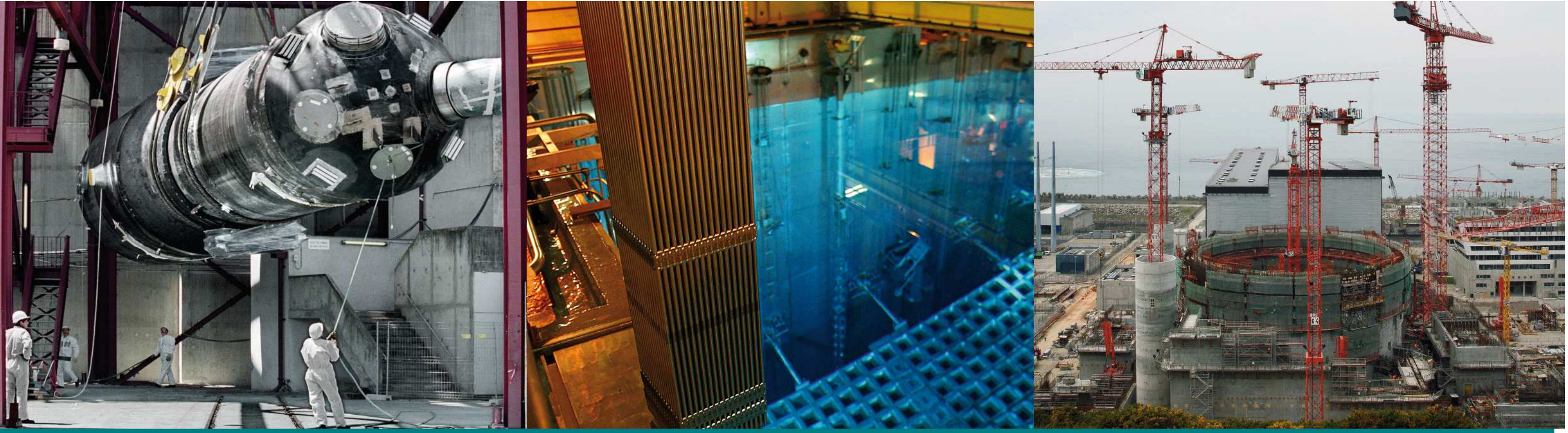

FRANCE

Convention on Nuclear Safety

Fifth National Report for the 2011 Peer Review Meeting

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RÉPUBLIQUE FRANÇAISE

July 2010

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INTRODUCTION AND SUMMARY

1. 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 in order to contribute maintaining a high level of nuclear safety worldwide. The convention aims to propose 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.

The purpose of this fifth report, which was drafted pursuant to Article 5 of the *Convention on Nuclear Safety*, is to present the measures taken by France in order to fulfil each of her obligations as specified in the said *Convention*.

1.2 Installations concerned

Since the *Convention* applies to all nuclear-power generating reactors, most of this report is dedicated to the measures taken in order to ensure their safety. However, as in previous reports, France has decided to present also in this fifth report, the measures that were taken for all research reactors, together with a graduated approach, if need be, for taking their size into account.

First of all, research reactors are actually submitted to the same overall regulations as nuclear-power reactors with regard to safety and radiation protection. It should be noted that the most powerful French research reactor, called PHÉNIX, which also used to produce electricity, was disconnected from the grid in March 2009, but continued to run an "ultimate-test programme" until 1 February 2010. Later, in the framework of the *Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management*, to which France is a Contracting Party, an account was made of the measures taken in those respective fields with regard to research reactors. Lastly, the Board of Governors of the International Atomic Energy Agency (IAEA), of which France is a member, approved in March 2004 the *Code of Conduct on the Safety of Research Reactors*, which reiterates most of the provisions of the *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) which became the French Atomic and Alternative Energies Commission on 10 March 2010 and the Laue-Langevin institute (ILL). The final version was completed in July 2010 after consultation with the French parties concerned.

1.4 Structure of the report

For this report, France took into account the lessons learnt with the four previous reports and is presenting a self-standing document, which has been developed mostly on the basis of existing documents and reflecting the views of the different stakeholders, including the regulatory body and the various operators. Hence, for every chapter in which the regulatory authority is not the only entity to express its own views, a three-fold structure was adopted, starting with a description of the regulations by the regulatory authority, followed by an overview presented by the operators of their measures for complying with regulations, and ending with an analysis of operator measures by regulatory bodies.

This report is structured according to the guidelines on national reports, as revised at the special meeting of 28 September 2009. The presentation progresses "article by article", with each one giving rise to a separate chapter at the beginning of which appears the corresponding text of the *Convention* in a box with a half-tone background. Following this introduction, which describes the main evolutions that occurred since the *Fourth Report* as well as the French nuclear-power policy, Part A addresses generic provisions (chapters 4-6), Part B summarises the legislation and the regulations (chapters 7-9), Part C is dedicated to general safety considerations (chapters 10-16), while Part D describes the safety in installations (chapters 17-20), including future French orientations in the field of safety (chapter 20) as well as measures of international co-operation. Seven annexes also complete the report.

The major changes concerning the content compared to France's Fourth Report are summarised by chapter in § 3.1.

1.5 Publication of the report

The Convention on Nuclear Safety does not stipulate any obligation regarding public communication of the national reports. 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. National nuclear policy

2.1 General policy

The first decision of the French government concerning nuclear energy was to create in 1945 a public research organisation, called the French Atomic Energy Commission, which became the French Atomic and Alternative Energies Commission (CEA) on 10 March 2010. The first French experimental reactor became critical in December 1948, thus leading the way to the construction of other research reactors, followed by further reactors designed to generate electricity.

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

Placed under the aegis of Parliament, France’s energy policy is defined by the government and is supervised by the Ministry of State for Ecology, Energy, Sustainable Development and the Sea (MEEDDM).

The government stipulates 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.

The French Nuclear Safety Authority (ASN) is in charge of taking regulatory decisions with a view to detailing government decrees and orders, and also of taking spot decisions. The control of nuclear safety is described in chapter 8.

2.2 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 currently dismantled and 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 2009 the PWR reactors supplied approximately 75% 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):

- Among 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),
- Among 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-sur-Seine and Penly,

- the N4 series, comprising four 1500MWe[1] reactors: two at Chooz and two at Civaux.

In December 2009, the average age of reactors, based on the dates of the first reactor criticality phases, stood as follows:

- 28 years for the 34 reactors producing 900 MWe;
- 22 years for the 20 reactors producing 1,300 MWe, and
- 12 years for the four N4-level reactors producing 1,500 MWe.

In addition, in 2007 the construction of an EPR reactor was started at Flamanville[2]. The construction of a second EPR reactor is envisaged at Penly, for which a public inquiry is organised.

Because of the overall standardisation of the French nuclear power reactor fleet, certain technological innovations were introduced successively 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 using a computerised instrumentation interface for the reactor operation.

2.3 Nuclear research reactors

Although this report lies outside the scope of the *Convention*, it also describes the measures being taken concerning the safety of French research reactors, which fall under the same regulations as nuclear-power reactors.

Administratively speaking, 11 research reactors are in service in France, which means that they are still subject to the regulatory process of an operating installation. Consequently, that figure takes into account the number of shut-down installations, either temporarily for renovations or modifications, or permanently, pending decommissioning. It also encompasses the Jules-Horowitz reactor (RJH), whose creation authorisation decree was issued in 2009 in the hope of commissioning it in 2015. It consists of a light-water-cooled and moderated: pool-type reactor with a nuclear power of 100 MW. It is already under construction and should be commissioned by 2015.

The very large majority of research reactors located in France also belong to the pool type, since only the MASURCA reactor – the critical mock-up designed for neutron studies for the fast-neutron system – is air-cooled. Most of those reactors were commissioned between the 1960s and the 1980s, but have generally undergone extensive work since then.

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[1] Even though the Arabelle turbine had a design power of 1,450 MWe, its sound performance leads EDF to note that it is able to reach an electric power of 1,500 MWe, while complying with the capacity of 4,270MW(th) specified in the creation authorisation decree.

[2] Refer to Appendix 6, § 6.2 the website concerning the information available on EPR Flamanville 3.

Among those 11 research reactors, 10 are operated by the CEA at its Cadarache, Saclay and Marcoule sites. The High-flux Reactor (HFR) is located close to the CEA's Grenoble site and operated by the *Institut Laue-Langevin* (ILL), a research institute grouping several European partners.

The fast-neutron nuclear-power reactor PHÉNIX, which is located on the CEA's Marcoule site, stopped producing power in 2008 and entered into its decommissioning phase, once the relevant decree was issued.

Regulatory requirements applicable to research reactors are the same as for other nuclear installations, notably for power-generating reactors. The analysis of their safety demonstration and of the measures taken for ensuring it, results from a "graduated approach" consisting in adapting the means to be implemented to the various potential risks of those installations. When feasible, ASN may rely on the requirements that are specifically dedicated to certain types of installations, such as research reactors, or to certain types of operations. However, they only correspond to adaptations of existing regulatory requirements.

2.4 Legal framework

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 operator 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.

Thirteen different implementation decrees regarding *Act No. 2006-686 of 13 June 2006 on Transparency and Security in the Nuclear Field* hereinafter referred to as the *TSN Act*, have been issued. In conjunction with the *MEEDDM*, ASN also started to consolidate the general technical regulations in 2008. That work should result in the publication of a ministerial order, which has already given rise to a consultation with stakeholders and to approximately 20 technical regulatory decisions by ASN (refer to Appendix 2.1).The French legislation now covers clearly and thoroughly all nuclear activities in terms of nuclear safety and radiation protection.

3. Summary

3.1 Main changes since the Fourth French report

3.1.1 Changes in nuclear-safety regulations in 2010

Since the last review meeting, ASN has confirmed its responsibilities as an independent administrative authority in accordance with its attributions, as mentioned in the *TSN Act,* which not only provide the legislative base for the control of nuclear safety and radiation protection in France, but also introduce notably a suitable sanction regime.

While controlling the construction of the EPR reactor in 2008, for instance, ASN detected several anomalies concerning civil-engineering operations and consequently requested *Électricité de France* (EDF), the French public electrical utility, to suspend concrete-pouring activities in the case of significant safety-related structures and to analyse the observed malfunctions and to propose potential corrective actions. In 2008, ASN also sent a formal notice to EDF ordering the company to comply with regulations concerning the control of internal explosion risks at the Cruas Nuclear Power Plant (NPP). Moreover, in 2009, ASN did not certify EDF's environmental-measurement laboratories.

In 2010, ASN is reinforcing the transparency of its decision-making process by publishing its decision together with the opinions of the French Radiation Protection and Nuclear Safety Institute (IRSN) concerning the major issues it refers to the Institute and on which ASN relies to take its own decisions. Since 2002, ASN has been publishing its inspection letters after visiting every nuclear installation. In 2009, it issued every position it had taken following the opinions submitted by the advisory committees (GP), particularly with regard to the EPR's instrumentation and control system or, with respect to research reactors, the safety report of the CABRI reactor in preparation for its upcoming return to service. ASN will also ensure that operators fulfil their transparency-related obligations in accordance with the *TSN Act*.

3.1.2 Changes in the content of the Fifth Report with respect to the Fourth 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 fourth 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 as well as the major events occurred since the fourth review meeting are summarised below.

This chapter 3 has been redrawn and updated to take account of changes in chapter 2 of the fourth report. Chapter 2 of this report - National nuclear policy- was redrawn and updated from changes in chapter 3 of the fourth report. Chapters 4 and 5 are unchanged. Chapter 6, dealing with the main measures taken to improve reactor safety in France, has been updated.

Both chapter 7, dedicated to the safety legislation and regulations, and chapter 8, dealing with the regulatory body, were both entirely rewritten in order to introduce the *TSN Act* and to describe the resulting impact on the regulations themselves and ASN, as well. In addition, Appendix 5 reports on the follow-up mission carried out by the IAEA's Integrated Regulatory Review Service (IRSS) in March 2009, at ASN's request. Experts took note that ASN has enforced most of the recommendations they had formulated during their first mission in 2006. Chapter 9 was also modified in order to take the new act into account.

Chapters 10 to 20 were updated from the version of the fourth Report.

3.1.3 Topical safety issues in France in 2010

Since the review meeting of the last report, in April 2008, France did not encounter any major event regarding nuclear safety. In the meantime, although three incidents occurred in nuclear power reactors, but were classified at Level 2 on the International Nuclear Event Scale (INES Throughout that period, ASN maintained its efforts in order not only to identify long-term challenges in the field of nuclear safety and radiation protection, but also to develop appropriate actions with a view to fulfilling them.

The major issues at stake concerning safety in France in 2010 relate to the safety review associated with the third decennial outages (VD3) of 900-MWe reactors, EDF’s control and maintenance operations on steam generators and ASN’s supervision of the construction of the EPR reactor at Flamanville. In addition, the control of NPPs in service remains a priority for ASN.

3.1.3.1 Safety reviews relating to the third decennial outage of 900-MWe reactors

Safety reappraisals constitute one of the cornerstones of safety in France by imposing upon the operator not only to maintain, but also to improve the safety level of the installation. The review process includes the following:

- a “compliance review” involving a thorough examination of the state of the installation in order to verify that it complies fully with all relevant safety requirements , and
- a ”safety review” of the installation in order to improve its safety level, notably by comparing the requirements applicable to the installation to those that are in force for more recent installations, and with due account of national and international experience feedbacks.

Once both steps are completed, the operator submits a report to ASN on the basis of which the latter decides whether the installation will remain in service or not.

The third decennial outages VD3s of 900-MWe reactors started in 2009 at Tricastin-1 and Fessenheim-1 units and will end around 2020 with those at Chinon. The safety review of the safety reassessment associated with those decennial outages (VDs) deals more specifically with the following topics: floods and explosions induced by internal causes, fires, earthquakes, resistance against extreme climate conditions, protection of water intakes against oil patches and situations likely to induce a simultaneous loss of the cold source and of power supplies.

In July 2009, ASN issued its position on the generic aspects of the ongoing operation of 900-MWe reactors. It did not detect any generic problem involving EDF’s capability to control the safety of such reactors up to a period of 40 years.

That generic position from ASN will be completed subsequently by a position on every individual reactor by relying notably on the results of the controls carried out in the framework of the compliance review of every reactor during the third decennial outages (VD3s) and on the safety review of every reactor.

3.1.3.2 EDF’s control and maintenance operations on steam generators

EDF’s control and maintenance of steam generators, which were addressed at the last review meeting, remain a high concern for ASN. Over the last few years, the controls performed on steam generators during maintenance and fuel-reloading outages or following unscheduled events, revealed a certain number of degradations. Some of them are significant and unexpected, and required EDF to implement large-scale maintenance measures in many reactors among the French nuclear fleet, considering that such intervention would have an impact on the availability of such reactors. ASN ensures that the safety level of those steam generators remains satisfactory. In addition, it required EDF to carry out a comprehensive review of the oversight and design of steam generators with a view to ensuring that replacement operations are properly scheduled ahead if time in order to limit any significant degradation risk to such equipment.

3.1.3.3 Construction control of the Flamanville EPR

The construction of the future EPR at Flamanville-3 started in September 2007, once the French government issued the licence on the basis of ASN's favourable opinion, in which states that the proposed design truly met the ambitious safety objectives ASN had prescribed for new reactors.

The next regulatory step will involve the "implementation" licence to be delivered by ASN. In preparation for that step, ASN launched as early as 2007 an anticipated review of certain topics requiring a long examination and a control of the detailed design of the major systems, including the instrumentation and control system, with a view to being able to decide whether or not they are capable of meeting safety requirements. Following a thorough examination carried out by IRSN and the opinion of the advisory committee for nuclear reactors (refer to § 8.1.3.2), ASN sent EDF in October 2009 a letter emphasising the complexity of the proposed design for the instrumentation and control system. ASN requested EDF to provide further safety justifications and to study different design specifications in case that qualification application failed. That position is consistent with that of Finnish and British safety authorities with whom ASN published, on 2 November 2009, a joint statement on the safety of the EPR's instrumentation and control system (refer to § 18.3.1.4).

