.

After the positive conclusions of the advisory committee for nuclear reactors (GPR) in October 2002, in January 2003, ASN authorized the restart of operation at two-thirds of the rated power (563 MWth) for a period restricted to 720 Equivalent Full Power Days (EFPD).

In June 2003, the plant started its 51st operating cycle. Its experimental objective was to carry out, over a period of six cycles, an irradiation programme relating to experimental transmutation and nuclear waste management, and also to support research into future nuclear power plants.

The 54th irradiation cycle finished at the end of March 2007. Since 2003, around 30 experiments have been carried out in the reactor, each authorised by ASN.

Since 2003, the main safety improvements have been:

- major works to define fire zones and upgrade the ventilation in the buildings where irradiated assemblies are handled and dismantled;
- renewing the health care system.

6.4.2 The other research reactors

The other research reactors also undergo a safety review, in principle every ten years. Among the areas considered, the following three generic points are regularly discussed:

- the capacity of the installations to withstand earthquakes, given the significant scientific progress in this area over the last few decades, which have changed the consideration of this hazard for nuclear installations;
- installation ageing, particularly the ageing of electrical and electronic equipment, where replacement with modern technologies may pose compatibility and reliability problems. In general, ASN is particularly interested in installation ageing, and in ensuring that a licensee shuts down an installation definitively before it becomes too obsolete;
- human factors, particularly in areas relating to reactor operation and fuel handling. Changes to the core configuration of experimental reactors involve multiple fuel-handling operations.

The ISIS reactor at the Saclay Centre had an obsolescent command and control system, which between 2005 and 2006 was completely overhauled. ASN monitored all the work, from the installation of new equipment until the reactor went critical, and its technical support organisation analysed all the working papers presented by the licensee.

Information about the work undertaken at the other research reactors is also given in Chapter 14 relating to safety reassessments.

B. LEGISLATION AND REGULATION

7. Article 7: Legislative and regulatory framework

Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of nuclear installations.

The legislative and regulatory framework shall provide for:

- *i) the establishment of applicable national safety requirements and regulations,*
- *ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence,*
- *iii) a system of regulatory inspection and assessment of nuclear installations to ascertain compliance with applicable regulations and the terms of licences,*
- *iv) the enforcement of applicable regulations and of the terms of licences, including suspension, modification or revocation.*

7.1 Legislative and regulatory framework

The legislative base governing the safety of nuclear installations in France is the act of 13 June 2006 on transparency and security in the nuclear field, referred to as the "TSN act", which fundamentally recast the legal framework applicable to nuclear activities and their regulation. The act establishes a nuclear safety authority (ASN), an independent administrative authority with responsibility for regulating nuclear safety and radiation protection and informing the public in these areas. The act contains advances with regard to transparency. It draws on lessons learnt from the review of foreign legislations.

It should be remembered that in 2001 the government submitted the TSN bill to Parliament, and sent it to the Senate after the general election in 2002. At the beginning of 2006, at the request of the President of the Republic, the government introduced two new provisions into the bill: the establishment of ASN as an independent administrative authority and significant reinforcement of the instruments for regulating the safety of major nuclear installations. The TSN act was promulgated on 13 June 2006.

7.1.1 The major principles

The act confirms that the four main principles of environmental protection apply to nuclear activities: prevention, precaution, polluter-payer, and public participation. In this regard it reproduces the environmental Charter, which is now part of the constitutional *acquis*. It also reaffirms the major principles of radiation protection: justification, optimisation and limitation. It lays down the fundamental principle of the prime responsibility of the licensee for the safety of its installation, incorporated into international law, applicable on a day-to-day basis and essential to give each party, licensee and regulatory authority, a clear awareness of its responsibilities.

7.1.2 The establishment of ASN

The act confers the status of independent administrative authority on ASN, tasked by the State with the regulation of nuclear safety and radiation protection.

The government retains the power to define the general regulations applicable to nuclear activities by decree or by order. It takes the limited number of major individual decisions concerning large nuclear installations, including authorisation and dismantling decrees. The government is responsible for civil protection in the event of an emergency situation.

ASN is tasked with regulating nuclear activities, both in the large nuclear installations (BNIs) and the "small-scale" nuclear installations (in industrial facilities, research laboratories and medical facilities using ionising radiation) as well as the radioactive transport of substances.

ASN must be consulted on government draft regulatory decrees and orders and can clarify such regulatory texts by means of technical decisions. It takes individual decisions concerning nuclear activities (for example licences to commission a BNI, to use radioactive material transport packaging or to use a radioactive source); it defines individual requirements. It carries out inspections and can impose penalties, including suspension of the operation of an installation. It organises continuous monitoring for radiation protection (including monitoring of the environment and of worker exposure). It assists the government in emergency situations.

ASN has a responsibility to contribute to informing the public on nuclear safety and radiation protection.

7.1.3 Transparency regarding nuclear safety and radiation protection

The right of access to the information on nuclear safety and radiation protection held by the public authorities existed already in the French environment code. The act extends the requirement, introducing a right of access by the public to the information held by BNI licensees, by radioactive material transport managers and by holders of radioactive materials. This major innovation distinguishes nuclear activities from other industrial activities, which are not subject to such an obligation of transparency.

The act also requires BNI licensees to draw up an annual report describing the arrangements implemented for nuclear safety and radiation protection, the incidents and accidents notified to ASN, the nature and the results of the measurements of radioactive and non-radioactive releases from the installation, the nature and the quantity of radioactive waste stored on the site and the steps taken to limit their volume and effects on health and on the environment.

By giving them a legal basis, the act strengthens the local information committees (LICs) which have been established over the years for large nuclear installations, in application of a 1981 circular from the Prime Minister. It sanctions the involvement of local authorities, particularly the *département* councils (elected assemblies governing the 100 French *départements*), in their operation. It gives them the possibility of forming associations and ensures continuity of funding. It stipulates a federation of LICs to provide a base for the national association of local information committees.

The act institutes a High Committee for Transparency and Information on Nuclear Safety, superseding the High Council for Nuclear Safety and Information. The High Committee is a forum for debate and contributes to informing the public at national level. It has an open composition, and its members include members of Parliament, representatives of LICs, associations and trade unions and qualified public figures.

7.1.4 Recasting of the legislation on the safety of major nuclear installations and of the transport of radioactive materials

The act introduces an integrated system based on a broader conception of nuclear safety, covering accident prevention as well as protection of the health of persons and the environment.

It specifies the conditions applied to the delivery of the authorisation or dismantling decree for a BNI, placing appropriate emphasis on prevention and limitation measures in accordance with the environmental Charter. In particular, it acknowledges the fact that, in this area as in all others, there is no such thing as zero risk and that the purpose of the measures taken is to prevent and limit the risks given the current state of scientific and technical knowledge.

The act gives ASN the power to impose requirements on the licensee throughout the lifetime of the installation, including its dismantling, for example in order to request the correction of a nonconformity or to prevent a particular identified risk. It provides a legal basis for the periodic safety reviews and for the control of urban development around nuclear sites.

It establishes a nuclear safety inspectorate and upgrades the range of administrative and legal sanctions that can be applied to licensees in the case of deficiencies. Labour inspections in NPPs are undertaken by ASN personnel, under the authority of the minister for labour.

The act also strengthens the role of employees in risk prevention in BNIs (provision of information to health, safety and working conditions committees, association of contractors with these committees, etc.).

Several decrees implementing the 13 June 2006 act must be published. As a consequence, the previous texts that they supersede will be repealed. The main implementing decrees will cover:

- the procedures relating to BNIs and to the transport of radioactive substances;
- BNI nomenclature;
- the nuclear safety inspectorate (inspector appointment procedures, inspector approval and swearing-in);
- radiation protection and public health: regulation and oversight organisation (updating of the public health code);
- radiation protection in the working environment (updating of the labour code);
- nuclear accident inquiries;
- local information committees;
- the High Committee for Transparency and Information on Nuclear Safety (organisation and operation).

7.1.5 Repeal of previous texts

Act of 2 August 1961 on the control of atmospheric pollution and odours has been repealed by the act of 13 June 2006. However, the licenses and requirements relating to BNIs delivered pursuant to the act of 2 August 1961 or its implementing regulatory texts are equivalent to licenses and requirements as defined in the act of 13 June 2006. They are amended under the conditions laid down by this act and by its implementing texts.

Decree of 11 December 1963 on nuclear installations and decree of 4 May 1995 on liquid and gaseous effluent discharges and water intake by BNIs will be repealed by the decree on BNIs and the transport of radioactive substances, implementing the act of 13 June 2006.

7.2 Basic nuclear installation regulations

In addition to the generally applicable regulations such as those concerning radiation protection described in chapter 15 or those pertaining to labour law and environmental protection, BNIs are subjected to two particular types of regulations:

- licensing procedures;
- technical rules.

Facilities covered by regulations for installations classified on environmental protection grounds (ICPE) are required to comply with specific procedures when located within the perimeter of a BNI.

7.2.1 Licensing procedures

The unlicensed operation of a nuclear installation is prohibited by French legislation and regulations. In this context, BNIs are currently regulated by the act of 13 June 2006. Section IV of the act stipulates an authorisation procedure, followed by a series of licenses issued at the main stages marking the life of a BNI: construction, commissioning, any modification of the installation, final shutdown and dismantling.

A licensee who operates a plant either without having obtained the requisite licences or in breach of these licences lays itself open to legal or administrative sanctions, as stipulated in articles 41 to 52 of the act of 13 June 2006.

A detailed presentation of the procedures is given in Chapters 17 to 19.

7.2.2 Technical rules

This section covers the technical rules regarding nuclear safety, both regulatory and para-regulatory (circulars, basic safety rules (RFS), guides).

7.2.2.1 Ministerial and interministerial orders

7.2.2.1.1 Pressure vessels

BNIs comprise two types of pressure vessels: those which are specifically nuclear, in other words those which contain radioactive products, and conventional pressure vessels which are not specific to nuclear installations.

The applicable regulations are detailed in the table below.

<table>
<tr><th rowspan="2"></th><th colspan="3">Nuclear</th><th rowspan="2">Conventional</th></tr>
<tr><th>Main primary system of pressurised water reactors</th><th>Main secondary systems Of Pressurised water reactors</th><th>Other equipment</th></tr>
<tr><td>Construction</td><td>• Decree of 2 April 1926
• Order of 26 February 1974*</td><td>• Decree of 2 April 1926
• RFS II.3.8 of 8 June 1990*</td><td>• Decree of 2 April 1926
• Decree of 18 January 1943
or
• Decree 99-1046 of 13 December 1999</td><td rowspan="2">• Decree 99-1046 of 13 December 1999</td></tr>
<tr><td></td><td colspan="3">or Order of 12 December 2005</td></tr>
<tr><td>Operation</td><td colspan="2">• Order of 10 November 1999</td><td>• Decree of 2 April 1926
• Decree of 18 January 1943*</td><td>• Decree 99-1046 of 13 December 1999
• Order of 15 March 2000</td></tr>
</table>

* As of 2011, the order of 12 December 2005 will apply to the operation of nuclear pressure vessels, except for the main primary and secondary systems of pressurised water reactors.

7.2.2.1.2 Quality organisation

The order of 10 August 1984 concerning the quality of the design, construction and operation of BNIs ("quality order") specifies the steps to be taken by a BNI licensee for defining, obtaining and maintaining the quality of its installation and the operating conditions necessary to guarantee safety.

It thus stipulates that the licensee must define quality requirements for each activity concerned, employ the appropriate skills and methods for meeting these quality requirements and, finally, guarantee quality by checking compliance with these requirements.

It also specifies:

- that detected discrepancies and incidents be thoroughly corrected and that preventive action be taken;
- that suitable documents provide evidence of the results obtained;
- that the licensee supervise the subcontractors used and check the satisfactory operation of the organisation adopted to guarantee quality.

Experience feedback from incidents and accidents occurring in BNIs and inspection findings enable ASN to analyse the various problems and to assess the application of the order of 10 August 1984.

A draft revision of the quality order has been produced, aiming to bring it into line with the WENRA reference levels. This order will be replaced by one dealing with BNI safety policy and management. As part of the WENRA reference levels transcription process, five working groups have been drafting texts (order and guides) since the beginning of 2006 in the following areas: safety policy and management (all BNIs); safety approach; pressurised water reactor (PWR) design; PWR operations and emergency situations.

7.2.2.1.3 Prevention of off-site detrimental effects and risks resulting from BNI operation

BNI operation can entail detrimental effects and risks for the environment in the broadest sense, including the surrounding installations and their workers, but also the public and the environment off the site. ASN policy aims to prevent and limit the risks for installations by confirming the application of:

- the order of 31 December 1999 defining the general technical regulations designed to prevent and limit the off-site detrimental effects and risks resulting from operation of BNIs;
- ICPE legislation for installations of this type within the BNI perimeter.

The order by the ministers for the environment and industry of 31 December 1999, as amended by the order of 31 January 2006, defines the general technical regulations for preventing and limiting off-site detrimental effects and risks resulting from BNI operation, with the exception of water intake and effluent discharge. It introduces principles concerning waste management, prevention of accidental pollution, fire, lightning, criticality and radiolysis applicable to all nuclear equipment, including those situated outside the sensitive parts of the BNIs. Application of this text ensures that environmental protection concerns are taken into account by the licensees at a level comparable with that required for non-nuclear industrial installations.

7.2.2.2 The texts produced by ASN

7.2.2.2.1 Technical regulatory decisions

Pursuant to article 4.1 of the act of 13 June 2006, ASN can issue decisions to supplement the implementation procedures for the decrees and orders concerning nuclear safety or radiation protection, except for those dealing with occupational medicine.

The decisions require approval by the ministers responsible for nuclear safety when they concern nuclear safety, or by the ministers responsible for radiation protection when they concern radiation protection.

These ASN decisions are published in its Official Bulletin, available on line at its website.

7.2.2.2.2 Basic safety rules and ASN guides

ASN issues basic safety rules (RFS) on various technical subjects concerning both PWRs and other BNIs. These rules are recommendations defining the safety objectives and describing practices which ASN considers satisfactory for achieving the objectives.

They are not, strictly speaking, regulatory documents. A licensee may decide not to comply with the provisions of a basic safety rule, providing he can demonstrate that the safety objectives defined by the rule can be achieved by the alternative means which he proposes to implement.

7.2.2.3 French nuclear industry codes and standards

The nuclear industry produces detailed rules dealing with the state of the art and industrial practices. It compiles these rules in “industrial codes”. These rules allow concrete transposition of the requirements of the general technical regulations, while reflecting good industrial practice, thus facilitating contractual relations between customers and suppliers.

In the particular field of nuclear safety, the industrial codes used by the nuclear constructors and licensees are drafted by AFCEN, the French association for rules on design, construction and in-service monitoring of nuclear steam supply systems, of which EDF and AREVA-NP (formerly Framatome ANP) are members. The RCC (design and construction rule) codes were drafted for the design, manufacture and commissioning of electrical equipment (RCC-E, 4th edition), civil engineering structures (RCC-G) and mechanical equipment (RCC-M, 2000 edition). As of 1990, a code of mechanical equipment in-service monitoring rules (RSE-M) was drafted to deal with this subject.

Production of these documents is the responsibility of industry and not ASN, which nonetheless reviews them to ensure their conformity with the general technical regulations, in most cases leading to the drafting of a RFS, a guide or a decision recognising their overall acceptability on the date of the edition concerned.

In the field of nuclear pressure vessels, these requirements changed with the publication of the 12 December 2005 order implementing the 13 December 1999 decree on pressure vessels. The use of a code now depends on the demonstration of its conformity with the essential safety requirements defined in these texts. This provision thus enables the use of other construction codes to be envisaged.

With regard to the RCC-M code, AFCEN has undertaken a number of changes aimed to bring it into conformity with the previously mentioned requirements. ASN will review these changes.

The RSE-M code changed in October 2005, in particular to ensure conformity with the 10 November 1999 order concerning supervision of the operation of PWR reactor main primary and main secondary systems. ASN carried out an overall analysis of these changes. With regard to the most important changes, this analysis concluded that the 2005 version of this code is currently applicable. However, the analysis will continue in 2007 in order to issue a comprehensive ruling on all the changes presented.

7.3 Basic nuclear installation oversight

Regulatory oversight of nuclear activities is a fundamental task that enables ASN to verify that the licensee is assuming its responsibility fully and complying with the requirements of the regulations regarding radiation protection and nuclear safety in order to protect workers, patients, the public and the environment from nuclear-related risks.

Under the terms of article 4 of the act of 13 June 2006, ASN checks compliance with the general rules and the special requirements regarding nuclear safety and radiation protection applicable to:

- nuclear reactors;
- the construction and use of pressure vessels specifically designed for these installations.

In the case of BNIs, regulatory oversight by ASN encompasses environmental protection and, in NPPs, labour inspections.

Regulatory oversight by ASN is part of a multi-level approach and is carried out with the support of the Institute for Radiation Protection and Nuclear Safety (IRSN):

- before the licensee performs an activity requiring licensing, through a comprehensive review and analysis of files, documents and information provided by the licensee to back up its actions; this check aims to ensure that the information supplied is credible and complete with respect to the act;
- subsequently, through visits and inspections of all or part of an installation; this check uses the principle of spot checks and analysis of the supporting documentation provided by the licensee concerning the performance of its activities and the analysis of any deviations and incidents it has observed.

ASN's goal of ensuring effective, impartial, legitimate and credible oversight is expressed through its respect for the values of competence, independence, diligence and transparency. In order to reinforce the credibility and quality of its actions, ASN strives for continuous improvement of its regulatory practices by drawing on the experience gained from more than thirty years of nuclear safety inspections and from observation of the inspection methods of foreign safety authorities. The major consequences on ASN practice are outlined below.

- Like foreign safety authorities, ASN has defined a system of qualification for its inspectors, based on recognition of their technical competence. This system is now regulated by decree and was identified as a good practice in the report of the IRRS mission (IRRS: integrated regulatory review service; refer to section 8.1.3).
- ASN has adopted certain foreign practices identified through exchanges of inspectors between safety authorities, either for a particular inspection or for longer periods up to a 3-year assignment. For example, observing the benefits to be gained from conducting broader-based inspections, involving larger numbers of people for a longer time, ASN has adopted the review inspection model described in this chapter. Conversely, it has not opted for the system of inspectors resident on the nuclear sites: ASN considers that its inspectors must be in a structure large enough to allow experience to be shared and must take part in inspections of different licensees and installations. This also avoids any collusion with the licensee.
- ASN encourages its inspectors to be open-minded about other regulatory practices. It promotes professional careers encompassing other regulatory authorities (classified installations, SEVESO installations, AFSSAPS (French Health Products Safety Agency), etc.) and proposes the organisation of joint inspections with these authorities (labour inspectorate, inspectorate for installations classified on environmental protection grounds (ICPE)) of activities within the remit of ASN. In order to identify other methods of risk management by the licensees, ASN inspectors may also take part in inspections on specialised topics in installations which do not fall within its remit.

Although historically focused on verifying the technical conformity of installations and activities with regulations and standards, oversight now encompasses a broader dimension taking in human and organisational factors; it includes review of individual and collective behaviour, management, organisation and procedures, based on a variety of indicators, such as significant events, inspections or relations with the stakeholders (including personnel, licensees, contractors, trade unions, occupational physicians, inspectorates). This regulatory oversight does not relieve the licensee of the need to organise its own in-house supervision of its activities.

ASN aims to ensure that the principle of the licensee's prime responsibility for safety and radiation protection is respected. It applies the concept of proportionality when determining its actions, so that the scope and thoroughness of its oversight is commensurate with the issues in terms of nuclear, health and environmental safety. In this respect, it relies on current scientific and technical knowledge to assess the issues involved in the operations or activities concerned.

7.3.1 Scope of the regulatory oversight

7.3.1.1 Regulatory oversight of nuclear safety

BNI safety concerns all technical and organisational measures taken at all stages of the life of nuclear installations (design, construction, commissioning, operation, final shutdown, dismantling) to guarantee normal operation, prevent accidents and mitigate their effects in order to protect the workers, the public and the environment against the effects of ionising radiation. It also covers technical measures to optimise management of radioactive waste and discharges.

The regulatory oversight by ASN covers installation equipment, operators, working methods and organisation, from the start of the design process up to dismantling. ASN reviews the steps taken concerning safety and the procedures for waste management, effluent discharge monitoring and environmental protection.

7.3.1.2 Regulatory oversight of radiation protection

ASN ensures application within BNIs of the regulations regarding protection of persons against ionising radiation. In the same way as for nuclear safety, this work continues throughout the life of nuclear installations. It consists in ensuring that the licensee takes all measures for monitoring and limiting the doses received by the workers.

ASN checks compliance with these rules by examining specific cases and by dedicated inspections. In addition, the implementation of criteria common to all licensees for the notification of radiation protection events enables ASN to be better informed of any abnormal situations which have occurred.

7.3.1.3 Pressure vessels

A large number of nuclear installation systems contain or carry pressurised fluids and are consequently subjected to the pressure vessel regulations.

The act of 13 June 2006 stipulates that ASN regulates compliance with the general rules and special requirements concerning nuclear safety and radiation protection applicable to […] the construction and utilisation of BNI pressure vessels. Responsibility for checking the application of the regulations lies with ASN for nuclear pressure vessels containing radioactive products in BNIs, and with DARQSI (directorate for regional action, quality and industrial safety) at the ministry for Economy, Finance and Employment for other pressure vessels.

Of the BNI pressure vessels subject to ASN regulation and oversight, the main primary and secondary systems of EDF PWRs are particularly important. Since under normal conditions they operate at high temperature and pressure, their in-service behaviour is one of the keys to NPP safety. Consequently, ASN regulates these systems particularly closely.

The operation of pressure vessels is subject to regulatory oversight covering in particular in-service monitoring programmes, non-destructive testing, maintenance work, processing of non-conformities affecting the systems and periodic system requalification.

7.3.1.4 Working conditions in BNIs

Checking the application of all provisions relative to labour regulations (in particular working contracts, working hours, personnel representation, health and safety, arbitration and conciliation, in particular in the event of collective labour disputes, advice and information for employers, employees and personnel representatives concerning their rights and obligations) is the responsibility of the staff of the labour inspectorate.

In NPPs, regulatory oversight of nuclear safety, radiation protection and working conditions share a number of common concerns, particularly with regard to the organisation of worksites and the conditions governing the use of subcontractors. The legislator has therefore given labour inspector powers to engineers and technicians specifically designated for this purpose by ASN among the personnel under its authority.

In the other BNIs, such as research reactors, exchanges with conventional labour inspectors are a valuable source of information on the labour relations situation, in the context of a view of nuclear safety and radiation protection more attentive to the importance of people and organisations.

7.3.2 BNI oversight procedures

The licensee is required to provide ASN with the information necessary for its regulatory oversight. The volume and quality of this information must enable the technical demonstrations presented by the licensee to be analysed and the inspections to be targeted. The information must also allow identification and monitoring of the key events marking BNI operation.

When ASN regulatory oversight reveals breaches of compliance with safety requirements, penalties can be imposed on the licensees, if necessary after formal notice to comply. These penalties can include prohibition of restart or suspension of operation of a nuclear installation until corrective measures are taken.

7.3.2.1 Technical examination of licensee files

Review of the supporting documents produced by the licensees and technical meetings organised with BNI licensees or the manufacturers of equipment used in the installations are two types of ASN Regulatory action.

At the design and construction stages, ASN checks the safety reports describing and justifying the design principles, the equipment design calculations, the equipment utilisation and test rules, and the quality organisation set up by the prime contractor and its suppliers. ASN also regulates the manufacture of PWR main primary system (CPP) and main secondary system (CSP) equipment. Once the nuclear installation has started operating, all safety-related modifications made by the licensee are subject to ASN approval. In addition to meetings necessitated by changes in installations or their operating procedures, ASN requires the licensees to conduct periodic safety reviews, providing opportunities to reinforce safety requirements according to changes in techniques and policy and to experience feedback.

Examination of these files may lead ASN to accept or reject the licensee's proposals, or to ask for additional information, studies or works to ensure conformity. ASN's requirements take the form of an authorisation or a decision.

7.3.2.1.1 Evaluation of the information provided

The purpose of many of the files supplied by a BNI licensee is to demonstrate that the objectives set by the general technical regulations or those set by the licensee are respected. ASN checks both the completeness of the file and the quality of the demonstration.

Whenever it considers it necessary, ASN requests an opinion from its technical support organisations, the most important of which is IRSN (Institute for Radiation Protection and Nuclear Safety). Safety assessment involves the collaboration of many specialists and effective coordination in order to identify the essential safety issues. The IRSN assessment relies on research and development programmes and studies focused on risk prevention and improved comprehension of accidents. It is also based on in-depth technical exchanges with the licensee teams responsible for designing and operating the installations.

For major issues, ASN requests the opinion of the competent advisory committee, to which IRSN presents its analyses. For other matters, safety analyses are summarised in IRSN opinions transmitted directly to ASN.

7.3.2.1.2 Main areas concerned

NUCLEAR POWER PLANT SCHEDULED OUTAGES

Nuclear power plants are periodically shut down for refuelling and for maintenance of their main components.

Given the importance for safety of the maintenance work done during the outage and the safety risks of certain outage situations, ASN requires detailed information from the licensee. This information mainly concerns the work programme and any incidents occurring during the outage. During on-site inspections, the inspectors carry out spot checks on the conditions under which the various works in progress are conducted, whether for repair or modification of the installations, in-service monitoring of equipment or periodic equipment testing. Approval of the outage programme is the responsibility of ASN.

OTHER INFORMATION SUBMITTED BY THE LICENSEES

- The licensee submits periodic activity reports and summary reports on water intake, liquid and gaseous discharges and the waste produced.
- Similarly, there is a considerable volume of information on specific topics, such as the installation's seismic behaviour, fire protection, PWR fuel management and relations with subcontractors.

7.3.2.2 Internal authorisations

ASN strives to regulate nuclear safety and radiation protection as effectively as possible.

Expansion of the scope of regulation by ASN in recent years, in particular the inclusion of regulation of radiation protection in local nuclear activities, is not without risks: ASN could make implementation of all nuclear activities subject to the granting of licences that it would deliver, without consideration of the overall picture and prejudicial to the overall effectiveness of ASN. Furthermore, regulatory oversight has an influence on the level of responsibility of persons carrying on nuclear activities. Inspectors are sometimes incorrectly seen as an ultimate line of defence, for example through their close reading of the safety files.

For these two reasons — performance of its actions (commensurate with the stakes) and licensee empowerment — ASN is developing an approach in which certain decisions are devolved to the licensee. The licensees may, on the basis of an opinion from an internal commission independent of the operators concerned, themselves take decisions, previously the preserve of ASN, provided they do not compromise the safety assumptions adopted for operation or dismantling of the installations.

These internal authorisations must be planned. The agenda is transmitted to ASN sufficiently in advance for ASN to check that the envisaged decisions do indeed correspond to internal authorisations. Once taken, they are declared to ASN, which may then decide to inspect their implementation. By means of dedicated inspections, ASN also ensures the quality of the internal opinions given and assesses the independence of the commission. The licensees must ask ASN for authorisation to implement decisions which may compromise the safety assumptions or the safety demonstration.

This approach enables ASN to concentrate its efforts on the changes which could have the greatest impact on the safety of the installations, while empowering the licensee in its choices. It also gives greater value to the inspection, as a licence application, formerly assessed beforehand by ASN, becomes an internal decision, checked subsequently by ASN.

7.3.2.3 Use of experience feedback

A system of nonconformity notification by BNI licensees has been set up in accordance with the order of 10 August 1984 on the quality of design, construction and operation of BNIs. The order requires that the licensee implement a reliable system for detecting possible anomalies, such as equipment failures or errors in application of operating rules. This system must allow early detection of any excursion from the normal operating range.

The purpose of analysing the events detected in an installation or during a transport operation is:

- to ensure that an event which has already occurred will not be repeated, by taking account of appropriate corrective measures;
- to prevent occurrence of an aggravated situation, by analysing the potential consequences of precursor events;
- to promote good practices thus improving safety.

To give an order of magnitude, between 100 and 300 anomalies are detected and analysed by EDF every year for each reactor.

The classification of these events must ensure that the more important ones are given priority treatment. For this purpose, and for all the BNIs, ASN has defined a category of “significant events”. These are events that are sufficiently important in terms of safety to justify rapid ASN notification, followed by a subsequent and more complete report. This report should contain the conclusions drawn by the licensee from analysis of the events and the measures it is taking to improve safety. This information is extremely valuable for ASN and its technical support organisation IRSN, in particular for the periodic safety reviews of installations. An average of about ten significant events are declared every year for an EDF reactor.

ASN ensures that the licensee has carried out a pertinent analysis of the event and taken appropriate steps to remedy the situation, prevent recurrence and ensure that experience feedback is circulated to the nuclear licensees.

On the basis of twenty years' experience, ASN considered that it would be useful to transpose this concept from the safety field to radiation protection and environmental protection. For this purpose, ASN has updated the principles defined in the 1980s for safety and extended them to radiation protection. The guide, published on 21 October 2005 and accessible on the ASN website, contains all the provisions applicable to licensees and transport operators with regard to procedures for notification of significant events affecting BNI safety, the transport of radioactive material, radiation protection and environmental protection.

This notification system aims at acquiring experience feedback. Notification of significant events should not be considered as covering radiological emergencies, for which a different organisation is established, or as a system intended to penalise errors by the licensee or by an individual.

7.3.2.4 ASN decisions

ASN decisions are positions which it considers to be of particular importance and which are intended to be made public. Their purpose is to close an issue or at least a stage. They are the result of a technical review of the available information and expert assessments. These decisions must be not only technically relevant, but also understandable by stakeholders: elected representatives, media, associations, foreign nuclear safety authorities, etc.

Technical dialogue between ASN and the licensees is a key factor in the preparation of ASN decisions: the arguments must be complete and exhaustive. When all the arguments have been presented, the regulatory authority makes the decisions.

Ensuing actions include the following:

- granting or refusal of the requested licence;
- requests for information or additional undertakings on the part of the licensee;
- requests that certain work or tests be carried out;
- partial or complete, temporary or final shutdown of the installation;.

It must be emphasised that ASN has the power to suspend installation operation on safety grounds. This is not a frequent practice, but the capacity to shut down an installation is a vital element in the effectiveness of ASN. Every year, several PWR maintenance and refuelling outages are in fact extended owing to additional checks or justifications required by ASN.

To improve the legibility of its action, on 17 July 2000 ASN introduced a formal system for its decisions. They are made public, including by publication on line on the ASN website. When a particular site is concerned, the local information committee (LIC) is informed.

The application of ASN decisions and requests gives rise to checks, in particular by inspections.

The ASN technical decisions stipulated by the act of 13 June 2006 supersede these decisions, which did not have a genuine regulatory basis.

7.3.2.5 INSPECTION

7.3.2.5.1 Principles and objectives

Compliance with the safety reference system by the nuclear licensees is verified by spot inspections in order to check effective implementation of the provisions concerning safety, radiation protection and the related fields regulated by ASN (waste management, effluent discharges, prevention of non-nuclear hazards).

ASN inspection consists in checking that the licensee complies with the provisions that it is required to apply. Without being systematic or exhaustive, its purpose is to detect individual anomalies together with any drift suggesting possible deterioration of installation safety.

These inspections give rise to factual records, made available to the licensee, concerning:

- anomalies in the installation or points requiring further justification in the opinion of the inspectors;
- deviations between the situation observed during the inspection and the regulatory texts or the documents produced by the licensee pursuant to the regulations.

ASN draws up an annual programme of inspections. This programme is not communicated to nuclear installation licensees. It is produced using a methodical approach enabling the technical areas inspected at fixed intervals to be supplemented by topical subjects on which ASN wishes to obtain a more comprehensive picture. It aims to ensure appropriate distribution of ASN resources commensurate to the issues involved in the various installations.

The inspections are either announced to the licensee a few weeks beforehand or unannounced. They are conducted mainly on the nuclear sites. They may also concern the corporate offices (or design offices) of the major nuclear licensees, the workshops or design offices of the subcontractors, the construction sites, or the factories or workshops manufacturing the various safety-related components.

Inspections are usually performed by two inspectors, one of whom directs the operations, with the assistance of an IRSN representative specialised in the installation to be inspected or the technical topic of the inspection. ASN conducts various types of inspection:

- routine inspections;
- reinforced inspections, on topics involving particular technical difficulties and normally directed by senior inspectors;
- review inspections, scheduled over several days and requiring a full team of inspectors, for the purpose of in-depth reviews;
- inspections including sampling and measurements, aimed at spot checking discharge levels independently of licensee measurements;
- reactive inspections, carried out further to a particularly significant event;
- worksite inspections, ensuring a significant ASN presence on the sites on the occasion of PWR unit outages or particular works, especially in the dismantling phase.

7.3.2.5.2 Inspection activities in 2006

In 2006, 733 inspections were conducted, of which more than 400 on power reactors (refer to section 7.3.3.1).

7.3.3 ASN organisation for BNI oversight

All of the nuclear safety regulatory oversight tasks are distributed within ASN between central services and the regional divisions. The regional divisions are responsible for oversight in the field: in permanent contact with the nuclear licensees, they manage most of the inspections carried out on the nuclear sites and, in the case of PWRs, monitor the maintenance and refuelling outages, on completion of which ASN must decide whether to approve the restart of the installation. They are also tasked with examining certain licence or waiver applications. ASN central services coordinate and supervise the regional divisions in these areas, deal with matters of national importance, and define and implement national nuclear safety policy.

7.3.3.1 Nuclear safety inspectorate

The nuclear safety inspectors (previously known as BNI inspectors) are ASN engineers designated by decision of ASN. They carry out their regulatory oversight duties under the authority of ASN's Director General. They are sworn-in and bound by professional privilege.

On 31 December 2006, the number of active nuclear safety inspectors stood at 151, including 80 in the regional divisions and 71 at central services.

Number of inspections conducted by ASN

Year	Total	Unannounced inspections	Reactors (announced and unannounced)
2004	757	215	374
2005	724	192	414
2006	733	195	417

7.3.3.2 Regulatory oversight during PWR outages

EDF takes advantage of refuelling outages to inspect all installations and verify their condition by carrying out checks. These operations, which are particularly important as indicators of the current condition of installations, are closely followed by ASN, particularly in the course of worksite inspections, when the inspectors spot-check the conditions under which the various works are carried out, whether these concern plant repair or modification, equipment in-service inspection or periodic equipment testing.

7.3.3.3 Regulatory oversight for pressure vessels

The act of 13 June 2006 requires ASN to designate certain personnel as responsible for verifying compliance with the regulations concerning pressure vessels designed specifically for BNIs. A decree must clarify the procedures for designating these personnel.

ASN nuclear pressure equipment department (DEP) is responsible for watching the application of the nuclear pressure vessel regulations, including for PWR main primary and secondary systems.

This department has direct responsibility for oversight of the design and manufacture of the main primary and secondary systems (CPP and CSP). Oversight for the design and manufacture of the other nuclear pressure vessels is performed by organisations approved and monitored by ASN.

Oversight of the operation of nuclear pressure vessels is the responsibility of ASN’s regional divisions, with the support of DEP.

7.3.3.4 Significant events

The ASN regional divisions are responsible for immediate analysis of significant events in order to check that immediate corrective steps have been taken and, if needed, prepare the necessary information for the public. The ASN departments coordinate the action of the regional divisions in this area, and provide training each year for the engineers concerned.

The analysis of a significant event covers compliance with the rules in force concerning detection and notification of significant events, the immediate technical steps taken by the licensee to keep the installation in or bring it to a safe condition and, finally, the relevance of the significant event reports provided by the licensee.

ASN and its technical support organisation IRSN carry out a subsequent review of the feedback from the events. The information received from the regional divisions and the analysis of significant event reports and periodic records communicated by the licensees form the basis of the ASN organisation for experience feedback. This feedback is taken into account for the periodic safety reviews of installations, and may lead to requests for improvement of installations or of the organisation set up by the licensee.

7.3.4 Penalties

The act of 13 June 2006 set up an infringement system based on:

- a scale of administrative penalties defined in articles 41 to 44 of the act:
  - formal notice to regularise the administrative situation or meet certain conditions placed on the licensee of an installation or on the person responsible for transport, within a specified time-frame;
  - suspension of installation operation or of performance of the unauthorised operation;
  - in the event of failure to comply with a formal notice, deposition with a public accountant of a sum covering the cost of the work to be done;
  - after deposition, completion of the work at the expense of the person served with formal notice.

  The licensee is asked to submit its observations concerning these penalties.
- Legal penalties defined in articles 48 to 51 of the act: in the event of conviction of an offence, natural persons are liable to fines up to €150,000 and to imprisonment up to 3 years; legal entities can be declared penally responsible and are liable to fines up to €1.5 million.

ASN must define the procedures for application of these new instruments.

8. Article 8: Regulatory body

1. *Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 7, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.*
2. *Each Contracting Party shall take the appropriate steps to ensure an effective separation between the functions of the regulatory body and those of any other body or organisation concerned with the promotion or utilisation of nuclear energy.*

In France, regulation and oversight of nuclear safety and radiation protection are primarily the responsibility of three bodies: Parliament, the government and ASN. Article 4 of the act of 13 June 2006 on transparency and security in the nuclear field lists the respective duties of the government and ASN.

8.1 The Nuclear Safety Authority (ASN)

The act of 13 June 2006 establishes an independent administrative authority, the nuclear safety authority (ASN), tasked with the regulation and oversight of nuclear safety and radiation protection. ASN prepares draft regulatory texts on behalf of the government and clarifies the regulations through technical decisions. It issues certain individual licences and proposes others to the government. The nuclear safety and radiation protection inspectors at ASN monitor and regulate nuclear activities. Finally, ASN contributes to informing the citizens. From a technical viewpoint, ASN relies on the expertise provided by IRSN (Institute for Radiation Protection and Nuclear Safety) and advisory committees.

In more detail:

- ASN is consulted on draft decrees and ministerial orders of a regulatory nature dealing with nuclear safety.

  It can take regulatory decisions of a technical nature to supplement the implementing procedures for decrees and orders adopted in the areas of nuclear safety or radiation protection, except for those relating to occupational medicine. Decisions related to nuclear safety are subject to the approval of the ministers with responsibility for nuclear safety and decisions related to radiation protection are subject to the approval of the ministers with responsibility for radiation protection. Approval orders and approved decisions are published in the *Journal officiel* (official gazette).
- ASN examines BNI initial and dismantling authorisation applications and makes proposals to the government concerning the decrees to be issued in these areas. It defines the requirements applicable to these installations with regard to the prevention of risks, pollution and detrimental effects. It authorises commissioning of these installations and pronounces their delicensing following dismantling.

  Some of these ASN decisions require approval by the ministers responsible for nuclear safety.

  ASN also issues the licenses for small-scale nuclear facilities provided for by the Public Health Code.
- ASN verifies compliance with the general rules and specific requirements for nuclear safety and radiation protection applicable to BNIs, the construction and use of pressure vessels designed specifically for such installations, the transport of radioactive substances, and nuclear activities outside BNIs. ASN organises a permanent watch in the radiation protection sphere covering the entire country.

From among its own staff, it appoints nuclear safety inspectors, radiation protection inspectors and officers responsible for verifying compliance with pressure vessel requirements. It issues the required approvals to the organisations participating in the verifications and monitoring concerning nuclear safety or radiation protection.

- ASN is associated with the management of radiological emergencies resulting from events liable to harm human health and the environment by exposure to ionising radiation and occurring in France or likely to affect French territory. It provides the competent authorities with its technical assistance in drawing up measures within the emergency response organisation plans which take account of the risks arising from nuclear activities.
- ASN participates in informing the public in its areas of competence. It drafts information documents that are as simple and complete as possible and accessible to the broadest readership, and reports regularly on its activity. For this purpose its uses a range of channels, including written media (*Contrôle* magazine, annual report), website (www.asn.fr), public information and documentation centre, press conferences, seminars and touring exhibitions at national and regional level.

8.1.1 Organisation

8.1.1.1 The ASN Commission

ASN is managed by a Commission consisting of five commissioners appointed by decree on account of their competence in the fields of nuclear safety and radiation protection. Three of the commissioners, including the Chairman, are appointed by the French President. The other two commissioners are appointed by the president of the National Assembly (lower house of the French Parliament) and by the president of the Senate (upper house), respectively.

The ASN commissioners exercise their functions on a full-time basis.

Once they are appointed, the commissioners draw up a declaration of the interests they hold or which they have held during the previous five years in the areas within the competence of the authority. During the course of his or her mandate, no member may hold any interest such as to affect his or her independence or impartiality. For the duration of their functions, the commissioners will express no personal views in public on subjects within the competence of the authority.

The mandate of the members is for a non-renewable period of six years. A member's term of office may only be terminated in the event of impediment or resignation duly noted by a majority of the commissioners. The French President may also terminate the service of a member of the Commission in the event of a serious failure to meet his or her obligations.

The commission takes the major decisions: it communicates to the government the requested opinions on draft decrees and orders, it takes technical regulatory decisions and grants individual authorisations, it draws up the annual report on nuclear safety and radiation protection in France, and it communicates opinions to the National Assembly or to the Senate. The commission defines the general policy of ASN with regard to its strategic plan, human resources, budget and national and international external relations.

8.1.1.2 ASN central services

The Director General of ASN, under the authority of the Chairman, organises and runs the ASN central services and its eleven regional divisions.

The ASN central services departments are tasked with producing the general technical regulations and coordinating the work of the regional teams responsible for regulatory oversight in the field of installations and activities. Each ASN entity contributes, in its own area of competence, to informing the public on nuclear safety and radiation radioprotection.

8.1.1.3 Regional representatives and ASN divisions

The ASN regional divisions operate under the authority of the regional representatives, appointed by the ASN Chairman. The divisions carry out most of the direct regulatory oversight of BNIs, transport of radioactive materials and small-scale nuclear activities. They examine most of the licence applications submitted concerning these activities. They support the ASN central services in their examination of major decisions. In emergencies they assist the prefect of the *département*, responsible for the protection of the population. Finally, the regional representatives represent the ASN Chairman in the regions. With the support of the divisions, they contribute to the ASN's public information task.

8.1.2 ASN operation

8.1.2.1 Human resources

The total workforce of ASN as of 31 December 2006 was 412 persons, half based in central services and half in the regional divisions.

The first meeting of the ASN Commission took place on 13 November 2006. On this date, as stipulated by the act of 13 June 2006, ASN was legally established and all the personnel of the DGSNR (General Directorate for Nuclear Safety and Radiation Protection) and of the nuclear safety and radiation protection divisions of the DRIREs (Regional Directorates for Industry, Research and the Environment) were assigned to the new ASN.

As of 31 December 2006, the average age of the ASN staff was 40 years and 3 months, with 64% (264) of them being under 45. This well-balanced age pyramid enables ASN to carry out active regulation of nuclear safety and radiation protection, avoiding the pitfalls of habit and routine, while favouring the mentoring of younger staff and the transmission of knowledge.

Competence is one of the four key values of ASN. Mentoring, together with initial and continuous training, whether general, related to nuclear techniques, legal or in communication, are key factors in its professionalism. Staff must follow a formal technical training curriculum, according to a detailed and regularly updated training reference system. In 2006, 3,861 days of technical training were given to ASN staff on 68 different training courses. The financial cost of the courses, provided by organisations other than ASN, amounted to €523,000.

8.1.2.2 Financial resources

Since 2000, all the personnel and operating resources involved in the performance of the tasks entrusted to ASN have been covered by the State's general budget. The full-cost budget of ASN for 2007 is approximately €54 million, including €32.4 million for personnel costs.

As stipulated in the act of 13 June 2006, ASN relies on IRSN for technical expertise, backed up whenever necessary by research. The budget for this work amounts to €71 million in 2007, out of a total budget of €247 million.

The ASN Chairman is responsible for notification and assessment of the tax on BNIs, on behalf of the State. The revenue from this tax amounted to €358.7 million in 2006. It is paid into the general budget of the State. To encourage rapid dismantling of nuclear installations, a rate of this tax reduced by 50% has been introduced for installations after final shutdown and undergoing dismantling. The tax is no longer due when the delicensing of the installation has been pronounced.

Licensee	BNI TAX for 2006 in thousands of euros
EDF	320,748
CEA	8,082
Others	29,850
TOTAL	**358,680**

The act of 28 June 2006 on the sustainable management of radioactive materials and waste introduced three taxes, in addition to the BNI tax, on nuclear reactors and spent nuclear fuel reprocessing plants, known as the "research", "support" and "technological dissemination" taxes respectively. They are allocated to the funding of economic development measures and of ANDRA research on underground disposal and interim storage. For 2007, the expected revenue from these new taxes amounts to €150 million.

8.1.2.3 Internal communication and information system

The ASN Intranet, Oasis, is the main vector for ASN internal information, with all the documents and information needed by the staff on a day-to-day basis, plus news and the daily press review. Oasis is also the interface for the ASN information system: some ten specific applications accessible to all ASN staff organise, harmonise and maintain information concerning the main processes within ASN.

8.1.2.4 Quality management system

To guarantee and improve the quality and effectiveness of its actions, ASN defines and implements a quality management system inspired by IAEA and ISO international standards and based on:

- action plans setting ASN objectives and annual priorities, adjusted during the course of the year by exchanges between entities (discussions, periodic meetings, internal memos, etc.);
- organisation memos and procedures, gradually structured and compiled to form an organisation manual, defining the ASN internal rules for the correct performance of each of its tasks;
- internal and external audits and context, activity and performance indicators for supervising and improving the quality and effectiveness of ASN actions;
- listening to the needs of stakeholders (the public, elected representatives, associations, media, trade unions, industry) within the framework of regulatory procedures (public inquiry) or in less formal contexts (qualitative opinion studies, hearings, internal consultations, etc).

8.1.3 The IRRS audit of the ASN in 2006

Further to an ASN request submitted in 2005, an Integrated Regulatory Review Service (IRRS) audit mission, directed by IAEA, was conducted in France from 5 to 17 November 2006. This was the first -ever full-scope audit, concerning all the areas of nuclear safety and radiation protection covered by IRRS missions. In addition to the topics normally dealt with by IRRS missions, ASN had also requested that the experts review its public information organisation and practices, so that all ASN tasks were covered.

The auditors thus reviewed all of ASN's areas of activity: nuclear reactors, research installations, medical sector, radiation protection of workers, etc., in each of its duties: regulation, oversight and information. The only special feature was that, as ASN underwent a TransSAS audit in 2004, the part of the IRRS audit concerning the transport of radioactive materials was devoted to follow-up of the implementation of the action plan in response to the TranSAS audit.

The IRRS audit of ASN was conducted by a team of 16 peers from nuclear safety authorities of other countries, coordinated by six IAEA experts. In addition, two foreign observers observed the audit process in order to learn lessons for a future audit of the same type in their own country. In teams of two or three experts, the auditors were able to examine all areas of ASN activity and review all ASN practices. The audit included conference room presentations and interviews with personnel of ASN and its technical support organisations. It also included appraisals of ASN organisation and practices at national and regional levels. In order to gain maximum benefit from this mission, ASN made sure that the experts were able to conduct their investigations freely in an open and frank context. Auditors accompanied ASN inspectors in their oversight work in the field, including inspections, technical meetings and emergency management exercises.

The IRRS audit was written up in a report published in full on the ASN website www.asn.fr. The report lists the recommendations, suggestions and good practices identified by the IRRS mission experts. Recommendations concern deviations from the requirements of IAEA standards and must be acted upon. Suggestions are guidelines for improving the effectiveness of the audited authority. Good practices are flagged for the attention of other authorities who study the report. ASN will strive to disseminate these good practices.