The EPR's safety review follows an iterative process, with the industry proposing solutions and ASN accepting or rejecting them. ASN's positions may obviously lead to certain evolutions in the design. Such an in-depth technical dialogue irremediably promotes enhanced safety. The position expressed by ASN in 2009 concerning the instrumentation and control system is only but a single step in that iterative process.

In parallel, ASN supervises the construction of the reactor (detailed design studies, factory manufacturing, worksite), by examining documents and performing inspections in proportion with objectives regarding safety, radiation protection and environmental protection. Hence, in 2009, ASN conducted nine inspections in engineering centres and 24 on the construction site. On the other hand, ASN also performed or had performed by certified control organisations more than 1,600 inspections concerning that equipment on the premises of the manufacturer (AREVA NP), its contractors and their subcontractors. ASN also carried out its work-inspection mandate on the construction site (11 inspections in 2009).

With regard civil-engineering activities on the worksite and whenever anomalies were recorded, ASN verified if EDF dealt satisfactorily with the situation and in accordance with the safety plan. It intervened specifically, for instance, to request EDF to reinforce the welding quality of the metal liner of the internal containment envelope of the reactor building. Nevertheless, such anomalies shed light on the considerable amount of pressure being exerted on the construction schedule.

With respect to the manufacturing of nuclear pressurised equipment, ASN assesses or has assessed by certified control organisation their compliance with regulatory requirements. Such assessments are conducted by reviewing documents and inspecting manufacturers' premises, as well their contractors and subcontractors. Significant anomalies were detected at the end of 2008 and were addressed in 2009, as follows:

- following a mistake in the location of a hole on a steam-generator component, AREVA NP proposed to ASN to replace that component by another, whose manufacturing was already completed, but whose characteristics were not identical and ASN verified that such proposal was acceptable, and
- following a non-conformity involving the fabrication procedure for forged parts of one of AREVA NP's Italian contractor, ASN requested that further mechanical tests be performed on certain components and rejected others; it also requested that supervision be reinforced at that contractor.

Lastly, in March 2010, ASN and STUK, the Finnish nuclear safety authority, conducted a joint AREVA NP inspection at one of its Nancy contractor, FIVES NORDON, concerning the corrective actions set in place following the detected discrepancies detected in the fabrication of primary pipes for the Olkiluoto-3 EPR (EPR OL3).

3.1.3.4 Regulation of NPPs in service remains a priority for ASN

ASN recognises that the 2008-2010 period has proven rather satisfactory in the field of nuclear safety and radiation protection in NPPs. With respect to day-to-day operation, ASN noted improvements on certain sites, but feels that EDF's efforts over the recent years in order to improve rigour need to be furthered.

ASN considers EDF's preparedness to manage emergency situations as satisfactory. Four national emergency alerts were triggered in 2009 and only once so far in 2010. EDF dealt efficiently with the situation in all cases. However, experience feedback from those situations ought to be drawn.

The overall structure set by EDF in NPPs to address nuclear experience feedback is considered satisfactory. However, ASN feels that EDF must improve the quality and depth of the analyses being performed, as illustrated by the repetition in 2009, at the Tricastin NPP, of an identical incident which involved fuel assemblies that had remained attached to the internals of the vessel cover once the latter was opened and which had occurred the previous year at the same installation.

EQUIPMENT-MAINTENANCE AND REPLACEMENT PROGRAMMES, the safety-review approach and the correction of identified non-conformities all contribute to maintaining all NPP equipment in what is considered as generally satisfactory conditions. However, ASN noted that EDF did not forecast early enough certain issues that now call for some delicate and large-scale corrective operations to be undertaken on steam generators in order to ensure their safety. The lack of anticipation in the equipment-maintenance and replacement programmes also required on certain steam generators some major control and audit programmes that were essential in order to determine the state of such equipment before their return to service.

With regard to the performance of maintenance operations, ASN noted that certain operations were marred with quality gaps that EDF must aim at preventing better. The quality of risk analyses carried out in preparation for maintenance operations, together with their appropriation by the relevant interveners must be improved. EDF must also enhance its performance in the management of spare parts, because they are not always available or lack the required specifications.

Most maintenance activities on the sites are delegated to contractor organisations as selected on the basis of a qualification and assessment system. ASN feels that the principle of such system is satisfactory, but requires that EDF assess its subcontracting policy with contractor organisations. In fact, ASN notes degradation in the field oversight of the activities performed by contractor and considers that such oversight must be rapidly improved and reinforced. Lastly, ASN observed, as in previous years, that physical resources are often lacking or inappropriate, and that interveners do not always have the required time to intervene under serene conditions.

WITH REGARD TO RADIATION PROTECTION, dosimetric results throughout the nuclear fleet remain at satisfactory levels after many years of reduction, while an increase in the overall dosimetry, which was observed in 2009, may be explained by various technical and organisational contingencies. ASN considers that adequate vigilance must be maintained with regard to dose optimisation during reactor outages and the control of contamination risks at the source.

IN THE FIELD OF ENVIRONMENTAL PROTECTION, ASN considers that EDF's overall situation receded in 2009, although radioactive discharges decreased constantly and remained largely inferior to regulatory limits. A large number of discrepancies were registered in comparison to previous years. ASN will remain vigilant on the set of corrective actions implemented by EDF.

3.1.3.5. Management of ageing installations against the shortage risk of medical radioelements

Following several concomitant incidents in several international irradiation reactors participating in the fabrication of medical radioelements, especially molybdenum 99, which is used to produce technetium 99 for medical-imaging purposes, ASN raised the attention of the various stakeholders on the need to prevent conflicts between public health and nuclear safety. Since ASN is directly concerned by the control of the *OSIRIS* reactor, which partakes in the production of certain radioelements, it feels that the solution is not to extend the lifetime of older reactors, but involves a new concerted international approach.

In January 2009, ASN organised a seminar on the "Safety-Availability of Radioisotope Production Installations" designed to gather the safety authorities from the main radioelement-producing countries and the French Health Product Safety Agency (AFSSAPS), the Nuclear Energy Agency (NEA) of the Organisation for Economic and Co-operation Development (OECD) and the Association of Imaging Producers and Equipment Suppliers (AIPES). Among The seminar conclusions, include notably the need to reinforce information exchanges between safety authorities on topics relating to the safety and availability of reactors. On 29-30 January 2009, the NEA also organised a seminar on the supply of radiopharmaceuticals, where one of the identified goals to improve the safety of supplies over the short term is to reinforce co-ordination efforts among reactor operators concerning their maintenance schedules.

Similarly to its reaction with respect to the implementation conditions for nuclear reactors in newly-nuclearised countries, the ASN Board took a public stand on the production of medical radioelements.

3.2 Safety perspectives for the next three years

ASN's work and control actions will be oriented towards the major elements described below.

3.2.1 Regulation of NPPs in service

The regulation of NPPs in service will remain a priority for ASN, since it considers that preserving the safe state of nuclear reactors will require EDF to pursue its maintenance efforts. The significant extension of the outage period of certain reactors in 2009 reflects the amplitude of the required maintenance operations, when cases of equipment degradation have not been anticipated properly. With regard to environmental protection, ASN expects appropriate actions from EDF in order to ensure a prompt return to a more satisfactory situation. Lastly, ASN will further its reflection on the required conditions to ensure the extended operation of reactors, which are currently in service, for more than 40 additional years by setting the reflection within an international framework.

3.2.2 Ongoing development of technical regulations consistent with best European practices

The ongoing development of technical regulations will be guaranteed in order to table before the government and to implement a consistent series of regulatory (ministerial orders, ASN decisions) and pararegulatory documents (ASN guides) derived from the "reference levels" adopted in Europe by the Western European Nuclear Regulators' Association (*WENRA*).

3.2.3. Upgrading of old research reactors

In 2007, ASN noted with satisfaction that the CEA had proposed a practical tool to orient at the highest level all decisions concerning the upgrading of older installations and new projects, thus ensuring more transparency and visibility for ASN in any process likely to delay complex projects with high stakes for nuclear safety and radiation protection. That observation concerned about 20 major involvements, which exceeded the exclusive perimeter of research reactors, thus allowing for setting the priority where the highest risk was. ASN feels that the approach based on "major commitments", which are reviewed formally every six months by the CEA, aims precisely at preventing commitment postponements for other reasons than justified technical contingencies by highlighting a limited number of high-stake projects. Since it is important that the CEA dedicate the required resources, both budgetary and human, to the successful fulfilment of those "major commitments", ASN wishes that such approach be rigorously applied. That is the reason why ASN requested the CEA in 2009 to pursue that approach, which should lead the CEA to a better control of its projects.

3.2.4. Regulation of research reactors under construction or renovation

With the support of its foreign partners, the CEA felt that it was necessary to build a new reactor, called the Jules-Horowitz Reactor (RJH), due to ageing of European irradiation reactors, which are currently in service and to their scheduled shutdown over the short or medium term.

Following the favourable results of the 2006 public inquiry and the analysis of the preliminary safety report of the implementation project, the creation authorisation decree of the Basic Nuclear Installation (BNI) was signed in October 2009. Once the first earthworks were completed, the first concrete was poured in August 2009, with due account of the fact that the publication of the creation authorisation decree is not a prerequisite condition for that operation. During a previous inspection, the organisation principles for managing, overseeing and controlling the RJH worksite did not raise any major comment from ASN.

ASN supervises the quality of the construction and of its compliance with both the creation authorisation decree and the safety-demonstration elements, which have been submitted. It has also undertaken regular exchanges with the CEA with a view to facilitating the follow-up of requested actions following the analysis of the preliminary safety report and in preparation for the future commissioning-licence application.

In addition, several research reactors are undergoing significant modifications, renovations and safety-improvement programmes. That is notably the case for the CABRI Reactor, which is used to carry out tests to determine the behaviour of fuel rod in accident situations. Renovation and modification works on that reactor were overseen rigorously by ASN, either by reviewing the safety reports relating to the completed changes or by conducting quality-control inspections of the completed operations and of their conformity with the elements submitted for review. That approach covers notably the quality follow-up of civil-engineering operations and the qualification process of the major safety-related equipments in preparation for the restart of the installation, all such elements being of particular significance to ASN.

Other research reactors are undergoing important work, which have reached various stages of progress. At the OSIRIS reactor, located on the Saclay site, for instance, the safety-improvement programme will be completed in 2010 in order to ensure its operation under satisfactory safety conditions until its final termination of operation in 2015. The MASURCA reactor, located on the Cadarache site, is also scheduled to undergo a rejuvenation phase, but nothing had started yet at mid-2010 and the reactor is still shut down and its core is empty. Other installations, such as the ORPHÉE, ÉOLE and MINERVE reactors, whose safety reviews under way, may also be modified pending on the conclusions of such reappraisals. ASN is always paying a special attention to each of periodic reviews, which constitute critical phases in the life of such installations.

3.2.5 Construction control of the Flamanville-3 EPR

The construction control of the Flamanville-3 EPR II, which is made through sampling activities and is commensurate with safety challenges, will continue throughout the construction duration. At the peak of civil-engineering and system-assembly activities with regard to its oversight-control mission, ASN intends to favour EDF’s oversight of achievements’ quality and the prevention of professional accidents. In parallel, it will continue its review of the required elements for the commissioning-licence application, notably accident-investigation methods and the operating principles of the installation. It will endeavour to co-operate as much as possible with its foreign counterparts in order to reach harmonised positions. Furthermore, ASN will also start reviewing the suitable conditions for creating an EPR at the Penly NPP.

ASN will be attentive to EDF’s expected responses to the letter of October 2009 on the EPR’s instrumentation and control systems (refer to § 18.3.1.4).

3.2.6 Review of the creation conditions for the Penly EPR

The public-debate procedures for the creation of an EPR at Penly NPP started during the spring of 2010. For that purpose, EDF, together with its partners (*Gaz de France Suez* (GDF-SUEZ), the French public gas utility; Total; the National Italian Electricity Authority (*Ente nazionale per l'energia elettrica* – ENEL) and the German group E.ON) in the project, submitted a client's case to the Ad Hoc Commission on Public Debate. The Government stated in April 2010 that EDF would be the license holder. While mentioning that the arrival in France of a new operator may contribute in improving the safety level of nuclear reactors in the country by introducing new working methods, ASN has emphasised how important it is to specify the governance of the project and to identify clearly the operator.

ASN considers that the operator must hold the required technical skills and financial resources to manage the full scale of the project and to ensure its control at all times. The organisational structure between actors must also be robust.

3.2.7. Review of the ITER licence application

The International Thermonuclear Experimental Reactor (ITER) involves an experimental installation designed for the scientific and technical demonstration of the control of thermonuclear-fusion energy resulting from magnetic confinement of deuterium-tritium plasma during long experiments with significant power. The supporting case of the BNI creation authorisation application for the ITER was submitted at the end of January 2008. However, ASN has pointed out to ITER Organization (IO) that the application case was not acceptable in its current form and needed to be completed on several items before initiating the creation authorisation procedure and, especially, the public inquiry. The revised version of the case has been submitted at mid-2010 and is currently reviewed. The Local Information Committee (CLI refer to § 7.1.3), which was instituted in 2009, will be consulted. ASN will convene the relevant advisory committees for that case and will partake in the drafting of the creation authorisation decree for the ITER.

3.2.8. Initiation of discussions on Generation-IV reactors

Research institutions and the industry from 12 large nuclearised countries, together with the European Union (EU) via the European Atomic Energy Community (EURATOM), are developing the fourth generation of reactors in the framework of the "Generation-IV international Forum" (GIF) launched in 2000. Within the GIF, those different partners federate their research-and-development (R&D) efforts with a view to assessing the potential of various reactor systems being contemplated.

In the context of that international co-operation project, the French industry (CEA, AREVA NP, EDF) have committed themselves more particularly in R&D programmes on sodium-cooled fast-neutron reactors (RNR-Na) – a system for which France benefits from a wide expertise with the PHÉNIX and SUPERPHÉNIX reactors –, but also on gas-cooled fast-neutron reactors – a more prospective system requiring more technological innovations.

As illustrated in the *2006 Planning Act No. 2006-739 of 28 June 2006 on the sustainable management of radioactive materials and waste*, hereinafter referred to as the *Planning Act*, France's ambition is to commission the first industrial prototype of Generation-IV reactor by 2020 with a view to developing a potential industrial deployment between 2040 and 2050.

In that prospect over both the medium and long terms, ASN considers that Generation-IV reactors will need to provide safety improvements in comparison to existing reactors, including the EPR. In that regard, ASN is already involved in technical discussions on the development of Generation-IV reactors and on relevant safety prospects.

Those discussions deal mostly with the following:

- the safety objectives to be assigned to Generation-IV reactor systems and the selection of that system;
- the experience feedback from RNR-Na operation (RAPSODIE, PHÉNIX, SUPERPHÉNIX) in France, and
- the Generation-IV RNR-Na prototype the CEA may build in 2020.

3.2.9 Transposition of European Directive of 25 June 2009 on the safety of nuclear installations

While there was still no European legislation on nuclear safety, the European Union issued on 25 June 2009 a directive on the safety of nuclear installations, to which ASN was a significant contributor. It consists of a major text for the implementation of a legally-binding community framework concerning nuclear safety. The directive, which imposes more particularly on all member States to set in place a legislative framework for nuclear safety as well as an independent safety authority, also provides for a peer-review system based on the IAEA's Integrated Regulatory Review Service (IRRS) and includes various public-information, training and competency provisions. In 2010, ASN will also oversee the harmonisation of French regulations with that directive, a task that should be completed by July 2011.

3.2.10 Continuation of the reflection on European and international plans for the safety of reactors producing medical radioelements

With regard to research reactors, ASN noted that, contrary to the case of nuclear-power-generating reactors, no work has ever been undertaken at the international scale with a view to harmonising the safety of installations, research reactors (and fabrication plants), whether older or under construction. Hence, it considers that such harmonisation is important and supports the project in its bilateral and multilateral exchanges with its foreign counterparts.

The issue was highlighted recently by the shortage risk of medical radioelements and the need to prevent conflict between public health and nuclear safety in the production of those radioelements. In fact, most of the world production involves reactors that have been in service for more than 40 years.

For ASN, the solution is not to extend the operation of older reactors, which would compromise the safety of such installations, but develop a consultation and a reflection process between all States concerned around the world in order:

- to optimise the use of technetium 99m, to seek alternative production (e.g., by accelerator) and to investigate the use of other medical-imaging methods, and
- to build a robust and economic model for producing those radioelements. In fact, the current model does not integrate the full fabrication cost of those radioelements and, notably, that of the molybdenum produced in public research reactors.

3.2.11 Promotion of ASN's responsibilities and role

If ASN was comforted in its legitimacy as an independent administrative authority by the *2007-2009 Multi-year Strategic Plan*, its ambition for 2010-2012 is to affirm its responsibilities and its position, notably through the following strategic areas:

- featuring and developing its skills, reinforcing its organisation and promoting its doctrine in order to fulfil its missions and to secure the relevant means to achieve its ambitions;
- investing in new medical, security and research fields in order to improve the consistency and effectiveness of State actions in the control of nuclear activities;
- clarifying the role and organisation of expertise in the control of nuclear activities in order to ensure the quality of such control over time;
- clarifying and developing institutional relations with the other State partners in order to improve effectiveness, while defending its independence;
- acting as a driver for building a nuclear safety and radiation-protection culture in Europe in order to maintain a high level of shared excellence and to constitute an international reference, and
- encouraging and nurturing public exchanges and other debates on topics involving ASN (EPR, operating lifetime, etc.) in order to inform citizens, to enrich ASN and to allow for it to take the best possible decisions.

3.3 Integration by France of the major international trends about safety

From a general point of view, ASN dedicates important means to international cooperation, paying particular attention to multilateral and bilateral relations.

ASN notably commits itself in all initiatives aiming at harmonising practices and regulations, which are at the top of the priorities at the international level.

At AIEA, ASN participates actively in the work of the Committee on Safety Standards (CSS) and four related committees.

ASN is also very much involved in IRRS missions and underwent one of those missions in 2006 and the corresponding follow-up mission in 2009. It partakes frequently in auditing teams in the framework of the missions to be carried out abroad on other safety authorities.

On the other hand, ASN co-operates closely with other safety authorities in the MDEP Programme, which is dedicated notably to the EPR's and the AP-1000's safety assessment, with a view to harmonising safety objectives with the matching codes and standards for the safety assessment of new reactors.

Lastly, in order to contribute in the reinforcement of the nuclear-safety and radiation protection culture and to ensure the promotion of its major principles throughout the world, ASN is very much interested in sharing its work and experience by developing information exchanges with its foreign counterparts on regulatory systems and practices, on missions and duties of a regulator – notably on independence and transparency - and by promoting the best international and European practices.

3.3.2 Towards multinational co-operation

In addition, ASN participates actively in the *Multinational Design Evaluation Programme* (MDEP) for new reactors. Since 2008, five plenary meetings have been dedicated to the EPR in the framework of that programme. The international co-operation undertaken in the framework of the MDEP Group materialised notably in 2009 by the consistency of the positions of the HSE, STUK and ASN concerning the safety of the instrumentation and control system. Other topics may also give rise to joint statements in order to illustrate the robustness of the completed safety reviews.

Furthermore, ASN will continue to partake into IRRS missions in other countries. In fact, ASN feels that the generalisation of such audits should contribute to the constitution of a network of experts originating from nuclear-safety authorities and, thus, the harmonisation of practices.

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A. GENERAL PROVISIONS

4. Article 4: Implementation 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 fifth 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 currently all operated by a single operator, *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.

The PHÉNIX fast-neutron research reactor is operated by the CEA for research and power-generation purposes. However, it was disconnected from the grid in 2009, ceased to produce power during the same year and is now maintained under shutdown state. The CEA operates nine other research reactors, and the ILL one. A list of French reactors in service, nuclear-power reactors and research reactors, as well as a map of their locations, is provided in Appendix 1.

The principles of the *Convention* were applied to the safety of those installations as early as the design stage.

6.2 Safety assessments

Before a nuclear reactor is commissioned, ASN reviews all the safety assessments carried out by the operator 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 operators 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. 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 reactors

6.3.1 Main equipment/procedure modifications

The reactor safety review process, based around periodic reviews or specific issues, leads in certain cases to reactor 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 reactors in the series concerned. Grouping modifications in this way allows more coherence and industrial-scale implementation by simplifying scheduling, document updating and operator training.

Batches of modifications are generally implemented during decennial outages (VD) to minimize the impact of the works on reactors availability. The main projects during the period 2007-2010 concerned the thirty-four 900 MWe reactors (third decennial outage VD3), the 1300MWe reactors (second decennial outage VD2) and the four 1,500 MWe reactors (first decennial outage VD1).

6.3.1.1 Third decennial outage of 900-MWe reactors (VD3-900)

The scope of the safety review for 900 MWe reactors 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 decennial outages is to ensure that the reactors are able to continue operating up to a service lifetime of 40 years, while retaining the possibility, as a precaution, of extending reactor operation duration beyond 40 years when the time comes, subject to the implementation of appropriate provisions. 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 reactor 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.

In 2008, the advisory committee for nuclear reactors issued its opinion, with due consideration to the fact that “the safety review of 900 MWe reactors during the third decennial outages (VD3) was certainly the most thorough review ever conducted on pressurised-water reactors (PWR)”.

In July 2009, ASN made a statement on the generic aspects relating to the extension of operation duration of 900-MWe reactors and did not identify any generic issue questioning EDF’s capability to maintain the operational safety of those reactors up to 40 years.

The first VD3 took place at Tricastin-1 during the summer of 2009 and the final report containing the review conclusions of that reactor was submitted to ASN in February 2010. The first VD3 of a CP0-level reactor is almost complete at the Fessenheim-1 reactor.

6.3.1.2 Second decennial outage of 1300-MWe reactors (VD2)

The first VD2-1300 outage, integrating the review conclusions took place at Paluel-2 in 2005. Experience feedback for that reactor prototype was instrumental in validating the series of modifications for the entire level.

The 12th VD2-1300 outage (out of 20) occurred at the end of 2009. Experience feedback of those activities confirmed the validity of the initial technical choices and the relevancy of the reference documentation.

However, a particularity concerned a change in of fuel-handling-and-storage system (PMC) for which the experience feedback regarding the integration and the operation of the first reactors has led EDF to suspend temporarily its implementation between 2008 and 2010 in order to specify more precisely its technical perimeter and to optimise operator training.

6.3.1.3 First decennial outage of 1,500-MWe reactors (N4)

With due account of the recent approval of the reference system of those reactors, which corresponds to the “final commissioning” (according to its regulatory definition) of the Civaux-2 reactor in 2005, it was decided to orient the content of the safety review on the backfitting of the level with regard to the evolutions, which the reference system has undergone since the coupling of the reactors and which have not been yet integrated in the initial safety report.

The transposable conclusions of the VD2-1300 and VD3-900 safety reappraisals to the N4 level were also integrated to that safety review. The enforcement of the first part of the series of modifications and the review of compliance with requirements took place from 14 March to 23 July 2009 on the Chooz-B2 prototype reactor. No technical contingency or significant discrepancy was recorded. The final review report was submitted to ASN and other relevant ministries responsible for nuclear safety on 22 January 2010, that is, within six months after start-up, in accordance with the decree No. 2007-1557 of 3 November 2007. Implementation on all N4 1,500-MWe reactors should last until 2012 (Civaux-2 reactor).

The specific modifications to N4 reactors include some, which aim at:

- completing the physical upgrades concerning the qualification to post-accident ambient conditions;
- reliabilising the triggering of primary motor-driven-pump groups in case of degraded ambient conditions and the modification consisting in qualifying the cooling system of the control-command mechanisms of fuel clusters with regard to seismic resistance, and
- reducing fuel-damage probabilities by acting on the sequences detected by probabilistic safety analyses (PSA).

6.3.1.4 Changes implemented following the experience feedback from all power series

Following the events that occurred throughout the nuclear fleet in operation, modifications were initiated according to short implementation schedules, including the following, among the major ones:

- in early 2006, modifications were brought on all safety injection and containment-spray pumps in order to improve vibration resistance during long-term phases of accidents, and
- the modification programme for the filters of circulation sumps was completed on all reactors by the end of 2009.

6.3.2 Protection against external climate aggressions

Following the flooding at the Blayais site in December 1999, EDF engaged in a reassessment process concerning the protection of sites against external flooding risks. The review of the flooding risk is determined by a specific case for every site concerned and covers the following items:

- the revision of the maximum design flood level (CMS)[3];
- the integration of additional contingencies that may lead to a flood on site, such as heavy rainfalls, the rupture of water-storage capabilities, groundwater rises, and
- the conduct to apply to reactors, with due account of the completed work to ensure protection against any CMS level and other contingencies.

On the basis of those studies, EDF determined complementary protection devices, as required.

For all sites, several protective measures were adopted, as follows: sealing of structures in the subsoil (completed before 2008), implementation of adapted alarm and control procedures and implementation of a local and national organisations.

The advisory committee, which met on 21-22 March 2007, issued a favourable opinion regarding the implementation of the methodology to integrate the flood risk, as described in 2001, and the sufficient nature of the protective measures. Complementary studies were conducted in order to take into account the experience feedback, which was recorded by the water-circulation network during the flood in the machine room on the Nogent-sur-Seine site. They will be reflected in the implementation of complementary protective devices on five sites.

Consequently, studies involving the description of anti-flooding devices have been finalised on all sites.

The remaining work on the Saint-Alban and Fessenheim sites will be completed in 2010. The programming of the last activities concerning the Tricastin site will be approved once the work agreement between EDF and the *Compagnie nationale du Rhône* (CNR) is validated, subject to the State's approval.

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 generation 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.

Over the longer term, the robustness of reactors against high temperatures will be the subject of a safety review according to the same approach described above for flooding risks induced by external causes: preparation of a safety reference system on the basis of a contingency characterisation, with due account of climate evolutions, followed by the study of required complementary protective measures in order for installations to withstand such contingencies. The schedule for studies and for the enforcement of complementary protective measures at the different levels is as follows:

- CPY series: the preparation of the specifications of complementary protective measures is under way, with enforcement on the sites scheduled to start in 2012;
- CP0 series: the enforcement of the complementary protective measures is scheduled to start in 2014, while the possibility of anticipating certain measures is being examined in parallel, and
- 1,300-MWe and N4 series: studies are under way with a view to enforcing the complementary protective measures as of the third decennial outages for 1,300-MWe reactors and the of the

[3] That level corresponds to the water level to be taken into account in the specifications of protective devices in relation to the site location. Most calculation hypotheses are the millennial flood rates for river sites, with a 15% mark-up and a tide coefficient of 120 coupled with 120-km/h winds for coastal sites.

second decennial outages for 1,500-MWe reactors advance, while the possibility of anticipating certain measures is being examined in parallel.

During the transient period preceding the enforcement of those complementary measures, other provisions are made to reinforce the robustness of installations against heat waves during the summer.

6.3.3 Protection against seismic events

As in previous VDs, the VD3 for 900-MWe NPPs involved a safety review of anti-seismic measures with due account of the following items in comparison to the prevailing situation during the previous decennial outage:

- the evolution of state-of-the-art engineering practices, mainly in relation to the considerable advances in the calculation power of computers;
- the update of the standards regulating that practice; in that regard, EDF has been relying mostly on IAEA's document entitled "Seismic Evaluation of Existing NPPs" (Safety Report 28, 2003), and
- the safety review of seismic hazards on sites, resulting from the enforcement of the new Basic Safety Rule on that issue (RFS); the most sensitive upward impact of the reappraisal occurred on the Bugey site.

Small-scale generic work was conducted, is under way or will be completed on all 900-MWe reactors. More significant activities are still pending on the Fessenheim site and especially on the Bugey site with a view to maintaining important margins in the protection against earthquakes.

EDF is pursuing its R&D efforts on seismic risks and has set up two specific areas, one to control uncertainties relating to the identification of seismic risks and the other to quantify design margins.

6.3.4 Environmental protection

The Ministerial Order of 31 December 1999 and modified later in January 2006 prescribes the general requirements to be met by BNIs concerning environmental protection. It completes the relevant texts for every installation in that regard, such as discharge -licensing orders or operating-licence orders for installations classified for environmental-protection purposes (ICPE) existing on the sites. Since the enforcement of the *TSN Act* and of the decree No 2007-1557 of 2 November 2007, release approvals now consist of the following:

- the creation authorisation decree of the BNI concerned (without time limitation);
- the ASN decision regulating discharges, and
- the ASN decision, endorsed by the ministers responsible for nuclear safety, regarding discharge limits in the environment.

More particularly, the Order of 31 December1999, besides providing general rules for preventing incidents and accidents (training of agents, security instructions, installation maintenance, etc.), prescribe specific objectives in certain areas, such as protection against fires, lightning, noise or accidental water pollution. Significant work has been achieved on installations and all NPPs had reached their required conformity level by 15 February 2006, in accordance with those texts.

From the more general standpoint of progress approaches regarding the environment, EDF has engaged into a spontaneous strategy to obtain Certification 14001 (ISO-14001) issued by the International Standard Organization (ISO). The EDF Group was given that certification in April 2002, and all units of the Nuclear Power Generation (– DPN) have been certified since 2004. On 10 July 2008, *Det Norske Veritas* (DNV), the competent certifying entity, renewed the DPN's ISO-14001 certification in the framework of the Group's certification.

6.3.5 Fire protection

With regard to nuclear safety, EDF considers fire as a significant risk likely to prevent the cooling of the nuclear fuel and to damage it.

In the context of the reflections conduced in 1992 on the evolution of fire protection for PWRs, EDF is involved in an overall safety review approach, which is reflected by the development of a new design and operation reference system, followed by the upgrading of reactors to that new system, in the framework of a fire action plan (PAI). The system relies primarily on the sectoring of premises. Its implementation was completed at the end of 2006 in all 900-MWe and 1,300-MWe reactors, bearing in mind that1,500-MWe reactors had already integrated the new reference system right from their initial construction.

In addition to this work, ASN also requested that, within the scope of the third decennial 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.

That revision led to the implementation of the following complementary measures:

- the internal assessment of the satisfactory nature of the fire-fighting organisation of every BNI and the formal stand of its director in order to ensure the existence of such organisation. Every BNI director shall inform ASN officially of that guarantee;
- the creation of fire scenarios with the support of departmental fire and emergency services (SDIS) and the integration of those scenarios in their Plan of Listed Establishments with a view to improving the intervention. Some major exercises, based on those scenarios, have taken place in 2010;
- the conduct of fire-risk studies on all structures containing toxic, radiological, flammable, corrosive and explosive products. Some of those studies have been furthered and some structures will undergo fire-protection improvements within regulatory delays, and
- the reinforcement of the co-operation between every site and its SDIS through the implementation of a partnership agreement focusing on intervention effectiveness, a sound knowledge of the installations by firemen, the implementation of joint exercises and the availability of a seconded professional fire-fighter officer (– OSPP) on every site.

6.3.6 Control of criticality risks

Experience feedback from the positioning of a vessel assembly at a non-conforming location with regard to the loading plan led to the specification of operating modes limiting the consequences of a potential error, such as reloading in "serpent mode"[4]. NPPs are now implementing additional control measures with a view to reducing such risks.

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.

The analysis of the recommendations formulated in 2007 by the World Association of Nuclear Operators (WANO) was followed by a review of reactivity-management practices and led to the development of a reactivity-management standard, which was made available to operators in 2010.

6.3.7 Safety of spent-fuel storage

The evolutions in operating practices tend to increase the residual power of the fuel that is likely to be stored in de-activation tanks and, consequently, to reduce the intervention lead times in case of total loss of coolant. That observation led EDF and ASN to question once again the safety of fuel storage in fuel buildings. The design-correction case covers the different issues associated with an incidental loss of coolant or of water inventory, and will allow the following:

- the unloading of fuel assemblies and transfer to the spent fuel cooling pool to be based on a limit of the spent fuel cooling pool water temperature, instead of the initial core residual power;
- the improvement of monitoring and detection means, and
- the implementation of water-make-up means to the pool against total and extended loss of the coolant system of the pools.