The audit concluded that ASN was well positioned with regard to best international practices in nuclear safety and radiation protection. In particular, ASN practices regarding inspection, emergency preparedness, public information and international action constitute a benchmark. The experts also gave a favourable judgement on the ASN response to the conclusions of the TranSAS audit. ASN will strive to ensure sustainability of all the good practices identified during this audit.

The areas for improvement identified and recorded in the mission report include the preparation of procedures for enforcement of the new sanctions stipulated by the act of 13 June 2006 (fines, formal notices, installation shutdown decisions, etc.), better formalisation of ASN internal practices and further work on management of the consequences of nuclear accidents.

To take account of the recommendations and suggestions highlighted by the IRRS mission, ASN has developed and implemented an action plan to guarantee full conformity of its practices and organisation with best international standards. A follow-up mission will be organised by the IAEA in two years' time to assess the progress in implementing the action plan.

ASN had three objectives when it requested this IRRS mission.

First, it wanted to undergo a frank and open external assessment by its peers in order to make sure that its organisation and practices comply with international standards, fully implementing the recommendations made at the end of the audit to improve its effectiveness and the relevance of its work.

Second, it wanted to present a number of its practices to its peers, in particular those that it considers go beyond IAEA recommendations such as those mentioned above.

Third, ASN hoped to trigger a general trend so that over the next few years all large safety authorities would also request IRRS audits. This appears to be the case. Several IRRS missions are already scheduled for 2007 and 2008, one of which headed by the ASN Chairman. This international approach should lead to beneficial mutual comparison of safety authorities and thus to "upwards" harmonisation of nuclear safety and radiation protection organisations and practices, with a view to making progress in these areas. ASN considers that it has achieved these three objectives.

8.1.4 ASN technical support organisations

ASN relies on the expertise of technical support organisations (TSO) when preparing its decisions. IRSN (Institute for Radiation Protection and Nuclear Safety) is the main TSO. For a number of years now, ASN has also been following a policy of technical support provider diversification, both nationally and internationally.

8.1.4.1 Institute for radiation protection and nuclear safety (IRSN)

IRSN was set up as an independent public establishment as part of the national reorganisation of the regulation of nuclear safety and radiation protection, in order to consolidate public expertise and research resources in these fields.

The institute conducts and implements research programmes designed to base the national public expert assessment capacity on the most advanced international scientific knowledge in these fields, and to contribute to developing scientific knowledge on nuclear and radiological hazards. It is tasked with a technical support mission to the competent public authorities on nuclear safety, security and radiation protection in both civil and defence fields. The decree that established IRSN gives it certain public service tasks outside the research domain, in particular regarding the monitoring of the environment and of persons exposed to ionising radiation. In particular, these tasks include radiation protection training, management of national databases (national nuclear materials inventory, national radioactive sources file, SISERI file on worker exposure to ionising radiation, etc.) as well as helping to inform the public on hazards linked to ionising radiation.

IRSN has developed a quality approach based on the ISO 9000 standards to ensure constant quality of its expertise. The opinion of ASN is taken into account for continuous improvement of the opinions that IRSN delivers to ASN. Periodic meetings are also scheduled for discussions between ASN and IRSN on completed, current and future assessment work.

ASN is consulted by the government on the amount of the State grant to IRSN corresponding to the institute’s task of technical support for ASN. An agreement between ASN and IRSN governs the procedures for calling upon this technical support.

8.1.4.2 Advisory committees

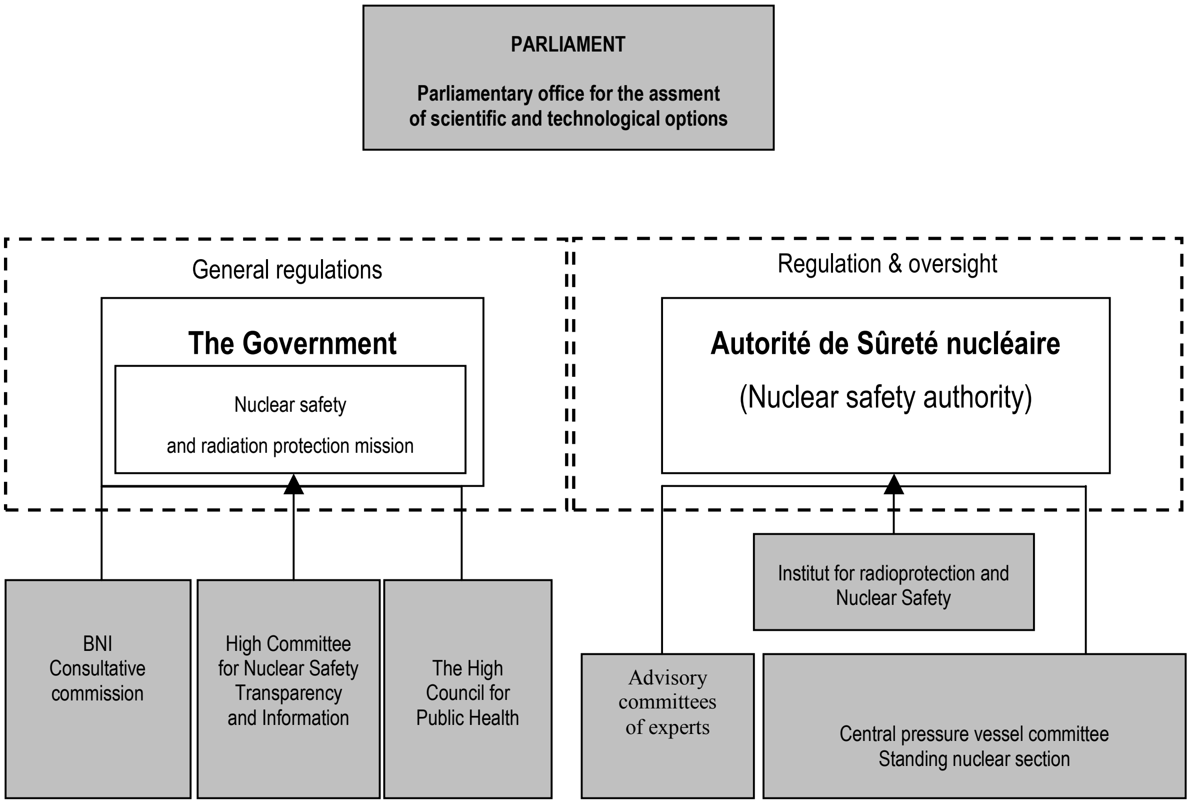
When preparing its decisions, ASN relies on opinions and recommendations from advisory committees of experts and the standing nuclear section of the central committee for pressure vessels.

Four advisory committees (GPE) of experts and civil servants reporting to the ASN Director General have been set up by decision of the ASN Chairman. They analyse the safety-related technical problems raised by initial authorisation, commissioning, operation and shutdown of nuclear facilities and their auxiliaries and the transport of radioactive materials.

Each GPE may call on any person recognised for his or her particular competence. It can hold hearings of licensee representatives. Participation of foreign experts can help diversify the approach to problems and take greater advantage of experience acquired internationally.

ASN is currently forming two new advisory committees on issues relating to radiation protection; one of them focuses more particularly on patient protection issues.

The scheduling and results of the work of the advisory committees are followed with particular attention by the ASN and IRSN management. Discussion and coordination meetings are organised three times a year to contribute to the continuous improvement of the technical quality and the consistency of their opinions, which are key elements for ASN.



8.2 Parliament

Parliament is involved in nuclear safety and radiation protection, in particular by passing acts. Two major acts were passed by Parliament in 2006 in the area of nuclear safety and radiation protection: the act of 13 June 2006, and the programme act of 28 June 2006 on sustainable management of radioactive materials and waste.

THE PARLIAMENTARY OFFICE FOR ASSESSMENT OF SCIENTIFIC AND TECHNICAL OPTIONS

Established by act 83-609 of 8 July 1983, the parliamentary office for assessment of scientific and technological options is a parliamentary delegation comprising eighteen MPs and eighteen Senators, the composition of which was renewed after the June 2007 general elections. The office is responsible for informing Parliament of the consequences of scientific or technological options, in order primarily to assist it with its decisions.

The office is assisted by a scientific council of 24 members, the composition of which reflects the diversity of scientific and technical disciplines.

In 1990, Parliament asked the parliamentary office to review how the nuclear and industrial safety of nuclear installations was regulated. Since then, this task has been renewed each year.

From the outset, the parliamentary office carefully defined the scope of the work of its rapporteurs, tasked with investigating how safety and radiation protection are organised both in the civil service and by licensees, comparing their characteristics with those of other countries and checking that the authorities have the resources to carry out their tasks. This “regulation of the regulators” thus concerns the operation of administrative structures as well as technical issues, such as the future of nuclear waste or the transportation of radioactive materials, or socio-political questions, such as the circulation and perception of information on nuclear matters.

Hearings open to the press have become a well-established tradition at the parliamentary office. They enable all parties concerned to express their opinions, defend their arguments and debate in public on a given topic, moderated by the rapporteur from the office. A verbatim record of the hearings is appended to the rapporteur's reports. These hearings thus make a substantial contribution to informing Parliament and the public and to the transparency of decisions.

In 2006 members of the parliamentary office participated actively in the legislative transcription of their recommendations on the regulation of nuclear safety and the long-term management of radioactive materials and waste, recommendations based on several years of studies and consultations.

Having completed its tasks, the parliamentary office was given increased responsibilities in the future by the act, in particular for regulating the implementation of the two 2006 acts on sustainable management of radioactive materials and waste and on transparency and security in the nuclear field. In particular, the ASN annual report will be presented to the office in a public session.

8.3 The government

In accordance with the French constitution, the government, headed by the Prime Minister, exercises the regulatory power. The government is therefore responsible for laying down the general technical regulations concerning nuclear safety and radiation protection. The 13 June 2006 act also gives it responsibility for taking major decisions concerning BNIs. It is required to consult ASN on draft regulatory decrees and orders on nuclear safety. It also has access to consultative bodies such as the consultative committee on basic nuclear installations, the high committee for nuclear safety transparency and information, and the high council for public health.

The government is responsible for civil protection in the event of emergencies.

8.3.1 Ministers with responsibility for nuclear safety and for radiation protection

The ministers with responsibility for nuclear safety, as stipulated in the act of 13 June 2006, are the minister of Economy, Finance and Employment and the minister of Ecology and Sustainable Development. They define the general regulations applicable to nuclear activities, if necessary on the basis of a proposal from ASN. They take the limited number of major individual decisions concerning the initial authorisation and shutdown of BNIs.

After an opinion from ASN, if an installation presents serious hazards, the above-mentioned ministers may pronounce suspension of its operation.

The minister for health is responsible for radiation protection. He or she defines the general regulations, based on proposals from ASN when applicable, concerning radiation protection. The radiation protection regulations for workers are also the responsibility of the minister for labour.

Finally, the ministers responsible for nuclear safety and the minister responsible for radiation protection jointly approve the ASN rules of procedure. They also each approve ASN regulatory decisions of a technical nature within their respective spheres of competence.

Under the joint authority of the ministers with responsibility for nuclear safety and radiation protection, a unit has been set up to assist them. This unit is accommodated within the ministry of the Economy, Finance and Employment.

8.3.2 The prefects

The prefects are the representatives of the State and the guarantors of public order in the *département* under their responsibility. They are responsible for civil security, preventive measures applicable to the population and emergency measures in the case of an accident. These measures are proposed to them by ASN.

The prefect, after obtaining the opinions of his other own services and of one or more investigating commissioners following a public inquiry, also communicates his or her opinion to ASN for the ministerial decisions that it examines and for ASN decisions on discharges.

The ASN regional representatives, who are also regional directors of industry, research and the environment, under the authority of the regional prefects, are independent of the latter with regard to nuclear safety and radiation protection.

8.3.3 Consultative bodies

8.3.3.1 Interministerial commission for basic nuclear installations (CIINB)

The consultative commission for basic nuclear installations (CIINB) must be consulted by the ministers with responsibility for nuclear safety on BNI initial authorisation, modification and final shutdown licence applications, and on the specific requirements applicable to each such installation. It is also required to give its opinion on the drafting and application of the general BNI regulations.

8.3.3.2 High council for public health

The high council for public health (HCSP) contributes to the definition of multi-year health objectives, has a general function of providing expert assistance for the assessment and management of risks to health with the agencies concerned, and carries out forecasting watch on epidemiological trends and technological changes likely to affect the health of the population. The ASN Chairman will be represented on the board of experts which heads the council.

8.3.3.3 High committee for transparency and information on nuclear safety

The high committee for transparency and information on nuclear safety is a body for information, discussion and debate on hazards associated with nuclear activities and their impact on human health, on the environment and on nuclear safety.

The high committee can issue an opinion on any question in these fields, as well as on related controls and information. It can also examine any issue concerning the accessibility of nuclear safety information and propose any measures intended to guarantee or improve nuclear transparency.

Any question concerning information about nuclear safety and its regulation can be referred to the high committee by the ministers with responsibility for nuclear safety, by the chairmen of the competent committees of the National Assembly and the Senate, by the Chairman of the parliamentary office for the assessment of scientific and technological options, by the chairmen of the local information committees or by the licensees of BNIs.

The Chairman of the high committee is appointed by decree from among members of Parliament, representatives of the local information committees and public figures chosen for their competence.

9. Article 9: Responsibility of the licence holder

Each Contracting Party shall ensure that responsibility for the safety of a nuclear installation rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

The fundamental principle on which the French system of organisation and specific regulations for nuclear safety is based is that of prime responsibility of the licensee. This principle of prime responsibility of the licensee for safety is defined by the legal framework described in section 7.1 and summarised below.

The principle of prime responsibility of the licensee is laid down in the act of 13 June 2006. Article 28 of the act stipulates that "the licensee of a BNI is responsible for the safety of his installation".

Furthermore, article 1 of the "quality" order of 10 August 1984 stipulates that a BNI licensee must ensure that a quality, in relation with the importance of their function for safety, is defined, obtained and maintained for the various components of the installation and its operating conditions. The system set up by the licensee must be capable of demonstrating that this component quality is obtained and maintained from the design phase and through all subsequent phases of the life of the BNI.

On behalf of the State, ASN ensures that this responsibility is assumed in full, in compliance with the regulatory requirements. The respective roles of ASN and the licensee are as follows:

- ASN defines the general safety and radiation protection objectives;
- the licensee proposes and documents technical measures for achieving them;
- ASN checks that these measures enable the objectives to be achieved;
- the licensee implements the approved measures;
- during inspections, ASN checks correct implementation of these measures and draws the corresponding conclusions.

C. GENERAL SAFETY CONSIDERATIONS

10. Article 10 : Priority to safety

Each Contracting Party shall take the appropriate steps to ensure that all organisations engaged in activities directly related to nuclear installations shall establish policies that give due priority to nuclear safety.

10.1 Regulatory requests

Pursuant to its mission (see section 8.1), the ASN from the outset asked BNI operators to adopt an organisation guaranteeing that the top priority be given to safety.

The steps taken by the nuclear installation operators, as meant in this Convention, are presented below.

10.2 Measures taken for power reactors

Nuclear licensee responsibility within Électricité de France S.A. (the EDF Group) resides at four main levels: the Chairman; the Senior Executive Vice President, Generation; the Director of the Nuclear Power Generation Division, who is responsible for the operation of the entire French NPP fleet; and individual NPP managers (see organisation of EDF S.A. in Appendix 3). In the specific case of one BNI currently in the process of dismantlement on an isolated site, EDF S.A. as the nuclear licensee is represented by the director of the Nuclear Engineering Division, who reports to the Senior Executive Vice President, Generation.

The prime responsibility of EDF S.A, as the leading producer of electricity from nuclear power, is to deliver exemplary performance in terms of transparency and nuclear safety. EDF considers that this is vital to ensuring that nuclear power is accepted by society.

The primacy accorded to safety within EDF is based on:

- a corporate policy that places safety and radiation protection at the very heart of the company's priorities and concerns (the latest version of the policy was published in 2000);
- an operating safety management system, the general principles of which were established in 1997, and supplemented in 2005 and 2007 (described in section 12.2).

EDF's aim is to ensure that the safety management system, as the backbone of the company's overall management system, delivers exemplary performance in order to drive excellence in all areas, including competitiveness.

The guiding principles of the safety management system ensure that particular attention is paid to:

- strict compliance with safety requirements and corresponding recommendations, which are partly defined at corporate level, and applicable to all sites. They constitute a permanent reference framework that, in addition to requirements and recommendations, provides strategic orientations as well as a formalized structure for leveraging expertise across the nuclear fleet. Four categories of products derive from this reference framework: management, policy, operation, and procedure;
- clearly-defined responsibilities for nuclear safety;
- availability of appropriate skills, and consideration of human factors in design and operation;
- empowerment and commitment of all players, based on the knowledge that people are a vital component of nuclear safety in particular, and a key driver of progress in general. Moreover, empowering each and every individual means they must have the right to express themselves

and to criticize, and a system of recognition must be in place; hence the steps taken to facilitate the development of the "right to inform"[3] and the "duty to report"[4].

- a statement of ambitions as well as a constant vision that is shared and known, and deployed by management to the field level; this vision and these ambitions go beyond recommendations to express a desire to improve and achieve excellence in the field of safety;
- analysis of decision-making processes, in particular via the safety/radiation protection/availability/environment monitoring units in place at all sites;
- analysis of organisational changes and projects likely to have a major impact in accordance with the recommendations of INSAG 18; this methodology was developed by EDF in 2006 (refer to section 12.2);
- development of different real time and non-real-time monitoring and verification systems to measure the effectiveness of the safety management system and correct any deviations or drift, and to enable fundamental improvements in operating quality;
- implementation of a major Human Performance project (described in section 12.2.1.);

The following procedures are used as a platform for implementing these principles:

- For all entities:
  - decision-making at the various levels of management is guided by the subsidiarity principle[5];
  - prior assessment, involvement and consensus, rather than application of decisions made at a central level;
  - a short management line with support functions;
  - a collegial management structure within each entity to foster debate on decisions to be made, guarantee the quality of decision-making, and ensure that decisions are carried forward by all players. The entity manager shall have ultimate decision-making capability for the entity when he/she considers it necessary;
- At corporate level, internal audit of the Nuclear Power Generation Division is organized as follows:
  - Nuclear Power Generation Division management draws up an annual performance agreement (or business plan) with each NPP which defines the objectives and performance targets for the coming year, as well as the associated orientations and areas for improvement.
  - This yearly business plan describes the contribution to be made by the NPP to the achievement of overall performance objectives, notably in the three key areas of safety/radiation protection, competitiveness (availability/cost) and people management. It forms an important basis for the contractual relationship between the plant and Division management, and for the associated monitoring activities. It is deployed in a lower-level annual performance agreement, which is discussed and monitored.

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[3] **Right to inform:** individuals must adopt a questioning attitude in the performance of activities, and must alert line management if an order or instruction is such as to negatively impact the quality of the activity.

[4] **Duty to report:** if the safety significance of any event is considered by an individual to be more serious than the assessment made by the individual's line manager, the individual must notify a person or body with responsibility for safety within EDF (for example the safety/quality advisor at a NPP, the deputy director of the Nuclear Power Generation Division with responsibility for nuclear safety, the Energy Branch's Senior Vice-President, Nuclear Affairs, or EDF's general inspector for nuclear safety).

[5] **Subsidiarity principle:** decisions must be taken as close to the field as possible; decisions should only be passed on to a higher level of management if this is likely to provide genuine added value.

  - Every year, the NPP manager makes an assessment of the safety condition of his/her site on the basis of a safety report derived from an analysis of results as well as experience feedback on safety. The safety report serves as a basis for dialogue with the Director of the Nuclear Power Generation Division.
  - The Director of the Nuclear Power Generation Division performs regular assessment visits to nuclear sites.
  - Safety indicators are periodically analyzed (general compliance of control and maintenance operations with specifications, alignment, reduction in reactor scrams, incipient fires, etc.).
- A monitoring and verification system is in place within each entity. In addition to monitoring by line management, verifications are also carried out by independent bodies. In the field of safety, these independent bodies are: Safety/Quality Advisory Units at the NPPs, the Nuclear Inspectorate (IN) within the Nuclear Power Generation Division, the Senior Vice-President, nuclear affairs (Generation), and the General Inspectorate for Nuclear Safety (IGSN), acting respectively on behalf of plant managers, the Director of the Nuclear Power Generation Division, the Senior Executive Vice President, Generation, and the Chairman of the EDF Group. Safety analyses and comparisons are carried out regularly at the different levels under the supervision of entity managers (Safety Technical Committees at plants, Nuclear Operating Safety Committee within the Nuclear Power Generation Division, and Nuclear Safety Council at Group top management level. Safety analyses are drawn up at each plant, while a safety and radiation protection report is produced for EDF Generation, and the IGSN submits an annual report to the Chairman of EDF.
- The following applies specifically to the Nuclear Power Generation Division:

  At national level, all plants have been audited since 2003 as follows:
  - by the Nuclear Inspectorate, the Division's audit body. Assessments conducted by the Nuclear Inspectorate consist of an audit checking compliance with a corporate reference system relating to safety, radiation protection and the environment. Cross-comparison is conducted between sites.
  - by the International Atomic Energy Agency (IAEA), via OSART missions, with a specific preparatory audit carried out by the Nuclear Inspectorate 18 months to two years beforehand.
  - by the World Association of Nuclear Operators (WANO), via peer reviews.
- With regard to the Nuclear Fuel and Nuclear Engineering Divisions, bodies similar to the Nuclear Inspectorate of the Nuclear Power Generation Division perform checks on activities related to nuclear safety and radiation protection carried out by these divisions.

Internal audit is currently the subject of an enhancement plan across the company, and concerns all operational and engineering entities of the nuclear fleet.

10.3 Measures taken for research reactors

10.3.1 CEA research reactors

The measures to ensure safety taken by the CEA take into account the considerable variety of its installations, resulting from the broad range of research programmes the CEA carries out, and the way those programs develop over time. The consequence is a diverse range of potential risks.

Nuclear safety has always been and is still the CEA priority, and as demonstrated by feedback from experience, its installations are operated so that the environment and the population are entirely safe.

The CEA's excellent safety levels are based on fulfilling the following three conditions:

- a well-defined organisation, in which each member at each level is trained in, made aware of and given responsibility for the role which is unequivocally assigned to him or her (refer to the organisation chart in Appendix 3);
- a taught, maintained and developed safety culture;
- staff that are professional, skilled and capable of working in teams.

Centrally, the General Administrator has implemented measures intended to ensure the CEA's nuclear safety. The General Administrator is supported by the Department of Nuclear Protection and Safety as regards nuclear safety and quality, and by the Central Security Department for radiation protection and transport. The two Departments are part of the Risk Management division and define the CEA's safety policy, which is based on continuous improvement.

The Director of Nuclear Energy (DEN), supported by the Security, Quality and Safety Department (DSQS), interprets and monitors the application of the CEA safety policy in all installations, and particularly experimental reactors.

Documents defining the existing principles and policies are contained in the CEA Nuclear Safety Manual. They include:

- circulars that are General Management Directives,
- recommendations intended to define the CEA's policies and principles.

At local level, the centre directors and department and installation managers, who comprise the management hierarchy, ensure the defined safety policy is applied in each installation for which they have responsibility.

The audit function is carried out by entities independent of those forming part of the management hierarchy. The audit function reviews the efficiency and adequacy of the actions taken, and of the internal technical supervision.

The audit function for the General Administrator is carried out by general inspectors from the Risk Management division.

In the DEN, each centre director is assisted by a Safety Group that carries out installation audits.

In addition, the CEA continues to strengthen and develop some areas, including:

- improvements to the organisation of radiation protection;
- enhancements to installations' technical-support organisation for some areas of expertise, such as earthquakes and human factors.

10.3.2 The High-Flux Reactor (RHF)

Nuclear safety has always been, and is still the priority for the Laue-Langevin Institute (ILL): as demonstrated during over thirty years of operational experience, the RHF is operated so that both the environment and the population are entirely safe. The ILL's excellent safety levels are based on the following organisation:

- a Radiation Protection Unit reporting directly to the Institute's Director;
- a Reactor Division, the Head of which has delegated responsibility from the Director for operation and overall safety of the reactor and its associated buildings, and to provide the operation's quality assurance.

There is a defined list of those of the activities described as "of monitored quality activities" (*MQA*). Such activities are subject to a special procedure. MQA are checked twice, as defined in the quality order of 10 August 1984:

- first-level check: this is essentially a technical supervision, to ensure that the result defined for the MQA is obtained. The functional group responsible for carrying out the MQA normally carries out the supervision;
- second-level check: additional checks, possibly based on sampling, of both the technical and management aspects of the MQA take place in the Reactor Division. These external (or second-level) supervision are carried out by the Quality Assurance function within the Reactor Division. This function comprises the Coordination and Quality-Assurance Office, supervised by the Quality Assurance Manager.

10.4 Analysis by the regulator

The regulator's assessment of the organisations adopted by the operators with regard to the priority to safety is presented in the subsequent chapters along the various articles of the Convention, but mainly in Chapters 12 and 13.

11. Article 11: Financial and human resources

1. *Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*
2. *Each Contracting Party shall take the appropriate steps to ensure that sufficient numbers of qualified staff with appropriate education, training and retraining are available for all safety-related activities in or for each nuclear installation, throughout its life.*

11.1 Regulatory requests

Article 29 of the act of 13 June 2006 on transparency and security in the nuclear field stipulates that, for the construction of a BNI subject to authorisation, “the authorisation takes account of the technical and financial capacities of the licensee”. These capacities must enable it to carry out its project while complying with article 28 part I of the act, “in particular to cover the costs of dismantling of the installation and restoration, monitoring and maintenance of its site or, for radioactive waste storage installations, to cover the costs of final shutdown, maintenance and monitoring.”

Article 7 of the “quality” order of 10 August 1984 stipulates that “the human and technical resources and the organisation implemented for performance of an activity concerned by quality (refer to chapter 13) must be appropriate to this activity and enable the defined requirements to be met. In particular, only persons with the required competence may be assigned to an activity concerned by quality; the assessment of competence is based in particular on their training and their experience.”

11.2 Resources assigned to the safety of power reactors

11.2.1 EDF financial resources

The EDF Group is an integrated energy supplier, operating in all sectors of the electricity industry: generation, transmission, distribution, sales and trading of energy. It is the leading player in the French electricity market, and is strongly positioned in the three major European markets (Germany, the UK and Italy), making it one of Europe’s leading energy suppliers.

In 2006, the Group posted consolidated revenues of 58,932 million euros, a net income, Group share, of 5,605 million euros, and a gross operating surplus of 13,930 million euros.

Group cash flow, which stood at 11,165 million euros in 2006, financed a revival of investments. 5.9 billion euros, for example, were invested in replacement and organic growth in 2006, an increase of 14.8% compared with 2005. In France, total investments stood at 3.8 billion euros, 31% of which was spent on replacement (notably the start of works for the EPR plant at Flamanville) and maintenance of power generation installations.

In addition, in order to secure the funding required for these long-term nuclear commitments, EDF has, in previous years, put in place a portfolio of assets assigned exclusively to covering provisions associated with the dismantlement of NPPs and the back end of the nuclear fuel cycle. In 2006, the progressive development of this portfolio was accelerated, and the net allocation for the financial year was 2.8 billion euros. The total value of this portfolio of assets was 6.3 billion euros as at 31 December 2006.

EDF’s electricity sales in France in 2006 totalled 389.4 TWh, with total electricity generation standing at 490.8 TWh, of which 428.1 TWh was produced by NPPs.

Sales in the European market in 2006 reached 94.9 TWh. These results confirm that EDF’s generating capacity is perfectly adapted to European energy demand.

EDF believes that all of the data provided above show that it possesses the financial resources to meet the safety needs of each nuclear installation throughout its service lifetime.

By way of example, the following investments have been made with a view to enhancing safety:

- continuation of the ten-yearly outage program, for which safety-related expenditure accounts for around 60% of total investments (all ten-yearly outages taken together);
- continuation and acceleration of the steam generator replacement program in 900 MWe series plants;
- continued implementation of the safety injection system/containment spray system sump modification (completion of works scheduled for late 2009);
- the Fire Action Plan (refer to section 6.3.5) was completed in late 2006. In addition, an upgrade programme for firefighting water and fire detection systems is under way;
- multi-year programme designed to establish an exemplary plant condition at all NPPs: this broad-scope program, designed to run 2006-2013, aims to achieve the best international standards at all nuclear sites in order to facilitate improvements in operating rigour;
- action plan aimed at reducing the number of reactor scrams.

11.2.2 EDF human resources

Approximately 19,000 people are employed in EDF's Nuclear Power Generation Division (19,161 in 2006, as against 20,615 in 2003), divided into three groups: operating staff (around 5%), supervisory staff (around 68%) and management (around 27%).

In addition to these 19,000 members of staff who are directly involved in the operation of EDF's 58 nuclear reactors, EDF also devotes human resources to the development, operation and dismantling of nuclear reactors:

- around 2,000 engineers and technicians at the Nuclear Engineering Division;
- almost 150 engineers and technicians at the Nuclear Fuel Division;
- more than 600 engineers and technicians at the EDF Research and Development Division (EDF R&D).

Specific human resources are devoted to nuclear safety and radiation protection and EDF has designed its organisation to ensure that a large majority of personnel devote a significant proportion of their time and activities to these two issues. The company's policy of empowerment and decentralisation (refer to section 10.2) and the development of a safety culture within teams (refer to chapter 12) mean that nuclear safety and radiation protection are an integral part of work planning, execution, inspection and verification activities.

More than 300 members of staff work exclusively in the field of nuclear safety (safety engineers at NPPs, as well as safety specialists and experts in corporate departments, engineering groups and audit bodies).

A similar number are devoted to industrial safety and radiation protection.

In 2006, EDF implemented an in-depth program designed to secure skills and career paths, in order to start preparing for the process of generational handover and succession planning. An initiative launched in late 2005 on the basis of uniform principles applicable to all NPPs, and prepared, through successive iterations, with a detailed focus on field realities, has secured sufficient development potential to ensure the renewal of skills. These programmes are specifically tracked, coordinated and audited.

11.3 Resources assigned to the safety of research reactors

11.3.1 CEA reactors

It is important to stress at the outset that as regards nuclear safety and radiation protection, the personnel at installations have specific training in safety awareness, and devote a significant part of their working time and work activities to it.

11.3.1.1 The Phénix Reactor

To meet the safety needs, the Phénix licensee is given a Safety and Quality Mission, and has 6 engineers working on safety and 3 on quality.

The Radiation Protection Service at the Phénix installation comprises 16 people, of whom 10 provide continuous cover to ensure the installation is monitored and staff are radiologically monitored.

As needed, the safety studies are either:

- processed by specialist CEA Units;
- or contracted to external consultancy firms.

The Nuclear Safety Group at the Valrhô Center, the DSQS, and the DPSN contribute to the monitoring, supervision and coordination of the files.

Thus during normal operation, around €10 million are spent each year on reactor safety (personnel, training, subcontracted services, studies and construction work, etc.).

11.3.1.2 Other CEA reactors

A Safety Engineer position has been created in each installation. This is held by an engineer who is familiar with the installation and is experienced in analyzing and processing safety cases. The installation also has access to the skills of an engineer qualified in criticality.

Under Article 7 of the order of 10 August 1984 and the "Human Resources" section of the standard ISO 9001-version 2000, the skills of persons assigned to safety-related positions in a BNI must be guaranteed.

The principles forming the basis of the qualification and accreditation procedure are:

- the responsibilities for qualification and accreditation are segregated;
- the process to recognize qualification is assigned to someone who may, if he or she considers it useful, refer to specialists for advice;
- the particular process to recognize qualification validates skills acquired during professional experience and not just those acquired by training;
- diverse ways of gaining skills are taken into account (initial and professional training, professional experience, self-study and tutoring);
- decisions on qualification and accreditation are documented.

Before they take up their positions, installation managers receive specific training in managing personnel and operations, in nuclear safety and operating as defined by the CEA, in radiation protection, and waste management and they are also informed of the licensee's legal responsibilities.

In addition, the monitoring, supervision and coordination of the safety cases are assigned to different contributors, as follows:

- the Nuclear Safety Group in each centre;
- the Security, Quality and Nuclear Safety Department (DSQS);
- the Department of Nuclear Protection and Safety (DPSN).

The human resources needed for the work require 10 and 20 engineers at each site. Including radiation protection, over €25 million are thus spent on the safety of the CEA's research reactors.

11.3.2 The High-Flux Reactor (RHF)

To meet the safety requirements, the ILL has a safety engineer reporting directly to the Head of the Reactor Division.

The Radiation Protection Unit comprises 9 people led by a radiological-protection engineer, who ensure the installation is monitored and staff are radiologically monitored.

11.4 Analysis by the regulator

11.4.1 Safety and competitiveness for power reactors

The act of 10 February 2000 on the modernisation and development of the public electricity service considerably modifies the domestic electricity market in France. While stipulating EDF's public service commitments, the act, which transposes a European directive on the internal market in electricity, places EDF, in particular, in a competitive situation for energy production and its supply to the largest customers.

Moreover, in 2004 EDF changed status, becoming a public limited company. At the end of 2005 the company was partially privatised, the State retaining an 86% holding. The act stipulates that the State hold at least 70% of the capital and of the voting rights.

Concern with cost control is now given more emphasis by the licensee in its discussions with ASN. Technical discussions with EDF have clearly become tougher on economic feasibility aspects, on the justification of some requests or schedules and on the handling of very short-term matters during outages. A broader discussion has begun and is continuing on the potential safety impact of electricity market changes and new practices implemented or planned by the licensee.

To adapt its regulation to this new context, ASN is developing instruments for early detection of any drift: the economic situation, changes in expenditure, personnel management, safety and radiation protection indicators and licensee organisational changes are subject to closer attention. As in previous years, in 2006 ASN reviewed the summary on these points communicated by EDF. Expenditure trends show that EDF is continuing its investments in asset maintenance and that the research and development level remains satisfactory. Overall, the 2006 review showed no worrying drift. However, in the future ASN will continue to keep a close watch on any consequences of new organisations set up by EDF to attain its economic performance targets.

ASN also considerably strengthened the regulatory oversight of EDF in 2006 by implementing inspections focusing on "safety and competitiveness". These inspections are intended to monitor the manner in which the licensee continues to guarantee a high level of safety in the context of changes that it is currently experiencing. The inspections examined the processes involved in the preparation of budget options and the organisation of the sites regarding arbitration of these options. ASN was able to observe that the "quality safety" departments of NPPs are involved in these processes in order to analyse the potential safety impact of the budget options.

Another area of work concerns the establishing of a more frank and responsible dialogue with the licensee on its economic issues. Safety cost-benefit analyses identifying measures that generate the largest safety improvements for given financial resources are one of the instruments of this dialogue.

In 2006 ASN also asked its technical support organisation IRSN to review the EDF safety management system in a context of competitiveness. The review aims to clarify the following points:

- the place given to safety in the day-to-day arbitrations related to operation and maintenance in the face of various other constraints;
- the operational meaning given to safety and its concrete assimilation into the definition and performance of operation and maintenance activities.

In particular, ASN wishes to obtain the opinion of the advisory committee for nuclear reactors on the arrangements and practices implemented by EDF to ensure and demonstrate effective compliance with safety requirements and to enable continued improvement of operating safety. This review will be a topic of a meeting of the advisory committee in 2008.

Finally, ASN is developing exchanges with its foreign counterparts to move towards harmonisation of safety requirements, as a response to licensee internationalisation and the opening of electricity markets to competition. The work done within the WENRA association, in which ASN plays an active role, contributes to this.

The ASN analysis of the qualification and skills of the personnel responsible for the operation of NPPs is presented in section 12.4.1.

11.4.2 Safety and budget restrictions for research reactors

Most research installations are operated by large public research organisations, and the 2004-2006 period showed that their resources remain very sensitive to the budgetary context of the State. Although installations whose continued operation might have been threatened by reduced research appropriations in 2003 were able to return to their usual level of operation from 2005, the upgrading of some of these installations for compliance with current safety requirements following safety reviews, often demanding major works, remains difficult, taking several years and sometimes interfering with research programmes. ASN will make sure that budget restrictions have no safety and radiation protection consequences on the operation of research facilities. However, this remains a sensitive subject.

12. Article 12: Human factors

Each Contracting Party shall take the appropriate steps to ensure that the capabilities and limitations of human performance are taken into account throughout the life of a nuclear installation.

12.1 Regulatory requests

ASN considers that people and organisations are key factors in safety and radiation protection and that there is substantial room for progress in the way in which they are taken into account in nuclear activities. Human and organisational factors are an essential source of safety improvements, but taking them into account demands consistent action on several levers: the training and skills of the personnel working in the installations, individual and collective working methods, organisation and management, and the ergonomics of the installations and of the operating documents.

The "quality" order of 10 August 1984 requires the licensee of a BNI to ensure that quality standards commensurate with the importance of their safety-related functions are defined, obtained and maintained for installation structures, components and equipment, and for operating conditions. This order (articles 7 to 9) stipulates in particular that the human and technical resources together with the organisation implemented for the accomplishment of an activity related to the quality of the design, construction and operation of BNIs must be appropriate to the activity and comply with the defined requirements. In particular, only persons with the required skills may be assigned to quality-related activities.

The circular associated with this order specifies that the persons assigned to quality-related activities must be made aware of the importance of their tasks for safety. As far as qualification or accreditation of persons is concerned, the conditions of recognition of the qualification or delivery and renewal of the accreditation must be appropriate to the tasks the persons concerned are to perform. Accreditation of a person for an activity is granted by the licensee for the activities performed by its staff or by the contractor for sub-contracted activities; this accreditation attests to a person's qualification for the specified tasks and responsibilities. If an activity or set of activities simultaneously or consecutively involves several organisations or units of the licensee or of one or more contractors, definition of the responsibilities and duties of each person, the limits of their actions, and the coordination between these organisations is part of the requirements.

Safety and radiation protection must not rely solely on the individual. Front-line personnel are rarely the only cause of accidents. In practice, accidents are often the consequence of deep, latent dysfunctions in organisations which weaken social and technical systems and make human and organisational lines of defence vulnerable.

In day-to-day operation, people and organisations make an essential positive contribution without which the installations could not operate. Taking human and organisational factors (HOFs) into account must not be limited to "reducing human error"; it must also include encouraging the specific capacities and skills of persons (intelligence, adaptability, creativity, capacities for anticipation and recovery, etc.) and strengthening the human and organisational lines of defence. In this context, organisations have a crucial role to play in establishing and guaranteeing conditions favourable to the improvement of human performance.

A systems approach to risk management, based on taking HOFs into account, must help nuclear installation licensees to optimise installation interfaces from the design phase, to improve conditions for carrying out the work by incorporating assessment of the associated risks, to strengthen the human and organisational lines of defence and to learn lessons from operating experience feedback.

The ASN objective is for nuclear installation licensees to incorporate HOFs explicitly and stringently into their risk control approach throughout the life cycle of the installations for which they are responsible. The safety and radiation protection demonstration that the licensee has to provide must be based on persons and organisations as well as on the technical features of the installation. ASN considers that incorporation of HOFs into an integrated risk control approach must be a priority for the nuclear industry.

12.2 Human factor provisions for power reactors

As a result of improvements in NPP performance, combined with the requirement for flawless control of operating safety and quality, EDF has, for several years now, focused considerable effort and attention on safety management and the consideration of human factors in the design and operation of its installations.

12.2.1 Human factors and safety culture at EDF

Safety management was established on the basis of the overall management policies of the division, described in section 12.2.2. Emphasis was placed on the importance of *fact-based management and leadership, personnel commitment,* and *continuous improvement.* Management strongly believes that safety must lead the way, thereby driving performance in all areas. A **Safety Management Guide** was produced in **2004** to guide management teams in their strategic actions, in addition to the levers used for several years[6].

This is now the reference document in this area. It shows the practices that are expected by Division Management and by each manager, highlighting the importance of the following:

- safety as the number one priority that drives performance in all areas, with communications on safety directed at all staff by Division Management;
- establishment of “improvement loops” at the level of each plant, each department and each team via the use of key performance indicators and by regular sharing of experience feedback and information on low-level precursors;
- presence of managers in the field to communicate requirements and perform monitoring, in addition to understanding difficulties, helping resolve them, and providing support to field staff;
- development of improvement actions on the basis of a shared diagnosis that leads to team projects;
- management of individual and collective skills development, particularly in the current context of personnel replacement.

The management policy and its implementation in the field of safety have brought significant improvements. Safety management practices applied by management teams have reached a degree of maturity: the use of key performance safety indicators and safety reviews feeding back into plants’ and departments’ annual performance agreements have made it possible to enhance *performance-based management processes*. However, the effects differ depending on the sites. For this reason, EDF decided to change gear in 2006 by placing the prerequisites for successful worker performance at the heart of each manager’s concerns, in order to help every professional to “get it right first time.”

A Human Performance project[7] has been launched at all sites, encompassing managers, department and contractors, and aimed at bringing about a significant change in daily safety management practices

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[6] **EDF has used the following levers:** development of risk assessment skills, safety/availability monitoring units, self-diagnosis, self-assessment, three-way communications, and handling of “sensitive” transients. A Safety Perception Questionnaire has also been used by management to evaluate the perception of staff in the field.

[7] **The Human Performance project:** is an operational initiative designed to ensure the success of activities carried out by people to operate an *installation*; it is based on the know-how and expertise derived from the Human Factors initiative.

in the field over a three-year period by providing training in human performance for all. The two key areas of the project are as follows:

- **Management presence in the field**: managers must become even more familiar with the conditions that positively and negatively impact work activities, and take action in respect of them.

The five goals of management presence in the field are as follows:

  - to encourage all individuals to develop and improve, identify good practices, and highlight the value of prudent and questioning behaviours;
  - to remind staff of requirements, and ensure that requirements are understood and complied with;
  - to support work by assessing the effectiveness of organisations, skills and work conditions;
  - to ensure that managers themselves develop and improve through their focusing on findings;
  - in overall terms, to compare the points of view of managers and staff, and to foster buy-in.

- **Use of error prevention techniques**: “standard” practices recognized as necessary by all professionals must be developed to ensure that workers can approach activities calmly, thereby reducing the risk of human error. Such practices include *pre-job briefings*, *one-minute time-outs* to allow staff to focus before starting a job, specific checking techniques (*self-checking* or *peer-checking*), *three-way communication*, and *post-job debriefings*.

In 2006, to ensure that safety remains paramount in the face of the need for increasing competitiveness, EDF introduced a specific component developed on the basis of the questioning proposed by INSAG 18. For all major projects that are likely to impact safety, departments are required to assess their choices from a safety point of view, while also evaluating the socio-organisational and human impacts. At the same time, safety specialists at the plants carry out an independent analysis. Placing safety responsibility with each department, and the performance of independent analyses by safety specialists, help support the continued development of safety culture.

In the field of design issues, meanwhile, EDF launched an initiative in 2001 to ensure the consideration of socio-organisational and human aspects in change packages as a result of an internal finding, confirmed by an ASN finding, which highlighted operational difficulties associated with technical changes that were not well adapted to operational conditions, or in respect of which insufficient support was provided.

Based mainly around an impact analysis guide, the initiative was strengthened in 2004 through its integration into engineering processes, as well as through skills development and the provision of practical tools for each design stage.

A socio-organisational and human aspects (“SOH”) network has now been set up, involving managers from engineering units. The SOH initiative is a powerful tool for bringing together plant designers and plant licensees.

Dismantlement document packages, as well as key documents for the VD3 900 outages, have already benefited from the improvements delivered by the SOH initiative, which is now firmly bedded in.

12.2.2 Nuclear Power Generation Division Management Policy

One of the company’s key strategic objectives is to make quality the driving force behind success, in order to achieve and sustain excellence within the scope of a continuous improvement dynamic.

This objective derives from the conviction that the greatest scope for progress can be achieved within work teams through the implementation of actions with a safety focus to improve the quality of operations and human performance, while ensuring management presence in the field and buy-in by personnel. The introduction of total quality management, which is directly linked to the strategic orientations defined by the Nuclear Power Generation Division, is designed to meet this goal. These values have been converted into eight management principles based on the fundamental principles of the European Foundation for Quality Management (EFQM).

The following changes, expressed as such in the management policy, are currently in the process of being implemented:

- management of skills to ensure renewal and development on a sustainable basis;
- strengthened management to coach teams in the field, with targets as well as quality requirements that integrate high-performance methods and practices;
- involvement of personnel in improvement actions and attainment of team targets;
- management of results consolidated at all levels, from Management to work teams;
- more dynamic coordination of activities incorporating effective management of processes and projects;
- "win-win" partnerships with contractors based in particular on a mutual commitment to improving performance.

12.3 Human factor provisions for research reactors

12.3.1 CEA reactors

Events and incidents are analyzed to identify the main causes of failure and to determine the necessary corrective actions to improve safety.

Its recognition of the influence of human factors on events and incidents explains the specific approach used by the CEA to manage these areas, in particular by creating a skills pool of experts and by promoting human factor internal audits.

Actions have been taken in a number of areas:

- carrying out studies of human and organisational factors (HOF) in several installations where problems had been identified or where the mode of operation had been changed, as for the ORPHEE reactor when its operation was reduced;
- carrying out HOF internal audits aimed in particular at complying with ASN's requests related to periodic safety reviews which, for research reactors, more specifically concern operation stages and fuel handling operations.

Safety reviews generally involve upgrading work. In this context, in 2005, the DPSN drafted a guide for those in charge of projects to design or modify installations. It is not restricted just to the design or modification of technical systems, but involves the more comprehensive design of working situations consistent with and adapted for the future installation's safety and productivity objectives.

Such design needs to comply with four major methodological principles:

- centre the design on the work activity. This is based in particular on an analysis of so-called reference scenarios and on feedback from experience of operation of installations similar to those that are the focus of the project;
- plan for multi-disciplinary design in which each person involved (and especially the HOF specialist) contributes to the proposed design choices;

- design in an iterative and incremental way, so that the HOF relating to the proposed solutions for each project stage are assessed and, if necessary, modified to take account of issues identified during the assessments;
- design according to standards, whether methodological or relating to features of future working scenarios.

The benefit of a HOF specialist is that he or she ensures that human factors are included throughout the project. The specialist analyses reference-scenario activities, simulates future activity using plans, digital models or full-scale mock-ups, and suggests improvements consistent with the project:

- taking HOF into account when processing and analyzing a significant event. In this context, in April 2004 the DPSN drafted a guide summarizing good HOF practice, including both the macro and micro aspects of working scenarios. This provided experientially-based evidence for the causes of human failures that resulted in a significant event.
- providing training aimed in particular at raising awareness of HOF among installation heads and safety engineers.

Human factors are also taken into account in subcontracting and in monitoring service providers. In particular, a training course on quality, safety and security in the service-provider's environment has been set up and is part of the quality-assurance requirements that the Phénix station imposes on its suppliers when their activity involves safety-related items and systems.

The Phénix plant carried out an HOF audit in 2006. The conclusions were presented to all personnel in November 2006 in the presence of ASN's technical support organisation, IRSN. An HOF action plan is planned for rollout at the plant during 2007.

12.3.2 The High-Flux Reactor (RHF)

The measures taken for the RHF in connection with HOF largely mirror those of the CEA. The two institutions are in regular contact as regards this area.