The execution of those modifications is under way on all 900-MWe reactors.

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 CEA in association with EDF, using the fast-neutron technology. It is sited at Marcoule (Gard). Its construction started in 1968 and it first became 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

[4] The "serpent mode" consists in a loading sequence of core assemblies through successive alternated diagonal lines.

- 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, IRSN, 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).

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.

After having been disconnected from the grid on 6 March 2009, the PHÉNIX reactor continued to remain in service for the purpose of an “ultimate-test” programme, which was instrumental in acquiring very valuable data on the operation of a fast-neutron reactor outside normal conditions. Control rods were last dropped on 1 February 2010, after which the unloading of 300 fuel assemblies was initiated. Decommissioning operations will last for a period of approximately 15 years.

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 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.

Information about the work undertaken at the 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.

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 Constitution. 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 operator for the safety of its installation, incorporated into international law, applicable on a day-to-day basis and essential to give each party, operator and regulatory authority, a clear awareness of its responsibilities.

7.1.2 Legal basis of ASN activities

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 decommissioning 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, in its fields of competences, 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 package or to use radioactive sources); it defines individual requirements. It carries out inspections and may take preventive measures or impose penalties, for example including suspension of the operation of an installation in the case of severe and imminent risks. It organises continuous monitoring for radiation protection (including monitoring of the environment and of workers' 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 information concerning nuclear safety and radiation protection held by public authorities already existed pursuant to the *Environment Code,* which goes even further by instituting for the public a right of access to safety-related information held by BNI operators, competent transport officers and holders of radioactive materials. That major innovation distinguishes between nuclear activities and other industrial activities that are not subject to such transparency obligation. ASN ensures that operators comply with such provisions.

In addition, the law provides for BNI operators to establish every year a public report describing the measures relating to nuclear safety and radiation protection, incidents and accidents reported to ASN, the nature and results of measurements of radioactive and non-radioactive discharges from the installation, the nature and quantity of radioactive waste being stored on site and the measurements taken, with a view to limiting their volume and their effects on human health and the environment.

By granting them a legal basis, the law reinforces the status of CLIS, which have been created over the years beside large nuclear installations in accordance with a circular issued in 1981 by the Prime Minister. It recognises officially the implication of territorial communities, notably that of general councils (elected assemblies heading 100 French departments), in their operation. It provides them with the possibility to constitute themselves into an association and perpetuates their funding. With its implementation Decree No. 2008-251 of 12 March 2008 on BNI-related CLIs, the law provides the legal basis to the National Association of Local Information Committees (ANCLI). ASN's regional offices provide support to the CLIs of their jurisdiction.

The law institutes the High Committee for Transparency and Information on Nuclear Security (HCTISN), which forms a forum and participates in public information at the national level. Its membership open and includes notably parliamentarians, representatives from CLIs, associations, labour unions, as well as qualified personalities. The Chairman of ASN is an *ex officio* member.

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

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 operator 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.).

Thirteen of the 15 implementation decrees of the *TSN Act* have already been published, while older texts have been abrogated correspondingly. The main implementation decrees include the following:

- Decree No. 2007-830 of 11 May 2007 concerning the nomenclature of BNIs;
- Decree No. 2007-831 of 11 May 2007 concerning the appointment and certification modalities for nuclear-safety inspectors;
- Decree No. 2007-1557 of 2 November 2007 concerning BNIs and the control, with regard to nuclear safety, of the transport of radioactive substances (on procedures), hereinafter called the “2007 Procedure Decree”;
- Decree No. 2007-1570 of 5 November 2007 concerning the protection of workers against ionising radiation and modifying the Labour Code;
- Decree No. 2007-1572 of 6 November 2007 concerning technical investigations on accidents or incidents involving a nuclear activity,
- Decree No. 2007-1582 of 7 November 2007 concerning the protection of individuals against the hazards of ionising radiation and modifying the *Public Health Code*,
- Decree No. 2008-251 of 12 March 2008 concerning BNI-related CLIs, and
- Decree No. 2010-277 of 16 March 2010 concerning the High Committee for transparency and information on nuclear security.

7.2 Regulations on basic nuclear installations

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. 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.

An operator 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.

The procedures are described in 2007 Procedure Decree concerning BNIs and the control, with regard to nuclear safety, of the transport of radioactive substances.

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 Pressurised equipment

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

The applicable regulations are detailed in the table below.

	Nuclear			**Conventional**
	Main primary system of pressurised water reactors	Main secondary systems of Pressurised water reactors	Other equipments	
Construction	• Decree of 2 April 1926 • Order of 26 February 1974*	• Decree of 2 April 1926 • RFS II.3.8 of 8 June 1990*	• Decree of 2 April 1926 • Decree of 18 January 1943 or • Decree 99-1046 of 13 December 1999	• Decree 99-1046 of 13 December 1999
	or Order of 12 December 2005			
Operation	• Order of 10 November 1999		• Decree of 2 April 1926 • Decree of 18 January 1943*	• Decree 99-1046 of 13 December 1999 • Order of 15 March 2000

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

With regard to all devices installed in an BNI, the Law of 28 October 1943 on pressure equipments [for nuclear and non-nuclear-purposes], as modified by Act No. 2009-526 of 12 May 2009 on legal simplification and clarification, and procedure alleviation provides that the enforcement control of that law and of its accruing regulations shall be ensured by the agents of the services placed under the authority of and designated by the Chairman of ASN.

7.2.2.1.2 Quality organisation

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

It thus stipulates that the operator 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.

The decree also prescribes that:

- detected discrepancies and incidents be corrected rigorously and that preventive actions be performed;
- appropriate documents provide proof of the results achieved, and

- the operator oversee his contractors and verify the sound operation of the adopted organisation in order to ensure quality.

Experience feedback on the events occurring in BNIs and inspection comments help ASN assess the enforcement of the "quality" Order.

The order is part of the texts to be recast, as listed in § 7.2.2.2.

7.2.2.1.3 Prevention of off-site detrimental effects and risks induced by BNI operation

The operation of BNIs may induce nuisances for the environment in the broadest sense of the term, which includes surrounding installations and their workers, the public and the environment outside the site. ASN's policy aims at preventing and limiting risks to the installations by enforcing the following:

- the Order of 31 December 1999, as modified by the Order of 3 January 2006, sets forth the overall technical regulations intended, except for water intakes and effluent discharges, to prevent and to limit external nuisances and risks resulting from the operation of BNI, and
- the ICPE legislation to all such installations located within the relevant BNI perimeter.

Over and above the general rules regarding incident and accident prevention (training of agents, security instructions, installation maintenance, etc.), the Order sets more particularly various objectives concerning fire protection, lightning, noise or risks of accidental pollution of the environment. It introduces the relevant principles relating to waste management, the prevention of accidental pollution, fire, lightning, criticality and radiolysis applicable to all nuclear equipment, including all devices located outside sensitive BNI sectors.

The Order is part of the texts to be recast, as listed in § 7.2.2.2.

7.2.2.2 Recast of the overall technical regulation

Following the adoption of the *TSN Act* and the 2007 Procedure Decree, ASN initiated the recasting of the above-mentioned orders in 2008 and the procedure will continue at least until mid-2011. Hence, the orders currently in force should be abrogated and superseded by a series of documents including an interministerial order and approximately 20 regulatory decisions by ASN forming a much more comprehensive and modernised regulatory mechanism.

7.2.2.2.1 The "BNI regime" order project

A so-called "BNI regime" Order will reiterate current basic provisions and integrate the reference levels from the association of responsible officers within WENRA. Once the required exchanges and consultations will be completed, the Order should be adopted at the end of 2010 or beginning of 2011.

7.2.2.2.2 Regulatory decisions

Pursuant to Article 4 of the *TSN Act*, ASN may clarify any existing decree or order relating to nuclear safety or radiation protection, subject to the endorsement of the Government.

ASN has adopted a regulatory decision programme with a view to clarifying the 2007 Procedure Decree and the new order described above; its enforcement will spread throughout 2010 and 2011 (refer to Appendix 2.1).

7.2.2.3 The texts produced by ASN

7.2.2.3.1 Technical regulatory decisions

As indicated above and pursuant to the *TSN Act*, ASN is taking decisions in order to complete the enforcement modalities of existing decrees and orders relating to nuclear safety and radiation protection, except in the case of those dealing with occupational medicine.

Decisions concerning nuclear safety and radiation protection are subject to the endorsement of the respective ministers in charge of each jurisdiction.

ASN's decisions are published in its official *Bulletin*, which appears on line on its Web site.

The first decision to be taken by ASN pursuant to the 2007 Procedure Decree was Decision No. 2008-DC-106 of 11 July 2008 concerning the implementation modalities for BNIs' internal authorisation systems (refer to § 7.3.2.2).

7.2.2.3.2 Basic safety rules and ASN guides

On various technical topics ranging from PWRs to other BNIs, ASN has developed various Basic Safety Rules (RFS) in the form of recommendations that detail safety objectives and describe practices that ASN considers as satisfactory to fulfil those objectives.

They do not consist in regulatory texts as such and it is not mandatory for operators to enforce them if the operator is in position to demonstrate that the alternative means the operator proposes to implement would also meet the required safety objectives.

In the framework of the current restructuring of the overall technical regulations, RFSs are modified in the form of ASN guides.

There are currently about 40 RFSs and other technical rules emanating from ASN and readily consultable on its Web site. Available RFSs and guides are listed in Appendix 2.2.

7.2.2.3.3 General policy notes

General-policy notes indicate ASN's major orientations in the fields of its regulatory actions: regulation, coercion and sanctions, monitoring, transparency, international relations, management of radiological emergencies, as well as dismantling and decommissioning of BNIs in France. Through those publications, ASN is promoting public awareness and understanding about the issue.

7.2.2.4 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 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 are members. The RCC (design and construction rules) codes were drafted for the design, manufacture and commissioning of electrical equipment (RCC-E), civil engineering structures (RCC-G) and mechanical equipment (RCC-M). 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 industrials 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.

7.3 Oversight of basic nuclear installations

Regulatory oversight of nuclear activities by ASN is a fundamental task. This supervision consists in verifying that all responsible for nuclear activity is assuming its responsibility fully and complying with the requirements of the regulations regarding nuclear safety and radiation protection. It helps in assessing performance of the operator and enables to appreciate the challenges associated with nuclear activities.

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 equipments specifically designed for these installations.

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

Oversight is part of a multi-level approach and is performed with IRSN's support, if required, as follows:

- prior to any activity subject to an authorisation to be conducted by an operator, a review and analysis of the files, documents and information provided by the operator in order to give action justification action. The purpose of that control is to ensure the relevant and sufficient nature of the submitted information, and
- during operation, through visits, inspections on all or part of the installation, document and field checks during interventions with major stakes, such as scheduled outages of nuclear reactors and the analysis of significant events. That control is based on samplings and the analysis of the justifications provided by the operator with regard to the activity performance.

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. Thus:

- 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 Appendix 5);
- 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 operators and installations. This also avoids any collusion with the operator;
- 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 operators, 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 sources, such as significant events, inspections or relations with the stakeholders (including personnel, operators, contractors, trade unions, occupational physicians, inspectorates, certified organisations…).

ASN aims to ensure that the principle of the operator'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.

7.3.1 Scope of regulatory oversight

7.3.1.1 Regulatory oversight of nuclear safety

Nuclear safety concerns all technical and organisational provisions taken at all stages of the life of nuclear installations (design, creation, 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. Moreover, technical measures to optimise management of radioactive waste and discharges are usually included in nuclear safety provisions.

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. ASN examines safety or monitoring measures, dose-limitation initiatives for interveners in installations and specific procedures for waste management, effluent-discharge monitoring or environmental monitoring.

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 operator 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 operators 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 equipments

A large number of nuclear installation systems contain or carry pressurised fluids and are consequently subjected to the pressure equipment 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 equipments. Responsibility for supervising the application of the regulations lies with ASN for nuclear pressure equipments in BNIs.

Of the BNI pressure equipments 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 equipments 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.

Labour inspectorate, with its three major purposes (control, information and advice), deals with working conditions and the protection of workers. Their legitimacy relies not only on international standards, notably Standard No. 81 from the International Labour Office (ILO), but also domestic documents regulating inspection services.

In NPPs, control actions regarding nuclear safety, radiation protection and labour inspectorate deal very often with common topics, such as worksite organisation or subcontracting conditions. Hence, the legislator has entrusted the attributions of labour inspectors to engineers or technicians appointed by the Chairman of ASN among its agents, who act under the authority of the Minister in charge of Labour.

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 operator 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 operator 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 operators, 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 Technique review of licensee files

Review of the supporting documents produced by the operators and technical meetings organised with BNI operators 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 operator are subject to ASN approval. In addition to meetings necessitated by changes in installations or their operating procedures, ASN requires the operators 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 operator'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 operator is to demonstrate that the objectives set by the general technical regulations or those set by the operator 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 operator 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

SCHEDULED NPP 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 operator. 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 OPERATORS

- The operator 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, etc.

7.3.2.2 Internal authorisations

Operators of nuclear installations are, in all cases, responsible for the safety of the activities they perform.

ASN considers that all BNI operations that involve the strongest challenges with regard to nuclear safety and radiation protection must be submitted to its prior authorisation. Inversely, it feels that operations with a limited stake should remain under the operator's responsibility.

In the case of intermediary operations which involve a major challenge concerning nuclear safety and radiation protection without questioning the adopted safety hypotheses with respect to BNI operation or decommissioning, the *TSN Act* allows the operator to authorise them, provided that the operator sets in place an internal reinforced and systematic control mechanism with the same sufficient quality, autonomy and transparency guarantees. The decision whether to conduct any operation or not must be formally authorised by operating agents that he has duly certified for that purpose. That system is called the "system of internal authorisations" and shall be duly presented at the CLI related to the BNI.

The system of internal authorisations is ruled by the 2007 Procedure Decree and by ASN's decision No. 2008-DC-106 of 11 July 2008, which prescribes the requirements imposed by ASN to all operators for the implementation of that system.

ASN obviously ensures a regular and careful oversight of the system right from its inception through site inspections or expert reviews of information files submitted by the operator. It maintains a disciplinary power and notably the freedom to suspend an operator's decision to apply the system of internal authorisations after defaulting his obligations.

In addition, any operation planned for "internal" authorisation shall be notified to ASN, with a view notably to plan potential inspections accordingly.

In fact, the system of internal authorisations helps ASN, and hence public authorities, in concentrating their review on truly challenging cases, while guaranteeing a rigorous handling of any type of modification. Furthermore, it emphasises actively the responsibilities of the operator in such choices and decisions.

All operations concerning the system of internal authorisations may, for instance, involve renovation work on the installations, lesser challenging decommissioning activities and safety reviews of experimental devices or experiments with prerequisite conditions.

Until now, EDF has only started that internal-authorisation approach in installations being dismantled. As for the CEA, it issues approximately 40 internal authorisations every year.

7.3.2.3 Use of experience feedback

A system has been enforced for BNI operators to declare anomalies pursuant to the Order of 10 August 1984 concerning the quality of BNI design, construction and operation, according to which the operator shall implement a reliable system to detect potential anomalies, such as equipment failures or application errors regard operating rules. That system should help in the early detection of any deviation from the normal operating mode.

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

- to ensure that any anomaly will not reoccur, by taking the relevant corrective actions;
- to prevent any aggravated situation to occur, by analysing the potential consequences of more severe precursor incidents, and
- to promote good practices in order to improve safety.

In order to provide an order of magnitude, EDF detects and analyses between 100 and 300 anomalies per reactor every year.

The purpose of ranking of anomalies is to ensure that the most significant ones are given priority. In that context, ASN has established a category of “significant events” for all BNIs. It consists of sufficiently important safety-related events in order to justify their prompt notification to ASN, followed later by a more thorough report. The purpose of that report is to describe the conclusions drawn by the operator after analysing the events and the measures the operator has taken in order to improve safety. That information is very valuable to ASN and its technical support body, IRSN, notably during the periodical safety reviews of the installations. Approximately 10 significant events are declared yearly for every EDF reactor.

ASN ensures that the operator conducts a proper analysis of the event and takes appropriate measures to correct the situation and prevent its reoccurrence, while disseminating the experience feedback among other nuclear operators.

On the basis of 20 years’ experience, ASN considered wise to transpose the concept from the safety field to those of radiation protection and environmental protection. For that purpose, ASN updated the safety principles adopted in the 1960s and extended them to radiation protection. The Guide, dated 21 October 2005, which may be consulted on ASN’s Web site, now groups the applicable requirements for BNI operators and transport companies regarding the declaration modalities in case of significant events relating to the safety of BNIs, the transport of radioactive materials, radiation protection and environmental protection.

The purpose of that declaration system is to enhance experience feedback. Declaring significant events should not be assimilated with radiological emergencies, for which a different structure is in place, or with a system intended to sanction any error committed by an operator or any other individual.

7.3.2.4 Inspection

7.3.2.4.1 Principles and objectives

In order to take into account health and environmental challenges, as well as operators’ performances in terms of nuclear safety and radiation protection, ASN identifies activities and topics with high stakes with a view to focusing its inspection efforts on them. The ASN Board specifies the control policy of the Authority and selects priority stakes every year.

In order to understand those stakes, ASN relies on the state-of-the-art scientific and technical knowledge, the information resulting for external controls, the review of cases submitted by operators and the results of its controls. ASN may at all times revise its views on those stakes in the light of the evolution of such elements and of significant events that occur in France and around the world.

Compliance with the safety reference system by the nuclear operators 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 operator 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 potential drift suggesting possible deterioration of installation safety.

During inspections, factual accounts are drawn and brought to the operator's attention concerning the following:

- anomalies within the installation or items requiring complementary justifications in the opinion of the inspectors, and
- discrepancies between the observed situation during the inspection and regulatory instruments or the documents established by the operator pursuant to regulations.

Every year, ASN establishes a provisional inspection programme, which is not communicated to the operators of nuclear installations. It specifies national priorities with a view to setting a reinforced control action on topics or activities with the highest stakes and local priorities for carrying out control activities in response to local concerns or objectives. It also allows for an appropriate distribution of ASN means commensurate with the objectives of the various installations.

Most inspections are announced to the operator a few weeks in advance, but about 20% of them are conducted unexpectedly. They are conducted mainly on the nuclear sites. They may also concern the corporate offices (or design offices) of the major nuclear operators, 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;
- 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 operator 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 reactor outages or particular works, especially in the dismantling phase.
- within 21 days of its completion, every inspection gives rise to a follow-up letter, which is made public on ASN's Web site.

7.3.2.4.2 Inspection activities in 2009

In 2009, 814 inspections were conducted on basic nuclear installations, of which more than 500 on power reactors (refer to § 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 offices. The regional offices are responsible for oversight in the field: in permanent contact with the nuclear operators, 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 offices in these areas, deal with matters of national importance, and define and implement national nuclear safety policy.

7.3.3.1 Nuclear safety inspection

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 2009, the number of active nuclear safety inspectors stood at 170, including 96 in the regional offices and 74 at central services.

Number of inspections conducted by ASN for BNI supervision

Year	Total	Unannounced inspections (all BNI)	Reactors (announced and unannounced)
2007	675	161	416
2008	796	188	494
2009	814	219	519

7.3.3.2 Regulatory oversight during PWR outages

EDF takes advantage of planned 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 equipments

The act of 13 June 2006 requires ASN to designate inspectors responsible for verifying compliance with the regulations concerning pressure equipments designed specifically for BNIs. Decree No. 2007-831 of 11 May 2007 describes the appointment and certification modalities for those inspectors.

ASN nuclear pressure equipment department (DEP) is responsible for checking the application of the nuclear pressure equipment 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 equipments is performed by organisations approved and monitored by ASN.

Oversight of the operation of nuclear pressure equipments is the responsibility of ASN's regional offices, with the support of DEP.

7.3.3.4 Significant events

In case of a nuclear or non-nuclear incident or accident that might have a significant impact on the safety of the installation or of a shipment, or cause actual or potential harm to human beings, property or the environment through a significant exposure to ionising radiation, the *TSN Ac*t provides that the operator of the BNI concerned or the competent officer for the shipment of radioactive materials involved shall report the incident or accident promptly to ASN and to the proper State representative in the relevant department where the event occurred, and if need be, to the relevant State representative at sea.

The ASN regional offices 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 offices 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 operator 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 body, IRSN, perform a deferred review of the experience feedback from the events involved. All information originating from ASN divisions and the analyses of the proceedings of significant events and of the periodical progress reports submitted by operators constitute ASN's structural basis for experience feedback. That feedback is taken into account during the periodical safety reviews of installations or on a regular basis during the multi-year analytical process of the entire nuclear fleet. It may be reflected in requests for improving the state of the installations and of the organisation selected by the operator.

7.3.3.5 Technical inquiries in case of incident or accident involving a nuclear activity

The *TSN Act* entrusts upon ASN the power to perform promptly a technical investigation in case of an incident or accident involving a nuclear activity. That investigation consists in collecting and analysing useful information, without prejudice to the judicial inquiry, in order to determine the circumstances and the actual causes of the event and, if need be, to formulate any relevant recommendation. It is carried out by an investigation team, which, apart from ASN agents, may include external members specifically designated for that purpose.

That measure covers both incidents and accidents occurring in BNIs and during the transport of radioactive substances, as well as those that may occur during activities involving an exposure risk to ionising radiation for human beings, notably in the case of medical activities

Since ASN was already investigating incident or accident in the past, in accordance with its oversight mandate, the major contribution of the *TSN Act* with that regard is to grant ASN the power to constitute an investigation team, to determine its membership, to specify its purpose and scope and to grant it access to all relevant elements in case of judicial inquiry.

7.3.4 Penalties

If any control action conducted by ASN reveals non-conformities with safety requirements, sanctions may be imposed on operators, if need be, provided they have received a formal notice. These sanctions may include, for instance, a ban on restarting the installation or a suspension of its operation until adequate corrective measures are taken.

In case of actual violation, the *TSN Act* also provides for various levels of the following administrative sanctions, as referred to in Articles 41 to 44, to be enforced after formal notice:

- the consignment to a public accountant of an amount corresponding to the cost of the work to be carried out;
- the automatic completion of the work at the operator's expense, with the possibility to use the previously-consigned amount for paying the work concerned, and
- a suspension of the operation of the installation or of current action until the operator has resolved his non-conformity .

The operator must also submit his comments to the ASN commission regarding those sanctions.

The law provides also for preventive measures to be taken for the protection of security, health and community sanitation or the protection of the environment. Hence, ASN is entitled:

- to suspend the operation of any BNI on a temporary basis, after prompt notification to the Ministers in charge of nuclear safety, in case of severe and imminent risks, and
- to prescribe at all times any relevant assessment and the implementation of any required measures if the interests mentioned above are threatened.

Actual violations are duly recorded in a minute drawn by the nuclear-safety inspectors and transferred to the public prosecutor, who then states on the soundness of further prosecutions.

In 2008 and 2009:

- ASN took six administrative measures (formal notices, prescriptions, suspension of operation, etc) against nuclear operators, and
- Simultaneously with those administrative actions, it also referred to the public prosecutor 11 minutes, which were drawn against BNI operators, including seven regarding labour inspectorate in NPPs.

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, the control of nuclear safety and radiation protection is the responsibility of three main stakeholders: Parliament, the government and ASN. Article 4 of the *2006 TSN Act* draws a list of the respective missions of the government and ASN.

8.1 The French Nuclear Safety Authority (ASN)

The *2006 TSN Act* created an independent administrative authority, known as the *Autorité de sûreté nucléaire* (ASN), with a view to controlling nuclear safety and radiation protection. It provides opinions to the government on general regulatory texts and major individual decisions. It drafts regulatory texts on the government's behalf and provides additional clarifications on regulatory issues by taking technical decisions. It issues all individual licences, except in the case of major BNI authorisations, such as creation and decommissioning, which are delivered directly by the government. Nuclear-safety and radiation-protection inspectors designated by ASN oversee and control nuclear activities. ASN participates also in the information of citizens. Lastly, it provides support to the management of radiological-emergency situations.

ASN relies on technical expertise work provided by IRSN 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 ASN decisions require approval by the ministers responsible for nuclear safety.

  ASN also issues the authorisations for small-scale nuclear facilities provided for by the Public Health Code and the authorisations or approvals for the transport of radioactive materials.

  ASN decisions and opinions are published in the *Journal officiel* (official gazette);
- 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-emergency situations. It provides technical support to competent authorities in order to develop, within the framework of the emergency organisation plans, appropriate measures with due account of the risks resulting from nuclear activities;
- In case of emergency situation, it assists the government on all relevant issues within its jurisdiction. It formulates its recommendations on the measures to be taken for medical, health or emergency-preparedness purposes; it informs the public about the situation in general, potential discharges in the environment and their consequences, and
- ASN partakes in public information about issues within the field of its jurisdiction; it prepares the simplest and most thorough information possible, which is accessible to the broadest public, and reports on its activities on a regular basis. For that purpose, it uses various channels, such as written supports (monthly "letter", *Contrôle* magazine, annual report), Web site (*www.asn.fr*), public information and documentation centre, press conferences, seminars and exhibits.

8.1.1 Organisation

8.1.1.1 ASN's Board of Administration

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. ASN Commissioners are appointed for a non-renewable term of six years and are irremovable except in case of inability or resignation as recorded by a majority vote of the Commission. The President of the French Republic may also terminate the term of any commissioner in case of severe dereliction of duty.

The Commission defines ASN's strategy. In that regard, it draws a multi-year strategic plan and develops general policies in the form of ASN doctrines and action plans for its essential missions, which include regulation, control, transparency, the management of emergency situations, international relations, etc.

Pursuant to the *2006 TSN Act*, the Commission provides ASN's opinions to the government and takes ASN's main decisions.

8.1.1.2 ASN's central services

Under the authority of the Chairman of ASN, the Director-General organises and manages ASN's central services and its 11 territorial delegations.

The central services includes eight departments (Nuclear Power Plants; Nuclear Pressure Equipment; Industrial Activities and Transport; Research Facilities and Waste; Ionising Radiation and Health; Environment and Emergency; International Relations, and Communication and Public Information), as well as the Office of Administration and a Management and Expertise Office. Their role is to manage the national issues regarding the nuclear activities, for which they are responsible. Not only do they participate in the implementation of general regulations, they also co-ordinate and serve as the driving force for the regional teams in charge of the *in-situ* control of installations and activities. Every ASN entity contributes to public information regarding nuclear safety and radiation protection.

8.1.1.3 ASN's regional offices

ASN's regional offices operate under the authority of the regional delegates who also serve as ASN's regional representatives. They conduct most of the direct oversight of nuclear installations, radioactive-material shipments and other local nuclear activities. They review most creation authorisation applications file submitted by operators within their geographical jurisdiction. In addition, they support ASN's central services in their review of major decisions. In emergency situations, they assist the departmental Prefect who is responsible for the protection of the population of the department. Lastly, they partake in the public-information mission entrusted by law upon ASN.

8.1.2 Operation of ASN

8.1.2.1 Human resources

On 31 December 2009, ASN's total effective included 443 employees, half of which were dedicated to the central services, while the other was disseminated among regional offices.

In December 2009, the average age of ASN agents was 43 years old. That balanced age pyramid and the diversification of profiles in terms of recruitment, and thus of background, ensures that ASN holds the required qualified and complementary human resources to fulfil its mission. In addition, training, integration modalities of the younger staff and the transmission of knowledge guarantee the required expert know-how.

Competency is one of ASN's four key values. Buddy-system arrangements, as well as initial and ongoing training, whether general or associated with nuclear techniques in the legal or communication field, constitute essential elements of ASN agents' professionalism. The management of its agents' skills is based notably on a formalised series of technical training sessions. In 2009, about 4,000 days of technical training were provided to ASN agents during more than 1,200 different training sessions. For ASN, the total direct financial cost of training sessions involving other organisations than ASN amounted to 405,000 €.

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 2010 is approximately €67 million.

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 €78 million in 2010.

8.1.2.3 Quality-management system

In order to ensure and to improve the quality and effectiveness of its action, ASN sets forth and implement a quality-management system derived from IAEA international standards and based on the following:

- a multi-year strategic plan (with the current one extending over the 2010-2012 period), together with shared operational objectives;

- an organisation manual grouping organisational notes and procedures providing internal rules for the sound conduct of each of missions;
- internal and external audits (refer to Appendix 5 on IRRS missions) concerning the implementation of the measures referred to ASN's management system by quality;
- performance indicators designed to measure the effectiveness of ASN's action;
- the listening to stakeholders (public, elected officials, associations, medias, labour unions, the industry), and
- annual reviews of the management system in a continuous effort to improve its operation.

8.1.3 ASN's technical support bodies

ASN benefits from the skills of a few technical supporting bodies in preparing its decisions, among which IRSN (*www.irsn.fr*) is the major one. In addition, ASN has been pursuing for several years a diversification effort among its experts.

8.1.3.1 French Institute for Radiation Protection and Nuclear Safety (IRSN)

IRSN was created by *Law No. 2001-398 of 9 May 2001* and by Decree No. 2002-254 of 22 February 2002 as an independent public establishment in the framework of the national reform of the control of nuclear safety and radiation protection with a view to federate public expert and research means in those fields.

IRSN leads and implements research programmes with a view to secure the national public expert capability on the most advanced scientific knowledge at the international level and to contribute to the development of scientific information concerning nuclear and radiological risks. It is responsible for a technical-support mission to competent public authorities in safety, radiation protection and security, not only in the civil sphere, but also for national-defence purposes. According to its constituting decree, it also ensures certain public-interest missions beyond the field of research, notably with respect to the monitoring of the environment and human beings exposed to ionising radiation.

Those missions include training in radiation protection, the management and processing of dosimetric data concerning workers exposed to ionising radiation, the management of the inventory of radioactive sources and the risks associated with ionising radiation.

In accordance with the ISO 9001 certification it received in 2007, IRSN develops its own quality policy based on a continuous-improvement approach in order to enhance the quality of its skills. In the framework of that approach, the opinion of ASN and of all organisations benefiting from IRSN's technical support is taken into account. In addition, periodical meetings allow for ASN and IRSN to exchanges ideas on all specialised projects, whether completed, ongoing or future.

The government consults ASN on the share of the State's study to IRSN regarding to its public-support mission to ASN. An agreement was signed between ASN and IRSN in order to set forth the intervention modalities of that technical support, which occupies about 400 people.

8.1.3.2 Advisory Committee groups

In preparing its decisions, ASN relies on the advisory committees' opinions and recommendations.

Seven advisory committees have been constituted to assist the Director-General of ASN. They are consulted on issues dealing with the nuclear safety and radiation protection of installations and activities relating to their field of competence, including nuclear reactors, laboratories and plants using radioactive materials, radiation protection in medical facilities, radiation protection in non-medical institutions, waste, transport and pressurised nuclear equipment.

For every topic under review, advisory committees study the reports prepared by IRSN, an *ad hoc* working group or one of ASN entities. They issue an opinion, together with recommendations.

The advisory committees gather experts that are appointed for their skills. They originate not only from the academic and associative worlds, but also from the circle of operators concerned by the topics being addressed. Every advisory committee may call upon any recognised expert for his own skills. It may also conduct a hearing of the operator's representatives. The involvement of foreign experts helps in diversifying the approach to problem-solving modes and in benefiting better from the acquired experience at the international scale.

With a constant concern to improve transparency of nuclear safety and radiation protection, ASN issues public documents relating to advisory committees meetings, especially its opinions along with ASN's position. ASN and IRSN managers follow up carefully the programming and results of advisory committees' work. Discussion and co-ordination meetings are organised three times a year for the ongoing improvement of the technical quality and consistency of advisory committee opinions, which remain key elements for ASN.