12.4 Analysis by the regulator

12.4.1 Human and organisational factors in power reactor operation

The action of ASN is based on the principle of licensee responsibility: within the framework of the general safety objectives, it is up to the licensees to define and upgrade their organisation, take the necessary action to take HOFs into account in installation design and operation, and train and manage the skills of their personnel. ASN analyses and where appropriate approves certain provisions but does not prescribe any standard organisation for nuclear licensees. However, it does encourage the licensees to implement appropriate actions to increase the consideration of HOFs.

ASN checks the arrangements made by the licensee and assesses their results, during inspections, for example. As well as the equipment, ASN pays close attention to personnel training and skills management, the definition and operation of organisations, the consideration of human aspects in the experience feedback, analysis and safety management.

ASN oversight applies from the design stage of a new installation or a new technical system. For example, in 2004, with IRSN, ASN reviewed the implementation of the human factors engineering programme in the design of the EPR reactor project, and more particularly the computerised control system in the control room. ASN considered that the proposed directions are satisfactory and should lead to optimum use of the potential offered by computerisation to provide the operators with effective assistance in controlling the installation, while leaving them sufficient autonomy in performing their duties. The use of mock-ups to involve the operators in validating the principles guiding the design of the computerised control system is also positive.

Oversight also concerns safety-related modifications incorporated by the licensee into an existing installation. In 2004 ASN consulted the advisory committee for reactors (GPR) to review the methodology used by EDF to include HOFs in the incorporation of technical and documentation modifications in its NPPs. This review led ASN to ask EDF to explain its strategy for incorporating human factors into the management of modification projects, to develop its approach at each phase of the design process, relying on existing best practices in the area, and to reinforce skills development and organisational measures contributing to implementation and assessment of its approach.

In general, ASN observes that improvement actions are undertaken by the licensees in installation design and modification, focusing mainly on system ergonomics. However, ASN considers that substantial progress can still be made by using a more systematic approach implemented as far upstream as possible in design and modification projects. As a matter of facts, in the absence of ergonomic analysis during the design phase, unforeseen impacts on the work of the operators may lead to errors after equipment commissioning and will be more difficult to correct.

ASN oversight also covers the arrangements made by licensees to improve the consideration of HOFs in day-to-day operation of installations.

In 2005 EDF submitted to ASN its new management policy for nuclear safety in operation and the application guide for this policy, which had been circulated to all sites. This policy establishes the link between its general safety policy as defined previously, the policy of management through quality, and the safety management tools that had been introduced by DPN (EDF nuclear production division) since 1997 to improve the safety consideration and operation rigor in the field.

ASN regulatory actions in this area have shown that the roll-out of this policy to the sites is effective but still somewhat uneven. Efforts have been undertaken to improve operational communication, including the use of the training simulator to train personnel in communication, particularly in situations of cooperation between several departments. Shortcomings persist in some NPPs, for example in the implementation of risk analysis, which is one of the tools whose use is required by DPN as part of its safety management policy.

The inclusion of HOFs in operation was the topic of inspections of nuclear installations in 2006. The inspections focused on the published policy of the licensees in this area, the organisation and the means set up, the improvement actions regarding the individual (skills, work environment and tools, human performance) and collective (operational communication, interfaces between teams or departments) aspects of operation, and the inclusion of HOFs in experience feedback analysis.

Inspections conducted in NPPs have shown the efforts undertaken by EDF to take HOFs into account, for example in the roll-out of the human performance project to the entire nuclear fleet, even though the situation must still improve with regard to the implementation of actions in the field.

In 2006 ASN also asked its technical support organisation IRSN to review the EDF safety management system in a context of competitiveness. The review aims to clarify the following points:

- the place given to safety in the day-to-day arbitrations related to operation and maintenance in the face of various other constraints;
- the operational meaning given to safety and its concrete assimilation into the definition and performance of operation and maintenance activities.

In particular, ASN wishes to obtain the opinion of the advisory committee for nuclear reactors (GPR) on the arrangements and practices implemented by EDF to ensure and demonstrate effective compliance with safety requirements and to enable continued improvement of operating safety; the GPR will review them in 2008.

With regard to skills, in 2006 ASN consulted the GPR to review the personnel skills management and accreditation system implemented by EDF. In general, ASN considers that the management system for the skills and accreditations of PWR operating personnel is satisfactory.

ASN considers that EDF has introduced a genuine skills management policy, allocated substantial resources, with an approach aiming to identify the precise skills needed and prepare appropriate professional development actions. The management tools developed by EDF (skill reference systems and maps, assessment grids) enable the sites to implement this skills management policy operationally.

ASN also considers that EDF has introduced organisational arrangements providing effective support for the roll-out of its approach. The local skills development systems enable the preparation of professional development solutions meeting the needs of the personnel. The “professional sector promoters” appointed at corporate level contribute to the roll-out of management tools and encourage exchange of good practices between sites. ASN has nevertheless asked EDF to strengthen corporate guidance of local development of skills management for the post of contractor oversight manager.

ASN has asked EDF to present a report on the conditions of access by personnel to training courses and the arrangements made to compensate the effect of postponements of training courses on skills related to safety and radiation protection. ASN has also asked EDF to review the steps to be taken to improve the appropriateness of the responses to individual skill needs.

Finally, ASN restates the particular importance it attaches to EDF pursuing and reinforcing the actions undertaken to ensure continuity of safety-sensitive skills when large numbers of personnel retire, which will be the case from 2008.

12.4.2 Human and organisational factors in research reactor operation

In 2003, ASN informed the CEA that the organisation introduced from 1998 contributed to better legibility of the responsibilities and tasks of the units, particularly with regard to continuity of the line of action, independence of the supervision function and identification of an installation support function.

However, ASN informed the CEA that it expected a self-assessment of the effectiveness of the steps taken, particularly through indicators tracking safety and satisfactory operation of the organisation. In 2006 the CEA communicated to ASN a three-year assessment of the safety of its installations including some of these indicators and showing that safety was being taken into account to a greater extent in its installations.

13. Article 13: Quality assurance

Each Contracting Party shall take the appropriate steps to ensure that quality assurance programmes are established and implemented with a view to providing confidence that specified requirements for all activities important to nuclear safety are satisfied throughout the life of a nuclear installation.

13.1 Regulatory requests

As mentioned in Chapter 7 (section 7.2.2.1.2), the order of 10 August 1984 on the quality of the design, construction and operation of BNIs provides a general framework for the measures that must be taken by the licensee of any BNI to define, obtain and maintain the quality of the installation and of its conditions of operation necessary to ensure its safety.

The order is intended first of all to specify the requisite quality level by means of defined requirements, then to obtain it by appropriate skills and methods and finally to guarantee it by verifying compliance with the requirements.

The "quality" order also requires that:

- detected deviations and incidents be stringently dealt with and that preventive measures be taken (article 8),
- suitable documents provide evidence of the results obtained (article 10),
- the licensee supervises its contractors and checks that the organisation implemented to guarantee quality does operate satisfactorily (article 4).

13.2 Quality assurance policy and programme for power reactors

As part of its industrial mission and its public service role as a generator of electricity, EDF has to guarantee that its NPPs are designed, built and operated in a safe, reliable and efficient manner in both technical and economic terms. The quality management policy helps meet this challenge, and provides the evidence needed to build trust, an essential prerequisite for nuclear power to be accepted by society.

The three objectives that derive from this are as follows:

- to consolidate acquired knowledge and experience, and improve results where required, as part of a continuous improvement dynamic;
- to ensure buy-in to the quality system by involving personnel in its implementation and improvement;
- to have a quality system in place that is compliant with French regulatory requirements, international recommendations on quality, and best practice captured via experience feedback.

For power plants to function correctly, they must be designed, built and operated in an appropriate manner. The quality management policy, which focuses on safety-related activities as a priority, incorporates the following objectives.

13.2.1 Evolution of the EDF quality system on the basis of acquired knowledge and experience

The need to guarantee safety has led EDF to develop a quality system for its nuclear activities based on:

- personnel skills;
- work organisation;
- formalized methods.

The quality system evolves on the basis of experience in respect of the following points:

- overview of all activities;
- analysis in advance of each stage of the process;
- the need to apply the requirements of the quality system in a tailored fashion to activities important to safety, availability, cost control and human resources management;
- involvement of all stakeholders in achieving quality (managers, personnel, contractors, etc.).

13.2.2 Utilising the EDF quality system to support professionals

Fundamental responsibility for quality in any task resides with the people entrusted with its performance. This is why the skill, experience and culture of workers are of paramount importance for achieving the required level of quality.

The quality system is the unifying force behind individual actions. It provides a framework for delivering overall quality as well as the corresponding quality assurance. It is built around the persons involved, and provides them with methods, an organisational structure and requirements, thanks to which they are able to derive full benefit from their know-how. The Quality Manual was recently revised to better highlight the quality requirements applicable to all activities and processes for operation of nuclear installations.

All involved have a key role within the quality system:

- managers must become involved in the field by explaining key challenges and implications, assigning resources, defining targets and quality requirements, and setting an example;
- personnel must become involved by identifying problems and difficulties, proposing appropriate solutions, and implementing those solutions;
- other partners (EDF and non-EDF staff) provide their skills and ensure the quality of their activities.

13.2.3 Tailoring EDF quality assurance requirements to the importance of activities

Activities of key strategic importance for the NPP fleet are identified. Each activity is subject to prior analysis with regard to the difficulties inherent in the activity, and the consequences (particularly for safety) of possible failures at each stage of its execution.

This highlights the essential quality characteristics of the activity, and in particular the required quality level. Appropriate quality assurance measures follow from this, in particular predefined methods and procedures which must be complied with, and which incorporate stopgap measures in respect of potential failures. The predefined measures provide a set of tools to be used by those involved. Through a questioning attitude, by performing risk assessments, and by making proposals for improvement, personnel can help perfect them.

13.2.4 Providing EDF with the appropriate organisation and resources

To meet quality objectives, activities must be clearly assigned, and tasks, responsibilities and interfaces between persons and entities must be defined at all levels within the company.

Technical capabilities and resources, as well as methods and procedures, are adapted to the required quality level, and their appropriateness is periodically reviewed.

RELATIONSHIPS WITH CONTRACTORS

EDF monitors activities assigned to contractors to ensure the quality of work. Such monitoring does not relieve contractors of their contractual responsibilities, in particular those relating to the application of quality requirements and the assurance of results. Contracts between the client and its contractors clearly define the responsibilities of each party, as well as applicable requirements and commitments in terms of quality and results. Initially launched in the period 2004-2006, this monitoring activity is being strengthened and pursued.

In addition, to enhance the quality of partnerships with contractors, an improvement programme has been initiated for the period 2006-2010. Key aims of this programme are to implement an improvement and sustainable development agreement with contractors, support contractor skills renewal, and help ensure that appropriate conditions are in place for the performance of work in the field.

13.2.5 Guaranteeing quality at EDF by means of appropriate checking processes

The quality of an activity depends first and foremost on the persons involved. Checking processes provide a guarantee of quality. They encompass compliance with the requirements defined during the preliminary analysis, and overall control of the activity and associated interfaces.

These processes depend on the significance of activities, and apply at all levels, from an individual person to an entire system. They include the following, where required:

- self-checking;
- checking by another qualified person capable of providing a critical view;
- subsequent independent verification actions designed to ensure that quality requirements have been correctly implemented.

All of the above contribute to defence in depth.

13.2.6 Certifying quality through traceability at EDF

Documents prepared and checked at all stages of an activity, from preliminary analyses to final report, certify that quality has been achieved. These documents are preserved, thereby ensuring the traceability of operations, particularly in the field of nuclear safety.

13.2.7 Anticipation, prevention and improvement at EDF

To prevent faults and improve results, an experience feedback system is implemented.

This approach involves gathering information on deviations, analysing them and determining their root causes, as well as validating good practices and rolling them out on a widespread basis. Experience from NPPs in France is supplemented by experience from other nuclear licensees. The effectiveness of this approach to capturing deviations is enhanced by the gradual implementation of an initiative to capture low-level precursors.

This approach utilises indicators to identify trends, thereby enabling preventive measures to be proactively implemented. Only a small number of indicators should be used, determined on the basis of the desired goal, and established in cooperation with those involved.

Periodic assessments enable acquired knowledge and experience to be noted, and areas of focus for improvement to be defined.

This continuous improvement dynamic is developed within the scope of process management, notably with periodic reviews enabling diagnosis of situations and definition of improvement plans.

13.3 Quality assurance policy and programme for research reactors

13.3.1 The CEA's quality assurance policy and programme

The CEA places great emphasis on quality, because it increases installations' reliability and safety.

The CEA's Quality Manual, written by the DPSN, sets out the quality policy and defines the guiding principles. Thus all departments and units within the CEA can organise their own quality systems to be consistent with each other.

The CEA's quality policy has been discussed and approved by a number of official bodies, and is based on:

- line-management responsibilities: in setting objectives, making the decisions that ensure those objectives are managed, and managing their implementation;
- the involvement of each person. This means aiming to increase his or her skills, rigour and transparency, and encouraging him or her to pass on knowledge and experience for the benefit of all;
- contributing to the control of safety and security.

The DSQS recommends to the Director of Nuclear Energy how the CEA quality policy should be interpreted when implemented throughout installations in the DEN.

The DSQS sets out this interpretation in the Quality, Security and Environment Manual, which describes the DEN's main processes, including "Maintaining nuclear installations under safe operational conditions".

The DEN has implemented these processes to rationalise the management of all its activities, and to enable an overall continuous improvement that will enhance both customer satisfaction and its internal operation.

Quality aside, the DEN's policy develops a business culture based on security, safety and the environment.

At each hierarchical level, Quality Managers interpret the CEA quality policy and ensure its implementation in the Unit is facilitated and directed following a consultative process. Exchanges are organized between the quality managers so that acquired experience may be disseminated and passed on.

Audits of units and their service providers, carried out by internal and external auditors with appropriate skills, are used to:

- measure the progress made and define new directions for progress;
- assess the abilities of suppliers and service providers to satisfy the CEA's quality requirements.

Around thirty audits are carried out each year in research reactors, including ten at the Phénix installation. The main areas covered in these audits are:

- installation management;
- maintenance;
- the testing process: managing checking, measuring and testing equipment;
- zoning and the processes of sorting, processing and removing waste;
- risk management as regards construction work.

The order of 10 August 1984 is applied by the DEN when operating its experimental reactors.

In addition, since December 2005, the organisation of all the DEN's activities at the three Centres at Cadarache, Marcoule and Saclay has been certified to the ISO 9001- 2000 standard, and this includes operating the reactors. The various certification, monitoring and follow-on audits have not identified any non-compliance or any anomalies in applying this reference system.

In addition, the sites at Marcoule and Saclay have been certified to ISO 14001 standard, since 2005 and 2006 respectively, and the Cadarache Centre should obtain its environmental certification during 2007.

13.3.2 The ILL quality assurance policy and programme for the high-flux reactor (RHF)

The Reactor Division is responsible for operating the reactor and its associated buildings (heat sink, detritiation, and specialised physics instruments). Given that the operating activities are especially relevant for safety and according to the "quality" order of 10 August 1984, the implemented quality-assurance organisation is intended to ensure that the required level of quality (defined either during design or during subsequent analyses) is reached and maintained, and that there is evidence of this.

There are six guiding principles for the quality-assurance organisation:

- I: The licensee defines the scope of the quality organisation, by identifying the safety-related activities and equipment and then defining the requirements for each of them. Such activities and equipment are referred to as of "monitored quality" (MQA and MQE respectively).
- II: Persons qualified to carry out a monitored-quality activity (such as writing documents or technical and management verification, etc.) are designated by the Head of Operation. Such persons are referred to as "accredited".
- III: All monitored-quality activities are performed following written documentation prepared in advance, and are reported on in writing. The documentation is referred to as "monitored-quality" documentation. To this end, it is subject to either a technical or an internal audit, and either a management or an external audit.
- IV: Monitored-quality documentation is updated and kept for a defined time depending on the document's importance.
- V: The results of a monitored-quality activity are verified both technically (quality control) and as regards management (quality monitoring). The verification is described in a report.
- VI: The performance and verification functions are segregated and assigned to different persons. The quality-monitoring function is independent of the operational functions.

13.4 Analysis by the regulator

Nuclear installation incident and accident feedback, together with inspection findings, enables ASN to assess the application of the quality order of August 1984 by analysing malfunctions.

13.4.1 Quality assurance aspects of power reactor operation

13.4.1.1 General monitoring of operation quality

During its inspections and regardless of the field (operation, maintenance, radiation protection) ASN strives to verify compliance with quality assurance principles. The adequacy of resources for tasks, staff training, working methods and the quality of the documentation associated with the operations, and procedures for internal monitoring of operations can thus be checked.

13.4.1.2 Quality aspect related to the use of contractors

Most NPP maintenance work is subcontracted by EDF to outside firms. This work, highly dependent on the schedule of power plant outages, concerns some 20,000 persons every year. The quality of operation is therefore particularly dependent on the quality of these service providers.

The introduction of this type of industrial policy is a choice made by the licensee. ASN is tasked with making sure, in application of the order of 10 August 1984, that EDF continues to fulfil its responsibility for the safety of its installations by setting up a quality system, including supervision of the conditions of this subcontracting.

The use of contractors requires oversight by ASN of the aspects mentioned below, on which the “Charter for progress and sustainable development” signed by EDF and the principal contractors providing services are also based.

13.4.1.2.1 Contractor selection and monitoring

In order to meet the requirements of the order of 10 August 1984, EDF has set up a contractor qualification system based on an assessment of their technical know-how and their quality organisation. In addition, EDF must supervise or have supervised the work done by its contractors and use the feedback from experience for continuous assessment of their qualification.

In 2005, ASN conducted inspections on all EDF sites and in the corporate departments, focusing on work supervision, whether the work was carried out by EDF entities or contractors. It also checked the definition and implementation of a consistent industrial policy to maintain in-house skills on the sites while outsourcing work.

In addition, in 2006 ASN conducted inspections on the implementation of the PGACs (inclusive site assistance services, which consolidate activities such as logistics, erection of scaffolding, radiation protection) and on the PMIs (integrated maintenance services, which consolidate a set of maintenance activities), including for opening and closing operations on tanks and other vessels. This organisation is intended to improve the management and coordination of subcontracted activities on NPP sites.

With regard to contractor supervision, ASN considers that EDF has made significant progress on its sites, both in the preparation and checking of the work and in monitoring in the field. This progress is linked to the approach undertaken by EDF corporate departments. Nevertheless, feedback from experience regarding working methods and human resources must still be analysed.

After having observed difficulties in PGACs implementation, in particular inadequacies with regard to the resources of the contractors, ASN also considers that the inspected sites supervise the work done by the contractors in a satisfactory manner. With regard to the PMIs, ASN considers that EDF must make further progress on monitoring in the field and on taking account of risks relating to concurrent work.

13.4.1.2.2 The conditions for carrying out work

An important factor influencing the quality of work is the care with which it is prepared and the time the contractor has to do it. On the basis of the inspections it has conducted, ASN considers that EDF must improve the quality of the risk analyses and their updating following checks that EDF personnel make on the worksites, and better ensure the effective implementation of appropriate compensatory measures for the identified risks. ASN also considers that EDF must enhance the supervision that it performs in the field, in particular regarding compliance with the requirements applying to contractors and the traceability of technical checks.

13.4.1.2.3 Radiation protection and working conditions

With regard to radiation protection of workers, ASN aims to ensure that EDF gives equal treatment to all nuclear workers, regardless of whether they are contractors or licensee employees.

With regard to radiation protection of workers, ASN aims to ensure, through inspections during reactor outages, that the labour code is applied. ASN has been able to confirm that monitoring of worker exposure to ionising radiation is carried out with the same level of quality whether the work is done by contractors or by EDF employees. It nevertheless considers that progress must be made on radiological contamination control and on compliance with rules on work in contaminated environments.

13.4.1.2.4 The contractor market

The choice made by the licensee to outsource part of the maintenance of its reactors must not generate a situation of dependency that would cause it to lose control of the planning or the quality of the work done.

Although EDF has set up an organisation to monitor the market of its contractors and the available resources, ASN keeps its full attention on the topic by means of the inspections it conducts on the sites and in the corporate departments, the analysis of EDF's assessment and by external audits.

13.4.2 Quality assurance aspects of research reactor operation

Unlike nuclear power reactors, research reactor maintenance makes far less use of outside contractors, except for exceptional maintenance operations.

In this context, ASN checks, notably through inspections, the application of quality assurance principles by the licensee during reactor operation and maintenance. ASN pays particular attention to the supervision by the reactor operator of work carried out by the common technical services of a CEA centre, which in the past might have tended to be less rigorous than the supervision of an external contractor, owing to the fact that the workers were CEA employees.

Exceptional maintenance activities are the subject of specific oversight programmes by ASN decided on a case-by-case basis. Consideration is currently being given to general formalisation of the ASN's requirements for quality assurance and documentation updating following an exceptional maintenance operation and before restart. This now forms part of the context of the transposition of the WENRA reference levels, which should lead to an order on safety policy and management applicable to all BNIs. This order may subsequently be the subject of specific application guides, including on the particular topic of maintenance in research installations.

14. Article 14: Assessment and verification of safety

Each Contracting Party shall take the appropriate steps to ensure that::

i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body,

ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.

As indicated in the text of article 14, “comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life”. These assessments are an integral part of the licensing and oversight process, which governs all stages of the life of an installation, from design and siting up to dismantling. As a consequence, this chapter should be read in conjunction with chapter 7 for the description of the regulatory framework and chapters 17 to 19 for the description of the licensing processes.

14.1 Regulatory requests

14.1.1 Initial requests concerning nuclear reactors

When a site is considered by a licensee for the construction of a nuclear reactor, ASN analyses the site characteristics concerning safety. When a licensee intends to build a new type of reactor, ASN asks the advisory committee for nuclear reactors (GPR) to review the proposal and informs the licensee of the issues to be included in its licence application.

Granting of the plant authorisation for a nuclear reactor is based on the analysis by the GPR of a preliminary safety report submitted by the licensee to support its application. The commissioning licence is subject to review by the GPR of a provisional safety report, together with provisional general operating rules and an on-site emergency plan, submitted by the licensee. Final commissioning is declared after review by the GPR of a final safety report, together with general operating rules and an on-site emergency plan taking account of lessons learned from operation since first start-up.

The content of the various reports is specified in the 27 March 1973 instruction implementing decree 73-278 of 13 March 1973. The standard structure of safety reports for nuclear reactors is given in Appendix 2.

The successive reviews by the GPR of the documents supplied by the licensee are based on analysis reports established by IRSN.

On the basis of GPR opinions, ASN gives its opinion to the government on whether the requested licences should be granted.

14.1.2 Reactor oversight

The continuous oversight of the safety of nuclear installations is based on general operating rules and regulation of maintenance (described in chapter 19). It is the subject of the major part of the ASN inspection programme, the practical details of which are presented in chapter 7.

In practice, each NPP undergoes an average of about twenty inspections a year, not including technical meetings between the licensees and ASN. In addition frequent contact, at least by telephone, is maintained between the licensee and the ASN regional divisions. Research reactors are the subject of the same kind of surveillance, but less frequently.

14.1.3 Reactor safety reviews and 10-yearly outages

14.1.3.1 General principles

The safety of a nuclear installation depends on a safety analysis performed at the outset, which demonstrates that the installation meets the safety requirements defined for it. However, this initial safety analysis does need to be reviewed periodically, for two main reasons. The first is that the installation changes: it can be modified, deviations can occur during construction, and the effects of ageing can lead to deterioration. The second is that the safety requirements themselves change, as ASN considers that safety requirements must keep pace with technical change and new knowledge, and that what was judged acceptable at a given time may no longer be acceptable later on.

This provision is stipulated by article 29 of the act of 13 June 2006, which states that “the licensee of a nuclear installation conducts periodic safety reviews of its installation taking account of best international practices”. In addition, the act of 13 June 2006 stipulates that the safety reviews take place every ten years, unless otherwise specified in the plant authorisation decree and justified by the particular characteristics of the installation.

The purpose of the safety reviews is therefore to reconsider the initial safety demonstration and on the one hand to verify that the installations are still in conformity with their initial requirements and on the other to raise their level of safety. The safety reviews are thus of prime importance, in order to detect any conformity deviations, ensure that ageing phenomena are controlled and improve the safety of the installations, through a realistic risk reduction approach. The review process takes place over several years and demands considerable resources on the part of the licensee, but also on the part of ASN and its technical support organisation IRSN.

14.1.3.2 Specificity of the power reactor safety review

The general process for the safety reviews involves a two-fold comparison.

- Comparison of the condition of the installation with its design reference system, taking into account the modifications incorporated since they were built: this is the conformity review.

  The conformity review, as carried out in France on power reactors, is a major procedure. The conformity reviews performed on the 900 and 1300 MWe reactors include verification of the conformity of the measures of protection against external hazards, including extreme weather conditions and seismic activity, and against internal hazards such as high-energy pipe breaks, or verification of the ability of the equipment to operate under degraded conditions (qualification for accident conditions). A “program of additional investigations” has also been defined, to check those parts of the installation which are not covered by maintenance programmes, such as certain portions of piping or tanks which are inaccessible during normal operation.

  Each reactor is thus subject to in-depth review and any anomalies are recorded, with the aim of ensuring that the reactors are in conformity with their design assumptions no later than during the ten-yearly outage. For anomalies with high impact on safety, ASN can nonetheless set shorter times to restore conformity.

- Comparison of the level of safety of the installation with that required for more recent reactors (in project, under construction or in service), review of the consequences of retroactive application of more recent safety rules, comparison with best international practices and taking account of the lessons learned from reactor operation: this is the safety reassessment.

  ASN asks the licensee to examine the consequences of implementing stricter safety requirements and, whenever feasible, to propose modifications to the plants.

These modifications are generally made during the reactor ten-yearly outages which, for a given reactor series, can extend over about ten years.

The review process comprises an orientation phase, setting the topics and scope of the conformity and reassessment studies, a study phase, the aim of which is to determine the modifications to be made, and a modification review phase. After the study phase, the choice of topics for the reactor conformity review is finalised. Each of the phases in principle is the subject of a proposal from the licensee, consultation of the GPR and a position statement from ASN.

In practice, given the standard design of the reactor series, the review is conducted jointly on all the reactors of a given series, which enables a large percentage of the studies to be shared and the review to be underpinned by extended operating feedback.

To this must be added measures which strictly speaking in France are not within the remit of the periodic safety review, but which are guided by the same determination to verify conformity and bolster requirements: this in particular concerns the current revision of the power plant effluent discharge licences and the application of the ministerial order of 31 December 1999 on the protection of the environment.

Before the first ten-yearly outage associated with the safety review, ASN issues an opinion on the assessment of the procedure, on the acceptability of the new safety reference system and on the continuation of reactor operation after the ten-yearly outage.

14.1.3.3 The ten-yearly outages of nuclear power reactors

The 10 November 1999 order requires that, every ten years, each main primary and secondary system of a PWR undergo a requalification comprising full inspection and a hydrotest. The full inspection enables verification of plant condition, in addition to the periodic checks carried out during refuelling outages, extending the checks to areas which are not inspected regularly. This outage is also an opportunity for inspection of the reactor vessel, particularly the most irradiated area in the immediate vicinity of the reactor core, and its welds.

The main primary system hydrotest, which consists in subjecting this system to a pressure 1.2 times the design pressure, constitutes an overall pressure resistance test. This test does not take into account all the types of loads the system in service has to deal with, but it does enable identification of serious defects in unsuspected areas. This was the case in 1991 for the detection of cracking of the vessel head adapters and in 1989 for the detection of cracks in the 1300 Mwe reactor pressuriser nozzles.

14.1.3.4 Research reactor safety reviews

Many current CEA installations began operating at the beginning of the 1960s. The equipment of these installations, of old design, is ageing. They have also undergone modifications over time, sometimes without an overall safety review. Mitigation measures are needed to improve the safety of these installations to satisfactory levels for the medium and indeed the long term.

ASN has informed the licensees that it considers safety reviews of old installations to be necessary about every ten years. The CEA has thus recently conducted safety reviews on the CABRI and MASURCA reactors on the Cadarache site. The corresponding work is now under way prior to the restart of these reactors.

The CEA plans to conduct safety reviews on its other installations over the next few years, following a schedule approved by ASN in 2002 and in 2005.

14.2 Safety assessments and verifications carried out for power reactors

14.2.1 Initial review by EDF

The safety analysis report informs ASN of the measures adopted at each stage in the lifetime of an installation (design, construction, commissioning, operation and dismantling) to comply with regulations and guarantee safety, and justifies these measures. It includes all of the information required to verify that due allowance has been made for all risks (nuclear or otherwise) and all potential hazards (of internal or external origin) and that, in the event of an accident, the personnel, the public and the environment are properly protected by the means put in place. The report takes account of the specific features of the site and its environment (meteorology, geology, hydrology, industrial environment, etc.).

The initial authorisation that EDF submits to the public authorities is accompanied by a file containing an environmental impact study and a hazard study. The preliminary safety analysis report describes the measures adopted to ensure safety in the plant design and construction. Six months before the beginning of start up tests, EDF submits the provisional safety analysis report along with an application for approval prior to fuel loading and reduced power operation. This report contains all the necessary details on the actual construction of the facilities and the conditions for its start up, as well as provisional versions of the general operating rules and of the on-site emergency plan. After a period of time set by the plant authorisation decree (usually ten years), EDF submits the final safety analysis report and the general operating rules, together with a licence application for normal commissioning.

In compliance with regulatory requirements, EDF carries out a comprehensive inspection of the installation every ten years, including in particular an inspection of the reactor pressure vessel, complete re-qualification of the main primary system, and a containment pressure test.

These measures evolve in line with the regulatory context.

14.2.2 Safety review by EDF

This type of safety review was initiated for the first time in 1988 at the first 900 Mwe PWR reactors, on the Fessenheim and Le Bugey sites. In particular, the review was aimed at performing an analysis of these installations, and comparing them with subsequent 900 Mwe installations (known as the CP1-CP2, or CPY series) to obtain a uniform overall safety level for all 900 MWe series.

The safety review was then initiated in the CPY series. This “second ten-yearly outage” (VD2) review concluded, after the “first-off” unit was restarted, with the approval of the updated safety analysis report. The last VD2 outage of a 900 Mwe reactor is scheduled for Chinon B4 in 2010.

The third ten-yearly outage(VD3) review for the CP0 and CPY series was initiated on the closure of the second ten-yearly outage (VD2) review, and its content was assessed by the GPR in 2004 and 2005. The GPR meeting to close the review is scheduled for 2008. The first 900 Mwe VD3 outages are scheduled for Tricastin 1 and Fessenheim 1 in 2009.

For the 1300 MWe series, the content of the second ten-yearly outage (VD2) review was assessed by the GPR in 2002 and 2003. The GPR meeting to close the review took place in December 2005. The first VD2 outage of a 1300 MWe unit was Paluel 2 in 2005.

The dates for the first review of the N4 series tend to match up with those for the VD3 outages of the 900 MWe series.

The review process comprises the following:

- a description of the safety requirements reference system, which comprises a set of rules, criteria and specifications applicable to a series;

- a demonstration that the plants are compliant with the identified reference system. There are two parts to this demonstration:
  - demonstration that the design is compliant with safety requirements. This part comprises studies, the majority of which are common to the entire series;
  - demonstration that the units are compliant with their design. This part is carried out by the licensee at each site;
- an assessment of the extent to which the safety requirements reference system is up-to-date and complete by examining all of the safety-related lessons as well as the reference systems applicable to more recent reactors. Any modifications to be made to the standard construction state of the series are identified.

Thanks to this approach the safety requirements applicable to a given series can be clearly identified. It also ensures that the units comply with this reference system and highlights any aspects of safety that require in-depth analysis, particularly in light of experience feedback from France or abroad, as well as new knowledge. This analysis may lead to a change in the reference system which constitutes a new reference state. The “ten-yearly outage edition” (VDn) of the safety analysis report is subsequently updated and the corresponding modifications incorporated.

14.2.2.1 Description of safety reference system

For example, for the 1300 MWe series, the safety requirements reference system prior to the second ten-yearly outage (VD2) is included in the 1998 edition of the safety analysis report. Similarly, for the 900 MWe series, the safety requirements reference system prior to the third ten-yearly outage (VD3) is included in the second ten-yearly outage (VD2) edition of the safety analysis report.

14.2.2.2 Compliance review by EDF

Plant compliance with safety requirements is key to the exercising of nuclear licensee responsibility at various levels.

Firstly, at the design stage, the designer defines a reference installation (corresponding to a series) that meets these requirements, and ensures that it is built according to pre-determined rules that enable verification of compliance of the installations up to their commissioning.

Then, during operation, the licensee (the Nuclear Power Generation Division) ensures that the installations continue to comply with the safety requirements applicable to them by utilising the organisational measures defined in the Quality Manual, via continuous monitoring (application of Technical Specifications, etc.) or periodic monitoring (periodic tests (EP), basic preventive maintenance programmes (PBMP), etc.).

As part of the safety review, EDF identifies the points that require:

- further analysis in respect of the safety demonstration for the reference installation;
- specific checks to be applied to the actual units, in addition to pre-existing monitoring measures. For the second ten-yearly outages (VD2), these checks consist of a “compliance review” programme and a “programme of additional investigations” (PIC).

The compliance review programme comprises a set of specific checks or targeted actions in respect of issues relating to safety requirements (classification of safety-related equipment, qualification for accident conditions, extreme cold weather conditions, seismic resistance, flooding risk, risk of high-energy pipe break, etc.), which, in certain areas, enable the establishment of a baseline for the state of the installations (for example civil engineering structures). Implementation of the programme enables identification of deviations, whose treatment is tailored to their safety significance, assessment of the compliance of the units, and contribution to the emergence of useful lessons for improving control of installation compliance, with a view to ensuring their durability.

For the second ten-yearly outage (VD2) review of the 900 MWe series, checks were carried out between 1997 and 2000 on the basis of initial experience feedback from the first-off sites. These checks were carried out on the 1300 MWe series between 1999 and 2003.

In the same way, preparation of the third ten-yearly outages (VD3) for the 900 MWe series and the first ten-yearly outages (VD1) for the N4 series plants led to the definition of the scope and conditions for the unit compliance review programme. Any non-compliances identified during this review will be resolved at the latest by the time of the ten-yearly outages of the units concerned.

The programme of additional investigations comprises non-destructive examinations (NDE) that are spread over several units and carried out during ten-yearly outages. The aim is to confirm the validity of the assumptions (degradation modes) on which basic preventive maintenance programmes are based. The programme is implemented at the start of the ten-yearly outage period.

14.3 Safety assessments and verifications carried out for research reactors

14.3.1 The Phénix Reactor

Each year, a large number of files (around 60) are sent to ASN, either in response to its requests (relating to inspections, safety re-assessments, etc.), or to obtain special authorisations (to carry out new irradiation experiments, or more rarely, general operating rules, etc.).

In order to supply ASN with complete and current information, the Phénix plant faxes it weekly a report of selected key points from the previous week's operation. This enables ASN to check that the CEA is taking full account of low level precursors that enable any departure from installation safety to be detected.

As regards the continuous surveillance discussed in section 14.1.2, each year ASN performs inspections of the Phénix installation several times (on average 8 times per year) covering a variety of areas:

- human factors and skills maintenance;
- periodic checks and tests, maintenance;
- fulfilment of commitments;
- fire;
- the command and control system;
- the management of radioactive sources and materials;
- radiation protection;
- X-ray examinations of the steam generators;
- accident procedures;
- the application of the order of 31 December 1999 on environmental protection within BNIs.

Moreover, second-level checks are carried out (roughly 5 times per year) by the Safety Group at the Valrhô Centre, which checks compliance with the reference system.

Planned reactor shutdowns are closely oversight by ASN. Before the shutdown, the licensee sends ASN a file describing the various work sites. During the shutdown, the licensee and ASN, accompanied by its technical support organisation, hold technical meetings. Lastly, an assessment file is drafted and sent to ASN on lessons learnt during the shutdown.

14.3.2 Other CEA reactors

The GPR met for two days in March 2006 to review the safety review of the MASURCA installation, located at the Cadarache Centre. They used the opportunity to review the planned renovation of the reactor, which is part of the plan to extend the installation's lifetime. The installation is considered to be a reference tool for experimental physics research into the design of so-called fourth-generation generating systems.

The GPR was in favour of continuing with the installation's safety review and renovation, on condition that a number of recommendations were implemented, and that the licensee took certain commitments. The following main points were addressed:

- the approach to safety and safety analysis based on operating conditions;
- the seismic risk (behaviour of civil-engineering structures and equipment);
- the criticality risk;
- the approach to addressing internal and external hazards;
- the fire risk;
- the risk of external flooding;
- the HOF, and in particular, a detailed analysis of reactor control and handling operations.

The licensee had chosen a safety approach that defined the operating conditions, put them into different categories based on their estimated frequency of occurrence, and reviewed their associated defence in depth. The GPR considered that this analysis by the licensee CEA enhanced the safety practices for experimental reactors.

In addition, in 2004, the safety review of the CABRI reactor located at the Cadarache Centre was continued with the support of the GPR. This assessment focused especially on the following points:

- the design and sizing of a new experimental loop;
- the re-assessment of the installation's safety and especially the list of operating conditions, the associated safety objectives and the accident envelope;
- the seismic risk (behaviour of civil-engineering structures and equipment).

Designing a new experimental loop for the CABRI reactor required amending the authorisation decree. Since then, the CABRI installation has thus been subject to a public enquiry, with a positive outcome. The decree for modification of the CABRI installation was published on 20 March 2006.

14.3.3 The High-Flux Reactor (RHF)

After the GPR meeting in 2002, the Refit Management Committee was set up. This Committee manages projects specific to the RHF and has worked with the Reactor Division to manage construction work totalling approximately €30 million over 4 years (2003-2006). Almost all the studies and construction work corresponding to the commitments it took have been completed, in particular:

- earthquake resistance: strengthening the reactor building and the adjacent ILL4 building; and splitting off the front section (guide hall) of the ILL7 building, so that it no longer poses a threat to the reactor building;
- fire protection: renovating the fire-detection system;
- containment: installing earthquake valves so that the primary system and the containment building can be isolated;
- installing an earthquake-resistant water make-up circuit in the pool and caisson.

Over the next four years, a specific project will be set up to manage research and construction work to improve the safety of the RHF's detritiation building, currently closed down. The allocated budget for this work is €6 million.

14.4 Analysis by the regulator

14.4.1 Safety review of power reactors

For nuclear power reactors, most of the safety reviews of which are conducted simultaneously on all the reactors of a given series, several important milestones were passed in 2005, including the completion of the safety reviews of the 1300 MWe reactors after 20 years of operation and the review by ASN of the studies conducted by EDF for the review of the 900 MWe reactors in preparation for their third ten-yearly outages.

14.4.1.1 Completion of the 20-year safety review of the 1300 MWe reactors

This review, begun in 1997, has shown that in terms of safety the operation of these reactors can be continued. The safety reassessment was conducted with reference to current requirements for the N4 series reactors. At the request of ASN, the conclusions of the safety review were submitted to the GPR for final consultation in 2005. This review improved the safety level of the reactors concerned, in particular by the correction of anomalies detected by the conformity review and by the incorporation of modifications recommended following the safety reassessment.

These modifications further reduce the risk of core meltdown in accident situations, improve the response to earthquake or high-energy pipe breaks, and increase the capacity of equipment to operate in a degraded environment (humidity, temperature and radioactivity). They will be incorporated into the 1300 MWe reactors during their second ten-yearly outages, scheduled up to 2014.

The conformity review programme encompassed all the verifications carried out on the 900 MWe reactors and included aspects such as protection against risks arising from the industrial environment of the reactors, protection against internal projectiles and the operability of the equipment called upon in incident or accident situations. This conformity review was completed in 2003 on all 1300 MWe series sites.

14.4.1.2 The 30-year safety review of the 900 MWe reactors

In 2003, after the initial technical discussions and consultation of the GPR, ASN defined the directions for the safety review of the thirty-four 900 MWe reactors in association with their third ten-yearly outages. ASN relied on national and international experience feedback and on a comparison with the most recent reactor types, including the EPR project, to define the scope of the review. At the end of 2004 and in the first half of 2005, ASN consulted the GPR on the various study topics selected, including severe accidents, containment, fire, explosion risks and the use of probabilistic safety studies.

On completion of these consultations, ASN issued its requests for changes and additional studies likely to lead to design or operation modifications. Incorporation of changes resulting from this review is scheduled during the third ten-yearly outages of the 900 MWe reactors, from 2009 until 2020.

14.4.2 Steps taken for research reactors

After substantial refurbishing work on the Phénix reactor and after a final review by the GPR of the last files related to overhaul of the reactor's steam generators at the end of 2002, ASN informed the CEA that it considered that satisfactory answers had been given on the issues related to the safety review of the installation and on which power build-up was conditional. ASN therefore informed the CEA in January 2003 that it had no objection to resumed operation of the reactor, at the partial power level of 350 MWth, for the six remaining irradiation cycles.

The first cycle was authorised in June 2003, enabling the CEA to resume the power operation of the Phénix reactor in July 2003. Feedback from experience and all the inspections carried out to date show that the reactor is working well. In 2005 and 2006, CEA also presented its programme for final shutdown and dismantling 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 must pay particular attention to the ageing of installation components and to the place given to human and organisational factors in reactor operation.

ASN took note of the commitment by CEA to reassess the safety of old installations every ten years. CEA plans to have run assessments on all its research reactors over the next six years, according to a schedule approved by ASN in 2002 and in 2005. In a guide published in 2005, ASN defined its expectations regarding safety reviews on CEA installations in terms of responsibility, content and planning. The provisions of this guide were applied in full for the first time to the CEA's Orphée reactor in 2006, with a view to presentation to the GPR in 2008.

The safety review of the CABRI experimental reactor on the Cadarache site and the modification of its experimentation loop were also presented to the GPR, in January and May 2004. In July 2004, ASN informed the licensee that it did not object to its project continuing, subject to the upgrading of its old installation. The result of the upgrade will be presented again to the GPR, in 2008. In March 2006 the safety review file of the MASURCA critical mock-up was also reviewed, and ASN authorised the licensee to continue the renovation of its installation.

With regard to ILL (Laue-Langevin institute), the files needed for completion of the safety review of the installation, which began several years ago, have all been communicated and their review by IRSN is nearly finished. The safety review of the installation should be completed in 2007, the main safety issues concerning earthquake resistance.

15. Article 15: Radiation protection

Each Contracting Party shall take the appropriate steps to ensure that in all operational states the radiation exposure to the workers and the public caused by a nuclear installation shall be kept as low as reasonably achievable and that no individual shall be exposed to radiation doses which exceed prescribed national dose limits.

15.1 Regulations and regulatory requests

The radiation protection regulations have been completely overhauled over the past five years.

The legislative and regulatory parts of the French public health code and the labour code were amended between 2001 and 2006 in order to transpose the Euratom directives on radiation protection (including directive 96/29/Euratom of 13 May 1996 laying down basic safety standards for the protection of the health of workers and the general public against the dangers arising from ionising radiation). The new regulations were practically completed in 2006 with the publication of the final orders implementing the public health code and the labour code. At the same time, ASN undertook to update the regulatory part of these two codes in order to transpose European directive 2003/122/Euratom of 22 December 2003 on the control of high-activity sources, include the ASN's new prerogatives and introduce a number of clarifications and simplifications based on the experience acquired regarding oversight. These amendments should be published during 2007.

According to the act of 13 June 2006, it is the responsibility of ASN to authorise the commissioning of a BNI and define the requirements for its design, construction and operation in application of the decrees. As part of this process ASN defines the requirements concerning water intake by and liquid and gaseous discharges of substances from the installation, whether radioactive or not.

15.1.1 The legislative and regulatory framework for radiation protection

15.1.1.1 The public health code

The new chapter V.I of part L (legislative part) of the public health code on ionising radiation applies to all "nuclear activities", that is, all activities involving a risk of human exposure to ionising radiation, coming from either an artificial source, whether a substance or a device, or from a natural source, when natural radionuclides are or have been processed because of their radioactive, fissile or fertile properties. It also includes "interventions" aimed at preventing or reducing a radiological risk following an accident, due to environmental contamination.

The general principles of radiation protection (justification, optimisation, limitation), laid down at international level (ICRP) and reproduced in directive 96/29/Euratom, are incorporated into the public health code (art. L.1333-1). They guide regulatory activities which are the responsibility of ASN.

15.1.1.1.1 The justification principle

"A nuclear activity or an intervention may only be undertaken or carried out if justified by the advantages it procures, particularly in health, social, economic or scientific terms, with respect to the risks inherent in the exposure to ionising radiation to which persons are likely to be subjected."

Assessment of the expected benefit of a nuclear activity and the corresponding detrimental health effects may lead to prohibition of an activity for which the benefit does not seem to outweigh the risk.

15.1.1.1.2 The optimisation principle

"Human exposure to ionising radiation as a result of a nuclear activity or an intervention must be kept as low as reasonably achievable, given current techniques, economic and social factors and, as applicable, the medical purpose."

This principle, commonly referred to as ALARA (as low as reasonably achievable), leads for example to reduction in discharge licences of the quantities of radionuclides permitted in radioactive effluents discharged from nuclear installations or mandatory monitoring of exposures at work stations in order to minimize them.

15.1.1.1.3 The limitation principle

"Exposure of a person to ionising radiation as a result of a nuclear activity cannot raise the sum of the doses received beyond limits set by the regulations, unless this person is exposed for medical purposes or for biomedical research."

The exposure of the general population or of workers as a result of nuclear activities is subject to strict limits. For a member of the public, the annual effective dose limit (article R. 1333-8 of the public health code) received as a consequence of nuclear activities is set at 1 mSv; the equivalent dose limits for the lens of the eye and the skin are set at 15 mSv/yr and 50 mSv/yr (average value for any 1 cm² area of skin) respectively. Exceeding these limits is considered to be unacceptable and in France can lead to administrative or legal sanctions.

15.1.1.2 The labour code

The new provisions of the labour code (art. L.230-7-1 and 2) introduce a legislative basis specific to the radiation protection of workers, whether employed by the licensee or not, for the transposition of directives 90/641/Euratom and 96/29/Euratom. They bring French legislation into line with directive 90/641 on outside workers exposed to ionising radiation.

The link with the three principles of radiation protection defined in the public health code is established in the labour code; the rules governing the protection of workers are the subject of a specific decree, the provisions of which are incorporated into the labour code (article R. 231-73 and following). In addition to the principles of radiation protection, the labour code lays down provisions on topics including worker dose limits, technical rules for the layout and outfitting of workplaces, training and dosimetric and medical follow-up of workers, abnormal work situations (exceptional exposure) and the functional organisation of radiation protection in the establishment.

15.1.2 Protection of persons against ionising radiation hazards

The changes introduced by the act of 13 June 2006 reinforce the integration of safety, radiation protection and environmental factors for the purpose of protecting persons against the risks related to nuclear activities and ionising radiation.

15.1.2.1 General protection of workers

Articles R.231-71 to R.231-116 of the labour code set up a single radiation protection system for all workers (whether employed by the licensee or not) likely to be exposed to ionising radiation in the course of their professional activity. These provisions include:

- application of the optimisation principle to work equipment, processes and organisation;
- reduction of the effective dose limit to 20 mSv over 12 consecutive months, except in the case of waivers granted to take account of previously-justified exceptional exposures or of emergency occupational exposures;

- the effective dose limit for pregnant women or more precisely for the unborn child (1 mSv for the period between declaration of pregnancy and birth);
- the limits of the various regulated areas, which have been revised in the light of the new dose limits (effective and equivalent): for the effective dose, the monitored area must cover potential worker exposure of more than 1 mSv per year, and the controlled area must cover exposure likely to exceed 6 mSv per year;
- the duties of the person with competence for radiation protection, extended to the demarcation of areas of work with radiation, to the assessment of exposed work stations and to the steps aimed at reducing exposure (optimisation); to perform these duties this person will have access to data from passive and operational dosimetry;
- the procedures for the medical surveillance of exposed workers and the role of the occupational medical officer.