8.2 Parliament

Parliament intervenes in matters of nuclear safety and radiation protection, notably in voting laws. Hence, Parliament adopted two major acts in 2006 in the field of nuclear safety and radiation protection: the 2006 *TSN Act* and the 2006 Planning Act.

Similarly to other independent authorities and pursuant to the *2006 TSN Act*, ASN reports to Parliament on a regular basis about its activity. Every year, for instance, it tables before Parliament its report on the status of nuclear safety and radiation protection in France.

PARLIAMENTARY OFFICE FOR THE ASSESSMENT OF SCIENTIFIC AND TECHNOLOGICAL OPTIONS (OPECST)

Created in 1983, the Parliamentary Office for the Assessment of Scientific and Technological Options (OPECST) is a parliamentary delegation consisting of 18 members of the French National Assembly and Senate, whose mission is to inform Parliament on the consequences of scientific and technological choices with a view, notably, to enlighten its decisions. A Scientific Council, with a membership of 24 members that reflect the diversity of the scientific and technical disciplines involved, assists the OPECST.

In the field of nuclear safety, the OPECST has always been interested since its inception in the administrative organisation of nuclear safety and radiation protection, as well as in the measures taken by operators in that field, the structures adopted by foreign countries and the suitability of the means allocated to ASN to fulfil its control missions. Other studies dealt with radioactive-waste management, the operation duration of nuclear reactors or socio-political issues, such as the diffusion and perception conditions of information on nuclear energy.

OPECST reports are drafted before the voting of the law in order to prepare the legislative decision or after it for the follow-up to the enforcement of the adopted version. The first OPECST report, for instance, dealt with radioactive waste and was prepared by Mr. Christian Bataille, M.P. It was adopted in December 1990 and largely inspired by *Law No. 91-1381 of 30 December 1991 concerning research on radioactive waste management*, hereinafter referred to the "1991 *Law*". Similarly, the report prepared by Messrs. Christian Bataille and Claude Birraux entitled (Marking a milestone: a new law in 2006 for the sustainable management of radioactive waste),was adopted by the OPECST on 15 March 2005 and also inspired the 2006 Planning Act**.**

OPECST members have also played a significant role in the drafting of the 2006 *TSN Act*. More particularly, the rapporteurs of the draft law in the Senate, Senators Henri Revol and Bruno Sido, were also OPECST members. Other OPECST members, such as Messrs Christian Bataille, Claude Birraux, Jean Dionis du Séjour, Claude Gatignol and Jean-Yves Le Déaut, took an active part in the debate around the draft law at the French National Assembly and several of their amendment motions were adopted.

Once the OPECST recommendations were integrated in the *2006 TSN Act* and the *2006* Planning *Act*, the OPECST was strongly involved in the follow-up of the enforcement of both acts.

It is actually before the OPECST that ASN reports on its activities, especially by tabling its annual report.

8.3 Government

Pursuant to the *Constitution*, the government led by the Prime Minister, holds regulatory powers and is therefore in charge of taking general technical regulations relating to nuclear safety and radiation protection. The *2006 TSN Act* has also entrusted it with the responsibility to take the major decisions concerning BNIs. It must consult ASN on all decree and order drafts relating to nuclear security. It also benefits from several advisory bodies, such as the Consultative Committee on BNIs (CCBNI), the HCTISN and the High Council for Public Health (HCSP).

The government is responsible for emergency preparedness.

8.3.1 Ministers for Nuclear Safety and Minister for Radiation Protection

As prescribed by the *2006 TSN Act*, the ministers in charge of nuclear safety are currently the MEEDDM and the Minister of Economy, Industry and Employment (MINEFE). After receiving ASN's opinion or, as the case may be, upon its proposal, those ministers specify the general regulations applicable to BNIs and take a limited number of major individual decisions concerning the creation and shutdown of BNIs.

If, following an ASN opinion, an installation involves severe risks, the above-mentioned ministers may suspend its operation.

In addition, the Minister of Health, whose current name is the Minister of Health and Sports (MSS), is responsible for radiation protection. On the motion of ASN, as the case may be, he sets forth the general regulations concerning radiation protection.

Regulations concerning the radiological protection of workers are under the jurisdiction of the Ministry for Labour, Social Relations, Family and Solidarity (MTRSFS).

Lastly, the Ministers in charge of nuclear safety and the minister in charge of radiation protection jointly endorse ASN's by-laws and certain individual decisions like such as decisions prescribing BNI discharge limits.

Under the authority of the ministers in charge of nuclear safety and radiation protection and within the MEEDDM's Directorate of Risk Prevention (DGPR), the mission concerning nuclear safety and radiation protection (MSNR) is responsible, among other tasks, for proposing, in connection with ASN, the government's policy with regard to nuclear safety and radiation protection, except for activities and installations relating to national defence and to the radiation protection of workers against ionising radiation.

8.3.2 Prefects

Prefects are the official representatives of the State and, as such, are in charge of ensuring public order in the department placed under their jurisdiction. More particularly, they are responsible for emergency preparedness, preventive measures for the population and emergency measures in case of accident. Those measures are proposed by ASN within its own jurisdiction.

After collecting the opinions of his services and that of one or more investigating commissioners following a public inquiry, the Prefect also presents his report to ASN concerning the ministerial decisions it reviews and the decisions it takes regarding discharges.

8.3.3 Advisory authorities

8.3.3.1 Consultative Committee on Basic Nuclear Installations (CCBNI)

The CCBNI replaced the Interministerial Committee on BNIs in accordance with the 2007 Procedure Decree. The ministers in charge of nuclear safety must consult the CCBNI concerning applications involving the creation authorisation, modification or permanent shutdown of BNIs, as well as the general regulations applicable to such installations.

The government is considering suppressing the CCBNI in 2010 and transferring its competencies to a new Consultative Committee responsible for installations classified for environmental-protection purposes, ICPE Committee.

8.3.3.2 High Council for Public Health (HCSP)

The HCSP partakes in prescribing multi-year objectives on public-health matters, assesses the annual performance of national objectives pertaining to public health and contributes to their yearly follow-up. In conjunction with health agencies, it provides public authorities the necessary skills for managing health risks, as well for designing and assessing policies and strategies relating to prevention and health security. It also provides prospective reflections and advice on issues relating to public health.

8.3.3.3 High Council for Transparency and Information on Nuclear Safety (HCTISN)

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 operators 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: Responsibilities of *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 operator. This principle of prime responsibility of the operator for safety is defined by the legal framework described in section 7.1 and summarised below.

The principle of prime responsibility of the operator is laid down in the Act of 13 June 2006. Article 28 of the act stipulates that “the operator 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 operator 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 operator 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 operator are as follows:

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

C. GENERAL CONSIDERATIONS ON SAFETY

10. Article 10 Priority given 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 ASN requests

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

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

10.2 Measures taken for nuclear-power reactors

The responsibility of any nuclear operator within the EDF Group SA lies at four major managerial levels: the President and Chief Executive Officer, the Senior Executive Vice-President for the Generation and Engineering (DPI) Group, the Director of the Nuclear Generation Division (DPN), who is the officer responsible for the operation of all French NPPs, and every NPP manager (CNPE) (see EDF's organisation chart in Appendix 3). In the case of a specific BNI in dismantling on an isolated site, the function of representative of the nuclear operator, EDF SA, is taken over by the Director of the Nuclear Engineering Division who reports to the Senior Executive Vice-President for DPI.

In its capacity as a leading producer of electricity generated by nuclear energy, EDF SA's primary responsibility is to serve as a model for transparency and nuclear safety. Hence, it considers both conditions as vital for the social acceptance of nuclear energy.

The priority given to safety within EDF relies on the following:

- a corporate policy, described in a document, last issued in 2009, which places safety and radiation protection at the very heart of the company's concerns and priorities, and
- a safety management system during operation, whose general principles were set forth in 1997 and completed in 2005 and 2007, as described in §12.2.

The ambition is for the safety-management system, which constitutes the backbone of the overall management system, to deliver exemplary performance in order to drive excellence in all areas, including competitiveness.

The guiding principles of the safety-management system aim at:

- fulfilling strictly all safety requirements and associated prescriptions, as described in part at corporate level and applicable to all sites. They provide a permanent reference framework, which contains strategic requirements and orientations, as well as prescriptions and a formalised structure for leveraging expertise across the nuclear fleet, which includes four categories of products: management, policy, operation and procedures;
- ensuring clear responsibilities with regard to nuclear safety;
- adapting skills and taking into account organisational and human factors as early as the design stage and throughout operation;
- ensuring that all stakeholders are accountable for and committed to their responsibilities, based on the recognition that human beings form an essential link, especially in the safety chain, and a fundamental vector in the general advancement of society. In addition, the accountability of every stakeholder implies the right of expression, the ability to criticise, a recognition system and hence,

the implementation of favourable conditions for the development of the right to inform[5] and the duty to report[6];

- stating ambitions and a constant vision as recognised, shared and supported by management, even at the field level, which, beyond the prescriptions, reflect the corporate determination to advance and to further performances in the field of safety;
- analysing the decision-making processes with the help of Safety, Radiation Protection, Availability and Environment Observatory (OSRDE), in place on all sites;
- analysing organisational changes or projects likely to have a major impact according to the arguments advocated in a publication entitled *Making Change in the Nuclear Industry: The Effects on Safety* published by the International Nuclear Safety Group (INSAG); that approach was developed by EDF in 2006 (refer to §12.2);
- developing different monitoring and verification systems both in real time and in differed time, which would be designed not only to measure the effectiveness of the safety management system and to correct potential discrepancies or drifts, but also to enhance the quality of operation;
- at implementing a large "human-performance" project, as described in §12.2.

In order to develop those principles, the following modalities are currently in place:

- At the corporate level: For all entities
  - the subsidiarity principle[7] shall guide the decision-making process at all management levels,
  - a rationale involving prior reflection, stakeholder involvement and a consensus are sought rather than the mere enforcement of centralised decisions,
  - a short management line with supporting functions is set in place, and
  - a collegial management structure of the Board is set in place for every entity in order to foster the debate on the decisions to be taken and to ensure their quality and their enforcement by the different stakeholders. The manager of the entity shall hold the ultimate decision-making power for any of the choices he makes on behalf of his entity.
- At the corporate level, the DPN's internal audit is structured as follows:
  - DPN managers and every NPP establish an annual performance contract (CAP) setting forth the objectives and performance goals, as well as associated orientations and improvement means);
  - the CAP presents the NPP input in order to achieve overall performances, notably in the three key fields, which include nuclear safety/radiation protection, competitiveness (availability, costs) and human-resource management. It constitutes a significant support for the contractual relation between the unit and DPN managers and for the associated control. The CAP is subject to exchanges and controls;
  - in 2008, the DPN prescribed an internal-audit policy with a view to ensuring that the overall risks to which the division is exposed are well under control. The policy recalls that every level in the management line (division, unit, service) is responsible for controlling and supervising its own activities. In order to enforce it, an audit manual, which is updated on a yearly basis, describes in detail the main points on which control must focus in relation to identified risks;

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[5] **Right to inform**: all stakeholders shall adopt a questioning attitude in the performance of their activity and alert management if an order or a instruction were to impede the quality of the activity.

[6] **Duty to report**: any stakeholder who considers that the significance of any event with regard to safety is more serious than the assessment made by his direct line manager shall notify the relevant person who in charge of safety within EDF (including the Head of the Safety Quality Mission of the NPP, the DPN's Deputy Director for Nuclear Safety, the DPI's Delegate for Nuclear Affairs and EDF's Inspector-General for Nuclear Safety.

[7] **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 that is likely to provide genuine added value.

- on a yearly basis, every NPP manager assesses the safety status of his site, based on a safety report derived from an analysis of results and of experience feedback regarding safety; the report serves as a basis for discussions with the DPN Director;
- the DPN Director pays regular assessment visits to nuclear sites, and
- safety indicators, such as the general conformity of specifications for operating and maintenance activities, alignment, the reduction in the number of solicitations upon the automatic shutdown protection system and starting fires are analysed on a periodical basis.

▪ A monitoring and verification system is in place within every entity. The oversight must be implemented first by the relevant operational line in accordance with the above-mentioned policy. In addition, verification actions are ensured by independent bodies. In the field of safety, safety-quality mission (MSQ) at NPPs, DPN's Nuclear Inspectorate, the DPI's Delegate for Nuclear Affairs and the General Inspectorate for Nuclear Safety (*IGSN*) constitute those independent entities on behalf of the site manager, the DPN Director, the DPI Director and the President and Chief Executive Officer of the EDF Group, respectively. Safety comparisons and analyses are carried out on a regular basis at those different levels under the chairmanship of the responsible manager of the relevant entity, such as the on-site technical group on safety, the Nuclear Safety Committee on Installations in Service within the DPN and the Nuclear Safety Council at the level of the President of the Group. Various progress reports are prepared, including a safety analysis of every NPP, the DPI's radiation protection report and the *IGSN Annual Report* to EDF's President and Chief Executive Officer.

▪ With regard more specifically to the DPN, at the national scale, all corporate units are audited at different levels, as follows:

- by the "performance-support-and-assessment mission" (MAAP): a DPI auditing entity carries out the following activities on a periodical basis:
  - audits dealing with the implementation of an internal-audit policy within units, and
  - assessments of units' heritage according to their technical, organisational and human scopes;
- by the Nuclear Inspectorate, a DPN audit entity performs triennial assessments that consist of a conformity audit with a corporate reference system relating to safety, radiation protection and the environment and are subject to an cross-comparison between sites;
- by the IAEA: missions of its Operational Safety Review Team (OSART) with a specific preparatory nuclear-inspection audit are conducted 18 months to two years beforehand (one annual OSART mission for the DPN), and
- by WANO: peer reviews are organ used with every unit being reviewed every six years in combination with an Nuclear Inspectorate-audit.

With regard to the divisions involved with nuclear fuel and nuclear engineering, the MAAP carries out internal audits of the units to the same extent as for DPN units. In addition, similar entities to the DPN nuclear inspectorate verify the conformity of the major activities conducted by those divisions in the field of safety and radiation protection.

10.3 Measures taken for research reactors

10.3.1 CEA 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.

The CEA's 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 Chairman has implemented measures intended to ensure the CEA's nuclear safety. The Chairman is supported by the Department of Nuclear Protection and Safety as regards nuclear safety, radiation protection, transport and quality. This Department is part of the Risk Management division and define the CEA's safety policy, which is based on continuous improvement.

The Director of Nuclear Energy Department (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 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.

At the level of the Chairman, the supervision task falls under the responsibility of the General and Nuclear Inspectorate (IGN) of the CEA's Risk Control Sector. The IGN performs planned inspections (amounting to about 10 every year) and reactive inspections after significant events. The Director of IGN may decide upon the Inspectorate's intervention on relevant topics.

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, civil engineering, criticality and human factors.

10.3.2 ILL's High-flux reactor (HFR)

Nuclear safety has always been and remains the priority at ILL, where the safety level to be achieved relies on the following organisation:

- a Radiation Protection Unit reporting directly to the ILL Director, and
- a Reactor Division, whose Head, by delegation of the Director, ensures the operation and safety of the reactor and of its annexes, as well as the quality assurance of that operation.

Among the overall activities, some of them, as mentioned on a specific list, are qualified as "quality-monitored" (AQS) and are submitted to a special procedure. By principle, AQSs are subject to a dual control, in accordance with the 1984 Quality Order, which includes the following:

- a first-level control: consisting essentially of a technical check in order to ensure that the AQS's objective is reached: it is normally carried out within the functional group in charge of conducting the ASS; and
- a second-level control is performed by the Reactor Division and includes complementary checks, with potential random samplings, if need be, that deal with the AQS's dual technical and

managerial aspects. The quality-assurance service of the Reactor Division conducts those external controls. The Service was instituted by the Quality-Assurance and Co-ordination Office (BCAQ), which in turn, is supervised by the Quality-assurance Officer.