Implementing orders published since March 2003 clarify the introduction of these new provisions. They cover:

- Zoning: new provisions concerning the demarcation of monitored areas, controlled areas and specially regulated areas (special controlled areas), applicable to all activity sectors, were laid down by the order of 15 May 2006. This order also defines the health, safety and upkeep rules that must be complied with in these areas. The demarcation of the regulated areas now takes into account three levels of protection: the effective dose for external and, as applicable, internal exposure of the whole body, the equivalent doses for external exposure of the extremities and, as applicable, the dose rates for the whole body. The order sets reference values which the head of the establishment is required to compare with the external and internal exposure levels encountered at the work stations when defining the areas.
- The person with competence in radiation protection (PCR): the new order of 26 October 2005 on procedures for training the person with competence in radiation protection and for trainer certification now defines three different sectors of activity, one of which is the “INB – ICPE” sector, encompassing establishments in which one or more BNIs are located and those including an installation subject to licensing on environmental protection grounds. The training includes a theoretical module, common to all the options, and a practical module, specific to each sector. The duration and content of the PCR training programme therefore differ according to the activity sector in which the person is to work and the type of sources used.
- Dosimetry: the procedures for worker medical supervision and transmission of information on individual dosimetry were published in the order of 30 December 2004.
- Radiation protection checks: technical checks on sources and devices emitting ionising radiation, protection and alarm devices and measuring instruments, as well as ambient environment checks, can be entrusted to IRSN, to the department with competence for radiation protection or to organisations certified in application of article R. 1333-44 of the public health code. The procedures for these checks were published in the order of 26 October 2005. In application of articles R. 231-84 of the labour code and R. 1333-44 of the public health code, this order defines the type and frequency of radiation protection technical checks. These concern sources and devices emitting ionising radiation, the environment, measuring instruments and protection and alarm devices, management of sources and of any waste and effluent produced. Some of these checks are carried out as part of the licensee’s in-house control procedures and the remainder by outside organisations (the outside checks must be performed by IRSN or an organisation certified in application of article R. 1333-44 of the public health code). The certification procedures for these organisations were defined in the order of 9 January 2004. ASN is now responsible for examining certification applications submitted by the organisations. A new list of approved organisations was published by an order dated 20 March 2006.

15.1.2.2 General protection of the population

Apart from the specific radiation protection measures taken within the framework of the individual nuclear activity licences for the benefit of the population as a whole and the workers, a number of general measures enshrined in the public health code are aimed at protecting the public against the hazards of ionising radiation from nuclear activities, including those outlined below.

- Intentional addition of natural or artificial radionuclides to consumer goods and construction materials is prohibited, in the absence of a waiver granted under strictly regulated conditions. The use of material or waste from a nuclear activity when the material or waste is contaminated, or likely to be contaminated, by radionuclides as a consequence of the activity is also prohibited.
- The annual effective dose received by a member of the public as a result of nuclear activities is strictly limited (see section 15.1.1.1). The calculation method for the effective and equivalent doses and the methods used to estimate the dosimetric impact on a population are defined by the order of 1 September 2003.

Other measures stipulated in the public health code related to environmental concerns contribute to this objective of general protection of the population, such as:

- the setting-up of a national environmental radioactivity measurement network in order to contribute to the estimation of the doses to which the population is exposed as a consequence of all nuclear activities. This network is being deployed for two main reasons:
  - to develop transparency of information concerning the health impact of nuclear activities in France. Reaching this goal entails a regulatory obligation on most of those involved in the measure (including the nuclear licensees) to transmit their measurement results to the network.
  - to implement a quality policy in the measurement of radioactivity, by setting up a system of certifications.

ASN has the responsibility of defining the directions for this network, full implementation of which is planned for the beginning of 2009 and which will be managed by the Institute for Radiation Protection and Safety (IRSN). It certifies the laboratories that submit data to it.

Management of waste and effluent from BNIs and ICPEs is subject to the provisions of the specific regulatory arrangements concerning these installations. Although directive 96/29/Euratom so allows, French regulations have not adopted the notion of a clearance level, in other words a level of radioactivity below which the effluent and waste from a nuclear activity can be disposed of without monitoring. In practice, waste and effluent disposal is monitored on a case-by-case basis when the activities which generate them are subject to authorisation.

The regulations also do not include the notion of a dose below which no radiation protection action is felt to be necessary. This notion nonetheless appears in directive 96/29/Euratom (10 microsieverts/year).

15.1.3 Basic nuclear installations (BNIs)

BNIs are “nuclear activities”, as defined by the public health code, but are subject to specific regulation and oversight because of the significant risks of exposure to ionising radiation.

The BNI licensee is required to take all necessary steps to protect the workers against the hazards of ionising radiation, and to comply with the same general rules as those applicable to all workers exposed to ionising radiation (annual dose limits, categories of exposed workers, definition of supervised areas and controlled areas, etc.), along with the technical and administrative requirements specific to BNIs (work organisation, accident prevention, keeping of registers, outside workers, etc.). The licensee must also take the steps necessary to attain and maintain an optimum level of protection of the population, in particular by checking the effectiveness of the technical systems implemented for this purpose.

15.1.4 Discharge licences

The normal operation of BNIs produces liquid and gaseous effluent, both radioactive and non-radioactive. The impact of these discharges on the environment and on the health has to be strictly limited.

The installations must therefore be designed, operated and maintained in a way that limits the production and impact of such effluent. These effluents must be treated so that the corresponding discharges are kept as low as reasonably achievable. These discharges must not exceed the limits set on a case by case basis by the public authorities according to the best available technology at an economically acceptable cost and to the particular characteristics of the site. Finally, these discharges must be monitored and their actual impact regularly assessed, in particular with regard to radioactive releases, which are the one truly specific aspect of nuclear installations.

Water intake and discharges of liquid or gaseous effluent, whether radioactive or not, are regulated by ministerial order implementing decree 95-540 of 4 May 1995 concerning BNI liquid and gaseous effluent discharges and water intake.

In particular, discharge licence orders set authorised limits, discharge conditions and practical details of the environment surveillance programme.

Each month the licensee communicates its discharge results to ASN (the NPP discharge surveillance programme is described in appendix 4). These data are regularly reviewed and compared with reactor operations during the corresponding period. Any anomalies detected lead to the licensee being asked for additional information.

ASN has undertaken a revision of discharge licences in order to encourage licensees to maintain their optimisation work and their control of discharges and to set limits closer to the actual discharges. This effort is continuing since the last few years (55% of installations are now fully regulated by provisions implementing decree 95-540 cited previously). The improvements obtained through application of these provisions justify the continuation of this procedure.

The licensees of BNIs are required to calculate the impact of the operation of their installation every year. These calculations show compliance with the maximum public exposure value of 1 mSv/year. The calculation is based on a reference group defined for each installation as the uniform group of individuals most likely to be exposed to the impact of the installation. Lifestyles and the local configuration are taken into account. The dosimetric impacts vary from a few microsieverts to several tens of microsieverts per year, according to the type of installation and the lifestyles of the reference groups chosen.

Decree 95-540 was a key step in improving control of the administrative procedures regulating BNI effluent discharges into the environment.

15.2 Measures taken in the field of radiation protection for power reactors

15.2.1 Radiation protection of workers

Any action taken to reduce the doses received by personnel has to start with thorough knowledge of collective and individual doses. The doses received by workers can result from internal contamination or external exposure to radiation. EDF's "radiological cleanliness" policy and the systematic use of breathing apparatus in the event of a suspected risk of internal contamination, mean that cases are rare and not serious. Since the majority of doses received can be attributed to external irradiation, this is what EDF is endeavouring to reduce.

To better optimise and reduce the doses of exposed individuals, EDF launched an “ALARA 1” policy in 1992. This led to significant improvements, with collective dose falling from 2.4 man-Sieverts per reactor per year in 1992 to 1.08 man-Sieverts in 2000, and 0.69 man-Sieverts by the end of 2006. Special measures have been taken to limit the highest individual doses. The maximum number of workers (EDF staff and contractors) receiving a dose of between 16 and 20 mSv—the statutory limit—was 17 in 2006.

EDF launched a new ALARA initiative in 2000 as part of a wider development in radiation protection management, which places the emphasis in particular on clarification of requirements, rigorous application and reinforced internal checking.

This initiative is based on three areas for improvement.

15.2.1.1 Reduced contamination in systems

Contamination in systems is one of the contributors to radiation exposure. Control of such contamination helps reduce doses during operation and above all during outages. Related actions are in the process of being studied, or have already been implemented, to optimise operating factors and the execution of shutdowns for refuelling, notably by modifying chemical conditions or optimising primary water purification (treatment by filters and resins).

Experience feedback from other countries (USA, Germany, Japan and others) shows that controlled injection of zinc into the primary system is aimed at reducing surface contamination by cobalt (cobalt-58 and cobalt-60). Trials were launched in France in 2004, for a minimum of three cycles each, in two PWR units at the Le Bugey plant.

According to experience feedback from abroad, a reduction of between 10 and 15% in surface contamination by cobalt can be expected for each injection cycle. For example, after two injection cycles in a unit with high doses, deposited Co-58 activity has fallen by 20%, while Co-60 activity remains unchanged. In addition, no negative impact on fuel, effluents or waste has been observed. Depleted zinc (less than 5% Zn-64) is mainly used by licensees to limit the quantity of radioactive zinc in the primary system and the impact on the standard spectrum of waste.

Moreover, as in any fleet of nuclear reactors, differences exist in terms of dosimetric results. Corporate engineering has therefore offered support to sites in understanding and dealing with radiological pollution since 2003.

Successful decontamination carried out in 2004 at Chinon 2 with support from the corporate level made it possible to validate this method. Since then, decontamination work has been carried out at Flamanville 1 in 2006, and is scheduled for Gravelines 3 and Bugey 2 in 2007 and 2008, respectively.

15.2.1.2 Dose optimisation in work planning

The process is as follows:

- individual and collective dosimetry forecasts are prepared;
- activities are classified according to a potential dosimetry level (very low, low, significant or high);
- an optimisation analysis is carried out in respect of activities, with the level of detail varying according to the potential dosimetry;
- collective and individual dosimetry targets are set for each activity on the basis of the optimisation analysis;
- collective and individual dosimetry during activities is monitored in real time, and any deviations are analysed and dealt with;
- experience feedback is collected, and deviations and good practices are analysed in order to benefit future activities.

Activity planning includes an assessment of individual and collective dosimetry, with the level of analysis depending on the potential dosimetry for the operation. The optimisation phase is aimed at reducing previously assessed doses.

For work with a significant or high potential dosimetry, activity planning must include an analysis of the worksite by a two-person team comprising one person competent in radiation protection and one person holding "prime contractor" responsibility for design. For the highest potential dosimetries, the operation is studied phase by phase and worker by worker to determine the best adapted protective equipment, tools and working methods. Individual and collective dose targets are set following the optimisation stage.

The individual and collective dose targets are indicators that enable workers to detect any dosimetry-related deviation.

Optimisation is a continuous improvement process, since analysis after the work has been completed must enable further optimisation of future work.

This dosimetric analysis process, from initial assessment to final optimisation, and concluding with integration of experience feedback, is now carried out using a new computer application, PREVAIR, shared by all nuclear sites and corporate engineering groups, and currently being rolled out to contractors.

PREVAIR enables preparation and optimisation of dosimetry forecasts, in advance of the activity itself.

In the execution phase, PREVAIR allows automated collection and tracking of doses received for each job. In addition, working in combination with new dosimeters equipped with alarms which are progressively being put into service at nuclear sites, the system enables reinforced protection of individual workers by adapting the alarm thresholds of their dosimeters to the dosimetric forecast for their work.

On completion of a job, PREVAIR allows experience feedback to be built up by archiving doses received in respect of each job.

The operational dosimetry put in place by EDF in the early 1980s, which was computerised in the early 1990s, became a statutory requirement for all work inside controlled areas in accordance with the decree of 24 December 1998, which amended decree 75-306 of 28 April 1975, and was incorporated into article R.231-94 of the French labour code by decree 2003-296 of 31 March 2003, enables real-time monitoring of worker dosimetry during operations inside controlled areas, and display of deviations in respect of set targets.

In addition, to control the risk of acute exposure, EDF has introduced an initiative to enhance the safety and security of radiographic examinations, in close cooperation with industrial gamma radiography contractors.

15.2.1.3 Use and dissemination of experience feedback

To limit the doses received by workers, EDF took proactive steps to reduce the annual exposure limit to 20 mSv in 2000. In addition, alarm thresholds have been implemented in the application for managing operational doses used at all EDF nuclear sites. The thresholds have been set at 16 and 18 mSv. Monitoring of worker dose on entry to the controlled area takes into account not only their dose over the past 12 months, but also their dosimetric forecast. If these values are reached, special consultation procedures involving workers, doctors and radiation protection specialists are put into action, leading to an assessment and detailed optimisation of subsequent doses, as well as enhanced follow-up to prevent statutory limits from being exceeded.

Jobs identified as receiving the highest levels of exposure (insulation fitters, welders, mechanical maintenance technicians and logistics personnel) are subject to specific follow-up. This has delivered concrete results, with individual doses, although still high, showing a constant decrease for the past four years.

EDF is working in partnership with contractors to target organisational and equipment-related improvements at insulation fitters, who receive the highest average individual dose.

15.2.2 Radiation protection of the public

15.2.2.1 Effluent discharges

Regulations on discharges of radioactive effluents comprise general texts described in Section 15.1.4, and specific orders for each site.

The general regulations define in particular the following:

- procedures for obtaining discharge authorisations;
- conditions for discharge, and associated standards;
- the role and responsibilities of nuclear site managers.

The orders specific to each site stipulate in particular:

- limits that must not be exceeded (authorised annual limits, maximum concentrations added to the receiving environment);
- discharge conditions;
- procedures of the environmental monitoring programme.

The concentration limits are associated with annual total activity limits set for reasons of effective management. For a given type of reactor, these limits depend on installed capacity. They obviously meet health criteria with an acceptable margin, including for the largest sites.

This regulatory framework also involves the implementation of the optimisation principle, the aim of which is to reduce the impact of radioactive discharges to a level which is "as low as reasonably achievable given economic and social factors". This approach was integrated into the design of facilities (through the installation of effluent treatment capabilities, etc.) and has resulted in the implementation of rigorous management of effluents during operation.

These measures led to a very significant reduction in liquid effluent discharges, excluding tritium, which were originally the predominant contributor to environmental and health impact (dose).

The substantial reduction in liquid discharges excluding tritium observed for a number of years means that, today, the dosimetric impact of discharges from a power plant is chiefly governed by discharges of tritium and carbon-14.

The dosimetric impact of radioactive discharges nonetheless remains extremely low, at approximately 1 to a few microsieverts per year, calculated for the reference group living close to a power plant. This value is well below the natural exposure level in France (2400 microsieverts per year) and the exposure limit for the general public (1000 microsieverts per year).

15.2.2.2 Environmental monitoring

Environmental monitoring encompasses continuous monitoring of the environment, as well as measurements relating to radioactive and non-radioactive discharges into the environment. The environment begins at the exit from the controlled area. Monitoring of site roads and monitoring of radioactivity on leaving the site therefore fall within the scope of environmental monitoring.

Environmental monitoring is a regulated activity, the quality of which is monitored.

Environmental monitoring by the licensee performs three technical functions:

- alert function;
- monitoring function;
- tracking and study function.

The alert function enables prompt information regarding environmental anomalies. It concerns variations in measurements which may be directly linked to the operation of the power plant.

At EDF, the alert function encompasses monitoring at the point of emission and continuous recording of the ambient gamma radiation around the power plant, automatic chemical monitoring of the receiving environment for riverside power plants, and radiation portal monitors at the site entrance and exit.

The monitoring function ensures compliance with regulations. It compares parameters with associated limits. The monitoring function consists of the checks stipulated by discharge licences and the checks on the presence of radioactivity on roads.

The scientific tracking and study function enables identification and prediction of changes. It tracks parameters which evolve slowly and which are generally linked to an integrating phenomenon. The tracking function comprises radioecological studies (ten-yearly and annual assessments, special studies, helicopter surveillance, etc.), and hydro-ecological campaigns.

In addition to these technical functions, the communication function encompasses communications with the authorities and the general public.

Following the establishment by the French authorities of the national environmental radioactivity measurement network, all environmental laboratories at EDF power plants embarked on the process of gaining certification for this network, via accreditation to the standard ISO 17025.

The first two EDF power plants, acting as the pilot plants for this process, Belleville and Fessenheim, were accredited by COFRAC in January 2007.

In addition, radioecological monitoring is carried out on an annual basis at all operating nuclear sites. It is part of a monitoring programme defined in a framework agreement with IRSN. This monitoring has been carried out across the entire nuclear fleet since 1992, and provides an overview of the plants' impact in terms of both space and time.

A ten-yearly assessment, similar to the baseline measurements performed at the time of commissioning the first unit at a site, is also carried out. All the sites have now conducted their first ten-yearly assessment. Second ten-yearly assessments, which began at Fessenheim in 1998, were carried out at Cruas in 2004, St-Alban and Paluel in 2005, and Flamanville in 2006.

As of the end of 2006, 12 NPPs out of 19 had carried out their second ten-yearly assessment.

Analysis of the results of radioecological tracking confirms that atmospheric discharges have no impact on the terrestrial environment.

In the aquatic environment, radioelements originating from liquid discharges from power plants are detected in trace quantities in sediments and aquatic vegetation close downstream from the discharge point.

15.3 Measures taken in the field of radiation protection for research reactors

15.3.1 Radiological monitoring at the CEA

Staff are subject to radiological monitoring at each site by specialist teams who are responsible for assigning and checking the passive dosimeters of every CEA employee. All the data collected are sent to IRSN. Each employee who enters a controlled area is also given a Dosicard personal dosimeter, so that any doses he or she receives may be monitored continuously.

Subcontractors are monitored by certified organisations, including IRSN, who provide dosimetric film and measure the dose. This monitoring is supplemented by Dosicard personal dosimeters, issued and analysed by qualified CEA staff on site.

The discharge of gaseous and liquid radioactive effluent is subject to:

- national regulation that applies to nuclear installations. This defines the general rules for discharges, the way in which the licence and declaration procedures work, the responsibilities of the various authorities, and the general rules relating to the investigation and monitoring of the environmental impact of such discharges;
- regulation specific to each site. This sets the annual authorised limits for discharges and the ways in which the environment is monitored.

The environmental monitoring programme is set up and maintained at each site by services with competence in radiation protection, and is supervised by ASN.

Over the last few years, the discharges have remained significantly below what is authorised, amounting to only to a few per cent of the permitted levels.

15.3.1.1 The Phénix reactor

The radioactivity in gaseous discharges (mainly as noble gases) from all the plant's installations is of the order of 5 TBq per year, and does not exceed one hundredth of the discharges authorised for normal operation. Thus the dosimetric impact is very small, significantly less than 0.1 µSv/year.

A fast-breeder reactor does not produce liquid effluent in normal operation, only during operations to clean irradiated assemblies or exceptional operations to decontaminate primary-system components.

The Phénix installation's radiation protection service comprises 15 people, of whom 10 provide continuous cover, to ensure the installation and staff are monitored.

In compliance with current rules, managing radiation protection includes:

- zoning that is clear and known to all;
- continuous management of radioactive materials, including nuclear materials;
- applicable procedures written clearly and in detail;
- the application of the ALARA principle, particularly to work sites.

The effectiveness of the current system and the continuous effort to reduce dose is demonstrated by the dose history for personnel both at the Phénix site and belonging to external contractors over the last 30 years: no-one has been exposed to an annual dose of more than 20 mSv and the total dosimetry (personnel + outside contractors) over that period is 2.2 person.Sv, or a total average annual dose of less than 0.075 person.Sv. During 1999 and 2000, when there were a large number of work projects, the total annual dosimetry (personnel + outside contractors) remained below 0.120 person.Sv.

The total dose may vary from one year to the next depending on the operations in progress. Outside periods of significant works, the total dosimetry is much lower (around 0.040 person.Sv/year in 2002, 2003, 2004, 2005 and 2006). The very low collective doses received during operations to inspect the reactor structures are another demonstration of the good practice current at the plant.

15.3.1.2 Other CEA reactors

For all the CEA's research reactors, liquid and gaseous discharges remain very low, at a few per cent of the authorised discharge limits.

To ensure that the installation and the personnel are monitored, the radiation protection service has a team at each installation with sufficient staff to provide an uninterrupted service outside normal hours.

As for the Phénix plant, managing radiation protection includes:

- zoning that is clear and known to all;
- continuous management of radioactive materials, including nuclear materials;
- applicable procedures written clearly and in detail;
- the application of the ALARA principle, particularly to work sites.

The effectiveness of the current system is demonstrated by the dose history for personnel both at the installations, and belonging to external contractors over the last few years: in 2006, just one person received an annual dose of more than 5 mSv; the total dosimetry (personnel + outside contractors) remained below 0.12 person.Sv for those provided with an operational dosimeter.

15.3.2. Radiological monitoring at the RHF

The radiation protection service providing ILL and personnel monitoring comprises 9 persons. They have a continuous presence at the ILL site outside normal hours.

Managing radiation protection includes:

- clear and comprehensive zoning for all BNI premises;
- continuous management of radioactive materials, including nuclear materials;
- applicable procedures written clearly and in detail;
- the application of the ALARA principle, particularly to work sites. In particular, DMC 2000S dosimeters are used for operational dosimetry. They can be read in real time by terminals sited appropriately throughout the installation, ensuring all exposed workers are properly tracked.

The effectiveness of the entire current system of radiation protection is demonstrated by the dose history for BNI personnel, for invited researchers and for staff from external contractors over the last few years. In 2005, no personnel received an annual dose above 10 mSv, and the average individual dose did not exceed 0.67 mSv for Category A staff, despite the amount of works carried out to strengthen earthquake resistance and the very significant maintenance and renovation work completed during the major outage in that year. The average or total dosimetry (personnel + researchers + outside contractors) was below 0.05 mSv for the 2,000 persons who wore a dosimeter.

Gaseous discharges were of the order of 10% to 20% of the authorised limit for tritium, and only a few per cent for the other categories of radioactive elements.

Liquid discharges were of the order of 10% of the authorised limit both for tritium and for the other categories of radioactive elements.

15.4 Regulatory oversight in radiation protection

ASN is working to define guidelines on environmental monitoring. To this end it organises a broadly-based working group (associations, ministry representatives, IRSN, LICs, etc.) with a view to producing an official radioactivity monitoring strategy. Implementation of this strategy will satisfy the requirement of article 4 of the act of 13 June 2006.

The general monitoring of the levels of radioactivity on French territory is performed by IRSN. In addition to this monitoring, BNI licensees are required by their discharge orders to monitor radioactivity in the vicinity of their installations.

The radiological monitoring of the environment performed by IRSN has the following objectives:

- to verify the healthy and compliant state of radioactivity levels in the environment, with a link to a warning system;

- to contribute to monitoring of radioactive sources and participate in compliance with and updating of the regulations on installations likely to discharge radionuclides into the environment;
- to observe the spatial and temporal changes in the radiological quality of environments in order to assess improvements in the management of radioactive emission sources;
- to provide information to the population on the radiological state of the environment of the food chain.

15.4.1 General monitoring of the environment

The environment is monitored by measurement and sampling networks for:

- air monitoring (aerosols, rainwater, ambient gamma activity);
- monitoring of surface water (rivers) and underground water (water tables);
- monitoring of the human food chain (milk, cereals, food intake);
- terrestrial continental monitoring (reference stations distant from any nuclear or industrial installation).

Two approaches are used:

- continuous on-site monitoring by self-contained systems (remote monitoring networks) with real-time transmission of results, including:
  - the Téléray network (ambient gamma radioactivity in the air) based on 180 measurement detectors;
  - the Sara network (radioactivity of atmospheric aerosols);
  - the Hydrotéléray network (monitoring of the major rivers, downstream of all nuclear installations and before they leave French territory);
  - the Telehydro network (wastewater monitoring in the treatment plants of major French conurbations);
- laboratory processing and measurement of samples taken in various compartments of the environment in the vicinity of or away from installations likely to discharge radionuclides (sampling networks, such as OPERA).

15.4.2 Monitoring the environment of nuclear reactors

Nuclear reactor discharge surveillance is first and foremost the responsibility of the licensee. The discharge licences stipulate minimum checks that have to be made by the licensee. These checks in particular concern effluent (monitoring of discharge activity, characterisation of certain types of effluent prior to discharge, etc.). They also include provisions for monitoring in the environment (checks at mid-discharge, sample taking of milk, grass, etc.). Finally, related parameters must also be measured (in particular meteorology). The environmental surveillance around NPPs is described in appendix 4.

The results of the regulatory measurements must be recorded in registers forwarded on a monthly basis to ASN, which checks them.

The licensees also regularly send to IRSN a number of discharge samples for analysis. The results of these "cross-checks" are communicated to ASN.

The cross-check programme, specified by ASN, is designed to provide assurance that the results obtained by the licensees are sound.

Finally, ASN ensures, through a system of unannounced inspections, that the licensees comply with the provisions of the regulations. During these inspections, nuclear safety inspectors, who may be assisted by a technician from an independent specialist laboratory, verify compliance with the licences, have samples taken from the effluent or from the environment and have them analysed by the laboratory. Since 2000, ASN has carried out 10 to 30 inspections with sampling per year (17 in 2006).

15.5 Summary of regulatory monitoring and checks

15.5.1 Doses received by nuclear workers

The new certification procedures for worker dosimetry organisations were published at the end of 2003 (order of 6 December 2003). They were supplemented at the end of 2004 by an order (of 30 December 2004) defining the procedures for medical monitoring of workers and for communication of information on individual dosimetry.

Several organisations (6 in 2005) have been certified for dosimetric monitoring (passive dosimetry or internal dosimetry). All results must nevertheless be transmitted to IRSN, which manages the national dose file (the new system, SISERI, was introduced in February 2005).

With regard to operational dosimetry, the person with competence in radiation protection is required to communicate the recorded doses periodically to IRSN.

The system for monitoring the exposure of people working in installations in which ionising radiation is used has been in place for several decades. Based on mandatory wearing of a passive dosimeter by workers likely to be exposed, supplemented if necessary by an operational dosimeter for personnel working in controlled areas, it verifies compliance with the regulatory limits applicable to workers; the recorded data provide the cumulative exposure dose over a defined period (month or quarter).

The summary of the dosimetric monitoring of persons working in BNIs is drawn up by IRSN every year. The most recent summary published, that for 2005, showed that only two workers in the nuclear industry received doses exceeding the regulatory limit of 20 mSv, although remaining below 50 mSv.

15.5.2 Monitoring of population and environment exposure

The results of radiological monitoring of French territory are published annually by IRSN. As an illustration, the results obtained by the networks for continuous measurement of ambient gamma dose rates and TLD are given in appendix 4.

In contrast, for methodological reasons, there is no overall system enabling comprehensive estimation of the doses received by the population as a consequence of nuclear activities.

15.5.3 Monitoring of discharges

Basic nuclear installation licensees are required to publish an annual report recording the discharges by their installations. The graphs in appendix 4 illustrate the significant changes in discharges from NPPs over the last ten years.

16. Article 16: Emergency preparedness

1. *Each Contracting Party shall take the appropriate steps to ensure that there are on-site and off-site emergency plans that are routinely tested for nuclear installations and cover the activities to be carried out in the event of an emergency.*

   For any new nuclear installation, such plans shall be prepared and tested before it commences operation above a low power level agreed by the regulatory body.
2. *Each Contracting Party shall take the appropriate steps to ensure that, insofar as they are likely to be affected by a radiological emergency, its own population and the competent authorities of the States in the vicinity of the nuclear installation are provided with appropriate information for emergency planning and response.*
3. *Contracting Parties which do not have a nuclear installation on their territory, insofar as they are likely to be affected in the event of a radiological emergency at a nuclear installation in the vicinity, shall take the appropriate steps for the preparation and testing of emergency plans for their territory that cover the activities to be carried out in the event of such an emergency.*

16.1 General organisation

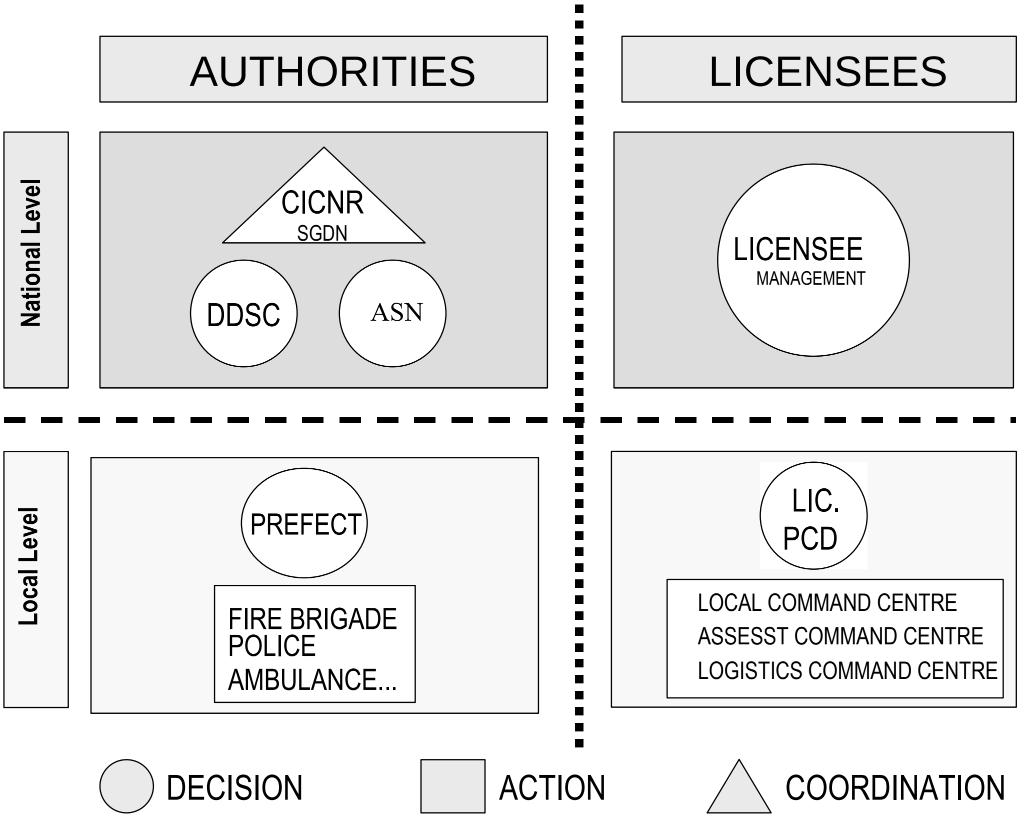
The organisation of the authorities in the case of incident or accident is defined by a number of legal texts concerning nuclear safety, radiation protection, public order and civil defence, as well as by the emergency plans.

Act of 13 August 2004 on the modernisation of civil defence defines new guidelines. It in particular provides for an updated inventory of risks, an overhaul of operational planning, the performance of exercises involving the population, information and training of the population, an operational watch and a warning system. A number of decrees implementing this act were published in 2005, in particular:

- decree 2005-1158 of 13 September 2005 on off-site emergency plans (PPIs);
- decree 2005-1157 of 13 September 2005 on the ORSEC plan (general plan organising the emergency services if a disaster is declared by the State at departmental, defence zone, or *maritime Préfecture* level);
- decree 2005-1156 of 13 September 2005 on the local safeguard plan.

Act of 13 June 2006 on transparency and security in the nuclear field stipulates that ASN assists the government on all matters within its competence and defines the tasks of ASN. These tasks are described in section 16.2.1.

The scope of a nuclear emergency and more generally of any radiological emergency, is clarified in the government directives cited above. The response organisation of the authorities and of the licensee is presented in the diagram below, for the case of an accident in an EDF reactor. A similar organisation is set up when dealing with another nuclear licensee or in the event of an accident involving radioactive material transport.



Independently of bilateral agreements on information exchange in the case of incident or accident with potential radiological consequences, France is party to the convention on early notification of a nuclear accident and applies the Council of the European Communities decision of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency. France is also party to the convention on assistance in the case of a nuclear accident or radiological emergency.

Two government directives of 30 May 2005 and 30 November 2005 specify the procedures for application of these texts in France and mandate ASN as the competent national authority.

Exercises are periodically organised to train emergency teams and to test resources and organisations with a view to identifying possible weak points.

16.1.1 Local provisions

In an emergency situation, only two participants are empowered to take operational decisions:

- the licensee of the affected nuclear installation, who must implement the organisational provisions and the means needed to bring the accident under control, to assess and mitigate its consequences, to protect site staff and to alert and regularly inform the authorities; these measures are defined in the on-site emergency plan (PUI), which the operator is required to prepare;
- the prefect of the *département* where the installation is located, who is responsible for deciding on the measures required to ensure the protection of both the population and property at risk owing to the accident. The prefect acts within the framework of the off-site emergency plan (PPI) prepared specifically for the vicinity of the installation considered. He or she is thus responsible for coordination of the resources committed to the PPI, both public and private, equipment and manpower. He or she keeps the population and the authorities informed of events.

16.1.2 National provisions

The ministries concerned, and ASN, make arrangements to advise the prefect on the steps to be taken, notably by providing, as does the licensee, information and opinions which could assist him in his appraisal of the condition of the installation, the seriousness of the incident or accident and possible subsequent developments.

The main bodies concerned are:

- the Ministry of the Interior: the Directorate for Civil defence and security (DDSC), which has at its disposal the Operational Centre for Interministerial Emergency Provisions (COGIC) and the Nuclear Risk Management Aid Mission (MARN), providing the prefect with the human and material reinforcements needed to protect people and property;
- the Ministry for Health, which is responsible for human health protection against the effects of ionising radiation;
- the ministries in charge of nuclear safety: the Minister for Industry also coordinates national communications in the event of an incident or accident affecting a nuclear installation under his responsibility, or occurring during radioactive material transport;
- General Secretariat for National Defence (SGDN): SGDN handles the secretarial functions for the Interministerial Committee for Nuclear and Radiological Emergencies (CICNR). It is responsible for coordinating the action of the ministries concerned regarding the planned measures in the event of an accident and for ensuring that exercises are scheduled and then assessed. The CICNR is convened at the initiative of the Prime Minister. Its role is to coordinate governmental action in the event of a radiological or nuclear emergency. In 2006, the CICNR was convened for the major nuclear emergency exercise carried out at Chinon on 9 November 2006;
- Météo France assists the public authorities, in particular in the case of accidental release of hazardous materials into the atmosphere or where there is a risk of such release.
- ASN, as stipulated in the act of 13 June 2006, participates in the management of radiological emergencies. It assists the government with all questions under its responsibility and informs the public about the safety of the installation in which the emergency originated. The ASN organisation makes use of its regional divisions and its technical support organisation IRSN.

16.1.3 Emergency plans

16.1.3.1 General principle

Application of the defence-in-depth principle implies inclusion of occurrence of severe accidents with a very low probability in the preparation of the emergency plans, in order to determine the measures necessary to protect plant personnel and the population and bring the accident under control.

The on-site emergency plan (PUI), prepared by the licensee, is aimed at restoring the plant to a safe condition and mitigating accident consequences. It defines the organisational provisions and the resources to be implemented on the site. It also comprises provisions for rapidly informing the authorities. The PUI is activated by the licensee based upon predetermined criteria, related to the condition of the installation or its environment, or at its own initiative when it feels the situation so warrants.

The purpose of the off-site emergency plan (PPI), prepared by the prefect, is to protect populations in the short term in the event of potential danger and provide the licensee with outside assistance. It defines the tasks assigned to the various services concerned, the warning system utilisation instructions and the material and human resources. The PPI is activated if measures to protect the population appear necessary (sheltering, administration of stable iodine tablets, evacuation, etc.).

16.1.3.2 Technical basis and countermeasures of emergency plans

The emergency plans must allow an effective response to accidents liable to occur at BNIs. This implies the definition of a technical basis, i.e. the adoption of one or more accident scenarios identifying the possible health consequences, with a view to determining the nature and extent of the resources that will be needed. The approach relies primarily on a conservative theoretical approach leading to estimation of the source terms, then calculation of their dispersal in the environment, and finally assessment of their radiological impact.

Based on response levels defined by the Ministry for Health, it is then possible to define in the PPI the population protection measures which appear justified to limit the direct impact of the release. Such measures could include:

- sheltering in dwellings, aimed at protecting inhabitants from direct irradiation by the radioactive plume and reducing the inhalation of radioactive substances;
- intake of stable iodine in addition to sheltering in cases where the release contains radioactive iodine (notably iodine-131);
- evacuation in situations where the above measures provide insufficient protection owing to the extent of the release.

To give an example, the maximum PWR accident considered could result in a decision, taken within 12 to 24 hours, to shelter populations and organise intake of stable iodine within a 10 kilometre radius and evacuate the population within a 5 kilometre radius.

It should be noted that the off-site emergency plans only comprise emergency measures and do not preclude steps that might be taken in the longer term and over longer distances, such as foodstuff consumption restrictions or clean-up of contaminated areas.

16.2 The role and organisation of ASN

16.2.1 ASN's role in an emergency

In an emergency situation, ASN, with the support of IRSN, has four tasks:

- ensure that sound measures are taken by the licensee;
- advise the prefect;
- contribute to the circulation of information;
- act as competent authority within the framework of the international conventions.

16.2.1.1 Supervision of licensee actions

In the same way as in normal operating conditions, licensee actions are supervised by ASN in an emergency situation. In this particular context, ASN must ensure that the licensee fully carries out its duty to control the accident, minimise the consequences and rapidly and regularly inform the authorities, but it will not attempt to replace the licensee in implementing the technical measures to deal with the accident. In particular, when several action strategies are available to the licensee to control the accident, some of which could have substantial environmental consequences, ASN must monitor the conditions under which the licensee makes its choice.

16.2.1.2 Advising the prefect

The decision by the prefect concerning the population protection measures to be taken depends on the actual or foreseeable consequences of the accident around the site. It is up to ASN to inform the prefect of its stance on this subject, on the basis of the analysis performed by IRSN. This analysis combines diagnosis (understanding of the situation at the plant concerned) and prognosis (assessment of possible short-term developments, notably radioactive release). This advice also concerns the steps to be taken to protect the health of the public.

16.2.1.3 Circulation of information

ASN is involved in several ways in the circulation of information:

- information of the media and the general public: ASN contributes to informing both the media and the general public in different ways (press releases, press conference). It is important that this should be done in close collaboration with the other organisations who are themselves involved in communication (prefect, local and national licensee, etc.);
- information of the authorities: ASN keeps the Ministers informed, together with the SGDN, which in turn informs the President of the Republic and the Prime Minister;
- information of foreign safety authorities: without prejudice to application of the international conventions signed by France concerning information exchanges in the event of an incident or accident liable to have radiological consequences, ASN informs foreign safety authorities, in particular those with which there are mutual safety information agreements.

16.2.1.4 The function of competent authority as defined by international conventions

ASN acts as competent authority with regard to international conventions (convention on early notification of a nuclear accident and Council of the European Communities decision of 14 December 1987 on Community arrangements for the early exchange of information in the event of a radiological emergency). In this capacity, it collects and summarises information in order to provide the notifications and information stipulated by these conventions on informing third countries in the event of radiological emergency. This information is communicated to international organisations (IAEA and European Union).

16.2.2 Organisation provisions as regards nuclear safety

16.2.2.1 Main action centres

In the event of an incident or accident occurring in a BNI, ASN, with its regional divisions and its technical support organisation IRSN, sets up the organisation described below.

16.2.2.1.1 At national level

- a decision-making body or command centre (called PCD), located in ASN's emergency management centre in Paris. This body is managed by the Director General of ASN or his representative. Its role is to adopt a stance or make decisions, but not to undertake technical analysis of the accident in progress. An ASN spokesperson, who is not the PCD manager, is appointed to represent ASN with the media;
- an information unit located close to ASN's PCD, run by an ASN representative assisted by staff from the communication service of the Ministry of the Economy, Finance and Employment;
- an emergency response analysis team, led by IRSN's Director General or his representative. This team is located at IRSN's technical emergency centre (CTC). It must work in close collaboration with the licensee's technical teams in order to reach common views on analysis

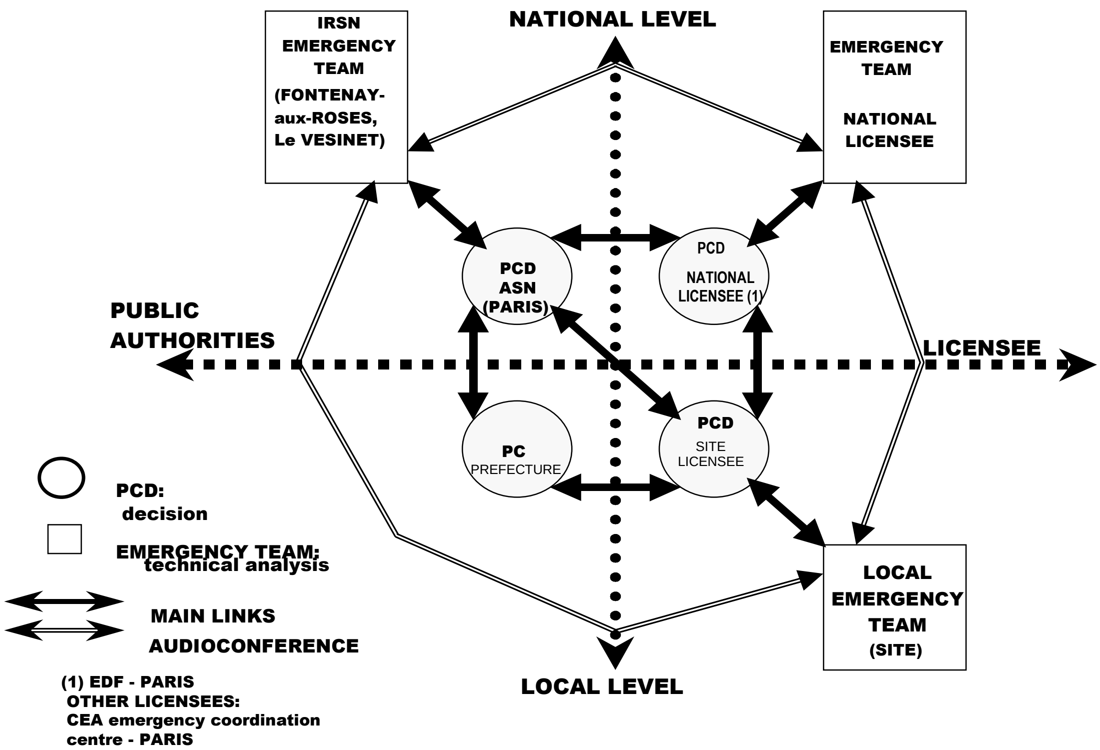
of the accident situation and prediction of how it will develop and what its consequences are likely to be.

16.2.2.1.2 At local level

- a local team at the prefect's offices, consisting mainly of staff from ASN's regional offices, whose purpose is to assist the prefect in making his decisions and implementing his communication actions by providing explanations enabling understanding of the technical aspects involved, in close collaboration with ASN's PCD;
- a local team at the accident site, also consisting of staff from ASN's regional offices, near the site PCD manager. This team does not take part in the licensee's decisions, but ensures that the licensee assumes its responsibilities in full and in particular that it correctly informs the authorities. The local team also collects any information of use to the inquiry that will follow the accident.

The ASN, its technical support organisation IRSN and the main nuclear licensees have signed protocols covering the setting-up of the emergency organisation. These protocols identify the responsible persons in the event of an emergency and define their respective roles and the communication methods to be employed.

The diagram below gives an overview of the planned safety organisation, linked with the prefect's offices and the licensee. It shows that the licensee has a local PCD on the site, and usually a national PCD in Paris, each in contact with its own technical emergency team. The various links shown in this diagram represent the exchange of information streams.



In addition an organisation following the same pattern is set up between the communication units and the PCD spokespersons with a view to allowing the necessary consultation ensuring consistency of the information issued to the public and the media.

16.2.2.2 ASN's emergency response centre

In order to be able to carry out these assignments, ASN has its own emergency centre, equipped with communication and data processing facilities enabling:

- swift mobilisation of ASN staff; and
- reliable exchange of information between the many partners concerned.

During the period under consideration, this emergency centre was activated in a real situation on several occasions, details of which are given in the table below.

Activation of the ASN emergency centre in real situations

Date	Site	Alert	Event
2 and 3 December 2003	Cruas NPP then Le Tricastin NPP and BCOT* at Pierrelatte	General	Violent storms over the Rhône valley
16 May 2004	Cattenom NPP	General	Fire in the non-nuclear zone
30 September 2005	Nogent-sur-Seine NPP	General	Incident on one of the reactors following water spraying on the rector electrical control cubicles
27 October 2005	Le Blayais NPP	General	Pressure increase in the core cooling system of one reactor
20 June 2006	Lorraine	Restricted	Radioactivity increase (Nancy detector triggered on 18 June 2006 and rumour at Metz military hospital)
8 December 2006	CEA Cadarache	General then restricted	Fire in a compartment of an ICPE
5 April 2007	RN4 at Fère-Champenoise (Marne)	Restricted	Road accident involving a van carrying a radioactive package
10 April 2007	Dampierre NPP	General	Incident on reactor 3 following an electricity supply failure
16 April 2007	Saône-et-Loire	Restricted	Fall during road transport of a package containing contaminated material from Dampierre NPP to BCOT*

*BCOT: nuclear maintenance facility

As demonstrated by these events, the ASN alert system allows swift mobilisation of ASN staff and of the IRSN duty engineer. This automatic system sends out an alert signal to all staff carrying radio-pagers or mobile telephones as soon as the alert is triggered remotely by the licensee of the nuclear installation in which the alert originated. It also sends the alert to the staff of the DDSC, the SGDN and Météo-France. This system is regularly tested during about ten exercises a year, as well as when actual emergencies occur.

In addition to the public telephone network, the emergency response centre is connected to several restricted access networks providing secure direct or dedicated lines to the main nuclear sites. ASN's PCD also has a video-conferencing system which is the preferred means of contact with the IRSN's CTC. The PCD also makes use of IT equipment adapted to its assignments, in particular for information exchanges with the European Commission and the Member States.

Since 2005, the PCD has had access to the dose rate values permanently measured by IRSN's Téléray network of probes.

16.2.3 Role of ASN in the preparation of emergency plans

16.2.3.1 Oversight of on site plan preparation and implementation

Since January 1990, along with the safety analysis report and the general operating rules, the on-site emergency plan is one of the safety documents which the licensee must submit to ASN at least six months before the use of radioactive materials in a BNI. In this context, the PUI is analysed by IRSN and the relevant advisory committee of experts issues an opinion on it.

ASN ensures proper implementation of on-site emergency plans in particular through inspections and exercises.

16.2.3.2 Participation in off-site emergency plan preparation

In application of the 13 September 2005 orders on the PPI and the ORSEC plan, the prefect is responsible for preparing and approving the PPI. He is assisted by ASN, which supplies the basic technical elements, as derived from IRSN's assessment, taking account of the most recent available data on serious accidents and dispersion of radioactive or chemical materials and ensuring consistency in this respect between the PPI and the PUI.

Definition of the response levels is based on the most recent international recommendations and, since 2003, has been stipulated in regulatory requirements.

16.3 The role and organisation of reactor licensees

16.3.1 Role and organisation of EDF

The establishment of an emergency response organisation (PUI - on-site emergency plan) is a regulatory requirement, the objective of which is to cover situations that present a significant risk to the safety of installations, and which may or may not lead to radioactive discharges into the environment. The emergency response organisation adopted by EDF as the nuclear licensee fully meets this objective.

Outside this scope, there are also a vast number of situations at an installation that require a rapid response. Some of these situations are of an obviously emergency nature (for example fires and accidents involving injuries). Other situations, the short-term consequences of which are less significant, are nevertheless liable to lead to an emergency if appropriate management measures are not rapidly implemented.

Consequently, the areas covered by the emergency response organisation are as follows:

- situations in which an on-site emergency plan is triggered for nuclear safety and radiological reasons are those in which the safety of installations is significantly affected and/or those in which there is a risk of radioactivity release inside the installation and/or into the environment that is likely to lead to exposure of persons working outside the controlled area or of neighbouring populations. The criteria for triggering a safety and radiological on-site emergency plan are contained in accident operating procedures, site protection instructions and alarm response sheets;

- It is also necessary to specify the other situations covered, in respect of which an appropriate internal organisation has to be put in place, in advance, to prevent a genuine emergency from developing, and to provide an appropriate response, by bringing together the necessary resources that are adapted to the situation.

The following distinctions can be made with regard to situations other than safety and radiological on-site emergency plan situations (not an exhaustive list):

- situations requiring triggering of a conventional on-site emergency plan (fires, and accidents involving injuries). In these situations, teams from departments on 24-hour duty (known as first-line and second-line response teams) are responsible for taking the first actions to fight a fire or provide aid to persons involved. External emergency services (SDIS, SMUR, SAMU) are always called in the event of a fire that is not controlled by the individual reporting it, or in the event of serious injury. External emergency services are always called before this on-site emergency plan is implemented;
- certain situations involving external hazards of climatic or human origin are also taken into account. In such cases, the analysis of the organisation to respond to these events is already pre-defined (examples include flooding risk in the event of extreme weather conditions, potential loss of heat sink in the event of pollution by a drifting hydrocarbon slick, or malevolent actions). For such hazards, the emergency response organisation put in place at local and corporate level is designed to manage an event affecting several units at an NPP, or several sites.

The emergency response organisation adopted by EDF to respond to these situations since the start of operation of its NPP fleet is based on human and equipment resources that can be mobilised 24 hours a day, seven days a week, in response to a call from an NPP to the national emergency response director (the Director of the Nuclear Power Generation Division, or his/her representative). Responsibility for triggering the on-site emergency plan, or the specific organisation to respond to the situations described above, lies with the unit manager or his/her representative, on the basis of pre-defined trigger criteria.

The emergency response organisation mobilised following triggering of an on-site emergency plan comprises a corporate level (Group management, nuclear operations management and corporate engineering) and a local level (senior NPP management). The organisation is structured into teams (known as emergency centres) which cover the four main areas of emergency management (expert assessment, decision-making, action and communications).

16.3.1.1 Structure of EDF's emergency response organisation, and tasks of the different units

Local level

The unit manager or his/her representative is responsible for managing the emergency response. As the emergency response director, he/she leads the local management emergency centre, which helps him or her to assess situations, define strategies for action, inform the corporate emergency centre and local public authorities, and communicate with the media.

The emergency response director is responsible for the safety of installations, for safeguarding equipment, and for protecting persons present on site. In this capacity, he/she is responsible for decisions relating to the operation of installations (outside the scope of incident and accident procedures) and for protecting workers on site.

The operations team of the affected unit is primarily responsible for restoring the situation. This team makes up the local emergency centre (PLC), under the responsibility of the shift operations manager, which is responsible for taking operating actions in accordance with applicable procedures. In addition to continuous operation and monitoring of the installation, a further specific task in incident situations is the transmission of technical data concerning the installation's state, using, in particular, pre-formatted messages.

The local management emergency centre is supported by two expert assessment teams:

- the local emergency response team (ELC), which is more specifically responsible for analysing the installation's state and predicting developments;
- the assessment control centre (PCC), which is responsible for assessing the consequences of the accident for the public and the environment.

All technical information concerning the installation is sent to the local emergency response team (via messages or parameters relayed via computer systems). Technical information concerning environmental monitoring is available at the assessment control centre. Environmental monitoring in accident situations is based largely on the monitoring resources used during normal operation. Radioactivity in the environment is monitored continuously by means of a network of radiation detectors located around the plant. Additional radiation measuring equipment is also located round the perimeter fence and in the vicinity of the plant within a radius of 10 km. Each NPP also has two laboratory vehicles fitted with measuring equipment (for measurement of external exposure and contamination, as well as gamma spectrometry) and sampling apparatus.

Meteorological data (wind speed and direction, atmospheric diffusion conditions (stability) and precipitation) are provided by the meteorological station on or close to the site. Weather forecasts from Météo France (the French national weather service) are supplied at local and national level under a national agreement to enable predictions to be made regarding the consequences of an accident.

In accordance with a specific protocol agreed between EDF, ASN and IRSN, both teams (the local emergency response team, and the assessment control centre) provide information to national technical teams (within EDF and IRSN), and regularly inform the local management emergency centre of events that may lead to a change in emergency response strategy (for example loss or recovery of an engineered safety system, or detection of a radioactive discharge into the environment).

The local management emergency centre is also supported by a local logistics control centre, which is responsible for all logistics activities at the site in support of the emergency response. The logistics control centre provides the local management emergency centre with information regarding its actions, additional resources available, and the working or living conditions of personnel. The logistics control centre also takes action at the request of the local management emergency centre in order to recover equipment that is unavailable or participate in the provision of mobile equipment or the establishment of specific alignments.

It also takes action in the following areas:

- protection of personnel, and management of muster points;
- management of telecommunications systems for all emergency centres;
- organisation of work and specific jobs on equipment;
- logistic support for external emergency services and emergency response teams.

Corporate level

The corporate management emergency centre (PCD-N) is led by the head of the Nuclear Power Operations Division. Working in continuous contact with the local management emergency centre, it coordinates the actions taken by EDF's entire emergency response organisation, advises the NPP management concerned by the event (defining strategies for managing all of the technical, organisational and media aspects of the event), and provides information to EDF Group top management and the public authorities at national level, as well as other NPPs.

The corporate management emergency centre maintains contact with EDF Group top management, which is also able to activate its emergency response unit. By the same token, it is in contact with experts from the corporate emergency response technical team (ETC-N).

This team has two main tasks:

- it provides technical support to the corporate management emergency centre. This involves continuous analysis of the situation, the status of the affected unit, and discharges (situation diagnosis) as well as short- to medium-term forecasts (prognosis). It maintains continuous contact with the local emergency response team and the IRSN emergency response team in order to compare results and provide additional information to the corporate management emergency centre;
- it provides technical assistance on-site, in conjunction with the local emergency response team (ELC) and the assessment control centre (PCC), and provides opinions and recommendations for management of the installation and in respect of environmental issues.

Coordination between the various teams described above can only be done correctly if all of the teams are provided with the right information simultaneously and promptly, and if they are capable of communicating easily among themselves. The telecommunications resources available for those involved are a key component of the organisation. Installation status parameters are relayed automatically to local and corporate emergency response teams, as well as being transmitted by means of telecommunications (pre-formatted fax messages). Information exchanged between emergency centres is supported by a dedicated EDF telephone network used specifically for emergency response situations, thereby guaranteeing that networks do not become saturated.

The skills and capabilities of the persons and organisations involved are maintained by providing training to the individuals concerned and performing regular exercises (internal NPP exercises, corporate EDF exercises, and national exercises with local and national public authorities). Such exercises are used to test the on-site emergency plan, validate options, correct any faults in the organisation, and help train personnel.

Experience feedback from real emergencies and emergency exercises helps improve emergency planning and response as well as coordination between public authorities and the licensee.

Lessons learned from exercises are leveraged at local and corporate level in order to share best practice, and to highlight weaknesses and deploy corrective actions at local level, as well as implementing strategic modifications at corporate level.

16.3.2 The CEA's role and organisation

The CEA's emergency organisation forms part of the general organisation described in section 16.1.

If an emergency occurs at an installation operated by the CEA, an emergency response organisation is set up to supplement the arrangements made by the public authorities.

As shown in the diagrams in section 16.2, the CEA has a role both locally (the emergency site) and nationally (the CEA's general management).

- The emergency site (local level):
  - manages the response inside the establishment;
  - manages communication with the local media for the establishment undergoing the emergency, in conjunction with the prefecture;

   - is responsible for relations with the prefecture and with the IRSN emergency response centre.
- The CEA's general management (central level):
   - directs the CEA's response at national level;
   - is responsible for communicating with the national media;
   - is responsible for relations with the public authorities at national level.

To assist them in their role, local and national levels each have a management emergency centre, respectively the PCD-L and the CCC (emergency coordination centre).

- The centre's director, or his or her representative, is responsible for the PCD-L. It comprises a decision-making unit, a local technical emergency team (ETC-L), a control team, an operational team, a communications unit and a press unit;
- The General Administrator, or his or her representative, is responsible for the CCC. It comprises a decision-making unit, a central technical emergency team (ETC-C), a communications unit and a press unit.

The communication and press units, in agreement with the PCD-L or the CCC, prepare press releases, answer external calls and manage interviews.

The site is responsible for triggering the on-site emergency plan (PUI).

It is the job of the establishment's director or his or her representative (on-call senior manager during non-working hours) to assess the seriousness of the event, based on criteria determined in advance for triggering the PUI and determining its level.

If the PUI is activated, the role of the Director or his or her representative is:

- to direct and coordinate the initial security actions;
- to inform immediately the local authorities, the nuclear safety authorities and the CEA general management;
- to contact, particularly outside working hours, all the staff required to supplement the teams.

In the case of an important event, the initial notification is given to the CEA's 24-hour alert organisation.

Based on the seriousness of the event, the General Administrator or his or her representative may decide to activate the CCC.

16.3.2.1 Application to the Phénix reactor

At the moment, the PUI for the CEA Centre at Marcoule applies to the Phénix plant. When the PUI was introduced in 2004, three exercises were carried out with the CEA and one with the public authorities.

In 2005, a fire exercise involved fire-fighters from outside the Marcoule site, and was also an opportunity to activate the PUI.

16.3.2.2 Application to other CEA Centres

In June 2006, a national emergency exercise was simulated at Saclay, involving the Osiris reactor. The scenario assumed that noble gases and fission products had been discharged from the chimney, prompting the implementation of the PUI and the PPI.

This exercise served:

- to test the mobilisation of the CEA's national emergency response organisation and the public authorities;

- to assess the CEA's capacity to request additional resources;
- to measure the capability to shelter populations so as to limit their exposure to risks;
- to address measurement-related issues (taking measurements quickly, using them and reporting the information to the prefect for decision).

All emergency exercises are organised to test the emergency organisation under live conditions, to train the emergency teams, test the resources and organisations in order to identify any anomalies, and to refine the overall arrangements.

16.3.3 The ILL's role and organisation

The ILL's emergency organisation forms part of the general organisation described in section 16.1.

As shown in the diagrams in section 16.2, the ILL has a role at both local level (the emergency site) and national level (via the CEA's general management).

In the event of an incident or accident, the ILL informs CEA-Grenoble immediately and, depending on circumstances, implements the arrangements stipulated in its PUI, which was completely updated at the end of 2004.

The emergency organisation is based on:

- a management emergency centre (PCD);
- a reactor technical emergency centre.

16.3.3.1 The ILL management emergency centre

The PCD is managed by the director, responsible for the ILL's general security (and, in the event of an accident, for safeguarding life and property), or his or her representative.

The person managing this PCD coordinates generally his or her establishment's action, and manages the official liaison between the ILL, CEA-Grenoble and the public authorities, both at local level (the relevant prefect) and centrally (ASN).

In particular, he or she informs these authorities of:

- the circumstances of the accident and of any personal injury or damage to property;
- the planned arrangements to limit the consequences;
- the status of the installation concerned and projected developments, as far as foreseeable;
- radioactive discharges, current or foreseeable, and their possible changes in the short and medium terms;
- radioactivity transferred into environment, assessed from measured or estimated discharges, measurements taken in the field and local weather data;
- predictions of the potential development of these transfers, based particularly on local weather forecasts.

Specialist teams, either existing or set up in response to the needs and circumstances of the accident, assist the ILL PCD. They are led by managers appointed by the Director of the ILL.

They include:

- the ILL's control team (*EC*), responsible for collecting and interpreting the radiological measurements and assessing the radiological impact of the incident or the accident. The team is led by the ILL's radiation protection manager, or his/her representative;

- the movements team (*EM*), responsible for managing movements of personnel, coordinating vehicle use and generally running the internal logistics. For an incident limited to the ILL's site, the team is led by the ILL's security unit manager, or his/her representative;
- the ILL's technical emergency team (ETC) comprises specialists and experts with a thorough understanding of the installation, of relevant technical problems, and of issues relating to safety and radiation protection.

16.3.3.2 The reactor technical emergency centre

This emergency centre is managed by the installation manager or his/her representative, and carries out the operation and safeguard functions. The technical emergency centre reports to the ILL PCD and sends relevant information to the ILL ETC.

The reactor technical emergency centre is located in a technical area (reactor control room or the PCS/LMA) and information from the reactor and its associated buildings is relayed from there. The area also has the telecommunications facilities required to keep in contact with the ILL PCD and ETC.

16.3.3.3 Organisation implemented by CEA-Grenoble

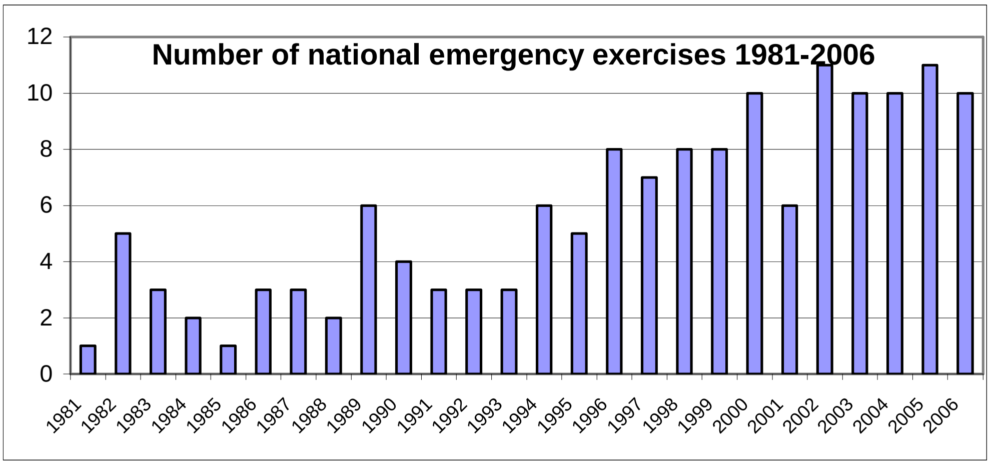
If an incident or accident occurs at the ILL, and on the request of the ILL's Director (or his/her deputy), the Director of the CEA in Grenoble (or his/her deputy) may provide the ILL with technical and human resources appropriate to the situation, in the following areas:

- emergency premises for managing the emergency;
- experts in environmental monitoring;
- response personnel (FLS, SPR, SST).

16.4 Emergency exercises

16.4.1 National emergency exercises

It is important not to wait for a significant accident to occur in France before testing the emergency response provisions described above under real conditions. Exercises are periodically organised to train emergency teams and to test resources and organisational structures with a view to identifying any weak points. In addition to the exercises organised by the licensees to test their in-house organisation, a national emergency exercise held every three years on each site with a BNI seems to be a fair compromise between staff training and the time needed to effect organisational changes. Since the 1980s, therefore, the number of national exercises has risen significantly, with 10 performed in 2006, as shown in the graph below.



The number and scope of the national exercises are considered to be greater than is the case abroad. They enable ASN staff and national stakeholders to accumulate a wealth of knowledge and experience in managing emergency situations. These exercises are also an opportunity to train field personnel, with about 300 persons being involved in each exercise.

For example, ASN prepared a programme of national nuclear emergency exercises for 2006, announced to the prefects in a circular of 28 December 2005, which provides for two different types of exercise:

- exercises targeting "nuclear safety", involving no actual population actions and mainly aimed at testing the decision process on the basis of a totally unrestricted technical scenario;
- exercises targeting "civil defence" involving actual and large-scale application of population protection measures as specified in the PPIs (alert, sheltering, evacuation), based on a scenario built around the role to be played by population.

During most of these exercises, simulated media pressure is placed on the main parties involved, in order to test their ability to communicate. The table below, as an example, describes the main characteristics of the national exercises conducted in 2006 that involved reactors: each site with nuclear power reactors performs an exercise every three years.

NUCLEAR SITE	DATE OF EXERCISE	EXERCISE TARGET	PARTICULAR CHARACTERISTICS
Civaux (NPP)	21 March 2006	Civil defence	Implementation of local safeguard plans
CEA Saclay involving the OSIRIS reactor	13 June 2006	Civil defence	Health aspect with several contaminated injured victims
Chooz (EDF)	22 June 2006	Civil defence	Belgian and Canadian observers
Paluel (EDF)	19 September 2006	Civil defence	Zone sealed off with evacuation of EDF staff
Cruas (EDF)	5 October 2006	Nuclear safety	
Chinon (EDF)	9 November 2006	Civil defence	Major exercise involving the ministerial offices
Bugey (EDF)	23 November 2006	Civil defence	Inter-*département* coordination between Ain and Isère tested
Cattenom (EDF)	7 December 2006	Civil defence	Alert of German and Luxembourg authorities

Review meetings are organised in each emergency command centre immediately after each exercise. Along with the other participants in the emergency exercise, ASN aims to identify good and bad practices highlighted during the experience feedback meetings in order to improve the response organisation as a whole.

One major benefit of the emergency exercises has been to improve procedures and policies. For example, to avoid exposure of the personnel in charge of distributing iodine tablets during the release phase, the authorities decided on preventive distribution of iodine tablets within a 10 km radius around NPPs. Furthermore, to take account of rapidly evolving accidents in which the authorities do not have time to respond, the decision was taken to incorporate a reflex phase in the PPIs asking the populations to take shelter by alerting them through a network of sirens or other means of telephone-based alert.

In 2006, the systematic use of decision-making audio-conferences led to greater consistency in the steps taken to protect workers and the population as decided by the licensee and the public authorities.

16.4.2 International exercises and cooperation

ASN maintains international relations to exchange good practices observed during exercises carried out abroad. In 2006, ASN:

- took part in an international workshop on INEX 3 exercises, organised in Paris by NEA, on the subject of post-accident management;
- received foreign delegations as observers of the exercises organised by France (Canadian, Belgian and IRRS auditors).

ASN took part in IAEA's work to implement an action plan by the competent authorities to improve international exchanges of information in the event of a radiological emergency. For this action plan, ASN is helping to define the strategy concerning international assistance requirements and resources and to set up the assistance request emergency assistance response network (ERNET). ASN is also working with NEA to define a strategy for carrying out international exercises.

Work is also in progress on international assistance in the event of an accident or radiological emergency, which in particular includes creation of a data bank listing the technical and human resources available and the definition of a protocol for the exchange of information with foreign safety authorities.

16.4.3 Lessons learned from exercises

The emergency exercise scenarios generally involve a simulated release of radioactivity outside the installation in which the accident occurs. This enables the entire national emergency response organisation, particularly the local emergency response services, to practice dealing with the risks and consequences of radioactive contamination of the population, their homes, the food chain and the environment. The first protective steps taken are generally based on highly conservative estimates and calculations. However, in the longer term, radioactivity measurements from around the installation are vital in being able to define the authorities' response to the events.

Experience feedback from the exercises showed that the measurement results were only reaching experts and decision-makers after a lengthy delay. In the light of these findings, the national stakeholders worked to improve the response organisation and procedures. This led to drafting of the above-mentioned government directive of 29 November 2005. This directive now needs to be implemented in the emergency plans, so that local measurement programmes can be tailored to the individual installations.

Every three years, each nuclear installation is required to take part in a national emergency exercise, involving the entire national emergency response organisation. The various prefects' offices involved in these exercises have been seen to be constantly progressing. To ensure that this constant improvement continues, the exercise scenarios are made increasingly complex and include increasing numbers of parameters and players. The exercises are also a means of improving existing procedures:

- the scenarios increasingly often include a health component, involving treatment of the injured (sometimes contaminated), who have to be given care and be evacuated in a potentially or actually hazardous environment; and

- the various emergency command centre procedures now include joint audio-conferences when necessary, in order to improve the understanding of sometimes complex situations.

Experience feedback from these emergency exercises also brings to light those actions or procedures which need to be improved. All the stakeholders take these points on board and actively look for solutions. In this respect, ASN calls all stakeholders together twice a year to review good practices, but also to identify areas for improvement.

16.5 Developments in nuclear emergency management

As in any other nuclear safety field, the emergency response organisation has to change on the basis of experience. The main sources of experience in France are exercises and exchanges with foreign countries, as well as any significant events in France or abroad (Tokai-Mura accident on 30 September 1999 for example).

16.5.1 Population protection measures

In national emergency exercises, ASN has striven to improve the recommendations on protection of the population in the case of a nuclear accident. These measures must be tailored to the phase considered: threat, emergency or post-accident. The population protection measures take into account the magnitude and speed of development of the event.

The population protection steps that can be taken during the emergency phase are described in the emergency plan, which for a BNI is the off-site emergency plan (PPI). The steps taken are designed to protect the population and prevent disorders attributable to exposure to ionising radiation and to any toxic chemical substances present in the releases.

In the event of a serious accident, a number of preventive measures can be considered by the prefect in order to protect the population:

- sheltering and listening: the persons concerned, alerted by a siren, take shelter in a solidly constructed building, with all openings carefully closed, and wait for instructions from the prefect;
- administration of stable iodine tablets: when ordered by the prefect, the persons liable to be affected by the releases take the prescribed dose of potassium iodide tablets;
- evacuation: in the event of an imminent threat of large-scale radioactive releases, the prefect may order evacuation. The population is then asked to prepare a bag, secure their homes, leave them and go to the nearest muster point.

Furthermore, in order to minimise contamination by ingestion, a ban on the consumption of contaminated foodstuffs may be ordered as a precaution during the emergency phase. Maximum allowable levels have been set for this purpose on foodstuffs. The prefect must inform the population regularly on the evolution of the situation and on its consequences. The prefect may remind people that they must not pick vegetables from their gardens or farms for consumption during the sheltering period.

16.5.2 Iodine tablets

The third preventive distribution campaign took place on all NPP sites in 2005 and 2006 (circulars of 8 February 2005 and 11 August 2005 on preventive distribution of stable iodine tablets). During the course of this campaign, ASN sent out a leaflet to about 500,000 households describing the regulation of nuclear safety and radiation protection.

The method adopted consisted in launching an initial phase involving distribution of boxes of tablets around the NPPs operated by EDF. This was based on a system of personal letters addressed to named persons on official headed notepaper, signed by the DDSC, ASN and the French Order of Pharmacists. A exchange voucher for named persons was enclosed with the letter, for presentation at one of the pharmacies listed on the back of the letter. In a second phase, an additional distribution was carried out by direct mailing of the box of tablets to households that had not picked one up. Finally, boxes are available permanently in each pharmacy of the area. This method was a way of better controlling distribution because those who actually received boxes were precisely identified. In this way, the final coverage was close to 100%. It also enabled a strong partnership to be forged with the pharmacists, providing identical, clearly identified points of contact in all areas, for the tablet 5-year validity period.

The government also asked the prefects to make plans for stockpiling in each *département* in order to cover the entire country. A circular dated 23 December 2002 provides the prefects with a guide for drawing up stable iodine tablet stock management plans. These plans are currently being drawn up by the prefects' offices.

16.5.3 Post-accident management

The post-accident phase concerns how to deal with the consequences of the event, which are of widely differing natures (economic, health, social) and which have to be resolved in the short, medium and indeed long term to restore a situation deemed acceptable.

Pursuant to the government directive of 7 April 2005, ASN, in association with the ministerial departments concerned, is responsible for "*establishing the framework, defining, preparing and implementing the steps necessary to deal with the post-accident situation*". In order to draft a post-accident policy, ASN first focused on developing the post-accident aspects when carrying out national and international exercises (such as INEX3) and initiating a more general debate by bringing together all the stakeholders in a steering committee (CODIR-PA) in charge of the post-accident aspects. ASN set itself a time-frame of 2 years for reaching agreement on a post-accident phase policy. The 9 November 2006 exercise around the Chinon NPP was an opportunity to review the lifting of sheltering measures and the decontamination of buildings.

16.5.4 Outlook

On the basis of work already started, ASN was mandated by the Minister for Health and Solidarity to draft a new iodine policy, which in particular targets the stable iodine tablets strategy on the most exposed populations, especially the under-eighteens and the pregnant women, in accordance with the recommendations of the French High Public Health Council (CSHPF) of 7 October 1998 and 7 December 2004. The aim is to produce a new iodine policy which will also incorporate the results of the harmonisation work conducted in parallel with neighbouring countries during 2007. This harmonisation work has been undertaken by five volunteer countries (Belgium, Luxemburg, Germany, Switzerland and France) since June 2006 to try and harmonise the health recommendations applied by the authorities following a nuclear accident. With an emphasis on pragmatism, it was decided to focus on the first hours following an alert, when international coordination has not yet been established. This work plans to harmonise dose estimation methods, response levels, protection steps and population protection messages.

D. SAFETY OF INSTALLATIONS

17. Article 17: Siting

Each Contracting Party shall take the appropriate steps to ensure that appropriate procedures are established and implemented:

i) for evaluating all relevant site-related factors likely to affect the safety of a nuclear installation for its projected lifetime,

ii) for evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment,

iii) for re-evaluating as necessary all relevant factors referred to in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation,

iv) for consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation and, upon request providing the necessary information to such Contracting Parties, in order to enable them to evaluate and make their own assessment of the likely safety impact on their own territory of the nuclear installation.

17.1 Regulatory requests

Well before applying for a BNI authorisation decree, the licensee informs the administration of the site(s) on which it plans to build the installation. Early examination of the main characteristics of the site(s) is thus possible.

This review deals with socio-economic aspects and safety. If the proposed BNI is intended to produce energy, the relevant departments of the Ministry for Industry are closely involved. ASN analyses the safety-related characteristics of the sites, including seismic activity, hydrogeology, industrial environment and sources of cold water.

In application of the act of 27 February 2002 on local democracy, decree of 22 October 2002 on the organisation of public debates and the National Public Debates Commission (CNDP) stipulates that the construction of a BNI is subject to the public debate procedure:

- in all cases when dealing with a new nuclear electricity generating site or a new site not generating electricity but costing more than €300 million;
- possibly, when dealing with a new site not generating electricity from nuclear power and costing between €150 million and €300 million.

Public debates were organised in 2005 and 2006 on the construction of an EPR nuclear reactor at Flamanville and the siting of the RJH and ITER research reactors at Cadarache.

In addition, the French government, in compliance with the treaties in force, notifies neighbouring countries.

If new data concerning the sites (earthquake, flooding, etc.) likely to compromise installation safety are identified, a safety reassessment is conducted as discussed in chapter 14.

17.2 Practice during the period under consideration

17.2.1 Power reactors

CHOICE OF FLAMANVILLE FOR THE SITE OF THE NEW EPR REACTOR

Changes in the international context as well as the growing internationalisation of safety issues and European construction have led to the development of a Franco-German reactor design, the EPR.

Three French regions submitted applications to host the first-off EPR unit. On completion of the bidding process, and on the basis of a close examination of the conditions for the prompt construction and commissioning of the first EPR unit, EDF decided, at its board meeting on 21 October 2004, to investigate siting the reactor at Flamanville.

The site was chosen on the basis of three criteria:

- availability of land reserves and preliminary facilities for new generating units;
- favourable environmental conditions, in particular a coastal location which gives the site significant cooling capability, avoiding the need to build a cooling tower, and the site geology (good rock quality for foundations, and the immediate proximity of the seabed);
- a good level of acceptance of the project within the region.

These three criteria relate both to technical feasibility and to EDF's desire to ensure that the start up date for the new unit is in line with its plans for the renewal of the current generating fleet.

The site's ability to meet these criteria is manifested in the following:

- the choice of open-circuit cooling for the coastal location. This represents the optimum technique in terms of installation cooling and local environmental impact, thanks to good dilution of discharges into the sea and atmosphere;
- the petrographic uniformity of the granite massif (Basic Safety Rule on geological and geotechnical studies (RFS I.3.c));
- the low seismicity of the area. (Basic Safety Rule on determination of seismic risk (RFS 2001-01));
- distance from large urban centres and low urban development of the area around the Flamanville NPP, as a result of which risks related to industry and communication routes are limited due to the resulting low level of local industrial development (Basic Safety Rule on consideration of risks associated with industrial environment and communication routes (RFS I.2.d));
- consideration of external flooding by means of a plant platform located above the design-basis flood level calculated for Flamanville (Basic Safety Rule on consideration of external flooding risk (RFS I.2.e).

17.2.2 Research reactors

The site selected by the CEA at Cadarache for the Jules Horowitz reactor (RJH) was approved by ASN in 2003.

Since then, blasting has been carried out on the site for calibration and to assess the impact on neighbouring installations. In addition, further geotechnical and hydrogeological surveys have investigated the nature of the rock massif supporting sensitive buildings and calculated the basis for sizing the drainage system in case of groundwater rise.

As indicated in section 17.1, authorisation of a BNI requires a public debate. In its decision 2004-28 of 28 September 2004, the national commission for public debate (CNDP) recommended to the CEA that it consults and co-ordinates on the RJH, in order to inform the public and set in train the various mechanisms for the public to express its views. The consultation process took place in May and June 2005, when four public meetings were held in the municipalities adjacent to the Cadarache Centre.

Issues raised by the public focused mainly on the social and economic impacts of the RJH project, such as problems with road traffic caused by simultaneous construction work for RJH and ITER (International Thermonuclear Experimental Reactor), and the need for the local institutions to plan an adequate infrastructure to support the influx of new people. Environmental issues were also discussed, in particular water management. Safety and security raised few questions.

17.3 Analysis by the regulator

THE PROPOSED EPR REACTOR ON THE FLAMANVILLE SITE

On 20 October 2004 the EDF board of directors selected the Flamanville site for the proposed construction of the first French EPR reactor, “Flamanville 3”. This site was selected on criteria including available land, electricity transmission capacity, environmental requirements and conditions for accommodation of the construction site.

On 1 December 2004 the CNDP decided to organise a public debate, considering that the objectives, nature and magnitude of the project and its place in French energy policy mean that it is of national interest. Nineteen public meetings were held from 19 October 2005 to 18 February 2006.

Following the conclusions of the national public debate, EDF submitted a plant authorisation application on 9 May 2006.

On 18 May 2006 the Ministers for the Environment and for Industry informed the prefect of the Manche *département* of the application by EDF. The prefect was invited to organise a local public inquiry and give his opinion on the application.

On 7 June 2006, the prefect communicated to the authorities of the Channel Islands the Flamanville 3 reactor description memorandum and the public inquiry technical file, including a hazard study and an impact study.

On 12 October 2006, following the local public inquiry held from 15 June to 31 July 2006, the prefect issued a favourable opinion on the licence application.

In parallel, with support from IRSN and after consultation of the GPR in July 2006, ASN confirmed that the project design is compatible with the characteristics of the Flamanville site. ASN has no safety objections to the selected site, which already has two operating nuclear power reactors.

18. Article 18: Design and construction

Each Contracting Party shall take the appropriate steps to ensure that::

i) the design and construction of a nuclear installation provides for several reliable levels and methods of protection (defense in depth) against the release of radioactive materials, with a view to preventing the occurrence of accidents and to mitigating their radiological consequences should they occur,

ii) the technologies incorporated in the design and construction of a nuclear installation are proven by experience or qualified by testing or analysis,

iii) the design of a nuclear installation allows for reliable, stable and easily manageable operation, with specific consideration of human factors and the man-machine interface.

18.1 Licensing process

The nuclear installation licensing process described below results in a “plant authorisation decree” which specifies the principles to be complied with in design and construction (quality of methods, component qualification) and in operation (defence in depth, prevention of accidents and limitation of their consequences, taking account of the risk of human error).

18.1.1 Safety options

When a licensee plans to build a new type of BNI, it submits the safety objectives and the main characteristics as early as possible, well before submitting a licence application.

ASN generally asks the competent advisory committee of experts (GPE) to review the project and then informs the licensee of issues to be covered in its plant authorisation application.

This preparatory procedure does not replace the subsequent regulatory reviews; it is intended to facilitate them.

18.1.2 Plant authorisation decrees

18.1.2.1 Submission of the plant authorisation application

The application for a BNI authorisation decree is submitted by the licensee to ASN, which then reviews it with the ministers with responsibility for nuclear safety.

The application is accompanied by a preliminary safety analysis report containing the description of the installation and of the operations which will be carried out there, the inventory of any hazards it presents, the analysis of the steps taken to prevent these hazards and the description of the measures capable of reducing the probability and the consequences of accidents.

This is followed by a period of parallel consultation of the public and technical experts.

18.1.2.2 Consultation of the public

The licence may only be delivered after a public inquiry as specified in article 29-I of the act of 13 June 2006.

The public inquiry is opened by the prefect of the *département* where the installation is to be built. The documents submitted to the inquiry must include the licence application, specify the identity of the applicant, the purpose of the inquiry, the nature and basic characteristics of the installation, and include a plan of it, a map of the region, a hazard analysis and an environmental impact assessment.

In addition to the prefect's offices concerned, a file and an inquiry register are made available in all municipalities completely or partially within a 5 km radius around the planned installation. If this area encompasses the territory of several *départements*, a joint order of the prefects concerned organises the inquiry in each *département*, with the prefect of the main site of the operation coordinating the procedure.

In accordance with general provisions in this respect, the public inquiry proceeds for a minimum period of one month and a maximum period of two months, with the possibility of a two-week extension on a well-founded decision by the inquiry commissioner.

The purpose of the inquiry is to inform the public and collect its opinions, suggestions and counter-proposals, so as to provide the competent authority with all the information that it needs. Any interested person, whatever his or her nationality or place of residence, is invited to express his or her opinion.

An inquiry commissioner (or an inquiry commission, depending on the nature or scale of the operations) is appointed by the President of the competent administrative court. The commissioner may receive any document, visit the site, take statements from any person, organise public meetings and request extension of the inquiry period. When the inquiry is over, he reviews the observations of the public entered into the inquiry registers or sent to him directly. Within the month following the end of the inquiry, the commissioner sends a report and his recommendation to the prefect.

In each *département* concerned by the public enquiry, the prefect also consults the *département* council and the municipal councils of the municipalities where the public inquiry is open, as well as the regional offices that the prefect considers to be concerned by the application.

If a local information committee is formed, it is consulted by the prefect or prefects of the *départements* in which the installation is to be located.

No later than fifteen days following receipt of the report and the conclusions of the inquiry commissioner, the prefect forwards them to the ministers with responsibility for nuclear safety and to ASN, with his opinion, along with the results of all the consultations he has carried out.

18.1.2.3 Formation of a local information committee

A local information committee is set up for any site comprising one or more BNIs. Its general role is monitoring, information and consultation on nuclear safety, radiation protection and the impact of nuclear activities on people and the environment. It comprises representatives of the *département* councils, municipal councils or deliberative assemblies of municipality groupings and the regional councils concerned, elected members of Parliament in the *département*, representatives of environmental protection associations, economic interests and representative trade unions and the medical professions, as well as qualified public figures. Representatives of ASN and other State departments concerned, as well as representatives of the licensee, may attend the sessions of the local information committee on a consultative basis.

18.1.2.4 Consultation of technical organisations

The preliminary safety analysis report appended to the plant authorisation application is transmitted to ASN, which submits it for review to one of the advisory committees of experts reporting to it, following a report from IRSN.

18.1.2.5 Plant authorisation decree

The ministers with responsibility for nuclear safety send the licensee a draft decree granting or refusing the plant authorisation. After consulting the licensee, the ministers with responsibility for nuclear safety submit the draft to the Interministerial Commission for Basic Nuclear Installations (CIINB) for its opinion. The commission is required to issue its opinion within two months of referral. The ministers with responsibility for nuclear safety ask ASN for its opinion concerning the draft decree granting or refusing the plant authorisation, possibly amended to take account of the opinion of the CIINB. ASN delivers its opinion within two months, failing which the opinion is deemed to be favourable.

The plant authorisation decree is issued after delivery of the ASN opinion, following a report from the ministers with responsibility for nuclear safety.

The decree defines the scope and characteristics of the installation and the specific rules with which the licensee must comply. The specific rules for the installation apply without prejudice to application of the general technical regulations, the regulations on discharge of effluents and any other texts applicable in particular with regard to environmental protection or worker health and safety.

18.2 Description of current projects

18.2.1 Power reactors

In 2000, the advisory committee for reactors (GPR) and a group of German experts completed their review of the main safety options for the planned Franco-German PWR, the EPR (European Pressurised water Reactor).

The EPR is an evolutionary PWR developed jointly by French and German manufacturers and electricity utilities (Framatome now AREVA-NP, Siemens, EDF and a group of German electricity utilities). In terms of safety, this project aims to deliver a significant improvement in defence in depth in comparison with current reactors.

The review of the project's safety options began in 1993 in the form of a Franco-German technical cooperation. Successive recommendations, issued by the groups of French and German experts, were approved jointly by the nuclear safety authorities of the two countries, and subsequently, from the end of 1998, by ASN in France.

The main subsequent stages of this examination process were as follows:

- a Basic Design Report submitted to the French and German safety authorities in 1997. An updated version was issued in February 1999;
- definition of draft Technical Guidelines, a set of recommendations relating to the main safety options for the EPR project. The final version of the Technical Guidelines was validated in October 2000 by the advisory committee for reactors with the participation of German experts;
- preparation of the provisional safety analysis report, leading to additional examinations with ASN.

In late 2003, the EPR was chosen as the design for Finland's fifth nuclear reactor. In France, meanwhile, Parliament came out in favour of the construction of an EPR reactor in June 2004, following a debate on the future direction of French energy policy.

Following a public debate in 2005 in accordance with articles L121-1 and following of the French environment code and decree 2002-1275 of 22 October 2002, the plant authorisation application was submitted in May 2006, allowing the launch of a public inquiry, which was held from 15 June to 31 July 2006.

In accordance with articles 3-I and 3-III of decree 63-1228 of 11 December, 1963, as amended, on nuclear installations and section II of article 6 of decree 85-453 of 23 April 1985 codified in articles R123-6 of the environment code, the plant authorisation application is accompanied by a file for the attention of the Ministry of the Economy, Finance, and Industry and the Ministry of Ecology and Sustainable Development, which comprises principally the following:

- a hazard study, describing the characteristics of the installation and its operation, and stating the measures deployed to deal with the risks presented by the installation and limit the consequences of a possible accident;
- an impact study.

At the same time, a preliminary safety analysis report was sent to ASN for examination.

Following the closure of the public inquiry, EDF issued a response to all of the comments raised within the scope of the inquiry and received in the observation report sent by the inquiry commission.

The plant authorisation file for the EPR reactor at Flamanville was approved by ASN in February 2007. The decree authorizing EDF to construct the Flamanville 3 EPR was signed by the Prime Minister on 10 April 2007.

18.2.2 Research reactors

The CEA, EDF and AREVA together with their European partners (CEN-SCK in Belgium, VTT in Finland, CIEMAT in Spain and UJV in the Czech Republic) consider that a new reactor, known as the Jules Horowitz Reactor (RJH), should be built, because the European irradiation reactors currently in use are ageing, and will be decommissioned in the short or medium term. This new pool-type irradiation reactor will meet research and development requirements until around 2050. The reactor is currently planned to go critical in 2013.

The reactor's primary objective is to irradiate materials and fuels in support of international nuclear power programmes. Additional functionality is also planned, such as the production of artificial radioactive elements for medical diagnosis and cancer treatments, and the production of doped silicon.

The RJH's design is based on the concept of defence in depth, so that particular attention is paid to containment, with defined barriers between the radioactive products and the environment outside the installation.

The safety options for the RJH were reviewed by the GPR during the first half of 2003. In the summer of 2003, ASN indicated that based on the information presented to it, and despite further requests, it had no objection to the RJH project continuing.

The process continued with the drafting of a preliminary safety analysis report, between 2003 and 2005. This included:

- the description of the installation and the operations carried out there, including the radiation protection of the workers;
- the risk inventory and an analysis of the measures taken to reduce their probability and limit their effect;
- arrangements intended to facilitate the installation's later dismantling.

Based on this report and the files from the public enquiry, the plant authorisation application (DAC) for the RJH BNI was submitted to the public authorities in March 2006, together with the effluent discharge and water intake licence application (DARPE), in compliance with decree 95-540 of 4 May 1995.

In September 2006, ASN issued its opinion on the admissibility of the files for the public enquiries for the DAC and the DARPE. A public enquiry by the prefect was held in eight municipalities adjacent to the Cadarache site during November and December 2006.

In addition, the engineering investigation based on the preliminary safety analysis report was initiated with IRSN, in preparation for the GPR meetings scheduled during 2007. Technical meetings between IRSN and the licensee were held to explore the following safety issues:

- civil engineering;
- controlling accidents that could occur at the installation, without resorting to countermeasures (such as containment, evacuation or iodine distribution) affecting the surrounding population;
- the rules for designing and building equipment;
- additional studies of the site and the risk of external flooding;
- transfer coefficients and quantified estimates of the radiological impact;
- radiation protection;
- safeguard systems;
- the approach to safety, operating scenarios and safety-related equipment;
- containment barriers;
- consideration of hazard risks, particularly the earthquake hazard;
- criticality;
- HOF.

18.3 Analysis by the regulator

18.3.1 Design and construction of power reactors

In 1993 the German and French safety authorities defined the safety objectives applicable to the new generation of PWRs:

- the number of incidents must decrease, in particular by improvement of system reliability and better consideration of aspects related to human factors;
- the risk of core meltdown must be further reduced;
- any radioactive releases which could result from all conceivable accidents must be minimised.

Finally, as a consequence of operating experience acquired from reactors in service, ASN also asked that operating constraints and aspects related to human factors be taken into account from the design stage, in particular in order to improve worker radiation protection and limit radioactive discharges and the quantity and activity of the waste produced.

The EPR safety options were then reviewed, leading in October 2000 to the approval of a document entitled "Technical guidelines for the design and the construction of the next generation of NPPs with PWRs" by the GPR and the associated German experts.

These technical guidelines incorporate all the technical recommendations put forward by the French and German experts and approved by ASN throughout the review of the safety options in a structured and organised form. As such, they constituted the principal technical reference system for the EPR project review over the period 2001-2006.

The technical guidelines were given official sanction in 2004 in a letter sent to the Chairman of EDF, in which the public authorities judged that the reviewed safety options satisfied the objective of overall safety improvement compared with the reactors currently in service.

In September 2006 ASN completed its review of the preliminary safety analysis report; this review had begun in 2002, in parallel with the production of this report. With regard to nuclear risks, it reviewed in particular:

- compliance with the overall safety objectives;
- the taking into account of recent experience feedback from reactors in operation;
- the innovations introduced with respect to operating reactors in response to industrial concerns;
- the design of nuclear pressure vessels.

It also checked the consistency of the treatment of non-nuclear risks with the approach applied to other industrial installations.

ASN thus verified that the documentation supporting the authorisation application submitted on 9 May 2006 complied with the provisions of the regulations and with the safety objectives and technical guidelines defined for the EPR reactor.

In February 2007 ASN communicated to the government its favourable opinion on the authorisation of the reactor.

As part of the technical review of the EPR reactor project, in 2006 ASN also began preparatory work on a programme of regulation and monitoring of the construction of a new reactor. The objective of this work is to prepare ASN to monitor construction work on an EPR reactor, possibly starting in 2007, incorporating experience feedback from the construction of the existing French reactors and the construction of the Finnish EPR reactor which is in progress.

On the subject of pressure vessels containing radioactive fluids, ASN carries out close oversight of the manufacturing operations, with particular attention to the main primary and secondary systems of PWRs. The design, in-factory manufacture and on-site erection of the vessels are the responsibility of the manufacturer as defined in the European directive on pressure vessels. The manufacturer must demonstrate, in documentation files, that the vessels it designs comply with regulatory requirements. It chooses the manufacturing processes, the checks to be implemented and the acceptance criteria for the results of these checks. The manufacturer also supervises its suppliers and subcontractors.

ASN, or organisations certified by ASN, checks compliance by the manufacturer throughout this process with the essential safety requirements and the radiation protection requirements stipulated in the regulations.

In 2007 ASN will begin implementation of its inspection programme for the construction of the third generating unit at Flamanville, according to the provisions of the quality order of 10 August 1984 and the order of 12 December 2005 on nuclear pressure vessels.

18.3.2 Design and construction of research reactors

ITER, the International Thermonuclear Experimental Reactor, to be built at Cadarache, is an experimental nuclear fusion reactor. The objective of this installation is to determine the feasibility of an industrial prototype nuclear fusion reactor, producing energy from the fusion of atoms, the same type of reaction as that taking place inside the sun. ITER will use atoms of deuterium and tritium as fuel, accelerating them and heating them to several million degrees Celsius in a toroidal cavity. Its operation and its purpose mean that ITER is an installation combining the characteristics of reactors and particle accelerators.

Its principal safety issues will concern radiation protection, because of the presence of tritium and the irradiation of the materials of the machine. ASN therefore has no particular concerns about the safety of the ITER reactor, but it is working to ensure that the ILE (ITER Legal Entity), the international organisation which will be the licensee of the ITER BNI, will be subject to the same nuclear safety and radiation protection obligations as the other French nuclear licensees, and that consequently ASN will be able to apply its regulatory oversight as comprehensively as for the other BNIs.

19. Article 19: Operation

Each Contracting Party shall take the appropriate steps to ensure that::

i) the initial authorisation to operate a nuclear installation is based upon an appropriate safety analysis and a commissioning programme demonstrating that the installation, as constructed, is consistent with design and safety requirements;

ii) operational limits and conditions derived from the safety analysis, tests and operational experience are defined and revised as necessary for identifying safe boundaries for operation;

iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

iv) procedures are established for responding to anticipated operational occurrences and to accidents;

v) necessary engineering and technical support in all safety-related fields is available throughout the lifetime of a nuclear installation;

vi) incidents significant to safety are reported in a timely manner by the holder of the relevant licence to the regulatory body;

vii) programmes to collect and analyse operating experience are established, the results obtained and the conclusions drawn are acted upon and that existing mechanisms are used to share important experience with international bodies and with other operating organisations and regulatory bodies;

viii) the generation of radioactive waste resulting from the operation of a nuclear installation is kept to the minimum practicable for the process concerned, both in activity and in volume, and any necessary treatment and storage of spent fuel and waste directly related to the operation and on the same site as that of the nuclear installation take into consideration conditioning and disposal.

19.1 Licensing process and regulations

The operation-related licensing processes described in this chapter are those in force at present.

A revision of these processes is under way in the form of a draft decree implementing the act of 13 June 2006.

ASN emphasises that the processes applicable to the EPR project, for example, will probably not be exactly the same as those described below.