10.4 ASN analysis

The analysis conducted by ASN concerning the consistency of the structure set in place by operators with the priority to be given to safety is presented in accordance with the various articles of the *Convention* in all following chapters and, especially, chapters 12 and 13.

11. Article 11: Financial and human resources

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.

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 ASN 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 operator". 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 of these persons is based in particular on their training and their experience."

11.2 Resources assigned to the safety of nuclear power reactors

11.2.1 EDF's financial resources

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

In 2009, the Group posted consolidated revenues of 66,336 million euros, a net income, Group share, of 3,905 million euros and a gross operating surplus of 17,466 million euros. The Group's cash flow stood at 12,133 million euros in 2009.

The Group's cash flow is used notably to finance investments. In 2009, for example, 2.2 billion euros were invested in the operation of the nuclear-power fleet, including 0.75 billion euros for the construction of the Flamanville EPR.

In 2009, the net generation of electricity in France amounted to 518.8 TWh, all generators being taken into account.

With regard to EDF, the results of the overall power-generation fleet over the last three years may be summarised as follows:

Existing plants (2009)	**2007 generation (*in TWh*)**	**2008 generation (*in TWh)***	**2009 generation (*in TWh)***
Nuclear energy (63,139 MWe)	418	417.6	389.8
Hydraulic resources (20,066 MWe)	41.2	44.8	35.1
Thermal resources (13,407 MWe)	18.2	15.8	16
Total	477.5	478.3	440.9

Furthermore, in order to secure the funding required for its long-term nuclear commitments, EDF has, in previous years, set in place a portfolio of assets assigned exclusively to covering provisions associated with the deconstruction of NPPs and the back-end of the nuclear fuel cycle. In accordance with a decision of the EDF's Board of Administration in June 1999, dedicated assets were progressively constituted by EDF starting in fiscal year 2000 through yearly allocations. On 31 December 2009, they represented a market value of 11,436 million euros.

EDF believes that the overall data presented above show that it possesses the required financial resources to meet the safety needs of every nuclear installation throughout its service lifetime.

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

- the continuation of the decennial-outage programme, for which safety-related expenditures account for about 40% of total investments (all decennial outages being taken into account), with the first occurrence in 2009 of decennial outages for 900-MWe reactors;
- the pursuit of the steam-generator replacement programme in 900-MWe reactors;
- the implementation and development of large projects, such as the control of fire hazards, major heat waves, floods, containment envelopes and re-racking;
- the pursuit of the project to achieve "exemplary installations", and
- the commitment, as early as 2009, for studies intended to help EDF meet its objective to extend considerably the service lifetime over and beyond 40 years by leaving open the hypothesis of prolonging it up to 60 years for all reactors.

It is in line with such orientation that the "safety-60-year service" project was committed and the first actions launched as follows:

- a preparatory phase to the third decennial outage for 1,300-MWe reactors and, notably, of the associated safety review; and
- studies on the control over time and in the framework of a step-by-step approach distributed over the third and fourth decennial outages for 1,300-MWe reactors, ageing consequences and obsolescence: development of the "exceptional maintenance" programme on components, such as 1,300-MWe NPP series steam generators, alternators, condensers, transformers, turbine wheels rotors and cooling towers.

11.2.2 EDF's human resources

At EDF, approximately 19,200 people are working for the DPN, which is in charge of operating nuclear reactors at EDF. Those employees are distributed among three groups: operating staff (about 3%), supervisory staff (about 67%) and management (about 30%).

In addition to those 19,200 members of staff who are all directly involved in the operation of EDF's fleet of 58 existing nuclear reactors, EDF also devotes human resources to the development, operation and deconstruction of nuclear reactors, as follows:

- about 4,000 engineers and technicians at the Nuclear Engineering Division (DIN) distributed among management (74%) and supervisory groups (26%);
- close to 170 engineers and technicians at the Nuclear Fuel Division (DCN), and
- more than 600 engineers and technicians at the EDF Research and Development (EDF R-D).

Specific human resources are devoted to nuclear safety and radiation protection, and EDF has designed its organisation for a large majority of employees to devote a significant fraction of their time and activities to both issues. The *corporate* total employee involvement policy (refer to §10.2) and the development of a safety culture within teams (see chapter 12) mean that nuclear safety and radiation protection form an integral part not only of intervention planning, execution, inspection and verification, but also of engineering activities for operational-support purposes.

More than 400 members of staff work exclusively in the field of nuclear safety (safety engineers at NPPs, safety specialists and experts in corporate departments, in engineering groups and audit bodies).

About 800 employees are also involved in industrial security and radiation protection.

Since 2006, EDF has been implementing an in-depth programme designed to secure skills and career paths in order to start preparing for the process of generational handover and succession planning of nuclear-power projects and activities.

Thanks to an initiative launched in 2005 on the basis of uniform principles applicable to all NPPs and prepared through multiple iterations with a detailed focus on field realities, it has been possible to secure sufficient development potential to ensure the renewal of skills. Those programmes are specifically tracked, co-ordinated and audited. Since it is updated every year, it is possible to secure the volume of number of required incubators for renewing skills. At the end of 2009, the DPN's incubator for technical skills amounted to 1,500 people.

Similarly, with regard to engineering, the DIN has been leading an approach based on a Development Plan for Key Nuclear-Engineering Skills (PDCC), which gathers unit representatives from the DIN, R&D and other DPI divisions. The purpose of that approach is to ensure a sound development of skills in the engineering trade and to nurture the reflections of units, through a transverse and prospective insight, on potential choices regarding provisional management of jobs and competencies.

More particularly, the safety and radiation-protection issues are covered by the development plan regarding "operation", which includes a staff of approximately 620 engineers and regulates the main field of activity (doctrine, accident methods and studies, probabilistic studies, severe accidents, appropriate conduct in case of incident and accident, system design, general operating rules, fire, tests, radiation protection, etc.).

Newcomers to the DNI are integrated within a five-week training programme on the common know-how of engineers concerning "studies" (operation, culture and quality culture, security and radiation protection, etc.).

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 PHÉNIX Reactor

To meet the safety needs, the PHÉNIX operator is given a Safety and Quality Mission, and has 6 engineers working on safety and 1 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 Marcoule site, the DSQS, and the Department of Nuclear Protection and Safety (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 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 operator’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 Department of Nuclear Protection and Safety.

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 High-flux reactor (RHF)

In order to meet safety needs, the ILL’s staff has been including since 2008 a second safety engineer who reports directly to the Head of the Reactor Division, as well.

In order to monitor the installation and to ensure the radiation protection of the staff, the Radiation Protection Unit includes nine employees supervised by a radiation-protection engineer.

11.4 ASN analysis

11.4.1 Safety and competitiveness for nuclear 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 generation 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 operator 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.

In order to improve safety management, the "observatory for safety, radiation protection, availability and the environment (OSRDE), which was instituted by EDF about 10 years ago, analyses how safety is taken into account during the decision-making process against other imperatives, such as the availability of installations, radiation protection or environmental protection. ASN considers that such a device constitutes a vital tool for the review and continuous improvement of decision-making processes. Similarly to previous years, however, ASN has noted that such tool is still practically unused or unevenly used in NPPs. ASN also feels that the participation of trade representatives associated with other imperatives than safety, especially radiation protection and environmental protection, is significant in order for the decision being adopted to be analysed in relation with the various imperatives.

In addition, EDF's safety-management review within a competitiveness context, which was presented at the meeting of the advisory committee for reactors of April 2008, has shown that the OSRDE is currently examining only if the process that led to the decision is consistent with the quality criteria, notably the solicitation of suitable supports, the taking of the decision at the relevant level, without questioning the relevancy of the decision itself, hence limiting the analytical capability of the mechanism. In order for the OSRDE to prove a good means to progress effectively throughout the decision-making process, that mechanism must also address the relevancy of the decision being taken, notably through the review of the elements having lead to the decision, such as information, the context, stakeholders, competencies and mobilised supports. Following that review, ASN requested EDF not only to improve the OSRDE mechanism, but also to make better use of it in order to ensure an effective organisational experience feedback.

Every year, EDF submits to ASN an annual report, including financial data on the following topics:

- operation:
  - purchases and services, and
  - salaries and wages;
- maintenance;
- R&D, and
- Reactor-shutdown programmes.

The operator is sometimes rather reticent to reveal his financial data, but ASN's control is not intrusive on those topics. On the contrary, it concentrates rather its attention on EDF's analysis of strategies to improve generation and reduce operating costs. That analysis, which highlights the relevancy and impact of the data as well as the safety strategy on its reactors, is added to the annual report of EDF.

EDF also includes in this report certain evolution tendencies as safety indicators over the last 10 years, such as the evolution of individual and collective doses received by workers.

However, ASN has not recruited yet a financial analyst to review those data. ASN and IRSN teams hire experts on organisational and human factors who refine the point of view of EDF engineers on corporate activities.

ASN's position on EDF's arbitration concerning safety and competitiveness is also based on various other tools of equal importance, such as inspections, the opinion of the advisory committee for the reactors, controls of maintenance operations and the operator's yearly assessment on that particular topic (as published in ASN's *Annual Report*).

The existence of a clear correlation between cost-efficiency, as stimulated by competition in electricity supply, and nuclear safety constitutes an interesting, but complex subject, which requires in-depth analyses.

If the association between economic problems and faulty safety is confirmed (see NUREG-6735 and INSAG 18), that does not necessarily imply that better cost-efficiency induces a higher safety level. It only means that certain solutions designed to improve a bad economic situation may have favourable consequences for safety. Inversely, cost reduction does not lead systematically to degraded safety. However, studies show that, in certain cases, harsher competitiveness may induce a larger pressure on the upstream people who have to carry out their tasks and may also lead to a more complex environment, with due account of the additional constraints to be incorporated.

Pressure and complexity levels must be taken into consideration, because they may jeopardize the lines of defence and induce negative consequences for safety.

Lastly, ASN is developing exchanges with its foreign counterparts with a view to progressing towards the harmonisation of safety requirements in the context of the globalisation of operators and the setup of a competitive electricity market. The work carried out within WENRA or in the framework of the MDEP initiative, in which ASN is participating actively, supports those activities.

ASN's analysis of the qualification and skills of NPP operating staff is presented in §12.4.1.

11.4.2 Safety and budget constraints for research reactors

Research installations are often operated by large public research organisations. Hence, their resources remain sensitive to the context of the State Budget. If the funding source, represented by the State, provides certain guarantees, it also leads sometimes to arbitrations that may compromise the future of certain research installations. Since safety reviews often entail large-scale renovations and retrofits to current safety requirements, those renovations and retrofits prove difficult. ASN ensures that budgetary constraints have no impact on the safety and radiation protection for the operation of research installations. In 2006, for instance, it requested the CEA, the major operator of research installations to implement an approach designed to follow up efficiently all major projects through an effective and transparent leading tool for ASN, especially for the decision-making process. Hence, that tool must ensure a better control of complex programmes with major challenges regarding nuclear safety and radiation protection, as well as protect those projects in limited number for any potential budgetary hazards. Such tool will help, for example, in preventing situations, such as those that ASN noted recently concerning delays in the decommissioning of the RAPSODIE and PHÉNIX reactors due to budgetary reasons, in spite of a completely opposite strategy that was presented a few years before. On a more general basis, it will need to prevent arbitrations that are likely to break the balance between safety and other issues, especially financial ones. By relying on anticipation, it would also be possible to prevent arbitrations, such as those likely to appear with the supply-shortage risk regarding medical radioisotopes, between nuclear safety and public safety, all of which ASN feels must be avoided (refer to §3.2.10).

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 ASN regulatory requests

The contribution of human beings and organisations to the control and safety of BNIs prevails not only within installations in service, but also in their design, construction and decommissioning. Ensuring that such contribution always leads towards safety improvement is all the more important since safety is always faced with other considerations, such as those relating to competitiveness.

For ASN, the overall elements of the work situation and of the organisation, which influence the effective activity of the workers within an installation, such as an NPP, constitute what is commonly called “organisational and human factors”. Those elements concern more particularly all aspects regarding the organisation of stakeholders’ work (staff, skills, motivation, etc.), technical mechanisms and work environment.

Irrespective of the prescriptive level of the activities to be carried out, the actual field situations encountered by those people vary constantly (erratic equipment, night activity, inexperienced colleague, more or less emergency, social tensions, etc.). This leads them to adapt their working habits (work procedures) in order to meet the set objective at an acceptable cost to them (fatigue, stress, health, etc).

It is the operator’s responsibility to ensure that the required means are available in sufficient number for the staff to adapt their own work procedures to variations in working situations. Workers must be able to perform their tasks efficiently with regard to safety, security, effectiveness and quality at an acceptable cost for health, while providing benefits, such as the satisfaction from work well done, peer recognition, development of new skills, etc.

Inappropriate means may lead to hazardous situations, for instance in the case of inadequate tools, exiguous or ill-lighted premises, insufficient training or practice, faulty design of man-machine interfaces, shortage of spare parts, destabilised professional collectives (operating team, maintenance) by organisational changes, insufficient staff or lack of allocated time to perform tasks. Hence, an operational context where performance is good, but was obtained at a very high human cost for operators, remains a source of risk since any slight variation in the context or any change of operator is sufficient to compromise performance.

ASN expects the operator to determine an explicit policy for taking into account organisational and human factors, to ensure that adapted means and resources exist to act efficiently and to implement actions that are not only consistent with relevant approaches, but also led and followed up in accordance with a continuous-improvement perspective.

ASN’s supervision with regard to organisational and human factors relies particularly on inspecting nuclear installations. The purpose of such inspections is to review the operator’s organisational policy regarding organisational and human factors, notably in terms of specific skills, the actions undertaken to improve the integration of such factors within his operation and to assess their implementation and their results on site. ASN relies also on the assessments made by IRSN and the advisory committee for reactors at ASN’s request.

ASN feels that the operator must also implement systematically an integration approach for organisational and human factors in engineering activities during the design of a new installation or the modification of an existing one.

The control of BNIs’ safety rests also on the capability of the operator’s management system to ensure that appropriate skills and sufficient resources are available at all times throughout the lifetime of the installation. Article 7 of the 1984 Quality Order provides notably that “only people with the required skills may be assigned to a quality-related activity”.

The certification issued by the operator guarantees the capability of the individual involved to carry out specific activities. ASN considers that such certification must rely on the justification of skills that have been acquired through training and professional experience, and put to use during the actual work itself.

The 1984 Quality Order also applies to all stages of the operating cycle of BNIs, including the design and construction phases. It covers organisation, skills and training sessions, contractor monitoring, documentation, the control and oversight of major safety-related activities, as well as experience feedback during the construction phase of a new installation. The technical guidelines for the design and construction of the next generation of PWRs, which were approved by ASN in 2004, include requirements concerning man-machine interfaces and human factors. ASN refers also to certain standards relating ergonomics, such as ISO-9241, ISO-11064, ISO-13407 and ISO 16982 Standards, IAEA guides and NRC reports, such as NUREG-0711 and NUREG-0700.

Lastly, the demonstration that the operator has to provide with regard to nuclear safety and radiation protection must rely on human beings and organisations to the same extent as the technical systems of the installation. ASN feels that the incorporation of organisational and human factors into an integrated risk-control approach ought to be a priority for all stakeholders within the nuclear industry.

12.2 Human-factor provisions for nuclear power reactors

For several years now, the performance improvement in NPPs, associated with a requirement for the full control of safety and of operational quality has led EDF to commit itself strongly to the management of safety and to integrate the human factor in the design and operation of its installations.

DPN management policy

One of the major objectives associated with the company's challenges is to consider quality as the driving force for success in order to reach excellent results within a context of continuous progress.

That objective reflects the conviction that the largest progress margins lie at the level of the working teams through the implementation of safety-oriented actions, the improvement of operational safety and of human achievements by mobilising site managers and involving the staff. The deployment of management through quality, which is directly associated with DPN's orientations, is a means of responding to that objective. Those values were reflected in eight managerial principles based on the basic principles of the European Formation for Quality Management.