19.1.1 Power reactor commissioning licences

The first load of fresh fuel elements can only be delivered to the fuel storage building after authorisation by the ministers for the environment and for industry. This authorisation is issued after review by ASN:

- of the storage provisions made by the licensee, as presented to ASN at least three months beforehand;
- of the conclusions of an inspection carried out just before the date fixed for delivery of the fuel elements.

Moreover, six months before fuel loading, the licensee must send to the ministers for the environment and for industry a provisional safety analysis report together with provisional general operating rules (RGE) and an on-site emergency plan (PUI) specifying the organisation and resources to be implemented on the site in the event of an accident. ASN consults the GPR on these documents, then prepares its own opinion. Upon receipt of this opinion the ministers can authorise fuel loading and commissioning tests.

For PWRs, at least four successive licences are required at the start-up stage:

- a fuel loading licence, authorising fissile fuel elements to be placed in the reactor vessel, enabling testing to start with the fuel in core (pre-critical cold tests);
- a licence for pre-critical hot testing, prior to first criticality. These tests are subject to satisfactory results of the pre-critical cold tests. The reactor coolant pumps are run until rated pressure and temperature levels are reached in the primary system. These tests are only authorised after the primary system hydrotest report is issued, in application of the order of 26 February 1974 (refer to section 7.2.2.1);
- a licence for first criticality and power build-up to 90% of nominal;
- a licence for power build-up to 100% of nominal.

After initial start-up and within a time limit stipulated in the plant authorisation decree, the licensee applies for the final commissioning licence to the ministers for the environment and for industry. Its application is substantiated by a final safety analysis report, final general operating rules and a revised version of the on-site emergency plan. These documents must take account of lessons learned from the operating period since initial start-up.

19.1.2 Research reactor commissioning licences

The plant authorisation decrees for BNIs other than power reactors stipulate that commissioning is subject to authorisation by the ministers for the environment and for industry.

This "pre-commissioning" licence is accompanied by notification of technical requirements. It is preceded by an ASN opinion, based on its technical support organisations including the competent advisory committee, on the documentation compiled by the licensee. These documents include the provisional safety analysis report, the general operating rules (RGE) for the installation and the on-site emergency plan (PUI).

Furthermore, before final commissioning of the installation, which must take place within a time limit stipulated in the plant authorisation decree, the licensee must submit a final safety analysis report. This final commissioning is authorised by an ASN decision.

19.1.3 Decommissioning and dismantling licences

Article 29 of the act of 13 June 2006 states that the final shutdown and dismantling of a BNI is subject to an authorisation delivered by decree after an ASN opinion.

The licence application must include provisions concerning the shutdown conditions, dismantling and waste management procedures, and subsequent monitoring and maintenance of the site depending on its planned future use.

According to article 6 ter of decree 63-1228 of 11 December 1963 a BNI final shutdown and dismantling authorisation application must contain:

- a document justifying the selected condition of the installation after final shutdown and indicating the various stages of subsequent dismantling;
- a safety analysis report covering the final shutdown operations and the provisions for ensuring installation safety;
- the general surveillance and maintenance rules for maintaining a satisfactory safety level;
- an updated on-site emergency plan for the installation concerned.

In compliance with the general environmental protection regulations, the licensee must also append to its application an environmental impact assessment of the proposed measures.

In some cases, operations such as the unloading and removal of nuclear material, the disposal of fluids, or decontamination and clean-up operations can be performed under the provisions of the plant authorisation decree, providing they do not lead to non-compliance with previously-imposed requirements nor with the safety analysis report and general operating rules currently in force, subject to certain amendments if necessary. In other cases they are covered by the final shutdown decree.

After any operations of this type, two consecutive phases of work are distinguished:

- final shutdown operations, authorised by decree as mentioned above, which mainly concern the dismantling of equipment outside the nuclear island which is not required for its surveillance and safety, the maintenance or reinforcement of the containment barriers and the production of a radioactivity inventory;
- dismantling work on the nuclear part of the installation. This work can start as soon as the final shutdown operations are completed or can be delayed to allow radioactive decay of certain activated or contaminated materials.

ASN requests that licensees carry out the dismantling work to the point where the total radioactivity of the remaining radioactive materials falls below the minimum regulatory level requiring classification as a BNI. The installation can then be removed from the list of BNIs (delicensing) by an ASN decision. Final shutdown and dismantling of nuclear installations are covered by two ASN guides, published in 2003 and 2006 and issued to the nuclear licensees. The objective of the first of these guides is to:

- clarify the definition of the main technical stages in dismantling, to adapt them more closely to the diversity of nuclear installations;
- encourage complete dismantling initiated immediately or only slightly deferred;
- encourage presentation and justification by the licensee, before initiation of regulatory procedures, of the chosen dismantling scenario, from the final generation shutdown phase to complete dismantling of the installation;
- clarify the administrative notion of delicensing of a BNI and any relevant criteria.

The second guide clarifies acceptable complete clean-up procedures, in particular with regard to civil engineering structures, with a view to obtaining delicensing of the installation.

19.1.4 Liquid and gaseous effluent discharge and water intake licences

The normal operation of nuclear installations produces radioactive effluents, discharge to the environment of which is subjected to stringent conditions stipulated in a regulatory licence in order to protect personnel, the public and the environment. The licence concerns liquid and gaseous radioactive effluents, covering both their radioactivity and their chemical characteristics.

Depending on circumstances, the operation of most nuclear installations also requires the intake of water from the immediate environment and discharges of non-radioactive liquid and gaseous effluents.

In application of decree 95-540 of 4 May 1995, as amended, on BNI liquid and gaseous effluent discharges and water intake, a single licence, issued at ministerial level, can where necessary regulate radioactive and non-radioactive liquid and gaseous discharges and water intake for a given BNI. The procedure, clarified in two interministerial circulars (health, industry, environment) of 6 November 1995 and 20 May 1998, is based on a single application, formulated accordingly and examined in all cases by ASN.

The procedural rules of the decree cited above also apply to installations classified on environmental protection grounds included within the perimeter of a BNI. The decree thus enables assessment of the overall environmental impact of an installation's effluent discharges and water intake.

19.1.4.1 Submission of the licence application

The effluent discharge and water intake licence application covers all such operations for which a licence is requested. It is sent to the ministers for industry and for the environment. In addition to various drawings, maps and information, the application comprises a description of the planned operations or activities and an assessment of their impact on human health and the environment including the proposed mitigation measures and the planned surveillance resources.

19.1.4.2 Opinions of the ministers concerned

The application is forwarded to the ministers for health and for civil defence and to the directorate for the prevention of pollution and risks at the ministry for the environment for their opinion.

19.1.4.3 Consultation of the public and local authorities and organisations

The ministers for industry and for the environment, after having requested additions or modifications where necessary from the licensee, forward the application, together with the opinions of the ministers, to the prefect of the *département* concerned.

The prefect organises an administrative conference between various deconcentrated State departments which he or she considers should be consulted and submits the licence application to a public inquiry under conditions similar to those described above for plant authorisations.

The inquiry is opened in the municipality where the operations in question are to be carried out and also in other municipalities where their impact might be felt.

The prefect also consults the municipal councils concerned together with various organisations, such as the health council of the *département* and, where necessary, the water authority for the catchment or the public agency administering the public domain. He or she also sends the application, for information, to the local water committee.

19.1.4.4 Interministerial licence order

The prefect sends the results of the administrative conference, the consultations and the inquiry, together with his or her opinion, to the ministers for industry and for the environment.

The licence is granted by a joint order of the ministers for health, industry and the environment.

This order stipulates, within the framework of general technical rules defined by an order of the ministers for industry, the environment and health of 26 November 1999, itself clarified by a circular to the prefects signed by the same ministers on 17 January 2002:

- the intake and discharge limits with which the licensee must comply;
- the methods of analysis, measurement and monitoring of the structure, installation, work or activity and of surveillance of their environmental effects;
- the conditions under which the licensee reports to the ministers for health and the environment and to the prefect on the water intakes and discharges that it has performed, together with environmental impact surveillance results;
- the procedures for informing the public.

At the request of the licence holder or on their own initiative, the ministers for health, industry and the environment may, after consulting the departmental health council, issue an order amending the conditions stipulated in the licence order.

Finally, any modification made by the licensee to the installation or its operation which entails consequences on effluent discharges or water intake must, prior to implementation, be notified to the ministers for industry and the environment, who consult the minister for health. If they consider that the modification is likely to prove dangerous or harmful for the environment, they may demand the submission of a new licence application.

19.1.5 Operating documents

For operation of NPPs, the personnel refer to various documents. Of these documents, ASN pays particular attention to those relating to safety.

The most important are the general operating rules (RGE) which describe the measures implemented during reactor operation; they supplement the safety analysis report, which deals essentially with measures taken at the reactor design stage. Decree 63-1228 of 11 December 1963 (amended) stipulates in particular that the licensee must provide these two documents to substantiate its BNI commissioning licence application.

The general operating rules contain a number of chapters approved by ASN on the topics given for nuclear power reactors in section 19.2.2. In particular a chapter describes the operating limits in the form of operation technical specifications (STE).

19.1.6 Incident follow-up

Articles 12 and 13 of the “quality” order of 10 August 1984 cited above stipulate measures for anomalies and incidents. Any deviation from a requirement defined for the performance or result of a quality-related activity, any situation liable to compromise the defined quality or any situation justifying corrective action with respect to safety, is referred to as an anomaly or an incident in the order.

The action taken to correct an anomaly or incident is considered as a quality-related activity. A record of anomalies and incidents is kept up to date.

Anomalies or incidents which are important for safety must be identified. Such anomalies or incidents are referred to as significant anomalies or incidents in the “quality” order.

To this end, there must be a procedure for each quality-related activity to determine which anomalies or incidents must be considered as significant, on the basis of established criteria as far as possible. The procedure specifies the functions of the persons responsible for this identification.

Incidents are declared to ASN within 24 hours in application of the following ten criteria, defined by a letter from ASN in 1982:

- automatic reactor shutdown;
- activation of safeguard systems;
- incident directly involving or which could have involved the operating limits (operation technical specification) if the same incident had occurred in a different state;
- external hazard likely to affect safety;
- actual or attempted malicious act likely to affect safety;
- uncontrolled radioactive material release;
- incident in which exposure to ionising radiation is higher than regulatory limits;
- incident of nuclear origin leading to human fatality or severe injury;
- design fault;
- any other anomaly deemed significant by the licensee or the safety authority and not covered by any of the nine criteria above.

The licensee must send an analysis report of the incident to ASN within two months.

All incidents are rated on the INES scale.

ASN actions are described in section 7.3.

19.1.7 Regulatory requirements concerning radioactive waste

Radioactive waste management in BNIs is regulated principally by the order of 31 December 1999. In application of this order, each BNI licensee must submit a waste study to ASN, in which the risk of producing radioactive or non-radioactive contaminated waste is described. Zoning of the installation, submitted to ASN for approval, distinguishes two types of zone. The zones likely to produce radioactive waste are identified as nuclear waste zones. Waste from nuclear waste zones must be managed in separate processes from other waste. Waste from the other zones, after checking for the absence of radioactivity, is processed as conventional waste (standard or special industrial waste). ASN has published a guide to the production of BNI waste studies, available on its website; the guide was revised in September 2002.

19.2 Measures taken for power reactors

19.2.1 Commissioning of EDF reactors

Commissioning tests are carried out in accordance with Commissioning Programmes (PPE) which specify, for each reactor system or category of tests, the aim and the list of tests to be carried out for commissioning of the function, and the criteria to be met.

The detailed description of the tests to be carried out is to be found in a test procedure (PEE) which specifies the procedures for carrying out each test and its acceptance criteria.

Commissioning tests include:

- preliminary tests: no-load tests (wire-by-wire tests, compliance of sequences with logic diagrams), pump rotation tests, cleaning of systems, etc.;
- overall tests: at the different stages of progress of commissioning.

Test procedures accompanied by record sheets and test results are known as test records (REE). Test record analysis sheets (FAREE) are prepared for safety-related equipment.

These documents are analysed by site personnel and corporate engineering centres. Analysis of results obtained may lead to tests being repeated. These documents are then given to the licensee, who is responsible for archiving them. The tests are coordinated and scheduled by a group comprising the licensee and the builders.

Incidents that occur during testing are mentioned in the corporate database and, if they are safety-significant, they are reported to ASN.

A site testing committee (CES) meets at each important transition between overall test phases. This committee is made up of EDF representatives, the builders and representatives from ASN, and reviews the main results of the overall tests and individual tests. ASN gives the authorisation to move to the next test phase, depending on the results presented to the committee (for example, approval for core loading).

The site manager becomes responsible for the safety of the unit from the first loading of nuclear fuel into the core.

19.2.2 Operation technical specifications for EDF reactors

The installations must be operated in compliance with general operating rules (RGE), a regulatory document comprising ten chapters.

Chapter 1: Organisation in operation

Chapter 2: Organisation of quality

Chapter 3: Operation technical specifications

Chapter 4: Organisation of industrial safety and radiation protection

Chapter 5: Procedures for liquid and gaseous radioactive discharges

Chapter 6: Incident and accident operating procedure

Chapter 7: On-site emergency plan

Chapter 8: Operating instructions

Chapter 9: Periodic tests on safety-related systems

Chapter 10: Physics tests relating to the reactor core

Chapter 3 of the general operating rules concerns the operation technical specifications (STE), the primary role of which is to define the limits of the normal operating ranges of the unit in order to ensure that it remains within the safety limits and design assumptions of the reactor. The second role of the technical specifications is to specify requirements for the availability of safety functions that are essential for monitoring, protection and safeguards, as well as the operability of incident, accident and beyond design accident control procedures. The third role of the technical specifications is to define the action to be taken if a required safety function is unavailable, or the normal operating ranges are exceeded.

For each operating range, the technical specifications define the operating envelope to be complied with, i.e. the limits for physical parameters (volumes of water, boron concentrations, temperatures, pressures, flowrates, etc.). These parameters can be monitored from the control room by means of indicators, recorders, alarms, etc.

In particular, the pressure and temperature of the primary system must lie within a clearly defined range at all times. Values outside this normal operating envelope are prohibited.

For each operating range, the technical specifications define the safety functions which must be available. These are “required” functions. A system or equipment item is available if, and only if, it can be immediately demonstrated that it is capable of performing its allocated functions with the required performance levels (in particular start up time):

- in particular, the auxiliary equipment required for its operation and its instrumentation and control is itself available;
- the periodic test programmes in the general operating rules that relate to the equipment items or systems concerned are carried out in a normal manner (compliance with specified frequency, including tolerance, and procedure) and the results are satisfactory.

An item of equipment that is available may be in the shut-down condition.

Unavailability may be:

- unplanned: it directly results from the unforeseen discovery of an operating defect in the equipment in question, detected by one of the means available to the licensee;
- planned: the frequency and cause are known and pre-defined (execution of preventive maintenance programme or periodic tests);
- neither planned nor unplanned (for example unavailabilities due to the incorporation of a modification).

Any non-compliance with a technical specification rule in a unit operating mode in which this rule must be complied with (for example exceeding a limit in an operating range, or unavailability of a required equipment item) constitutes an event. For each operating range, the technical specifications define the action to be taken following an event: fallback mode, fallback (initiation) time or repair time.

The fallback mode is a reactor mode in which the event either does not affect the safety of the unit, or affects it to a lesser extent. The transition from the initial operating mode to the fallback mode is made by applying normal operating procedures.

The actions for making the transition to the fallback mode must begin within the required "initiation" period, which provides time to make a diagnosis, assess the situation, consider a repair and prepare for the transition to the fallback mode. The repair period is authorised to allow work to be carried out and to enable the required equipment to be made available again.

Any waiver in respect of technical specifications must be exceptional and may only be applied with the approval of ASN. To obtain such approval, a waiver request must be submitted, specifying the requirement in respect of which non-compliance is planned, the need for the waiver and its acceptability in terms of safety, suggesting additional compensatory measures where appropriate.

19.2.3 Inspection, maintenance and testing of EDF reactors

19.2.3.1 Inspection and testing

Chapter 9 of the general operating rules (RGE) defines the inspection and periodic testing programme for safety-related equipment. To verify the availability of this equipment, and in particular engineered safety systems that would be required in the event of an accident, functional tests are carried out on a periodic basis. The action to be taken in the event of an unsatisfactory result is specified in the operation technical specifications. This type of situation can sometimes oblige the licensee to shut down the reactor in order to restore the failed function.

Periodic tests enable the following to be assured during unit operation:

- absence of deterioration in respect of the design reference system;
- compliance with the assumptions chosen for the design-basis operating conditions described in the safety analysis report accident studies;
- monitoring of the availability of the equipment and associated fluids that constitute the safety functions required by the operation technical specifications;
- monitoring of the availability of the means that are essential for the operability of incident and accident operating procedures.

The periodic tests described in Chapter 9 of the general operating rules (RGE) concern plant systems that are classed as important for the safety of the nuclear installation. Nonetheless, the following are not included:

- systems that are otherwise subject to regulatory inspections;
- auxiliary systems whose availability is the subject of continuous monitoring at all times, and whose configuration does not change for a safeguard role.

The most important systems in terms of safety are the subject of a completeness analysis report. This document aims to determine all of the tests and inspections required to ensure that equipment is available and able to perform its function.

All safety-related systems are the subject of a periodic testing rule which provides the information required for preparing test procedure worksheets: test execution conditions, test acceptability criteria (allowable values of parameters and associated tolerance intervals) and execution frequencies. The periodic testing rules and associated summary tables for the most important systems in terms of safety are submitted to ASN.

Satisfactory execution of the periodic test programmes specified in the general operating rules (RGE) is one of the conditions for declaring that equipment and systems are available in accordance with the definition of availability given in the operation technical specifications (STE).

Satisfactory execution means that the specified test frequency has been complied with, and that the results of the test are satisfactory (values recorded during the test comply with the criteria, test execution conditions comply with the conditions specified in the test rule, etc.). If this is not the case, the equipment in question must be declared unavailable.

There is a 25% tolerance in respect of the frequency of tests carried out on a calendar basis (daily, weekly, monthly, annually, every thirty equivalent full power days (EFPD), etc.). Use of this tolerance must not lead to the schedule for the next test being shifted back in time.

Chapter 10 of the general operating rules (RGE) defines the programme of physics tests relating to reactor cores. It was set up in 1997 to group together pre-existing tests in a consistent manner.

In 2006, EDF initiated an action plan designed to enhance the quality of periodic test programmes and improve consideration of measurement inaccuracies, taking account of experience feedback from 20 years of plant operation.

19.2.3.2 Maintenance

Preventive maintenance is primarily determined by assessing the consequences of equipment failure. Critical equipment is equipment whose failure has at least one of the following consequences:

- a safety function is affected;
- production is reduced;
- costly repairs are required.

By analysing the failure modes of such equipment using available information (vendor's data, experience feedback from EDF and other nuclear licensees, etc.) it is possible to define necessary checks.

Two types of document are prepared:

- maintenance policy, which contains the results of the failure mode analyses and the justification for the checks adopted;
- basic preventive maintenance programmes (PBMP), which list preventive maintenance tasks to be carried out on different types of equipment.

The programmes contain routine maintenance tasks with associated frequencies, and acceptance criteria for equipment condition observed during inspections, checks and overhauls (condition-based maintenance).

Maintenance policy as well as basic preventive maintenance programmes evolve on the basis of experience feedback regarding the behaviour of equipment in operation (failures, results of inspections, checks and overhauls, etc.). To achieve the optimum compromise between maintenance costs and plant availability, EDF has undertaken an initiative aimed at optimising preventive maintenance activities through reliability-centred maintenance (RCM): this has led to a review of maintenance programmes and the organisation of reliability data acquisition. In addition, and with the same aim of optimisation, EDF has begun preparing condition-based maintenance programmes.

In addition, since 2005, EDF has capitalised on the fact that it operates a standardised reactor fleet to develop an approach based around the notion of "reference equipment". This approach involves inspections and in-depth preventive maintenance on a limited number of large equipment items, and determining, on the basis of the results obtained, the preventive maintenance to be applied to identical equipment in the other units in the series.

The rules for in-service monitoring of mechanical equipment (RSEM) describe the basic in-service monitoring operations carried out on mechanical equipment and pressure vessels in accordance with regulations (inspections, tests, hydrostatic tests, non-destructive examinations, irradiation monitoring of materials, rules for replacement or repair of equipment). The rules for in-service monitoring of mechanical equipment (RSEM) are taken into account in basic preventive maintenance programmes (PBMP).

After maintenance work, modifications, or an operating event, requalification tests are carried out to verify that design performance has been maintained or restored.

Requalification generally starts with requalification of the equipment (intrinsic requalification), and ends with requalification of the system or a functional sub-assembly (functional requalification). Requalification is an integral part of any work carried out. It is planned at the beginning of the work, irrespective of whether the work itself is of the "planned" or "unplanned" type.

Planning of requalification consists in defining the following:

- whether or not requalification is required;
- the nature of requalification tests (type of test, procedure, criteria to be checked, test conditions);
- required additional or compensatory measures in the absence of appropriate tests.

Work documents contain the analysis carried out during planning, and the execution report, together with the result of requalification. Correct requalification results as well as the treatment of any deviations are prerequisites for equipment or systems being declared available.

In 2005, EDF embarked on a program to enhance the quality of requalification tests, and draw up specific requalification procedures for large equipment items.

19.2.4 Management of incidents and accidents in respect of EDF reactors

Operating parameters (pressure, temperature, neutron flux, activity, flow rate, etc.) are measured continuously by sensors, and serve as indicators of installation operation. In the event of pre-set limits being exceeded, automatic plant systems detect the phenomenon, and trigger an alarm in the control room to inform operators of the event so as to enable them to analyse the situation and take appropriate action, in particular as required by operation technical specifications.

Analysis of alarms and physical variables may lead operators to make a diagnosis that results in entry into an incident procedure.

Chapter 6 of the general operating rules (RGE) describes the actions to launch in the event of an incident or accident. It contains the rules defining the operating principles adopted for maintaining or recovering safety functions (reactivity control, core cooling, containment of radioactive material) under incident and accident conditions and returning the reactor to a safe condition.

As part of a deterministic approach, the events postulated at the design stage have led to the definition of four categories of operating conditions, together with their potential consequences for the installation and the environment.

Definition of the operating conditions in Category 2 (incidents) and Categories 3 and 4 (accidents) has enabled the following:

- design of installations in such a way as to limit the consequences of incidents and accidents;
- definition of medium- and long-term installation operation to maintain the reactor in, or bring it to, a safe condition without exceeding the maximum radiological consequences for the corresponding category.

These studies are carried out based on the following assumptions:

- conservative assumptions are applied regarding initial unit condition and operation of all devices and systems (protections, engineered safety systems, etc.) challenged by the transient;
- manual actions resulting from application of operating procedures by operators take over from automatic actions.

Event-based procedures were drawn up on the basis of the foreseeable development of an incident or accident in order to maintain the reactor in, or bring it to, a safe condition. These procedures are applicable if a single event occurs (without being combined with another incident or accident), and if the event has been correctly diagnosed.

The “state-oriented approach”, based on physical conditions in the nuclear steam supply system, was designed to deal with an aggregate of human and equipment failures. There is an infinite number of event combinations, but only a limited number of physical states of the nuclear steam supply system. These can be identified on the basis of a few representative physical parameters. In general, the required actions can be deduced from knowledge of this state, without the sequence of events that led up to it necessarily having been identified.

The principles of the state-oriented approach are as follows:

- to identify the overall physical condition of the plant, irrespective of the situation, on the basis of six state functions: sub-criticality, water inventory in primary system, decay heat removal, steam generator integrity and water inventory, containment integrity;
- to define the overall objective of the action to be taken directly based on this state (for example transition to a fallback mode);
- to define priorities among state functions;
- to specify all the actions necessary to control the situation by monitoring the state functions (if the systems normally used are unavailable, substitute systems will be used in a given order of priority);
- to monitor the availability of the main systems, so that substitute systems can be started up if necessary or unavailable systems recovered.

Taken together, identification of the physical state, definition of priorities, and actions for monitoring of state functions to achieve the overall objective, constitute an operating strategy.

This process is repeated in cycles.

All of EDF’s nuclear sites now use the state-oriented approach. Since 2005, EDF has collected experience feedback on the implementation of this approach. The aim of the programme is to propose improvements to be rolled out from 2009.

This method covers all “thermal-hydraulic” incidents or accidents (primary breaks, secondary-side breaks, core heatup, etc.), either single or multiple, whether or not combined with loss of systems, loss of power or human failures. Its primary goal is to prevent a risk of core melt.

In the hypothetical case of a core melt, unit operation must take account of the new and complex phenomena that will occur during accident development, as well as the difficulty of performing a diagnosis of unit condition in a severely degraded situation. In this situation, the primary objective is to safeguard the containment.

The operation strategy in this case is contained in the serious accident response guide (GIAG).

The decision to apply the serious accident response guide, which marks the abandonment of state-oriented approach procedures, is taken by the site management emergency centre on the basis of core outlet temperature and in-containment dose rate criteria.

The control actions defined in the serious accident response guide are aimed at:

- avoiding or minimizing atmospheric discharges outside the containment;
- allowing sufficient time before a possible loss of containment for the implementation of measures to protect populations under on-site and off-site emergency plans;
- returning the unit to a controllable condition; keeping the corium covered inside the reactor vessel is, in this respect, the key objective for regaining control of the situation and controlling discharges outside the plant.

19.2.5 Changes in the organisation of nuclear engineering in 2006

In 2006, EDF embarked on an initiative to change the nuclear engineering function. This initiative involves new modes of operation and new organisations at NPPs and within engineering units. It responds to the universally expressed need to simplify installation modification processes and the associated documentation processes, and to bring designer and licensee closer together.

EDF Generation & Engineering is very keen to forge stronger links between teams at the Nuclear Engineering Division and the NPPs to enhance the operation of the nuclear generation fleet. The aim is to enable corporate-level engineering groups to cooperate with the NPPs at the earliest possible stage in the design of modifications in order to facilitate their integration into the installations, while simultaneously establishing safety-related operation and maintenance rules and associated procedures.

The discussions that led to this closer cooperation resulted in the decision to define new responsibilities for the NPPs and engineering units.

- One site will be the pilot for each plant series: Tricastin (CPY), Paluel (1300 MWe), and Civaux (N4). Both Fessenheim and Bugey will jointly act as pilots for the CP0 series. The site acting as the “series pilot” is the single point of contact for the engineering units with regard to the joint compilation of modification files and the determination of their impact on operations, and will coordinate joint preparation of operating documents (the plants in conjunction with engineering units).
- All NPPs, including “series pilots”, will have a local integration unit for modifications and documentation, which will interface directly with the “series pilot” site.

Enabling design engineers and licensee to work directly together further reinforces the NPPs’ responsibility for operations, while also deriving greater benefit, within engineering processes, from the shared commitment to producing electricity in a safe, efficient and sustainable manner.

19.2.6 Reporting of significant events and anomalies by EDF

EDF reports significant events or anomalies to ASN as soon as possible. In this respect, it takes appropriate measures in relation to its contractors. Such reports describe the measures already implemented or planned to limit the extent of the anomaly or incident and, where applicable, to mitigate the consequences. If the installation is in operation, the reports specify the measures taken or planned to enable continued operation or resumption of operation under satisfactory safety conditions.

Significant anomalies or incidents are analysed in depth to determine their precise causes as well as their direct or potential consequences for safety, and to draw any useful lessons in respect of the affected quality-related activity and, where applicable, other quality-related activities. A file is created and kept updated for each significant event or anomaly, containing in particular the results of this analysis. EDF keeps ASN regularly informed of the status of this file.

In 2005, ASN expanded the list of criteria for reporting significant safety-related events, in order to improve the effectiveness of experience feedback. Criteria were also defined for reporting significant events and anomalies in the field of radiation protection and the environment.

Significant safety-related events ranked at level 1 or above on the International Nuclear Events Scale (INES) are the subject of external communication for the media, Internet, local public authorities and local information committees (CLI). Such communication meets the requirements of the act of 13 June 2006 on transparency and security in the nuclear field.

19.2.7 Experience feedback at EDF

EDF's operating experience is particularly significant, since it now totals more than 1,200 reactor-years. The volume of information generated by the 58 units currently in operation requires strict prioritisation to enable appropriate handling in terms of safety. EDF has established three levels of priority as follows:

- Safety-related events are entered in a common database by the sites so that experience can be shared (around 20,000 events per year). These events are dealt with locally and are also examined weekly at corporate level by a cross-functional group. In this way, recurring problems and those that are potentially generic can be identified at an early stage.
- Significant safety-related events (around 550 per year) are analysed on site, and then reviewed at corporate level. Each site applies the analysis method defined at corporate level by means of a guide and appropriate training. Some analyses are handled directly with the corporate level if this is warranted by the importance or generic nature of the event.
- For certain significant events that have the greatest impact on safety (around 60 per year), an assessment of the potential risk of core damage is carried out using a probabilistic approach. The method used enables identification of the most likely degradation scenarios and determination of whether the event is a precursor. The corrective measures adopted are linked to the extent to which the event is a precursor.

Grouping events of the same type together enables action plans to be drawn up with the aim of preventing the recurrence of defective conditions or inappropriate actions. This is done after a second-level analysis has been carried out. The change in the number of events of a given type (alignment, error, non-compliance with operation technical specifications, etc.) can be considered as an indicator of the effectiveness of measures taken.

The equipment data stored in the database described above is reviewed periodically to detect any drift in reliability and to measure the beneficial effect of the maintenance measures or modifications implemented.

In addition, events occurring at non-EDF nuclear installations are also monitored. The event at Forsmark in 2006, for example, was the subject of an analysis, submitted to ASN, to determine the robustness of EDF's NPP fleet in respect of the scenario concerned.

In December 2003, experts from the IAEA conducted an assessment of EDF's experience feedback process (PROSPER). At the follow-up mission in April 2006, satisfactory progress was considered to have been made, and 80% of problems had been resolved.

Work has been undertaken aimed at improving consideration of low-level events and precursors. Rollout of the associated actions will take place over the period 2007-2010. The programme will be based around encouragement by managers of unsolicited feedback, and increased management presence in the field to observe and understand work situations (this action is described in section 12.2.1).

In addition, a common typology for analysing events in respect of human factors has been in place at all nuclear sites since 2006.

19.2.8 Waste from EDF reactors

Waste management comprises the following main stages:

- waste zoning[8];
- collection;
- sorting;
- characterisation;
- treatment;
- interim storage;
- shipping.

Waste management, whether the waste is radioactive or conventional, complies with French regulations on waste disposal and recovery of materials.

Collection is a sensitive stage in the management of waste in nuclear installations. Waste is collected in a selective manner, either directly by the process or by workers at worksites. Starting with the collection stage, the physical management of radioactive waste must be kept separate from management of conventional waste at all levels.

Radioactive waste resulting from the operation of PWRs mainly comprises very low-low- and intermediate-level short-lived waste. It contains beta and gamma emitters, and few or no alpha emitters. It can be classed in two categories:

- process waste originating from purification of systems and treatment of liquid or gaseous effluents to reduce their activity levels prior to discharge. Such waste consists of ion exchange resins, water filters, evaporator concentrates, liquid sludge, pre-filters, absolute filters and iodine traps;
- technological waste originating from maintenance activities. This may consist of solid waste (rags, paper, cardboard, plastic sheets or bags, wood or metal items, debris, gloves, protective suits, etc.) or liquid waste (oils, decontamination effluents).

Process waste is packaged in concrete containers with a metal liner. Filters, evaporator concentrates and liquid sludge are encapsulated in a hydraulic binder in fixed installations (in the nuclear auxiliary building or the plant waste treatment building). For final conditioning of ion exchange resins, EDF applies the MERCURE process (encapsulation in an epoxy matrix) employing two identical mobile machines.

Low- and intermediate-level technological waste is:

- either shipped directly, after compacting on-site in 200-litre metal drums, to ANDRA's Aube repository, for further compaction and subsequent final disposal after encapsulation in 450-litre concrete drums. The most highly radioactive technological waste is packaged on-site in concrete containers and placed directly in disposal at the same repository;
- or shipped to SOCODEI's CENTRACO plant.

  The facility for treatment and conditioning of low-level waste (CENTRACO) is designed for the treatment of low-level waste, either by melting of metal waste or incineration of combustible or liquid waste (oils, solvents, evaporation concentrates, etc.). Thanks to

[8] **"Waste zoning":** divides the installations into zones that produce nuclear (or radioactive) waste, and zones that produce conventional waste. It takes account of the design and operating history of the installations and is confirmed by means of radiological inspections.

this installation, part of the low- or very low-level metal waste can be recycled in the form of biological shielding for packaging other more highly radioactive waste in concrete shells

Very low-level waste is shipped to a dedicated repository (CSTFA at Monvilliers) managed by ANDRA, which was commissioned in 2003.

19.3 Measures taken for research reactors

19.3.1 Operating documentation for research reactors

Four base installation documents are required under the regulation:

- the safety analysis report, which describes the reactor, its components and their characteristics;
- the technical requirements;
- the general operating rules;
- the waste study.

They are supplemented by the on-site emergency plan (PUI) for the Centre.

The safety analysis report for the Phénix reactor, issued in April 2006, includes all the modifications and studies performed since 1991, particularly those relating to the safety reassessment carried out between 1994 and 2003.

The base documents were supplemented by a set of procedures and instructions from the departments involved which ensure that all operations comply with the relevant rules.

These rules apply also to service providers, and the licensee must ensure that service providers comply with them.

In exceptional circumstances, ASN may be asked to grant temporary waivers, based on a detailed safety analysis and justified by documented reasons.

The experimental devices designed and operated in installations also meet very strict safety requirements.

In particular, a full safety analysis that takes into account the reactor's safety reference system, must demonstrate that any risks have been considered and are contained within acceptable limits.

Experimental devices must be authorised for use:

- either internally, if the operating conditions comply with safety rules defined with ASN's agreement;
- or by ASN, if the operating conditions fall outside the predefined boundaries.

Memorandum SD3-CEA-04 of 16 December 2003 defines the context for internal authorisation given by the CEA to load experimental devices into research reactors. A guide to technical design written by the DPSN defines the construction and design rules and the safety analysis rules for experimental devices. In particular, it may be used to determine the safety requirements and appropriate technical systems to use in relation to particular safety issues.

Authorisations are granted after reviewing a comprehensive application containing the design and construction rules, and the conclusions from the associated safety analysis.

The application also includes the principles adopted to operate, monitor and maintain the experimental device.

19.3.2 Inspection, maintenance and testing

In order to ensure that safety-related equipment and systems (EIS) are available in each installation, and to check they are working properly, they are subject to periodic checks and tests (CEP) The frequency of these checks and tests is narrowly defined, and may be date- or event-driven.

The list of EIS checks and tests is given in Section 9 of the installation's general operating rules (RGE). The list is significantly longer for the Phénix reactors than for other lower power reactors.

It should be noted that Section 9 of the RGE for the Phénix plant was updated in 2006, to include experience feedback from operating the installation since it was restarted in 2003.

If these tests are carried out at the defined frequency and have a satisfactory outcome, then the items concerned are declared formally available. EIS prone to ageing or fatigue are also subject to preventive maintenance. The aim of systematic maintenance is prevent the equipment failing and to keep it in the right condition to fulfil its function and deliver the required performance. This preventive maintenance is recurrent, as for the periodic checks and tests. Its frequency depends on the defined operating modes and, when the work could have an impact on safety; it is accompanied by a risk analysis.

These rules as written apply particularly to the Phénix reactor. For other smaller reactors, they are applied in less detail.

19.3.3 Incident and accident procedures

Apart from normal operating situations, the operators may take the action defined for incidents or accidents (or even for hypothetical or emergency situations) when they analyse the installation's alarms and measured operating parameters, as relayed to the control room. This is particularly so for the Phénix reactor.

The incident and accident procedures describe the operating practices for such situations, aimed at bringing the reactor to and maintaining it in a safe state, and at limiting the consequences of the incident or accident.

The operating rules applicable during incidents and accidents are described in Section 6 of the RGE, and those for hypothetical or emergency situations in Section 10. They have been approved by ASN.

These rules as written apply particularly to the Phénix reactor. For other smaller reactors, they are applied in less detail.

19.3.4 Processing of anomalies and incidents

Anomalies are subject to deviation reports, and significant incidents must be declared to ASN. Anomalies and incidents are analysed with the staff concerned. Experience feedback is an integral part of deviation processing, and all equipment and systems that could give rise to such a deviation are also analysed.

Since 1 January 2006, the written guidance from ASN on how to declare and code criteria relating to significant events requires research reactors to declare to ASN any event causing a protective and/or safeguard system to be activated. In this context, any activation of the reactor's automated shutdown system, apart from intentional activation by programmed action, whether activated manually or automatically, and whether or not at the right time, must be declared to ASN as a significant event.

Very few significant incidents have been declared for research reactors over the last three years. They include:

- the loss of local ventilation on various occasions during stormy weather;

- an abnormal time between the order to lower a control rod during its requalification and the related action;
- reduced protection for several hours against the sodium-water reactions in the Phénix reactor's steam generators;
- inappropriate settings for safety thresholds;
- failure to comply with technical instructions regarding the efficiency of iodine filters;
- a general power cut in the external electricity supply to the Cadarache Centre.

All these events were declared to ASN. They are analysed in detail in significant event reports.

In addition, the DPSN (protection and nuclear safety directorate) of the "risk control" division, has set up an experience feedback network in collaboration with the safety units of the CEA Centres. The information held in the network is passed on to installations at meetings attended by installation managers.

19.3.5 Waste from research reactors

The production of waste is also monitored with the aim of reducing it.

In order to reduce waste production:

- waste zoning has been implemented;
- staff awareness has been increased.

Principles and policies relating to waste have been defined and are set out in the operational documents.

19.4 Analysis by the regulator

19.4.1 Power reactor operation

The nuclear reactors have not experienced noteworthy events in recent years. The sections below discuss the main current issues in terms of analysis of operating safety of nuclear power reactors.

19.4.1.1 Internal authorisations

As part of its nuclear installation safety regulation activities, ASN can subject certain reactor operations to its prior authorisation. In some cases prior authorisation systems have been imposed on the licensee following significant incidents. However, ASN considers that a prior authorisation system must remain limited to the cases which require it, either because of the regulations or because of safety, radiation protection or environmental protection factors. This type of system could encourage the licensee to shift the burden of validating its operations or documents onto ASN and pay less attention to their quality, which is contrary to the principle of the licensee's prime responsibility for nuclear safety.

On the basis of experience feedback acquired in recent years, ASN considers that some prior authorisation systems could be ended, provided that EDF reinforces monitoring of the activities and implements an appropriate monitoring organisation. The following operations are concerned:

- lowering of the primary system water level to the "low working range" of the residual heat removal system (mid-loop operation) with the core loaded;
- reactor restart after outages without significant maintenance.

Since January 2005 the authorisations for these two operations are delivered by DPN management or by site management after review by an independent internal committee including the safety and quality managers. EDF monitors the operation of this process and reports on it to ASN.

In 2006 ASN inspected each power plant on the topic of internal authorisations. These inspections verified compliance with the new arrangements.

19.4.1.2 Maintenance

19.4.1.2.1 Maintenance practices

Deregulation of the electricity market encourages EDF to control its expenditure. Optimising maintenance costs is one way for EDF to improve its competitiveness. EDF has therefore developed a "maintenance reduction" project which aims to concentrate maintenance on equipment which would constitute a safety, radiation protection or operational risk in the event of failure, and is relying on maintenance methods which do not require equipment dismantling.

An initial change was introduced in the mid-1990s with the implementation of the “reliability-centred maintenance” (RCM) method. This involves a functional analysis which determines the type of maintenance to be carried out according to the consequences of equipment failures on the system concerned, rather than simply according to their causes, as in the previous approach. ASN considered that this approach did not degrade safety.

Following ASN requests and in order to take account of experience feedback from the sites, EDF modified the RCM method to deal with redundancy losses and common-cause failures, and also failure modes not detectable from the control room.

Taking advantage of the standardisation of its reactors, EDF is developing the concept of “pilot equipment”-based maintenance, constituting technically-uniform families of similar equipment operated in the same way. Selection and close monitoring of a limited number of these equipment items, which thus act as pilot equipment within these families, could, if no deterioration is detected, avoid the need to check all the equipment.

ASN is closely monitoring how EDF takes account of experience feedback on the behaviour of the equipment concerned by these maintenance methodology changes, in particular with regard to the content and frequency of the checks.

19.4.1.2.2 Monitoring and maintenance of the main primary and secondary systems (CPP and CSP)

When designing the systems, the manufacturer assesses how the situations experienced by the steam supply system during operation are likely to damage it. He then allows for sufficient design margins to ensure that the various identified degradation modes, including fatigue, do not reduce the safety of the steam supply system.

In order to ensure that the licensee of a NPP has assimilated the nuclear steam supply system manufacturer's recommendations and adapted its operating conditions accordingly, the regulations require the compilation of “reference files” for the systems.

The licensee must also monitor the systems during operation and set up a documentation system including the reference files and all the events marking the life of the steam supply system.

19.4.1.2.2.1 REFERENCE FILES

The order of 10 November 1999 requires the licensee to compile and update all system design, manufacturing and operation documents which contribute to providing evidence of system integrity.

Given the uniformity of the French nuclear reactor fleet, EDF chose to organise these reference files into “series” files for all the reactors of each series (900 MWe, 1300 Mwe and 1450 MWe), breaking them down into “unit” files for each individual reactor. In particular, the unit files include documents on maintenance, faults and events that occurred on the reactor concerned.

19.4.1.2.2.2 SITUATION RECORDING

During reactor operation, the licensee must check that the steam supply system (SSS) equipment is not placed under conditions more severe than those for which it was designed. In particular, the licensee must note the situations actually experienced by the main SSS systems and record them in its documentation system. The objective of situation recording is to make sure that safety margins are maintained throughout the life of the reactor.

Between 2002 and 2006 ASN conducted a series of inspections in order to obtain an overview of the manner in which EDF carries out this procedure.

19.4.1.2.2.3 QUALIFICATION OF INSPECTION METHODS

International work has identified the need to demonstrate that the inspection method used for monitoring reactor main primary and secondary systems in operation effectively detects potential degradation.

Article 8 of the order of 10 November 1999 specifies that non-destructive testing procedures used on equipment in operation must be qualified prior to use by an entity, chosen by the licensee, whose competence and independence must be proven.

The order stipulates the establishment of a qualification commission, recognised as competent and independent both from the reactor operators and those directly involved in developing the procedures, to pronounce these qualifications.

This commission, chosen by EDF, has obtained its accreditation from COFRAC (French accreditation committee). It assesses the representativeness of the mock-ups used for the demonstrations and the faults introduced into them. On the basis of the qualification results, it confirms that the testing method effectively achieves the intended performance levels. A description of the qualification process has been codified in the in-service surveillance rules for mechanical equipment (RSE-M). Depending on the case, the aim is either to demonstrate that the inspection technique used is able to detect a degradation described in a specification, or to provide explicit information on the performance of the method.

The objective was to qualify all the non-destructive testing procedures used in in-service inspection programmes. The 144 applications were compiled in 76 qualification files on the basis of technical similarities. As of the end of 2006, only one file was still in the final phase of qualification. Pending its qualification, special measures are applied.

19.4.1.3 General operating rules (RGE)

19.4.1.3.1 Operation technical specifications (STE)

ASN has reviewed and authorised several changes in the STE applicable to the different reactor series. These changes take account of reactor operational experience feedback, changes in fuel management and improved handling of certain risks. The review of these changes led ASN to request further supporting documentation and to formulate requests prior to the application of the STE amendments on the sites concerned.

ASN considers that the amendment document guidance policy implemented by EDF, in particular by highlighting the proposed changes, facilitates the analysis and examination of the change proposals.

19.4.1.3.2 Waivers with respect to STE

When a licensee considers that on safety grounds it is unable or does not wish to comply strictly with the STE during an operating phase or a maintenance operation, it must apply to ASN for a waiver, on a case-by-case basis. ASN analyses the application and decides whether it is acceptable, imposing compensatory measures for the non-compliance with the STE, where necessary.

ASN closely tracks the number of waivers and performs a comprehensive analysis each year, based on a record compiled by EDF. EDF is required:

- to periodically review the reasons for the waiver requests in order to identify those which would justify amendment of the STE;
- to identify "generic" waivers, in particular those linked to implementation of national modifications and periodic tests.

The number of waivers examined each year is of the order of one hundred, with 148 in 2005 and 120 in 2006, giving an average of 2 to 2.5 waivers per reactor per year.

Although the majority of the waivers are granted, ASN sometimes has to accompany its authorisations with additional requests due to the inadequacy of the compensatory measures proposed by the licensee.

19.4.1.3.3 Periodic tests

ASN has continued its examination of changes in the periodic test programmes in the general operating rules (RGE). In most cases this has resulted, for the various series, in making the periodic tests consistent with the other chapters of the RGE and with the technical state of the installations.

In 2006 ASN accepted the strategy proposed by EDF for revising a number of operation documents to take better account of measurement uncertainties during periodic testing.

ASN is also pursuing its consideration of changes in the examination procedures for periodic testing programmes.

19.4.1.4 Incident and accident operating procedure

19.4.1.4.1 State-oriented approach (APE)

Until 1989 the procedures used for operation in an incident or accident situation were based on an event-oriented approach, consisting in initiating a predetermined operation strategy according to a single initial diagnosis intended to identify an "initiating event". This approach was not suitable for the management of complex situations, where the initiating event was combined with human or equipment failures. EDF consequently decided to gradually phase out the event-oriented approach.

Operation in the case of an incident or accident now uses the state-oriented approach (APE), gradually implemented from 1989 to 2004 on the various sites after ASN authorisation. The state-oriented approach consists in applying operation strategies which are prepared according to the identified physical state of the nuclear steam supply system, regardless of the events that led to this state. Should the state deteriorate, continuous diagnosis enables the procedure or sequence in progress to be aborted and a more appropriate procedure or sequence to be applied.

In general, ASN considers that the quality of the documents submitted by EDF is good, although the licensee must maintain its efforts with regard to the traceability of the origin and the end purpose of changes.

In addition, the inspections carried out by ASN have not detected any significant dysfunction, and ASN considers that the assimilation of the operation rules in the case of incident or accident by the sites (incorporation into local documents, circulation and team training) is generally satisfactory.

In 2006 ASN began an analysis of the EDF project on operation in the case of incident or accident (CIA). EDF undertook this project following consideration of the frequency of changes in the state-oriented approach procedures and of observed incidents which were not managed optimally by state-oriented operation, and in order to maintain competencies in operation in the case of incident or accident.

19.4.1.4.2 Reactor operation in severe accident situations

For highly-hypothetical severe accident situations not accounted for in the initial design of PWRs, various technical, documentary and organisational measures are taken so that the licensees, supported by the emergency teams, can manage reactor operation and ensure the containment of radioactive materials, thus limiting the consequences of the accident.

The emergency teams can use the severe accident response guide (GIAG), regular updates of which are proposed by EDF and examined by ASN.

In 2006 EDF completed the transposition of the GIAG into operation documents for all reactor series. These documents are intended for use by the operation teams and on-call personnel of the plant and the local and national emergency teams.

To obtain a better definition of all the safety requirements regarding severe accidents, and following a request from ASN, EDF proposed a draft “severe accident” reference system. This was reviewed by the GPR in 2005. It will have to be revised, in particular to take into account the conclusions of the 900 Mwe reactor safety review, associated with the third ten-yearly outages, and the long-term management of accidents.

19.4.1.5 Analysis of incidents and operating feedback

ASN checks that EDF actually draws lessons from experience to improve safety and radiation protection. At national level ASN reviews EDF processing of notified events. In addition, during NPP inspections, ASN reviews plant organisation and actions to process events and take into account experience feedback.

ASN also makes sure that EDF learns lessons from events that occur abroad and which can be applied to its nuclear reactors.

At the request of ASN, in 2005 the GPR reviewed PWR operational experience feedback over the period 2000-2002. The review of the recorded incidents for this period revealed that a non-negligible proportion of the significant events resulted from the implementation of periodic testing programmes. ASN asked EDF to undertake improvement actions targeting the identified shortcomings in the process of preparation and implementation of periodic tests and restart tests, and to communicate an assessment of the improvements resulting from these actions.

In addition, non-conformities with regard to the operation technical specifications account for more than one-third of the safety significant events. ASN asked EDF to undertake or continue determined actions to reduce the number of events in these areas, in particular to improve the consideration of human and organisational factors in the drafting of the operation technical specifications and the analysis and monitoring of non-conformities with regard to these specifications.

Review of the risk analysis approach and its implementation in operation revealed difficulties regarding cross-function risk analyses involving several departments and regarding the involvement of subcontractors in the risk analysis approach. ASN asked EDF to improve its approach on these aspects and to improve the in-depth analysis of safety significant events in order to identify the factors leading to inadequacies in the risk analyses. The next review, planned for late 2007, will cover the period 2003-2005.

At the beginning of 2004, the rules on the notification of radiation protection and environmental incidents were clarified.

In application of the rules on the notification of events in the areas of safety, radiation protection and the environment, each year (from 2004 to 2006) EDF notified on average almost 700 significant events rated on the INES scale, about 90% of which were at level 0. 21% of the rated events were rated with regard to radiation protection, and 1.5% with regard to uncontrolled release of radioactive materials into the environment.

The events declared with respect to environmental protection and which concern neither nuclear safety nor radiation protection are not rated on the INES scale. Some twenty events were notified in this category each year.

About 10% of the declared events were rated at level 1 on the INES scale, almost all of them concerning nuclear safety.

Two incidents which occurred on nuclear power reactors during the period 2004-2006 were rated at level 2 on the INES scale by ASN:

- in April 2004, a generic anomaly: anomaly likely to affect some electrical connection boxes necessary for operation of certain equipment items in an accident situation if steam or water is present in the reactor building;
- in December 2005, a generic anomaly: anomaly concerning the pumps of the low-pressure safety injection system and the containment spray system of the 900 MWe reactors.

19.4.1.6 Waste management

Following the ASN decision of 10 November 2000 on improving the interim storage conditions for very low level (VLLW) waste from NPPs, all the plants have set up VLLW interim storage facilities.

Most operations associated with management of waste generated by reactor operation and maintenance take place in the nuclear auxiliary buildings (BANs), the conditioning auxiliary buildings (BAGs) and the effluent treatment buildings (BTEs), of NPPs.

Inspection reports, in recent years, have shown that the safety of waste management in BANs, BACs and BTEs was unsatisfactory, particularly in terms of containment, protection against fire risks and radiation protection. Requests to correct this situation were made to EDF at the end of 2002.

ASN has undertaken a review of the studies submitted by EDF for eventual improvement of the design and operation of NPP waste storage and treatment buildings. EDF also carried out improvement work on these buildings in 2004. However, the safety analyses of these buildings show inadequacies in risk assessment because of the lack of a precise reference system describing the scope of operation of activities relating to waste collection, treatment and interim storage in these buildings.

The inspection campaigns conducted by ASN in 2005 and 2006 on topics relating to waste management in NPPs revealed increased awareness by the licensee that waste management improvements were indispensable and necessitated close monitoring of the installations and the quantities of waste present in them. In practice, however, these inspections showed that the operating conditions resulted in sometimes substantial cluttering of the installations, for example because of the difficulties experienced by the sites in the removal of waste (malfunctions of compacting presses, production of nonconforming packages, reduction of stocks). The inspections also showed the lack of precise definition of the scope of operation of the activities taking place in these buildings.

In 2006 ASN asked EDF to define a new operation reference system regarding waste management in BAN, BAC and BTE buildings in order to remedy this situation and ensure the availability of the conditioning equipment. ASN requested that this reference system be based on a comprehensive risk analysis.

19.4.2 Research reactor operation

19.4.2.1 Internal authorisations

ASN considered that research centre managers, with the assistance of centre safety units and safety commissions as applicable, should be allowed to authorise certain minor operations which do not compromise the installation safety demonstrations, without requiring formal authorisation from ASN. Some fifteen installations were concerned as of the end of 2003, and the system has since been extended to some twenty installations, usually after a comprehensive safety review of the installation showing that current safety requirements have been taken into account and that an updated safety reference system has been communicated and approved.

The purpose of this approach is to empower the licensee, as ASN sometimes had to deal with a large number of minor questions which did not compromise the safety demonstration or the risks of the installation, and which should have been dealt with by the licensee. The risk in this state of affairs was of the licensee avoiding responsibility, with over-reliance on the public authorities.

This approach also enables ASN to devote more resources to reviewing subjects entailing genuine safety issues, in particular the periodic safety reviews of the installations.

ASN monitors the implementation of this new system by CEA closely, in particular through a series of inspections and by assessment of certain files chosen from among those which were authorised internally by CEA.

Since this system was introduced, ASN inspections have revealed no major functional problems. Nevertheless, ASN considers that, in the files it submits, CEA must pay particular attention to documenting that the operations remain within the framework of the installation's safety demonstration. CEA must also remain attentive to updating the safety documents after these operations. With this in mind, ASN has started revision work on the guides corresponding to the letter cited above which provide a framework for CEA internal authorisations, in order to simplify the documentation reference system and clarify the expectations in terms of documentary evidence of compliance with the safety demonstration.

In parallel with the implementation of this system allowing CEA to authorise certain modifications or operations internally, ASN is setting up a programme for experimental reactors aimed at strengthening the safety requirements in two areas: the safety of experimental apparatus placed in the reactors and the safety of reactor core management (fuel element placement and criticality procedures).

19.4.2.2 Safety of experimental apparatus

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

ASN pays particular attention to these operations because of the related risks, in particular concerning reactivity control (chain reaction) and the potential for damage to the fuel elements.

Significant work was done in 2003 on experimental apparatus. At the beginning of 2004 ASN issued a guide providing a framework for the conditions of design, manufacture and authorisation of such apparatus. This guide requires that safety reviews be conducted on all experimental apparatus every ten years, which is an innovation with very positive safety implications. The application of this guide was the topic of an inspection campaign in 2005, and a substantial amount of work on incorporating experience feedback was done in 2006 by both ASN and CEA in its experimental apparatus safety analysis guide, referred to by the guide cited above. This work should lead to complete revision of the guides in 2007.

19.4.2.3 Core management safety

With regard to research reactor core configuration management, work to improve the framework or configuration change operations has been undertaken since 2000 and continues. One of the important issues is taking account of the specific features of each reactor type while making the rules as uniform as possible.

19.5 Operational reviews by international organisations

France's international cooperation in the field of nuclear safety is described in Chapter 20. In this regard, mention should be made in this chapter of the safety assessments carried out, at France's request, by experts from foreign countries acting on behalf of two international bodies already referred to previously: the International Atomic Energy Agency (IAEA) and the World Association of Nuclear Operators (WANO).

19.5.1 IAEA reviews

For many years, France has asked the International Atomic Energy Agency to conduct OSART operating safety assessment missions, as well as ASSET safety-significant event assessment missions, at French NPPs.

A PROSPER follow-up mission to assess the overall system for analysis of experience feedback was carried out at EDF Corporate in 2006.

French experts also take part in such missions in other countries, as described in Chapter 20.

The table below lists all of the missions carried out or scheduled by the IAEA in France as at the end of July 2007.

Date	Mission	Plant
4-29 October 1985	OSART	Tricastin
20 October – 10 November 1988	OSART	Saint-Alban
13-31 January 1992	OSART	Blayais (limited to three areas)
9-27 March 1992	OSART	Fessenheim
May 1992	ASSET	Fessenheim
15 March – 2 April 1993	OSART	Gravelines 3 and 4
November 1993	ASSET	Paluel
14-31 March 1994	OSART	Cattenom
7-10 November 1994	OSART follow-up	Gravelines 3 and 4
30 January – 16 February 1995	OSART	Flamanville
12-16 June 1995	OSART follow-up	Cattenom
3-7 June 1996	OSART follow-up	Flamanville
11-29 November 1996	OSART	Dampierre
12-30 January 1998	OSART	Paluel
15-19 June 1998	OSART follow-up	Dampierre
26 October – 12 November 1998	OSART	Golfech
8-25 March 1999	OSART	Bugey
21-25 June 1999	OSART follow-up	Paluel
6-10 March 2000	OSART follow-up	Golfech
5-9 June 2000	OSART follow-up	Bugey
9-26 October 2000	OSART	Belleville
14-31 January 2002	OSART	Tricastin
13-17 May 2002	OSART follow-up	Belleville
18 November – 5 December 2002	OSART	Nogent
10-28 May 2003	OSART	Civaux
17-25 November 2003	OSART follow-up	Tricastin
24 November – 3 December 2003	PROSPER	EDF Corporate
15-19 November 2004	OSART follow-up	Nogent
29 November – 15 December 2004	OSART	Penly
6-12 December 2005	OSART follow-up	Civaux
2-5 May 2006	OSART follow-up	Penly
2-18 May 2005	OSART	Blayais
6-10 November 2006	OSART follow-up	Blayais
3-7 April 2006	PROSPER follow-up	EDF Corporate
November 2006	OSART	Saint Laurent
23 November – 12 December 2007	OSART	Chinon
Spring 2008	OSART follow-up	Saint Laurent
2008	OSART	Cruas

The reports for all these missions are made public, and are available on the ASN website.

A PROSPER follow-up mission to assess the overall system for analysis of experience feedback was carried out at EDF Corporate on 3-7 April 2006. The original PROSPER mission was carried out in 2003.

19.5.2 WANO Peer Reviews

In order to have a variety of external views of its installations and their operation, EDF hosts WANO Peer Reviews every year, and contributes to such reviews abroad. A Peer Review is a plant assessment covering different technical and management fields, carried out by “peers” (nuclear licensees from other countries). Peer Reviews also provide an opportunity for productive exchanges between the review team and the host plant licensee. Since 2004, Peer Reviews have been organised wherever possible as “Joint Peer Reviews”, combining EDF’s own internal inspection programme, carried out by its Nuclear Inspectorate, with a review by a team of peers from other countries.

The table below lists the WANO missions already carried out or scheduled in France.

Date	Plant
1994	Nogent-sur-Seine
1996	Chinon
1996	Blayais
1997	Penly
1998	Saint Laurent
1999	Saint Alban
2000	Cruas
2001	Flamanville
2002	Chooz
2003	Fessenheim, EDF Corporate
2004	Cattenom, Dampierre, Bugey, Belleville, Tricastin
2005	Golfech, Paluel, Civaux,
2006	Nogent, Flamanville, Saint Alban, Gravelines,
2007	Cruas, Penly, Blayais, Fessenheim
2008	Tricastin, Belleville, Saint Alban

In 2003, WANO carried out a Peer Review of the Nuclear Power Operations Division (a “Corporate Peer Review”), which covered the operation of the Division’s headquarters and its different units (NPPs and support units). In March 2006, WANO also carried out a follow-up to the Corporate Peer Review.

20 Planned activities to improve safety

20.1 National measures

France is committed to continuing to seek ways for improving nuclear installations safety.

20.1.1 Objectives of ASN

In this general context, ASN's priority objectives concern the following points:

- improving the consideration of human factors and organisational problems by the licensees, these problems being the cause of numerous incidents;
- improving the stringency of NPP operation, in particular the application of operating procedures, the supervision of activities and the preparation of site work;
- improving radiation protection oversight in order to reach the same level as that obtained for nuclear safety;
- ensuring better consideration of environmental problems, in particular when renewing discharge licences;
- anticipating ageing problems, in particular through exhaustive preparation of the ten-yearly outages so that when the time comes, decisions can be taken regarding continued operation of the reactors beyond these milestones; this in particular concerns the power reactor third ten-yearly outages;
- issuing regulatory texts for more formal expression of requirements and practices which are not yet covered by regulations, in order to ensure that ASN has a clear position in a future context in which the economic constraints on the licensees will be greater and more uncertain.

20.1.2 Objectives of licensees

20.1.2.1 EDF's objectives

As the leading producer of electricity from nuclear power, EDF has a constant commitment to delivering exemplary performance in terms of transparency and nuclear safety.

EDF aims to enhance the economic performance of its facilities while simultaneously improving safety, radiation protection and environmental protection.

With this in mind, the licensee's key objectives relate to operation, as well as to its generating assets.

20.1.2.1.1 Objectives regarding operation

- Ongoing continuous improvement in operating safety across all operational nuclear sites.
- Reduction of errors associated with site work, and increased management presence in the field.
- Skills adaptation and renewal in light of the gradual retirement of the generation involved in the start up of nuclear reactors.
- Improved partnership with contractors.
- Ensuring that units comply with the safety requirement reference system through rigorous and appropriate treatment of deviations.
- Stabilising requirement reference systems by limiting changes to those that are the most advantageous in cost/ safety benefit terms.
- Consideration and integration of changes in regulations.

20.1.2.1.2 Objectives regarding generating assets

- Achievement of the highest standard of installation condition to ensure the durability of facilities, establish the conditions for rigorous operation, and develop a feeling of installation ownership among personnel.
- Securing and extending unit lifetimes under optimum safety conditions. In particular, successful planning and execution of safety reassessments, and control of equipment ageing. Supporting future unit operation by leveraging experience feedback at national and international level. In particular, successfully completing projects associated with such experience feedback, notably concerning climatic hazards.
- Preparing for the renewal of the NPP fleet by building an EPR reactor, taking account in particular of experience feedback from 1200 reactor-years of operation.
- Reducing fuel costs and increasing the potential availability of units by improving the efficiency of fuel management schemes and improving the quality of the fuel itself.

20.1.2.2 CEA objectives

To guarantee maximum safety during installation operation, the CEA continues working not only on safety but also in the areas of radiation protection, the environment and quality.

The CEA's priority objectives involve the following actions:

- monitor the effectiveness of first-level supervision;
- develop installations' internal communication;
- apply rules and procedures rigorously;
- use self-testing effectively to identify possible drift;
- use peer assessment;
- provide the training required to maintain the safety culture in installations and to raise line managers' awareness of risk control;
- implement good practice based on experience feedback;
- match the zoning of radiation protection within installations to the actual risks and the regulations;
- continue to apply ALARA methods to reduce doses received by personnel;
- remove unused sources and restrict the number of sources in use.

20.1.2.3 ILL objectives

RHF safety, both intrinsic and in operation, is subject to a process of continuous improvement. Particular stress has been placed over the last four years on improving earthquake resistance, and the major shutdown required for this work has also proved a good opportunity to complete significant renovation work (vertical heat sink, fuel-handling system and thermal well H1-H2). The objective for future years is to bring the safety of the detritiation building to the same level as that of the reactor building.

20.2 International cooperation measures

20.2.1 ASN international activities

20.2.1.1 General policy

The nuclear fleet regulated by ASN is one of the largest and most diverse in the world. ASN therefore aims to ensure that its nuclear and radiation protection regulatory activities constitute an international reference.

Article 9 of the act of 13 June 2006 stipulates that "ASN submits to the government its proposals for the definition of the French position in international negotiations in the areas of its competence" and that "it participates, at the request of the government, in the French representation in the instances of international and European community organisations competent in these areas". Finally, it states that "for application of international agreements or European Union regulations concerning radiological emergencies, ASN is competent to alert and inform the authorities of third states or to receive alerts and information from them".

ASN conducts its international action to ensure that nuclear safety and radiation protection principles are taken into account and promoted and to share its work and its experience. It has the following principal objectives:

- to develop exchanges of information with its foreign counterparts on regulatory systems and practices, communicate and explain the French approach and practices and provide information on the steps taken to solve the problems encountered;
- to inform foreign States of events that have occurred in France and provide the countries concerned with all useful information about French nuclear facilities located close to their borders;
- to contribute to ensuring that the updating of rules and practices at European and international levels is based on best practices and to take an active part in work to harmonise nuclear safety and radiation protection principles and standards and in work preparing European community law;
- to implement the undertakings of the French State concerning nuclear safety and radiation protection, in particular within the framework of international conventions.

These objectives are met in bilateral frameworks but also through ASN participation in work coordinated by the European Union, the IAEA or the OECD, as well as that of associations of nuclear safety authority managers.

20.2.1.2 Multilateral relations

20.2.1.2.1 European Union (EU)

With the Treaty setting up the European atomic energy community (Euratom) and its derived law, and with the work done by WENRA, the European Union is today at the very heart of the regulatory work in the field of nuclear safety and radiation protection. ASN is heavily involved in the various European working groups and makes extensive contributions to discussions on the integration of nuclear safety at European community level.

20.2.1.2.2 Western European Nuclear Regulators' Association (WENRA)

ASN is a member of WENRA, the Western European Nuclear Regulators' Association, currently working on the harmonisation of national safety practices by 2010.

20.2.1.2.3 Assistance to Eastern European countries

ASN is participating in assistance programmes set up by the European Commission to improve nuclear safety in Eastern European countries, the nuclear strands of the PHARE programme (aimed more particularly at candidate countries for membership of the Union) and the TACIS programme (for the countries of the former Soviet Union).

20.2.1.2.4 International Atomic Energy Agency (IAEA)

With respect to the areas of competence of ASN, the IAEA's activities chiefly consist in:

- organising discussion groups at different levels and drafting "Safety Standards", describing safety principles and practices which can then be used by Member States as a basis for their national regulations

  This activity is supervised by the CSS (Commission on Safety Standards). France is represented on this commission by a deputy Director General of ASN, while the ASN Chairman has chaired the commission since the beginning of 2005. This commission coordinates the activities of four committees entrusted with supervising the drafting of documents in four areas: NUSSC (NUclear Safety Standards Committee) for installation safety, RASSC (RAdiation Safety Standards Committee) for radiation protection, TRANSSC (TRANsport Safety Standards Committee) for the safety of transport of radioactive materials and WASSC (WAste Safety Standards Committee) for the safety of radioactive waste management. France, represented by ASN, is present on each of these committees. It also takes part in the technical groups which draft these documents.

- provision of "services" to Member States, intended to give them opinions on specific safety-related aspects

  This category includes OSART (Operational SAfety Review Team), IRRS (Integrated Regulatory Review Service), PROSPER (Peer Review of the effectiveness of the Operational Safety Performance Experience Review), TRANSAS (TRANsport Safety Appraisal Service) and RaSSIA (Radiation Safety and Security Infrastructure Appraisal).

  In 2006 ASN received an IRRS mission, the first mission covering the complete scope of the IRRS in a major nuclear country (refer to section 8.1.3).

  OSART missions and follow-up missions have been conducted every year in France, and a PROSPER follow-up mission in 2006 (refer to section 19.5).

  Finally, ASN takes part in RaSSIA missions and in the regional radiation protection courses organised by the IAEA.

- harmonising communication tools

  The new version of the INES scale for radiation protection incidents, which incorporates the principle of the relationship between the radiological risk and the severity of an event, has been applicable in France to BNIs and transport since 1 January 2005 on an experimental basis.

20.2.1.2.5 OECD Nuclear Energy Agency (NEA)

In the NEA, ASN participates in the work of specialist committees, in particular the Committee on Nuclear Regulatory Activities (CNRA). At its two annual meetings, the subjects of CNRA discussions included inspection practices.

20.2.1.2.6 Multinational Design Evaluation Program (MDEP)

ASN also participates in the work of the MDEP (Multinational Design Evaluation Program). This programme is a multinational initiative to develop innovative approaches to pooling the resources and knowledge of the safety authorities which will have responsibility for regulatory assessment of new reactors. Its secretariat is provided by the NEA.

20.2.1.2.7 International Nuclear Regulators' Association (INRA)

ASN also participates in the work of the INRA, which was chaired by the ASN Chairman in 2006.

20.2.1.3 Bilateral relations

Close relations, managed by liaison committees that meet at least once a year, have been established between ASN and about fifteen foreign safety authorities. They are an essential part of ASN's international cooperation programmes.

STAFF EXCHANGES BETWEEN ASN AND ITS FOREIGN COUNTERPARTS

One of the means adopted for improving knowledge of the operation of foreign nuclear safety and radiation protection authorities, learning lessons from them for ASN operation and broadening personnel training, is the expansion of personnel exchanges.

Provision is made for several types of exchange:

- very short-term actions (one to two days) offering our counterparts cross-inspections and joint emergency exercises: they involve inviting foreign inspectors to take part in inspections or emergency exercises performed in France and French inspectors being invited in the country concerned to take part in inspections or emergency exercises. Since 1997, some ten cross-inspections are conducted each year in France or in neighbouring countries;
- short-term assignments (3 weeks to 3 months) to study a specific technical topic. In 2004, 2005 and 2006 such exchanges took place with the South African and Chinese authorities;
- long-term exchanges (around three years). During the period under consideration, two British inspectors were seconded to ASN while two French inspectors were seconded to the NII.

20.2.2 IRSN international reactor safety activities

Within the scope of the duties assigned to it by the public authorities, IRSN (institute for radiation protection and nuclear safety) develops international relations with regard to research and expertise in the areas of nuclear installation safety, radioactive material transport safety, human and environmental protection, safety and regulation of sensitive nuclear materials and organisation and training for emergency management.

IRSN international activities have three basic objectives:

- to increase the scientific and technical knowledge required for better risk assessment and improved risk management;
- to contribute to the establishment of international consensus both on technical questions and on the drafting of guides, recommendations and standards;
- to take part in the implementation of projects aimed at reinforcing radiation protection, nuclear safety and security abroad.

These activities are conducted within the framework of bilateral and multilateral collaborations, work performed under the auspices of such international organisations as the IAEA, the OECD Nuclear Energy Agency (NEA), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiation Protection (ICRP) and the European Commission, but also as part of services or cooperation projects developed by the IAEA, the European Commission or the European Bank for Reconstruction and Development. Some of them are conducted in support of ASN's international collaborations.

The description of the IRSN international activities given in this report mainly concerns power reactor safety.

20.2.2.1 Increasing scientific and technical knowledge

Increasing knowledge relies on the development of research programmes and on sharing of experience.

With regard to research, IRSN implements various research programmes either on its own or together with foreign partners, some of them with the European Commission, covering severe accidents of PWRs (PHEBUS-FP programme), design basis or beyond design basis accidents of fast neutron reactors (CABRI-RAFT programme completed in 2001) and the behaviour of highly-irradiated fuel in reactivity accidents in PWRs (CABRI-REP programme).

IRSN also participates in many research projects abroad, including the study of in-vessel or ex-vessel corium behaviour (NEA MASCA and MCCI programmes), the study of PWR vessel rupture modes (NEA OLHF programme), and in projects of the European programme for research and technological development (FP6 and FP7) devoted to severe accidents. In this respect IRSN's coordination of the SARNET network of excellence as part of FP6 should be noted, one of its objectives being to make the ASTEC integrated code the reference European code for severe accidents.

Finally, in association with partners from the European Union, Eastern Europe, Japan, India and China, IRSN is using this research as a basis for work on qualifying and improving the computer codes used for PWR safety studies, mainly with regard to modelling of severe accidents, determination of potential releases in the event of an accident with core melt, and hydrogen behaviour within the reactor containment in the event of a severe accident .

20.2.2.2 Contributing to the development of international consensuses

IRSN is actively involved in the work of NEA specialist committees, including that of the Committee on the Safety of Nuclear Installations (CSNI) on operating experience, comparison of computer codes and in-depth analysis of topics essential for safety.

Similarly, IRSN is involved in the IAEA's work on drafting recommendations, guides and standards, in particular in support of ASN on the specialist committees of the Commission on Safety Standards (CSS).

IRSN is also developing a large number of bilateral collaborations for experience sharing and progress towards harmonised technical safety practices. Among the main topics currently being dealt with in this respect are probabilistic safety studies, the safety review of installations and the safety assessment of digital protection systems. In this context, the assessment work conducted by IRSN and GRS on the safety options for the EPR (European Pressurised water Reactor) project is an example of harmonisation based on the review of a French-German industrial project. It should also be noted that GRS, IRSN and AVN have initiated a comparative analysis of the safety assessment methods they use and of the main aspects to be considered in the analysis of safety problems encountered, in order to facilitate experience sharing, the performance of joint or complementary work and the comparison of results obtained.

20.2.2.3 International co-operation

IRSN is involved in consultations organised by the French authorities, the European Commission and the EBRD on cooperation programmes to be implemented to contribute to the improvement of safety in foreign NPPs.

IRSN also takes part in implementing bilateral cooperation projects conducted with safety organisations abroad and intended for transferring methods and regulatory practices, adapting and transferring analysis tools and conducting safety assessment work.

In recent years, these cooperation projects primarily involved Chinese, Eastern European, Moroccan and Vietnamese partners.

20.2.3 EDF's international activities in respect of reactor safety

EDF's international activities concern a number of key areas:

- international activities within the EDF group;
- bilateral exchanges of experience (mainly via twinning agreements);
- participation in international organisations, including secondment of experts;
- contract-based consultancy and service activities;
- planning for future reactors, and technology watch activities.

20.2.3.1 International activities within the EDF group

EDF and EnBW have developed a fruitful cooperation in the nuclear field, notably via the setting-up of a joint working group on nuclear safety. Safety management systems and safety indicators were compared in 2006. Information on safety-related events is regularly exchanged.

EDF holds a 50% share in the Tihange 1 unit in Belgium. This provides a framework for fruitful exchanges and sharing of experience on significant safety-related events, accident studies, etc.

20.2.3.2 Exchanges of experience/bilateral relations

Bilateral exchanges of experience take place via twinning agreements with power plants or licensees in other countries. There are a total of 11 active twinning programmes between French NPPs and plants around the world. In addition, regular exchanges also take place via a number of agreements with other licensees.

In 2005, a twinning agreement was signed between the Saint-Laurent NPP and the South Ukraine plant. More recently, in 2006, an agreement was signed between the Flamanville plant and the licensee of the Olkiluoto plant in Finland, which has two BWR units as well as one EPR unit under construction.

Visits organised around specific topics as well as periodic reciprocal meetings provide a platform for direct exchanges of information between licensees from different cultures who perform the same jobs in different environments. Such exchanges mainly concern specific activities such as outages, maintenance, safety management, radiological cleanliness and installation condition.

20.2.3.3 International organisations

International organisations promote dialogue and exchanges between nuclear licensees. EDF makes extensive use of such organisations with the aim of achieving overall improvements in the safety and reliability of nuclear plant operation.

20.2.3.3.1 World Association of Nuclear Operators (WANO)

WANO is an association of 140 operators from around the world, grouped into four regional centres, whose goal is to maximise the safety and reliability of NPPs by means of exchanges of information and comparisons between members. WANO's activities are divided among four main programmes:

- Operating Experience
- Peer Reviews
- Professional and Technical Development (seminars and workshops)
- Technical Support and Exchange (Good Practices, Performance Indicators, Operator Exchanges, and Technical Support Missions)

EDF is attached to the WANO Paris Centre, to which seven engineers are permanently seconded. Two other engineers are permanently seconded to the WANO Coordinating Centre in London.

OPERATING EXPERIENCE

EDF continuously supplies information to WANO's operating experience databases. In 2006, for example, information on 90 events occurring at EDF plants was disseminated via the WANO website, which can be accessed by all members of the association. EDF also utilises events at plants in other countries within the scope of its internal experience feedback process. In 2006, 19 events were integrated into EDF's internal process following analysis.

PEER REVIEWS

Peer Reviews carried out at French NPPs are listed in section 19.5.2.

In addition, EDF supplies more than forty peers each year (42 in 2004, 44 in 2005, 47 in 2006, and49 planned in 2007) for Peer Reviews organised by the four WANO centres. Peers are individuals qualified to engineer level who occupy various posts at a NPP. Participation in a mission such as a Peer Review is part of the professional development process for future heads of department at NPPs.

PROFESSIONAL AND TECHNICAL DEVELOPMENT (SEMINARS AND WORKSHOPS)

EDF participated in 19 seminars or workshops organized by WANO Paris in 2006.

TECHNICAL SUPPORT AND EXCHANGE

In 2006, WANO carried out 13 support and assistance missions at the request of power plants, with the involvement of peers from plants in other countries.

20.2.3.3.2 IAEA

For a number of years, France has asked the International Atomic Energy Agency to carry out OSART operating safety assessment missions as well as ASSET safety-significant event assessment missions at French NPPs.

French experts also participate in OSART missions in other countries. In 2004, for example, six experts took part in OSARTs, including one plant manager. In 2005, five experts were seconded to OSARTs, again including one plant manager. In 2006, two experts took part in OSARTS. Five experts have participated in OSART missions so far in 2007.

Three EDF employees are permanently seconded to the IAEA, one of whom is responsible for the OSART reference system and scheduling of OSART missions at all plants.

20.2.3.3.3 Framatome Owners Group (FROG)

Meetings of the Framatome Owners Group provide a forum for technical exchanges, notably in respect of recent events at members' plants, and reviews of studies carried out jointly by the different partners.

20.2.3.3.4 Westinghouse Owners Group (WOG)

EDF is also a member of the Westinghouse Owners Group (WOG). The Group's key areas of focus include ageing of materials, safety and human factors, and the problem of skills maintenance. WOG also enables stronger links to be forged with Westinghouse-licensed plants in the USA for the purpose of experience feedback. In particular, some American units, being older than EDF units, are interesting precursors.

20.2.3.3.5 Electric Power Research Institute (EPRI)

EDF is a member of the Electric Power Research Institute (EPRI), which has become a leading body in R&D for the electricity industry, not only in the USA but also at world level (EPRI represents three-quarters of all NPPs in operation around the globe). EPRI's nuclear activities cover four main areas: materials, asset management, plant technology, and non-destructive examinations (NDE). EDF has one employee permanently seconded to EPRI.

20.2.3.3.6 Institute of Nuclear Power Operations (INPO)

EDF is a member of INPO, which is also an important forum for exchanges. One EDF engineer is seconded to INPO in the United States, working within the team of INPO assessors, and monitoring developments in the American NPP fleet.

EDF also actively participates in the International Participant Advisory Committee (IPAC) with INPO.

20.2.3.3.7 German association of power plant operators (VGB)

EDF representatives participate in various VGB working groups, providing a further forum for exchanges, and helping improve the safety and reliability of plant operation, as well as radiation protection, housekeeping, etc.

20.2.3.3.8 European Nuclear Installations Safety Standards initiative (ENISS)

ENISS, a grouping of European nuclear operators, was set up within FORATOM to provide a point of contact for WENRA (the 17-country Western European Nuclear Regulators' Association). EDF is an active participant. ENISS has provided a platform for sustained discussions of fundamental issues such as the use of probabilistic methods in safety demonstrations, the aims and methods of periodic reviews, and the consideration of serious accidents. This initiative is certainly leading to a harmonisation of safety approaches, since it is no longer possible for operators and regulators to be unaware of important issues.

20.2.3.4 Consultancy and service activities

EDF's commitment to the licensees at Daya Bay in China continues on the basis of a cooperation agreement signed in December 2000 by the director of the Nuclear Power Operations Division and the directors of GNPS (Guangdong Nuclear Power Station) and LNPS (Lingao Nuclear Power Station). For several years, a team of 4-5 engineers has been providing support in the technical, nuclear safety, training and engineering fields, as well as in the organisation of the new company DNMC (Daya Bay Nuclear Management Company), which operates the four units according to the same organisational principles as four-unit plants in France. The Gravelines and Tricastin NPPs provide support to the overseas team, via twinning agreements, in operations, training and maintenance. In addition, various units of the Nuclear Power Operations Division and the Nuclear Engineering Division provide expert assistance to the Chinese licensees via seminars and specific missions.

EDF also provides support to the licensee of the Koeberg plant in South Africa, by seconding 2-3 engineers, who work within the plant's engineering department. The Blayais and Gravelines NPPs are also twinned with Koeberg. Technical missions are organised, both in France and at Koeberg, in various technical fields (safety, civil engineering, training, chemistry, etc.).

20.2.3.5 Planning for future reactors and technology watch

EDF's international activity mainly concerned:

- development of the European Utilities Requirements (EUR), a set of common specifications for future light water NPPs, which was initiated in 1992 in conjunction with Europe's main producers of electricity from nuclear power. Significant savings are expected in terms of development and construction costs. In 2003, the EUR organisation welcomed the Russian nuclear operator Rosenergatom as the project's eleventh partner. In 2006, Energoatom of the Ukraine joined as an associate member.

The EUR document, currently at version C, is now fully usable: the technical specifications applied for the call for tender for Finland's fifth nuclear reactor utilised more than 80% of the text of the EUR document.

Work is under way to prepare for a medium-term revision of the chapters describing the safety approach.

Within this context, the first report issued by WENRA (Western European Nuclear Regulators Association) on European harmonisation of regulatory requirements for safety has been analysed. The results of this analysis, which continued in 2004 and 2005, have been presented to WENRA.

In addition, a detailed review of applicable texts led to the drawing up of a list of items in respect of which revisions were either necessary or desirable, based on foreseeable developments in the regulatory and industrial environment over the next five to ten years. One or two key chapters are set to be completely restructured. The EUR organisation has made its position clear with regard to EU moves to harmonise safety rules.

A significant initiative was launched in 2003 on the harmonisation of conditions for connecting future nuclear units to European EHV transmission networks. This could change the boundary conditions for safety studies.

Comparisons between the European and American regulatory approaches, which began in 2003 in parallel with an analysis of the differences between the positions adopted by EUR and the IAEA, continued in 2004.

A solid basis should therefore be available in future for developing a revision D of volumes 1 and 2 that is adapted to the new European environment.

Relations with vendors are continuing under volume 3 of the EUR. Each section of volume 3 is dedicated to a project drawn up for the European market and supported by EUR utilities. It contains a description of the project, an assessment of the extent to which the project complies with volume 2 requirements, and, where applicable, specific requirements. The EUR organisation assessed two reactors between 2003 and 2006:

- Westinghouse's AP1000 design, for which US certification was obtained in 2004;
- The VVER AES92 design proposed by Russian industry (AEP Moscow).

The corresponding volumes III will be published in 2007.

- technology watch concerning future light water reactor projects, in particular via participation in Westinghouse's EPP 1000 project, General Electric's ESBWR and AREVA-NP's SWR 1000.
- monitoring of regulatory developments concerning design and licensing requirements, as well as international experience feedback on events likely to affect design.
- technology watch concerning the development of gas-cooled high temperature reactors (HTR). Among the six future reactor concepts selected by the Generation IV International Forum, the VHTR (Very High Temperature Reactor) and the GFR (Gas-cooled Fast Reactor) are helium-cooled reactors that produce heat at very high temperatures (950 °C and above). In addition to providing high efficiencies (around 50%), this temperature can be used for the production of hydrogen or co-generation of hydrogen and electricity. The VHTR, a graphite-moderated thermal reactor derived from the GT-MHR concept, should precede the GFR. The DOE (US Department of Energy) plans to commission a 600 MWth precursor by 2016 under the NGNP (Next Generation Nuclear Plant) project.
- For several years, the CEA and AREVA-NP have played a prominent role in developing this reactor concept. Consequently, in 2003 EDF decided to embark on an active cooperation

with these organisations, who are its major partners in the nuclear field. In addition to this cooperation, EDF aims to participate in international initiatives and exchange knowledge and know-how until experience feedback is available from the operation of this type of reactor. The long-term prospects for the hydrogen economy mean that the VHTR has serious development potential.

20.2.4 CEA's international activities in respect of reactor safety

The CEA participates in international collaborations in areas of nuclear energy, particularly those related to the safety of nuclear power reactors.

Research into safety is based mainly on four key objectives:

- minimise the dose rate during operation;
- use passive systems to return to a safe state from an accident situation;
- reduce the probability of core meltdown;
- limit the impact external to the site during a serious accident, in particular by strengthening the containment.

The CEA contributes to the IAEA's work on research reactors and has established a programme of regular dialogues with counterpart bodies abroad, exchanging operational experience and incident feedback. In the area of fast-breeder reactors, it is in close contact with Russia, India and Japan.

Since 2005, the Phénix plant has run a school on the safety and operation of fast reactors, sharing the CEA's experience of sodium fast reactors with operators developing such systems abroad.

20.2.5 ILL's international activities in respect of reactor safety

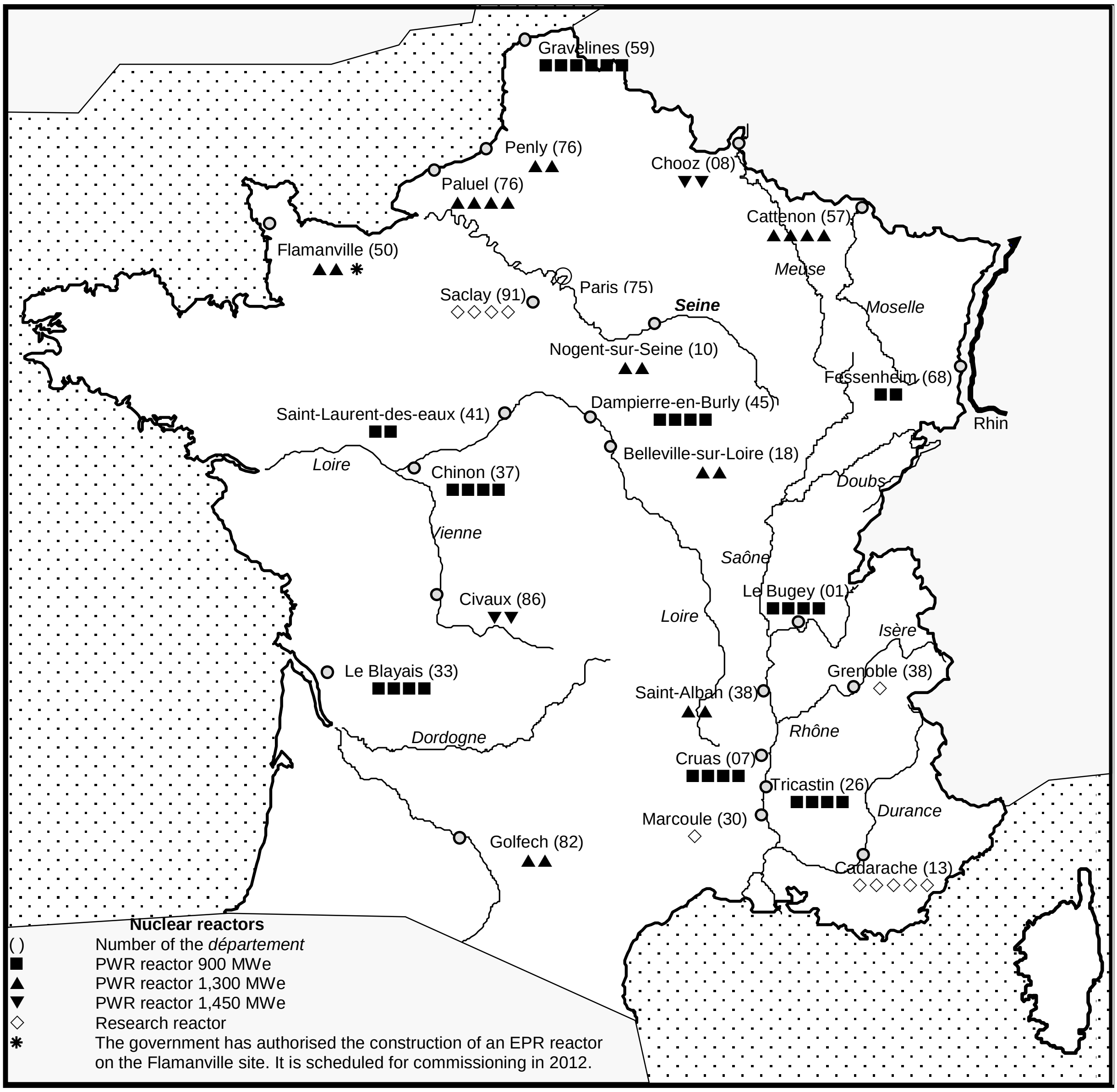
Internationally, the ILL's activity focuses mainly on basic research. However, it contributes to sharing experience feedback through the research reactor operator clubs of which it is a member, in particular at European level.

APPENDICES

Appendix 1 – List and location of nuclear reactors in France

1.1 Location of nuclear reactors

The 58 nuclear power reactors and the 11 nuclear research reactors in operation on 31 December 2006 are located in France as indicated on the map below.



Map of France with locations of nuclear reactors in operation

The total installed generating capacity is about 63,000 MWe.

The 58 pressurized water reactors located on 19 sites are operated by EDF.

The Phénix prototype fast reactor and 9 other pool-type research reactors are operated by the CEA. The RHF research reactor is operated by the ILL.

1.2 List of nuclear power reactors

The nuclear power reactors in operation are the following BNIs:

BNI no.	NAME AND LOCATION OF THE INSTALLATION	Licensee	Type of installation	Declared on:	Licensed on:	Official Gazette (O.G.) of:	OBSERVATIONS
75	FESSENHEIM NUCLEAR POWER PLANT (reactors 1 and 2) 68740 Fessenheim	EDF	2 PWR reactors CP0 900 MWe		03.02.72	10.02.72	Boundary change: decree of 10.12.85 O.G. of 18.12.85
78	LE BUGEY NUCLEAR POWER PLANT (reactors 2 and 3) 01980 Loyettes	EDF	2 PWR reactors CP0 900 MWe		20.11.72	26.11.72	Boundary change: decree of 10.12.85 O.G. of 18.12.85
84	DAMPIERRE NUCLEAR POWER PLANT (reactors 1 and 2) 45570 Ouzouer-sur-Loire	EDF	2 PWR reactors CP1 900 MWe		14.06.76	19.06.76	
85	DAMPIERRE NUCLEAR POWER PLANT (reactors 3 and 4) 45570 Ouzouer-sur-Loire	EDF	2 PWR reactors CP1 900 MWe		14.06.76	19.06.76	
86	LE BLAYAIS NUCLEAR POWER PLANT (reactors 1 and 2) 33820 Saint-Ciers-sur-Gironde	EDF	2 PWR reactors CP1 900 MWe		14.06.76	19.06.76	
87	TRICASTIN NUCLEAR POWER PLANT (reactors 1 and 2) 26130 Saint-Paul-Trois-Châteaux	EDF	2 PWR reactors CP1 900 MWe		02.07.76	04.07.76	Boundary change: decree of 10.12.85 O.G. of 18.12.85
88	TRICASTIN NUCLEAR POWER PLANT (reactors 3 and 4) 26130 Saint-Paul-Trois-Châteaux	EDF	2 PWR reactors CP1 900 MWe		02.07.76	04.07.76	Boundary change: decree of 10.12.85 O.G. of 18.12.85 and decree of 29.11.04 O.G. of 02.12.04
89	LE BUGEY NUCLEAR POWER PLANT (reactors 4 and 5) 01980 Loyettes	EDF	2 PWR reactors CP1 900 MWe		27.07.76	17.08.76	Boundary change: decree of 10.12.85 O.G. of 18.12.85
96	GRAVELINES NUCLEAR POWER PLANT (reactors 1 and 2) 59820 Gravelines	EDF	2 PWR reactors CP1 900 MWe		24.10.77	26.10.77	Boundary change: decree of 29.11.04 O.G. of 02.12.04
97	GRAVELINES NUCLEAR POWER PLANT (reactors 3 and 4) 59820 Gravelines	EDF	2 PWR reactors CP1 900 MWe		24.10.77	26.10.77	Boundary change: decree of 29.11.04 O.G. of 02.12.04
100	ST-LAURENT NUCLEAR POWER PLANT (reactors B1 and B2) 41220 La Ferté-Saint-Cyr	EDF	2 PWR reactors CP1 900 MWe		08.03.78	21.03.78	
103	PALUEL NUCLEAR POWER PLANT (reactor 1) 76450 Cany-Barville	EDF	1 PWR reactor P4 1300 MWe		10.11.78	14.11.78	

BNI no.	NAME AND LOCATION OF THE INSTALLATION	Licensee	Type of installation	Declared on:	Licensed on:	Official Gazette (O.G.) of:	OBSERVATIONS
104	PALUEL NUCLEAR POWER PLANT (reactor 2) 76450 Cany-Barville	EDF	1 PWR reactor P4 1300 MWe		10.11.78	14.11.78	
107	CHINON NUCLEAR POWER PLANT (reactors B1 and B2) 37420 Avoine	EDF	2 PWR reactors CP2 900 MWe		04.12.79	08.12.79	Modification: decree of 21.07.98 O.G. of 26.07.98
108	FLAMANVILLE NUCLEAR POWER PLANT (reactor 1) 50830 Flamanville	EDF	1 PWR reactor P4 1300 MWe		21.12.79	26.12.79	
109	FLAMANVILLE NUCLEAR POWER PLANT (reactor 2) 50830 Flamanville	EDF	1 PWR reactor P4 1300 MWe		21.12.79	26.12.79	
110	LE BLAYAIS NUCLEAR POWER PLANT (reactors 3 and 4) 33820 Saint-Ciers-sur-Gironde	EDF	2 PWR reactors CP1 900 MWe		05.02.80	14.02.80	
111	CRUAS NUCLEAR POWER PLANT (reactors 1 and 2) 07350 Cruas	EDF	2 PWR reactors CP2 900 MWe		08.12.80	31.12.80	Boundary change: decree of 10.12.85 O.G. of 18.12.85 and decree of 29.11.04 O.G. of 02.12.04
112	CRUAS NUCLEAR POWER PLANT (reactors 3 and 4) 07350 Cruas	EDF	2 PWR reactors CP2 900 MWe		08.12.80	31.12.80	Boundary change: decree of 29.11.04 O.G. of 02.12.04
114	PALUEL NUCLEAR POWER PLANT (reactor 3) 76450 Cany-Barville	EDF	1 PWR reactor P4 1300 MWe		03.04.81	05.04.81	
115	PALUEL NUCLEAR POWER PLANT (reactor 4) 76450 Cany-Barville	EDF	1 PWR reactor P4 1300 MWe		03.04.81	05.04.81	
119	SAINT-ALBAN - SAINT-MAURICE NUCLEAR POWER PLANT (reactor 1) 38550 Le Péage-de-Roussillon	EDF	1 PWR reactor P4 1300 MWe		12.11.81	15.11.81	
120	SAINT-ALBAN - SAINT-MAURICE NUCLEAR POWER PLANT (reactor 2) 38550 Le Péage-de-Roussillon	EDF	1 PWR reactor P4 1300 MWe		12.11.81	15.11.81	
122	GRAVELINES NUCLEAR POWER PLANT (reactors 5 and 6) 59820 Gravelines	EDF	2 PWR reactors CP1 900 MWe		18.12.81	20.12.81	Boundary change: decree of 10.12.85 O.G. of 18.12.85
124	CATTENOM NUCLEAR POWER PLANT (reactor 1) 57570 Cattenom	EDF	1 PWR reactor P'4 1300 MWe		24.06.82	26.06.82	

BNI no.	NAME AND LOCATION OF THE INSTALLATION	Licensee	Type of installation	Declared on:	Licensed on:	Official Gazette (O.G.) of:	OBSERVATIONS
125	CATTENOM NUCLEAR POWER PLANT (reactor 2) 57570 Cattenom	EDF	1 PWR reactor P'4 1300 MWe		24.06.82	26.06.82	
126	CATTENOM NUCLEAR POWER PLANT (reactor 3) 57570 Cattenom	EDF	1 PWR reactor P'4 1300 MWe		24.06.82	26.06.82	
127	BELLEVILLE NUCLEAR POWER PLANT (reactor 1) 18240 Léré	EDF	1 PWR reactor P'4 1300 MWe		15.09.82	16.09.82	
128	BELLEVILLE NUCLEAR POWER PLANT (reactor 2) 18240 Léré	EDF	1 PWR reactor P'4 1300 MWe		15.09.82	16.09.82	Boundary change: decree of 29.11.04 O.G. of 02.12.04
129	NOGENT NUCLEAR POWER PLANT (reactor 1) 10400 Nogent-sur-Seine	EDF	1 PWR reactor P'4 1300 MWe		28.09.82	30.09.82	Boundary change: decree of 10.12.85 O.G. of 18.12.85
130	NOGENT NUCLEAR POWER PLANT (reactor 2) 10400 Nogent-sur-Seine	EDF	1 PWR reactor P'4 1300 MWe		28.09.82	30.09.82	Boundary change: decree of 10.12.85 O.G. of 18.12.85
132	CHINON NUCLEAR POWER PLANT (reactors B3 and B4) 37420 Avoine	EDF	2 PWR reactors CP2 900 MWe		07.10.82	10.10.82	Modification: decree of 21.07.98 O.G. of 26.07.98
135	GOLFECH NUCLEAR POWER PLANT (reactor 1) 82400 Golfech	EDF	1 PWR reactor P'4 1300 MWe		03.03.83	06.03.83	Boundary change: decree of 29.11.04 O.G. of 02.12.04
136	PENLY NUCLEAR POWER PLANT (reactor 1) 76370 Neuville-lès-Dieppe	EDF	1 PWR reactor P'4 1300 MWe		23.02.83	26.02.83	
137	CATTENOM NUCLEAR POWER PLANT (reactor 4): 57570 Cattenom	EDF	1 PWR reactor P'4 1300 MWe		29.02.84	03.03.84	
139	CHOOZ B NUCLEAR POWER PLANT (reactor 1) 08600 Givet	EDF	1 PWR reactor N4 1450 MWe		09.10.84	13.10.84	Commissioning postponement: decrees of 18.10.1993 O.G. of 23.10.93 and 11.06.99 O.G. of 18.06.99
140	PENLY NUCLEAR POWER PLANT (reactor 2) 76370 Neuville-lès-Dieppe	EDF	1 PWR reactor P'4 1300 MWe		09.10.84	13.10.84	
142	GOLFECH NUCLEAR POWER PLANT (reactor 2) 82400 Golfech	EDF	1 PWR reactor P'4 1300 MWe		31.07.85	07.08.85	

BNI no.	NAME AND LOCATION OF THE INSTALLATION	Licensee	Type of installation	Declared on:	Licensed on:	Official Gazette (O.G.) of:	OBSERVATIONS
144	CHOOZ B NUCLEAR POWER PLANT (reactor 2) 08600 Givet	EDF	1 PWR reactor N4 1450 MWe		18.02.86	25.02.86	Commissioning postponement: decrees of 18.10.93 O.G. of 23.10.93 and of 11.06.99 O.G. of 18.06.99
158	CIVAUX NUCLEAR POWER PLANT (reactor 1) BP 1 86320 Civaux	EDF	1 PWR reactor N4 1450 MWe		06.12.93	12.12.93	Commissioning postponement: decree of 11.06.99 O.G. of 18.06.99
159	CIVAUX NUCLEAR POWER PLANT (reactor 2) BP 1 86320 Civaux	EDF	1 PWR reactor N4 1450 Mwe		06.12.93	12.12.93	Commissioning postponement: decree of 11.06.99 O.G. of 18.06.99

1.3 List of nuclear research reactors

The nuclear research reactors in operation are the following BNIs:

BNI no.t	NAME AND LOCATION OF THE INSTALLATION	Licensee	Type of installation	Declared on:	Licensed on:	Official Gazette (O.G.)	OBSERVATIONS
18	ULYSSE(Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor 0.10 MWth	27.05.64			
24	CABRI (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor 25 MWth	27.05.64			Modification: decree of 20.03.06 O.G. of 21.03.06
39	MASURCA (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor 0.005 MWth		14.12.66	15.12.66	
40	OSIRIS (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor 70 MWth		08.06.65	12.06.65	
	ISIS (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor 0.70 MWth		08.06.65	12.06.65	
42	EOLE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor 0.0001 MWth		23.06.65	28 and 29.06.65	
67	HIGH FLUX REACTOR (RHF) 38041 Grenoble Cedex	Institut Max von Laue Paul Langevin	Reactor 57 MWth		19.06.69 05.12.94	22.06.69 06.12.94	Boundary change: decree of 12.12.88 O.G. of 16.12.88
71	PHÉNIX NUCLEAR POWER PLANT (Marcoule) 30205 Bagnols-sur-Cèze	CEA	Reactor 563 MWth (350 MWth since 1993)		31.12.69	09.01.70	
92	PHÉBUS (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor 40 MWth		05.07.77	19.07.77	Modification: decree of 07.11.91 O.G. of 10.11.91
95	MINERVE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor 0.0001 MWth		21.09.77	27.09.77	
101	ORPHÉE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor 14 MWth		08.03.78	21.03.78	

Appendix 2 – Main legislative and regulatory texts

2.1 Laws and regulations

Act 2006-686 of 13 June 2006
On transparency and security in the nuclear field.

Decree 2002-460 of 04 April 2002
Decree on the general protection of persons against the hazards of ionising radiation.

Decree 2003-296 of 31 Mar 2003
Decree on the protection of workers against the hazards of ionising radiation.

Decree 2003-865 of 8 September 2003
Decree establishing the interministerial committee for nuclear or radiological emergencies.

Ministerial order of 10 August 1984
Order on the quality of design, construction and operation of BNIs.

Inter-ministerial order of 10 November 1999
Order on the surveillance of operation of PWR main primary and secondary systems.

Ministerial order of 31 December 1999
Order laying down the general technical regulations intended to prevent and limit the harmful effects and external risks resulting from the operation of BNIs.

Ministerial order of 12 December 2005
Order on nuclear pressure vessels.

2.2 Basic safety rules

2.2.1 Rules related to PWRs

RFS 2002-1 Basic safety rule 2002-1 on the development and the utilisation of probabilistic safety studies for PWRs (26 December 2002).

RFS-I.2.a. Inclusion of risks related to aircraft crashes (5 August 1980).

RFS-I.2.b. Inclusion of risks of projectile release following turbogenerator bursts (5 August 1980).

RFS-I.2.d. Inclusion of risks related to the industrial environment and communication routes (7 May 1982).

RFS-I.2.e. Inclusion of the external flooding risk (12 April 1984).

RFS-I.3.a. Use of the single failure criterion in safety analyses (5 August 1980).

RFS-I.3.b. Seismic instrumentation (8 June 1984).

RFS-I.3.c. Geological and geotechnical site studies; determination of soil characteristics and study of soil behaviour (1 August 1985).

RFS-II.2.2.a. Design of containment spray systems (5 August 1980); revision 1 (31 December 1985).

RFS-II.3.8. Manufacturing and operating the main secondary system (8 June 1990).

RFS-II.4.1.a Software for safety-classified electrical equipment (15 May 2000).

RFS-IV.l.a. Classification of mechanical equipment, electrical systems, structures and civil engineering works (21 December 1984).

RFS-IV.2.a. Requirements to be considered in the design of safety-classified mechanical equipment carrying or containing a fluid under pressure and classified level 2 and 3 (21 December 1984).

RFS-IV.2.b. Requirements to be considered in the design, qualification, implementation and operation of electrical equipment included in safety-classified electrical systems (31 July 1985).

RFS-V.I.a. Determination of the activity released outside the fuel to be considered in accident safety studies (18 January 1982).

RFS-V.I.b. Means of meteorological measurements (10 June 1982).

RFS-V.2.b. General rules applicable to civil engineering works (ref.: RCC-G code), (30 July 1981).

RFS-V.2.c. General rules applicable to the production of mechanical equipment (ref.: RCC-M code), (8 April 1981); revision 1 (12 June 1986).

RFS-V.2.d. General rules applicable to the production of electrical equipment (ref.: RCC-E code), (28 December 1982); revision 1 (23 September 1986).

RFS-V.2.e. General rules applicable to the production of fuel assemblies (ref.: RCC-C code), (28 December 1982); revision 1 (25 October 1985); revision 2 (14 December 1990).

RFS-V.2.f General rules related to fire protection (ref.: RCC-I code), (28 December 1982).

RFS-V.2.g. Seismic calculations for civil engineering works (31 December 1985).

RFS-V.2.h. General rules applicable to the construction of civil engineering works (ref.: RCC-G code), (4 June 1986).

RFS-V.2.j. General rules related to fire protection (20 November 1988).

Memorandum SIN 3130/84 of 13 June 1984
On the conclusions of the review of the document entitled : “Design and construction rules for PWR NPPs. Handbook of rules on processes - 900 MWe units” (ref.: RCC-P code).

2.2.2 Rules related to other BNIs

RFS-I.1.a Inclusion of risks related to aircraft crashes (7 October 1992).

RFS-I.1.b Inclusion of risks related to the industrial environment and communication routes (7 October 1992).

RFS-I.2.a Safety objectives and design bases for surface facilities intended for long-term disposal of solid radioactive waste with short or intermediate half-life and low or intermediate specific activity (8 November 1982 – revision of 19 June 1984).

RFS-I.2.b Basic design of ionisers (18 May 1992)

RFS-I.3.c Criticality risk (18 October 1984).

RFS-I.4.a Fire protection (28 February 1985).

RFS-II.2. Design and operation of ventilation systems in BNIs other than nuclear reactors (20 December 1991).

RFS-III.2.a General provisions applicable to the production, monitoring, processing, packaging and interim storage of various types of waste resulting from reprocessing of fuel irradiated in PWRs (24 September 1982).

RFS-III.2.b Special provisions applicable to the production, monitoring, processing, packaging and interim storage of high-level waste packaged in the form of glass and resulting from reprocessing of fuel irradiated in PWRs (12 December 1982).

RFS-III.2.c Special provisions applicable to the production, monitoring, processing, packaging and interim storage of low or intermediate level waste encapsulated in bitumen and resulting from reprocessing of fuel irradiated in PWRs (5 April 1984).

RFS-III.2.d Special provisions applicable to the production, monitoring, processing, packaging and interim storage of waste encapsulated in cement and resulting from reprocessing of fuel irradiated in PWRs (1 February 1985).

RFS-III.2.e Preconditions for the approval of packages of encapsulated solid waste intended for surface disposal (31 October 1986 – revision of 29 May 1995).

RFS-III.2.f Definition of objectives to be set in the engineering and works phases for final disposal of radioactive waste in deep geological formations, in order to ensure safety after the operational life of the repository (1 June 1991).

2.2.3 Other basic safety rules

RFS 2001-01 Determination of seismic movements to be taken into account for the safety of installations (revision of RFS-I.2.c and RFS-I.1.c - 16 May 2001).

RULE SIN C-12308/86 (RR1)
Cleaning systems equipping nuclear research reactor ventilation systems (4 August 1986).

RULE SIN A-4212/83
on meteorological measurement means (12 August 1983).

RULE SIN C-12670/9-1 (RR2)
Protection against fire risk in nuclear research reactors (1 July 1991).

2.3 Suggested plan for safety reports (preliminary, provisional and final)

The appendix to the instruction of 27 March 1973 on the application of decree 73-278 of 13 March 1973 provides the following suggested plan for safety reports (preliminary, provisional and final):

- **Volume I - Introduction and general background**
  - Chapter I – Introduction.
  - Chapter II – Site.
  - Chapter II – General characteristics. Main technical options.
  - Chapter IV – General safety principles.
  - Chapter V – Summary of the safety analysis: radiological consequences of accidents for the site.
  - Chapter VI – Interim storage, monitoring and disposal of radioactive waste and effluents.
  - Chapter VII – Organisation at the construction and operation stages. Personnel protection.
  - Chapter VIII – Personnel training and qualification.
- **Volume II – Plant equipment and operation**
  - Chapter I – General
  - Chapter II – Civil engineering. Buildings.
  - Chapter III – Nuclear steam supply system and associated safety systems:

a) Fuel.

b) Reactor unit, main primary system.

c) Fuel handling.

d) Associated safety systems.

- Chapter IV – Containment building and associated safety systems.
- Chapter V – Nuclear auxiliary systems.
- Chapter VI – Secondary system.
- Chapter VII – Common auxiliaries.
- Chapter VIII – Electrical auxiliaries.
- Chapter IX – Instrumentation and Control.
- Chapter X – Reactor core physics.
- Chapter XI – Operation.

- **Volume III – Safety analysis**
  - Chapter I – Quality of construction:

    a) General construction rules.

    b) Quality control.
  - Chapter II – Tests for verifying the validity of safety design assumptions.
  - Chapter III – Detailed safety analysis (prevention, monitoring, means of action):

    a) Core.

    b) Primary system.

    c) Primary containment.

    d) Containment building.

    e) Handling safety.

    f) Secondary systems safety.

    g) Safety of auxiliary installations.
  - Chapter IV – Accident scenarios and accidental releases.
  - Chapter V – Radiation protection:

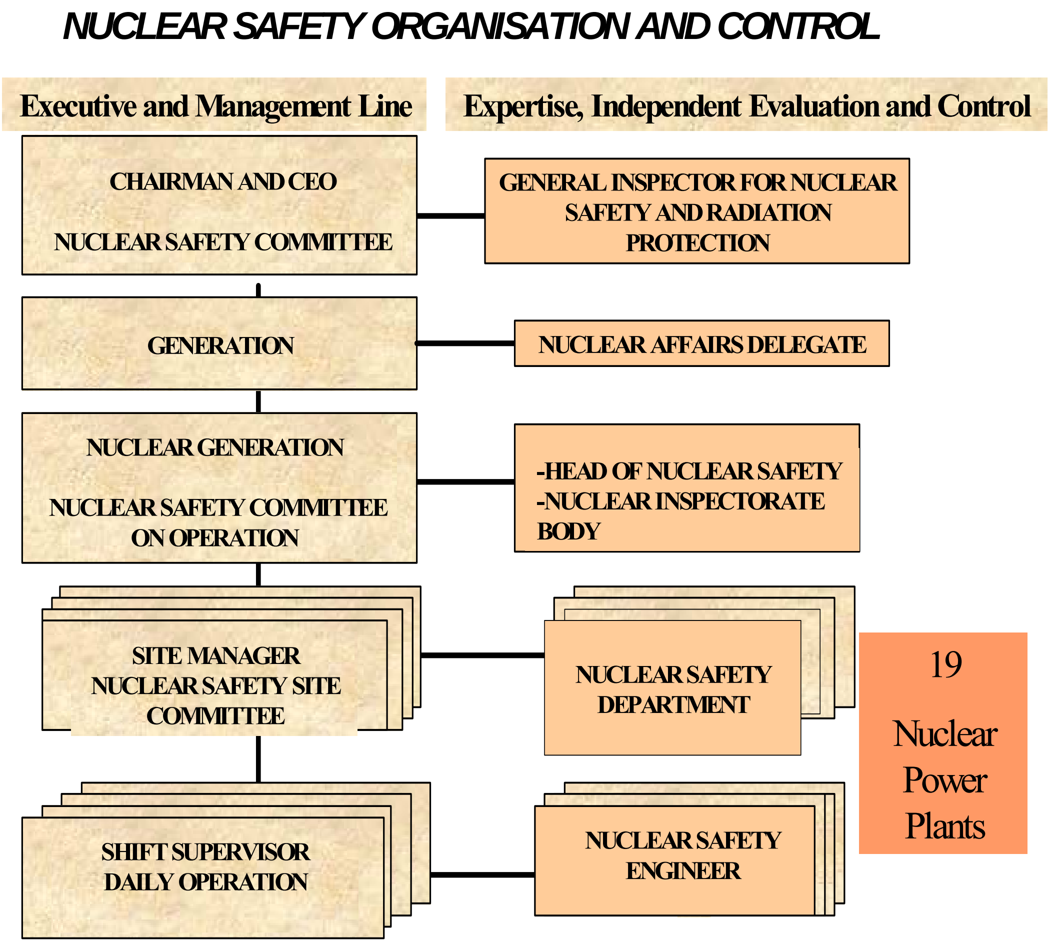
    a) Organisation of personnel protection.

    b) Monitoring of effluents and discharges.
  - Chapter VI – Lessons learned from commissioning tests.

Appendix 3 - Organisation of nuclear reactor licensees

3.1 Organisation of EDF

Founded in 1945, EDF is France's main electricity producer, and the country's only operator of nuclear power reactors. Nuclear safety and radiation protection are applicable to all BNIs operated by the company as well as to nuclear materials shipped from them.



In the case of facilities operated by subsidiaries of the EDF Group, responsibility for nuclear safety and radiation protection lies with the licensee named in the plant authorisation decree (or the equivalent in other countries).

Nuclear safety and radiation protection concern all personnel working or present in a BNI for any reason. However, where personnel from external companies are concerned, the provisions detailed below in no way limit the responsibilities of managers of the companies concerned, or relieve the latter of such responsibilities.

3.1.1 The Chairman & CEO

Under the powers delegated to him by the Board of Directors, the Chairman & CEO has all of the powers required for EDF S.A. to exercise its role as a nuclear licensee. In particular, he determines strategies regarding nuclear safety, and sets the general organisational principles that allow EDF S.A. to exercise its responsibilities as a nuclear licensee, with the support of the Senior Vice President with Responsibility for Integration of Deregulated Operations (France).

He ensures consistency of the main orientations and actions of the different sectors of the company that may affect nuclear safety and radiation protection, including in areas such as purchasing of goods and services, implementation of training programmes, research and development, etc.

The Chairman & CEO is the point of contact for the safety authority. He can ask the Senior Executive Vice President, Generation & Engineering to represent him in this task.

He chairs the Nuclear Safety Board. He can ask the Senior Vice President with Responsibility for Integration of Deregulated Operations (France) to represent him in this task.

The General Inspector for Nuclear Safety and Radiation Protection ensures that nuclear safety and radiation protection concerns have been properly taken into account in respect of the company's nuclear installations, and reports to the Chairman & CEO on this matter.

3.1.2 Senior Executive Vice-President, Generation & Engineering

Under the powers delegated to him by the Chairman of the Board of Directors, the Senior Executive Vice President, Generation & Engineering takes all of the measures required for EDF S.A. to exercise its role as a nuclear licensee. In particular, in all phases of the process for which the company is responsible, he proposes and implements the principles of organisation and operation that enable compliance with nuclear safety and radiation protection rules, and allow EDF S.A. to exercise its responsibilities as a nuclear licensee. In this respect, the Senior Executive Vice President, Generation & Engineering makes major choices in the area of investment and asset management.

He has a deputy who ensures effective monitoring of all activities contributing to nuclear safety and radiation protection, as well as general consistency of overall nuclear risk management.

3.1.3 Directors of the Nuclear Power Operations Division and the Nuclear Engineering Division

Under the powers delegated to him by the Senior Executive Vice President, Generation & Engineering, and under the latter's authority, the Director of the Nuclear Power Operations Division is the representative of EDF S.A. as a nuclear licensee, for all installations in operation.

In the case of one Basic Nuclear Installation currently in the process of dismantlement at an isolated site with no Basic Nuclear Installation in operation, and by decision of the Senior Executive Vice President, Generation & Engineering, EDF S.A. as a nuclear licensee is represented by the Director of the Nuclear Engineering Division.

The Director of the Nuclear Power Operations Division (or the Director of the Nuclear Engineering Division in the specific case referred to) takes all of the measures required for EDF S.A. to exercise its role as a nuclear licensee. In particular, in all phases of the process for which the company is responsible, he proposes and implements the principles of organisation and operation that enable compliance with nuclear safety and radiation protection rules, and allow EDF S.A. to exercise its responsibilities as a nuclear licensee.

Under the powers delegated to him by the Senior Executive Vice President, Generation & Engineering, and under the latter's authority, the Director of the Nuclear Engineering Division is, furthermore, responsible, in consultation with the Director of the Nuclear Power Operations Division, for drawing up the installation design reference system, and ensuring that it is taken into account in the construction of installations. With regard to the fleet in operation, the Director of the Nuclear Engineering Division is responsible for changes to the installation design reference system, in agreement with the Director of the Nuclear Power Operations Division. The Director of the Nuclear Power Operations Division is responsible for ensuring that changes to the installation operating reference system are taken into account, and is supported in this task by the Director of the Nuclear Engineering Division and the Director of the Nuclear Fuel Division.

Finally, the Director of the Nuclear Engineering Division is also responsible for implementing the dismantling programme decided upon by the Senior Executive Vice President, Generation & Engineering (strategy, technical and industrial choices, budget, general schedule, etc.). Related decisions that affect nuclear safety and radiation protection are taken in agreement with the Director of the Nuclear Power Operations Division, who remains the representative of EDF S.A. as the nuclear licensee for installations in the process of being dismantled, unless otherwise excepted.

As part of his tasks, the Director of the Nuclear Engineering Division organises the support provided by the design and engineering units within his Division for the activities of the Nuclear Power Operations Division.

Each of the two Division Directors determines the specific measures to be implemented in his field, as well as policy and strategy in terms of nuclear safety and radiation protection. He delegates to unit managers the powers required to exercise the role of representative of EDF S.A. as a nuclear licensee. He sets objectives, and distributes resources among the units. He ensures that unit managers have at all times the authority, skills and resources required to meet their objectives, either at their respective units, or in the form of collective resources available to them within the Division or outside it.

In particular, with the support of one or more employees, the Director of the Nuclear Power Operations Division ensures, on the basis of information received from unit managers, as well as monitoring carried out on his behalf in respect of the units' overall performance and compliance with nuclear safety and radiation protection requirements, that the tasks entrusted to unit managers are properly executed. The Director of the Nuclear Power Operations Division is the point of contact for the competent regulatory authorities in the area of nuclear safety and radiation protection in respect of the generic aspects of the Basic Nuclear Installations for which he acts as the representative of EDF S.A. as the nuclear licensee. He is assisted in this task by the Director of the Nuclear Engineering Division.

With regard to his responsibility as the representative of EDF S.A. as the nuclear licensee for the Basic Nuclear Installations under his charge, and with the support of one or more employees, the Director of the Nuclear Engineering Division ensures, on the basis of information received from unit managers, as well as monitoring carried out on his behalf in respect of compliance with nuclear safety and radiation protection requirements, that the tasks entrusted to unit managers are properly executed. He is the point of contact for the competent regulatory authorities in the field of nuclear safety and radiation protection for the BNIs concerned.

3.1.4 Unit manager

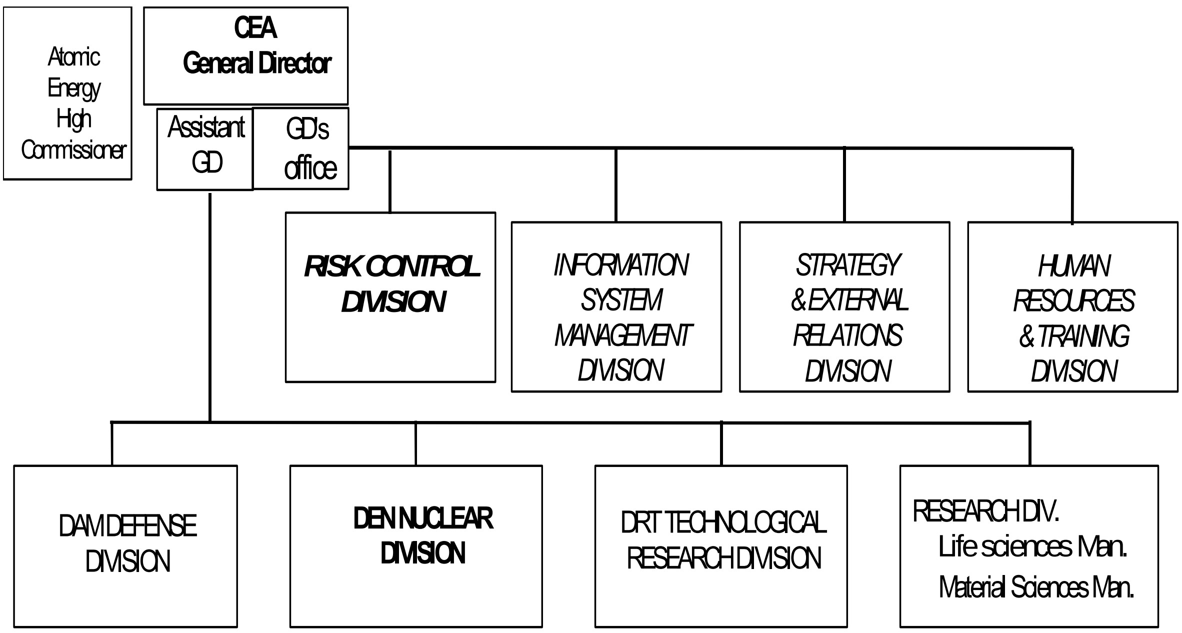
As the representative of EDF S.A. as the nuclear licensee in respect of the installations for which responsibility is delegated to him by the Director of his Division, and under the latter's authority, the unit manager takes all measures necessary for the exercise of this responsibility. In particular, in all phases of the process for which the company is responsible, he proposes and implements the principles of organisation and operation that enable compliance with nuclear safety and radiation protection rules, and allow the effective exercise of the responsibilities of a representative of EDF S.A. as the nuclear licensee. This responsibility may only be delegated to the person he has designated as his substitute if he is absent or unable to carry out his duties. Where he is representing EDF S.A. as the nuclear licensee for installations in the process of being dismantled, he applies the decisions of the Nuclear Engineering Division, and monitors compliance with nuclear safety and radiation protection provisions. The reciprocal obligations of the NPP manager and manager of the site under dismantlement are specified in a joint protocol.

The unit manager enacts internal measures to promote compliance with nuclear safety and radiation protection requirements. He commissions appropriate internal monitoring to verify that these requirements are complied with. He provides his Division Director with information relating to nuclear safety and radiation protection. He is the point of contact for the competent national and local regulatory authorities in the area of nuclear safety and radiation protection for issues specific to the installations under his responsibility.

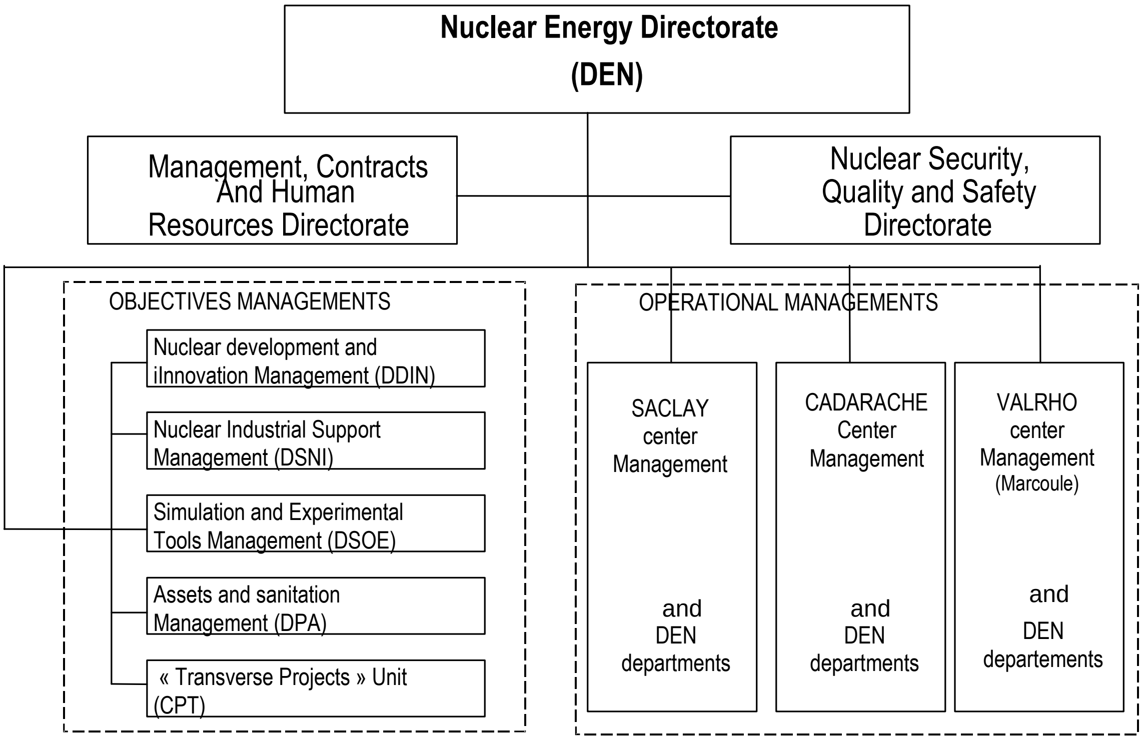
3.2 Organisation of the CEA

The CEA is a public research organisation established in 1945. In 2001, it set up an operational organisation based on the establishment of 4 "divisions" corresponding to its main areas of activity as illustrated on the organisation chart below: nuclear energy division, technological research division, fundamental research division and defence division. In addition four functional divisions, including the risk control division, complete the organisation.

Each operational division is provided with resources (general management, objectives departments, internal functional resources) that it uses to develop, plan and control all its activities.



All civil nuclear aspects of nuclear reactors described in this report form part of the nuclear energy division (nuclear energy directorate). The security, quality and nuclear safety division (which is a functional directorate) forms part of the nuclear energy directorate that is organised as shown in the following diagram.



3.3 Organisation of the ILL

Germany, France and the United Kingdom founded the Laue-Langevin Institute in January 1967 in order to obtain a very intense neutron source entirely dedicated to civil fundamental research. It is managed by these three founding countries in association with its partner countries (Spain, Italy, the Czech Republic in association with Austria, Russia and Switzerland).

It is currently organised into four divisions managed by the Director:

- the science division includes all scientific activities,
- the projects and techniques division manages infrastructures necessary for carrying out experiments. It also includes activities for the development of experimental techniques and techniques for the construction or modification of experimental devices,
- the administration division is responsible for normal administrative activities and some general services,
- the reactor division is responsible for the reactor and its installations and auxiliary equipment.

The safety, protection, health and environment unit reports directly to the Director. It in particular includes the radiation protection department.

Concerning management of the BNI and installations defined in the safety analysis report, the Director delegates his responsibility as licensee to the reactor division manager. The reactor division manager is the Director's deputy concerning safety and management of the BNI and installations defined in the safety analysis report. In this respect, he is responsible for making the final decision about the safe operation of the reactor, instruments and experimental devices.

Appendix 4 – Monitoring of the environment

4.1 NPP discharge monitoring (based on the most recent licences granted by ASN)

A.4.1.1 Regulatory monitoring of liquid discharges from a NPP

ORIGIN AND NATURE	REGULATORY SAMPLING AND CHECKS TO BE CARRIED OUT BY THE LICENSEE
TANKS T Process effluents, service effluents, SG blow down	- sampling from each tank, after mixing: pre-discharge analyses: pH, αT, βT, γT, ^{3}H, γ spectro post-discharge analyses: ^{14}C - continuous measurement of discharge pipe γ activity upstream of its outlet into the cooling water - at the end of the month, preparation of a pooled monthly average sample analyses: ^{63}Ni - analyses of chemicals according to site configuration
Tanks EX (Turbine hall effluents)	- sampling from each tank, after mixing: pre-discharge analyses: βT, ^{3}H - at the end of the month, preparation of a pooled monthly average sample analyses: pH, αT, βT, γT, ^{3}H, γ spectro
Waste water, rain water	- one-off water samples – analyses: βT, potassium, ^{3}H - samples from deposits in the collection systems, at least once a year analyses: γ spectro

α, β, γT activity = total α, β, γ activity

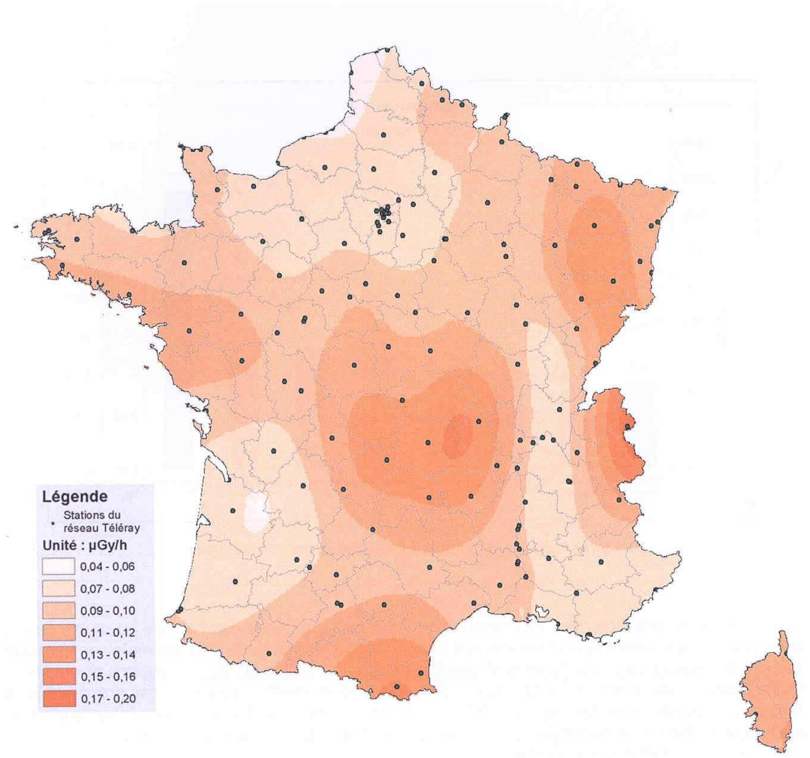
4.1.2 Regulatory monitoring of gas discharges from a NPP

ORIGIN OR NATURE	REGULATORY SAMPLING AND CHECKS TO BE CARRIED OUT BY THE LICENSEE
Continuous measurement with recording of βT activity in each chimney	
CONTINUOUS DISCHARGES (ventilation)	- weekly instantaneous gas samples - analyse: γ spectro (rare gases) - continuous sampling of tritium and weekly analyses (set-up in progress) - continuous sampling of halogen gases – weekly analyses: γT, γ spectro - continuous sampling of aerosols – weekly analyses: αT, βT, γ spectro - continuous sampling of 14C – quarterly analyses (set-up in progress)
PLANNED DISCHARGES (tank draining, reactor building air, etc.)	- pre-discharge sampling of: - gases - analyses: γ spectro (rare gases), ^{3}H - halogen gases - analyses: γT, γ spectro - aerosols - analyses: αT, βT, γ spectro

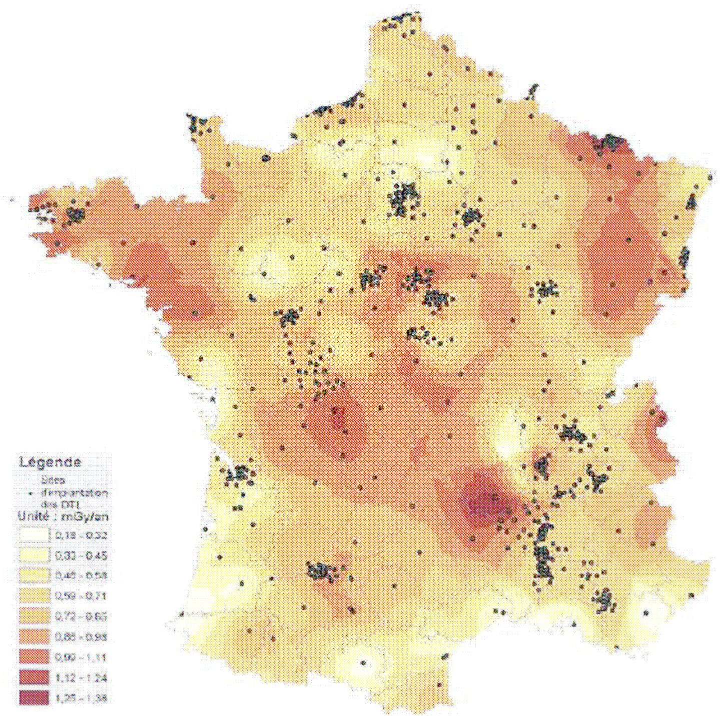
4.2 Environmental monitoring around NPPs

MONITORED MEDIUM OR NATURE OF CHECK	REGULATORY SAMPLING AND CHECKS TO BE CARRIED OUT BY THE LICENSEE
AIR AT GROUND LEVEL	- 4 fixed-filter continuous atmospheric dust sampling stations o daily total β measurements, γ spectrometry if total β activity greater than 2 mBq/m^3 - 1 continuous sampling station downwind of the prevailing winds o weekly tritium measurement
RAIN	1 station downwind of the prevailing wind (monthly collector) o measurements: total β and ^{3}H on monthly pool
AMBIENT γ RADIATION	- 4 detectors at 1 km o continuous measurement (10 nGy/h to 10 Gy/h) and recording - 10 integrating dosimeters on the site boundary (monthly reading) - 4 detectors at 5 km o continuous measurement (10 nGy/h to 0.5 Gy/h)
PLANTS	- 2 grass sampling points (monthly check) o measurements: total β, γ spectrometry, ^{14}C and C (quarterly) - main agricultural produce (annual campaign) o measurements: total β, γ spectrometry, ^{14}C
MILK	- 2 sampling points (monthly check) o measurements: β (excluding ^{40}K), K, ^{14}C (annual)
ENVIRONMENT RECEIVING LIQUID DISCHARGES	- sampling from the river at mid-discharge or after dilution in the cooling water (case of coastal plants), for each discharge - sampling upstream from the river for each discharge - bimonthly sampling from the sea (coastal plants only) o measurements : total β, potassium and tritium o measurement: ^{3}H in a daily average pool - annual sampling of sediments, aquatic flora and fauna o measurement: γ spectrometry
UNDERGROUND WATER	- 5 sampling points (monthly check) o measurements: total β, potassium and tritium
SOIL	- 1 annual sampling of topsoil o measurements: total β, γ spectrometry

4.3 Monitoring of exposure of the population and the environment: some illustrations

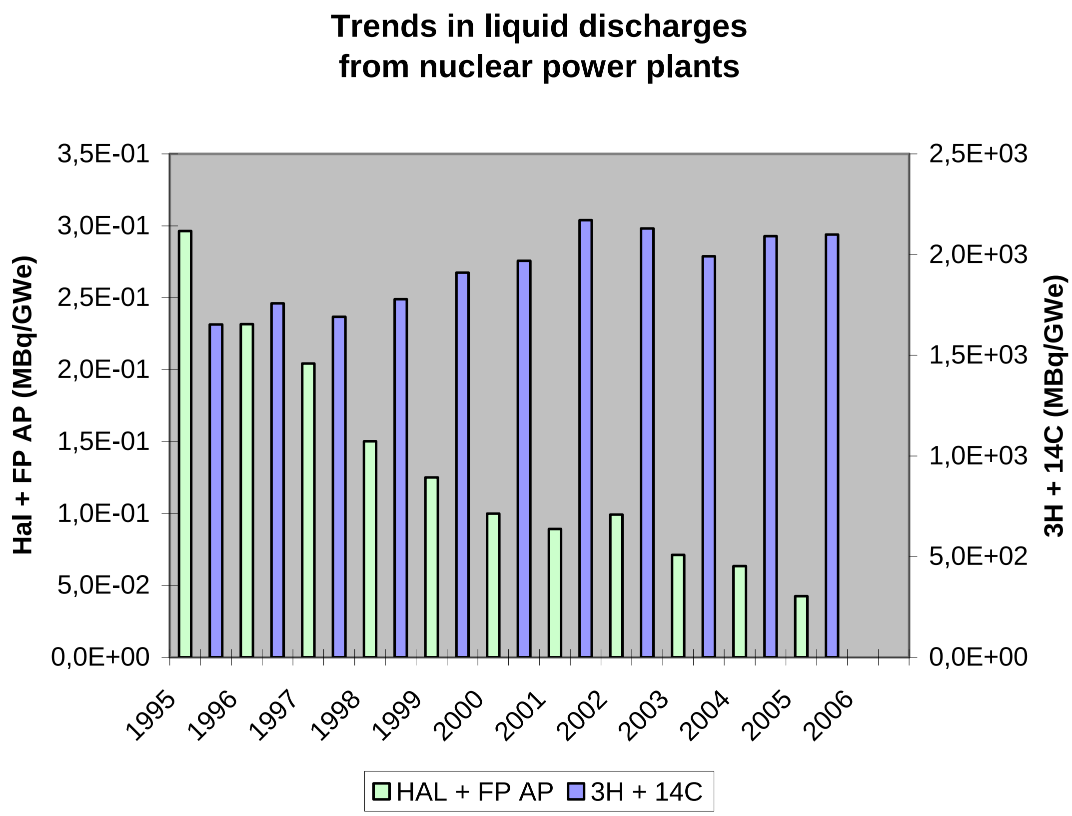


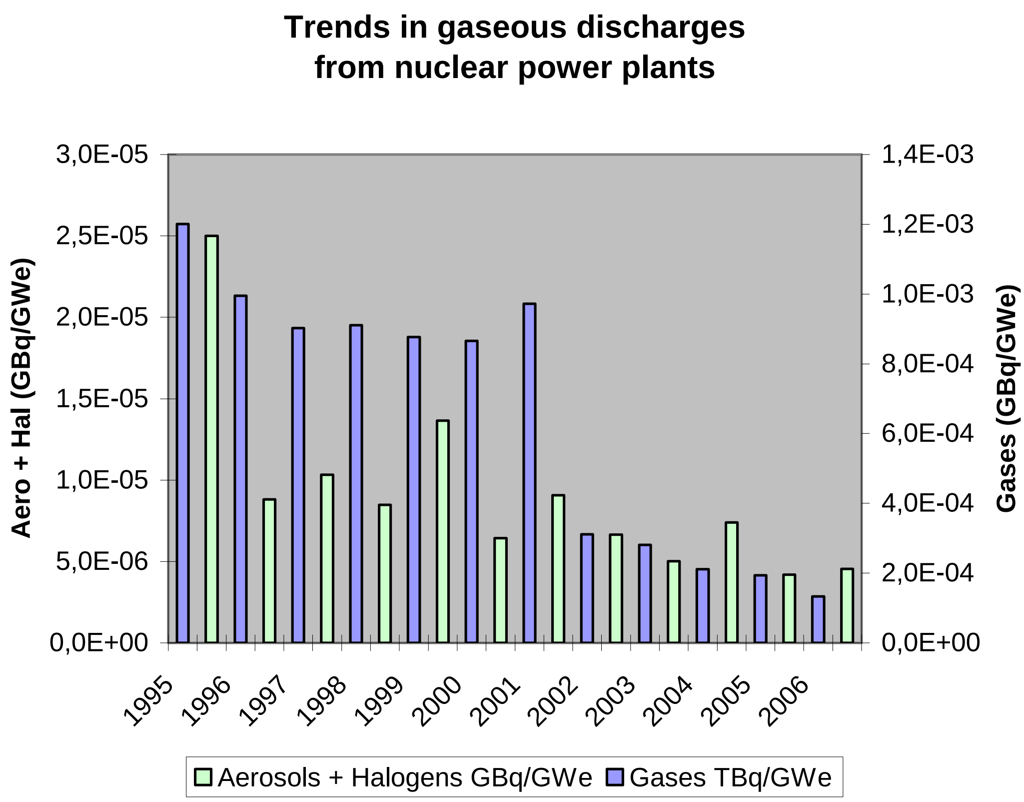
Locations of Téléray network stations and average ambient γ dose rate in 2004 (Source: IRSN)



Locations of thermoluminescent dosimeters and results for 2004 (Source: IRSN)

4.4 Nuclear power plant discharges over the last ten years





Appendix 5 - References

5.1 Documents

/1/ Convention on Nuclear Safety (CNS), September 1994.

/2/ Guidelines regarding national reports under the Convention on Nuclear Safety, IAEA - INFCIRC/572/Rev.2, September 2002.

/3/ Convention on Nuclear Safety - Third national report on the implementation by France of the obligations of the Convention, July 2004.

/4/ Droit nucléaire - Législation et Réglementation [nuclear law – legislation and regulation] - Recueil n°1791 - Les éditions des Journaux officiels, July 2006.

/5/ Annual Report: Nuclear Safety in France in 2004, March 2005.

/6/ Annual Report: Nuclear Safety in France in 2005, March 2006.

/7/ Annual Report: Nuclear Safety in France in 2006, March 2007.

/8/ EDF – The Inspector General's report on nuclear safety and radiation protection, 2004.

/9/ EDF - The Inspector General's report on nuclear safety and radiation protection, 2005.

/10/ EDF - The Inspector General's report on nuclear safety and radiation protection, 2006.

/11/ EDF – Generation and Engineering Directorate – Annual safety and radiation protection reports 2005 and 2006.

5.2 Web sites

The above mentioned documents, or at least most of their content, are available on the Web, along with other relevant information related to this report. The following web sites are of particular interest:

- Légifrance: www.legifrance.fr (most legislative and regulatory texts)
- ASN: www.asn.fr (includes previous report for the CNS)
- CEA: www.cea.fr
- EDF: www.edf.fr
- ILL: www.ill.fr
- IAEA: www.iaea.org

Appendix 6 – List of main abbreviations

ASN	Autorité de Sûreté Nucléaire (Nuclear Safety Authority)
BNI	Basic Nuclear Installation
CEA	French Atomic Energy Commission
CICNR	Interministerial Committee for Nuclear or Radiological Emergencies
CNRA	Committee on Nuclear Regulatory Activities (NEA)
CPP	Main primary circuit
CPxx	900 Mwe reactor series No. 'xx'
CSNI	Committee on the Safety of Nuclear Installations (NEA)
CSP	Main secondary circuit
DDSC	Directorate for Defence and Civil Security
DEN	Nuclear Energy Directorate - CEA
DGSNR	General Directorate for Nuclear Safety and Radiation Protection - ASN central structure until November 2006 reform
DPN	Nuclear Power Operations Division - EDF
DRIRE	Regional Directorate for Industry, Research and the Environment
EDF	Électricité de France
ESP	Pressure vessel
EU	European Union
GPE	Advisory Committee of Experts (GPR = Advisory Committee for Nuclear Reactors)
HOF	Human and organisational factors
IAEA	International Atomic Energy Agency
ICPE	Installation classified on environnement protection grounds
ICRP	International Commission on Radiation Protection
IGSN	General Inspectorate for Nuclear Safety and Radiation Protection (EDF)
ILL	Max von Laue – Paul Langevin Institute

INES	International Nuclear Event Scale
INRA	International Nuclear Regulators' Association
IRSN	Institute for Radiation Protection and Nuclear Safety
NEA	Nuclear Energy Agency (OECD)
NPP	Nuclear Power Plant
OECD	Organisation for Economic Cooperation and Development
OSART	Operational Safety Review Team (IAEA)
PC	Command Post (emergency response)
PIC	Programme for supplementary investigation
PPI	Off-site emergency plan
PUI	On-site emergency plan
PWR	Pressurised Water Reactor
RCC	Rules for design and construction
RFS	Basic safety rule
RGE	General Operating Rules
RHF	ILL High flux reactor
SAMU	French emergency medical service
SDIS	*Département* fire and emergency services
SGDN	General Secretariat for National Defence
SMUR	Mobile emergency and resuscitation services
STE	Operating Technical Specifications (= OLC : Operating Limits and Conditions)
VD'n'	PWR 10-yearly outage N°. 'n'
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association