The following changes, which are formulated as such in the management policy, are currently being deployed:

- skills being managed to ensure their renewal and their evolution over time;
- a reinforced management, which trains the team on the basis of hands-on experience with result objectives and quality requirements integrating effective methods and practices;
- a staff implication in progress actions and in the successful results of the team;
- a consolidated guidance of the results at all levels from managers to the work teams;
- a dynamic leadership of activities integrating an effective management of processes and projects, and
- "win-win" partnership relationships with contractors, relying on a mutual commitment for improving performance.

In the framework of the 2004 "Safety Management Guide", which constitutes a reference document intended for leader teams in order to orient their strategic actions in the field, various projects and mechanisms have been implemented over the last three years to reinforce even further the practices of all employees around the four key principles of DPN's safety management as follows:

- guidance through results, facts, processes and continuous improvement;
- leadership and constancy in vision;
- staff implication and development, and

- recognition and listening of the independent safety group.

Since 2006, a major lever, constituted by the “human performance project” was introduced for agents, managers and contractors.

The purpose of that project is to achieve a significant reduction in the number of events induced by human behaviour during the phase when activities are carried out.

Its implementation involves three different aspects, as follows:

- the “reliable-made” aspect aims at ensuring that any professional employee “succeeds the first time” by providing him with six recognised and proven reliable-made practices: pre-job briefing, shutdown minute, self-monitoring, cross-control, secured communication and debriefing;
- the “field-presence” aspect aims at positioning the manager beside his field teams in order notably to create the proper conditions for allowing such teams to intervene correctly, and
- since 2009, the aspect dealing with the “use of field visits” aims at achieving a significant and perennial reduction in the number of malfunctions and a sustainable implementation of good practices over time by establishing in every unit a structure responsible for the leadership and periodical performance of observations made during field visits.

Those aspects are deployed as follows:

- all interveners and managers (EDF and contractors) are trained in reliable-made practices (14,000 EDF agents and 17,000 contractors). the gradual implementation of training worksites at NPPs has already started to reinforce the skills of the groups involved;
- 750 referral agents have been disseminated among the units with a view to promoting the use of those practices among their colleagues, as a support to managers, and to advise them in that implementation;
- all six practices are applicable upon the first intervention at the installation;
- in 2008, the deployment helped in reducing by 35% the number of significant safety-related events that may be avoided by implementing reliable-made practices. That improvement was confirmed in 2009, but at a lesser level of 5%;
- at the end of 2009, the total number of formalised field visits in NPPs exceeded 50,000, compared to 40,000 in 2008. All sites have now reached the minimum level expected for the number of visits per manager, but the overall processing of observations remains to be industrialised, and
- the management-implementation doctrine for the processing of observations was established in co-operation with all units.

The socio-organisational and human approach to be adopted by every agent in charge of research and design was developed extensively.

Initially centred on cases involving technical changes and the documentation, the socio-organisational and human approach is now implemented for large changes brought to projects and at the initiative of the units themselves on their local changes. With due account of potential safety consequences, an INSAG-18-type reflection is systematically applied for all projects involving large changes.

The annual safety analysis (AAS), which constitutes a crucial step in the diagnosis and improvement actions over the short and medium terms of DPN units (NPP and engineering) is reinforced by the implementation of an internal approach of the unit aiming at ensuring sound working conditions between all trades involved and the independent safety group.

In order to support the development of those different projects and mechanisms, training is used as an appropriation vector by every stakeholder: training of agents and contractors in human performance within an apprentice-workshop; training of managers, project heads and designers to the socio-organisational and human approach, AAS training for unit directors.

12.3 Human-factor provisions for research reactors

12.3.1 CEA reactors

Events and incidents are analysed in order to identify the main causes of failures and to determine appropriate corrective actions in order to improve safety.

The recognition of the significance of human factors in events and incidents justifies the CEA's specific approach to manage those areas and the implementation of a dedicated structure.

That formalised structure includes the following:

- specialists in the safety-support units of CEA centres;
- relays in, notably for every research reactor, and
- correspondents in control cells placed close to every centre manager.

Actions have been undertaken in several areas, including:

- the conduct of studies on organisational and human factors (FOH) in several installations, following the appearance of identified problems or incidents, and
- the execution of systematic interventions relating to organisational and human factors within research reactors during safety reviews, and dealing more specifically with the operational phases, as well as activities relating to the handling of nuclear fuel and experimental devices.

Targeted training sessions have been set in place on the integration of organisational and human factors in hazardous activities and involve a combination of didactical courses and hands-on exercises.

12.3.2 High-flux reactor (HFR)

The measures taken by the HFR with regard to organisation and human factors follow essentially those of the CEA. Both institutions maintain regular exchanges in that field.

12.4 ASN analysis

12.4.1 Organisational and human factors in power-reactor operation

ASN feels that EDF's structure to deal effectively with nuclear-safety and radiation-protection issues must be applied with more rigour in NPPs. In general, ASN has noted on a regular basis significant discrepancies in the on-site application of the prescribed structures at the corporate level, notably in the case of maintenance or in the monitoring of contractors.

Sites set for themselves specific improvement objectives in the different areas of nuclear safety, radiation protection, environmental protection and work safety. However, in the field of safety, those objectives must be identified more realistically. In the field of radiation protection, the purpose of the dynamics involved in radiological cleanliness is for sites to implement an approach aiming at "evolving towards access in plain working gear " (EVEREST) and establishing more ambitious goals on that topic.

Current roles and responsibilities within services are described in organisational notes, but are sometimes difficult to apply when conducting the actual activities themselves.

Compared to previous years, ASN did not perceive any evolution in the preparation of the activities, which is considered too frequently to be insufficient. In general, the management lines are more present in the field, but the control to be applied during activities is sometimes wanting.

ASN considers that the management system for the skills and certification of NPP operating staff is enforced satisfactorily, while the implementation of apprentice workshops and trade academies for newly-hired employees constitute positive items to be emphasised. However, ASN feels that the training of interveners, and notably of contractors, ought to be enhanced in the field of radiation protection and the environment.

Management is still reticent at carrying out the necessary observations of field activities in order to assess the skills demonstrated by agents.

The overall effective is well sized. However, ASN has noted once again excessive workloads in certain cases. The monitoring of contractors' activities remains an activity for which staff members are sometimes too small in number.

ASN believes that operational and maintenance activities are not always carried out under satisfactory conditions. In the field of maintenance, the use of physical means, such as scaffoldings and protective tools or equipment in bad order raises concerns, while the lack or mismanagement of spare parts should be pointed out. The availability of NPP equipment at the contractors' disposal is considered as very unsatisfactory.

ASN also noted many ergonomic defects regarding documents, equipment, materiel and workplace layout.

In general, the analyses of significant events fail to show their actual causes associated with the ergonomics of the working place or do not draw sufficient consequences in terms of corrective actions.

Furthermore, ASN also noted that the preparation, execution or monitoring of activities is sometimes impeded by rather unfavourable conditions, especially during reactor outages.

Lastly, ASN took note that a large number of national projects and action plans are added to local action plans. Those projects and action plans all correspond to significant improvement objectives and are developed carefully by distinctive EDF entities both at the national and local levels. However, it is often the same people who, in the field, are concerned by the implementation of such objectives. Irrespective of the additional burden involved, EDF should pay greater attention to the consequences of interactions between those projects.

12.4.2 Organisation and human factors in research-reactor operation

The structure set in place by the CEA over several years contributes to a better legibility of the responsibilities and missions of the units, notably with regard to continuity in the action line, independence of the control function and identification of an installation-assistance function.

Since 2006, the CEA has adopted a safety policy, which is applied through a triennial plan. Thanks to that approach, contracts have been signed with a view to formalising specific nuclear-safety and radiation-protection objectives, together with the associated means, within units and at various levels in the management line. Hence, the CEA has committed itself within a self-assessment approach through a certain number of follow-up indicators for safety and the sound operation of the structure.

With regard more particularly to the integration of human factors, the CEA created a pole of excellence whose effects are felt in both central services and operational units. It also extends its support and assistance missions to operational units and contributes in the development of internal directives. If ASN feels that such initiative is satisfactory, it also considers that the actions being undertaken must be enhanced further and better structured with a view to constituting a true strategy to integrate organisational and human factors in the safety policy.

Nevertheless, ASN observed with satisfaction that organisational and human factors were taken into account within the design process of the RJH.

At ASN's request, the CEA submitted in 2009 a corporate report on the management of nuclear safety and radiation protection at the CEA. The report is currently being reviewed by the advisory Committees. That review includes the management of skills, the role of the different stakeholders at the CEA and especially the powers and the independence of General and Nuclear Inspectorate, as well as the management of nuclear safety and radiation protection. All aspects relating to the management of safety in the services being performed will be reviewed more thoroughly.

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 ASN requests

As mentioned in chapter 7 (refer to § 7.2.2.1.2), the quality 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 operator 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 operator 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 nuclear-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

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 highlights 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 the 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 the activities assigned to contractors in order to ensure the quality of work. Such monitoring does not relieve contractors of their contractual responsibilities, notably for the application of quality requirements and the achievement of relevant results. Contracts between the prime client and his contractors specify every party’s responsibility, together with applicable requirements and commitments with regard to quality and results.

An improvement programme has also been initiated in order to enhance the quality of partnership with contractors especially with a view to:

- contributing to the development and upgrading of the skills of paid contractors;

- reinforcing the quality of interventions (grading of companies, redefinition of monitoring, etc.);
- instituting innovating contracts with more weight being given to the lowest responsible bidder, and
- ensuring easier conditions for field interventions.

13.2.5 Guaranteeing quality at EDF through 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 operators. 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 quality-assurance policy and programme

The CEA places great emphasis on quality, because it enhances the reliability and safety of the installations.

The DEN has implemented quality processes to rationalise the management of all its activities and to enable an overall continuous improvement, while enhancing both customer satisfaction and the internal operation of the installation.

The quality-management system is prescribed by every operating entity. Within the CEA, the safety of research reactors is entrusted to the DEN.

The DEN was granted the ISO-9001 certification in 2005 for its overall activities and has implemented an integrated management system involving quality, health/security/safety and environment (QHE).

The DEN's Quality Security Environment Manual (MQSE) outlines both the structures of the CEA and of the DEN in various fields, such as, QHE, as well as the process implemented throughout the DEN and the specific measures relating to the *ISO 9001 Standard*.

That documented system relies on the following principles:

- the Director of DEN formulates the general policy and associated objectives;
- every process leader translates that policy into quantifiable objectives;
- an annual review per process, supported especially by the specific presence of operating departments, provides an opportunity to analyse the data relating to every process, and
- an annual review by management provides an opportunity to analyse the operation of processes and the QHE system of the DEN.

It also relies on the QHE management systems in use in operating departments.

Over and beyond quality, the DEN's policy aims at developing a corporate culture based on security, safety and the environment.

At every management level, "process" officers interpret the CEA's policy and ensure consultations, leadership and guidance for its implementation within the unit. Exchanges are organised between those officers in order to relay and disseminate the acquired experience.

Regular audits are conducted in units or at their contractors on a regular basis by internal or external auditors, who are qualified for such units, in order:

- to measure the advances achieved and to set forth new progress orientations, and
- to assess the capability of suppliers and contractors to meet the CEA's quality requirements.

The DEN enforces the 1984 Quality Order in the operation of its experimental reactors.

In addition, the Cadarache, Marcoule and Saclay sites have been granted the ISO-14001 certification.

13.3.2 The ILL quality-assurance policy and programme for the 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 operator 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 ASN analysis

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 in the operation of nuclear power reactors

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 in the use of contractors

A large part of NPP maintenance work is subcontracted by EDF to outside firms, which include about 20,000 contractors and subcontractors.

The implemented of that industrial policy is the choice of the operator. The ASN's task is to ensure, pursuant to the 1984 Quality Order, that EDF fulfils its responsibility for the safety of its installations by setting up a quality approach, including the supervision of the conditions of all subcontracted work. That approach is formalised in the "Charter for Progress and Sustainable Development", which EDF has signed with its major contractors.

13.4.1.2.1 Contractor selection and monitoring

EDF has set up a contractor-qualification system based on an assessment of their technical know-how and their quality organisation. In addition, it must also supervise or have supervised the work performed by its contractors and use the resulting experience feedback to assess on a continuous basis their capability to maintain their qualification.

ASN conducts NPP inspections on the implementation of and compliance with EDF's reference system concerning contractor supervision. In the framework of the construction supervision of the Flamanville-3 reactor, ASN also proceeds with such inspections on that topic within the different engineering services in charge of design studies.

With regard to maintenance operations, ASN noted that some of them, whether they were performed by EDF or its contractors, may have been marred with quality inadequacies that EDF must endeavour to prevent in the future. Improvements in the quality of interventions depend also on a better understanding of organisational and human factors at the preparation stage of such interventions.

Most maintenance activities on sites are entrusted to contractors, which are selected according to a qualification and assessment system. ASN considers that the principle of such system is satisfactory, but that it is also necessary for EDF to assess its industrial policy concerning maintenance and the use of contractors to deal with it. In fact, ASN feels that EDF has stopped progressing in the supervision of contractors. More particularly, ASN notes a deterioration of on-site supervision of the activities conducted by contractors and feels that the situation must be improved and reinforced promptly. Accordingly, EDF must verify the relevancy of its monitoring resources in terms of both quantity and quality, with regard to subcontracted activities and with due account of the challenges of such activities regarding nuclear safety, radiation protection and environmental protection.

As in previous years, ASN observes that physical resources are sometimes insufficient or ill-adapted, and may have led in certain cases to degraded working conditions for interveners with regard to nuclear safety and radiation protection.

13.4.1.2.2 Radiation protection and working conditions

With regard to the dosimetric results of the overall nuclear fleet, while they had decreased these last years, doses rose again due to various technical and organisational contingencies. Although dose results remain satisfactory, ASN considers that vigilance must be maintained for optimisation purposes during reactor outages and for managing of contamination at the source.

The action plans, which EDF has developed and implemented at the national level in order to improve radiation protection, are consistent with the diagnosis of the situation. At the local level, those action plans are implemented methodically and prove successful, especially with regard to X-ray shots.

In 2009, ASN has conducted specific inspections on contamination control at the Golfech, Civaux and Cattenom sites, which has used the EVEREST approach. Inspections revealed a few discrepancies that need to be taken into account before generalising the use of such approach.

ASN recognised some problems in the application of a shared radiation-protection approach among all stakeholders on one site and noted the lack of improvement in the behaviour of interveners, a situation that might have led to incidents.

Consequently, ASN feels that such action plans must be pursued and even reinforced, even more so when they concern skill enhancement, especially in the case of contractors in charge of radiation-protection missions or of field controls. The “radiation-protection culture” of interveners must be furthered even more and efforts must focus on the description of their specific responsibilities with regard to radiation protection. Lastly, progress margins remain with a view to controlling contamination at source, in the quality and integration of risk and optimisation analyses, and in the supervision of the enforcement of radiation-protection rules on worksites, notably for the relevant signage of the different areas and hot spots.

13.4.2 Quality-assurance aspects in the operation of research reactors

All requirements relating to the quality of the design, construction and operation prescribed in the 1984 Quality Order apply without restriction to all research reactors.

Unlike nuclear power reactors, the maintenance of research reactors relies generally far less on outside contractors, except for exceptional maintenance, renovation or modification operations.

In that context, ASN checks, notably through inspections, the operator’s enforcement of quality-assurance principles during reactor operation and maintenance. Over the last few years, ASN has observed an improvement in the contractual formalisation of safety requirements with outside contractors.

ASN pays particular attention to the operator’s monitoring and supervision of the activities conducted by common technical services of any CEA centre in order for that supervision to be as rigorous as for outside contractors. ASN notes that such control is submitted to a formal internal contract between units, thus contributing to the improved visibility in the sharing of responsibilities and to the clarification of each party’s tasks.

Together with renovation activities, exceptional maintenance operations are subject to a specific supervision by ASN, which adapts its inspection programme in order to ensure the performance quality of such operations.

In addition, the structure set in place within the CEA centres, as referred to in §12.4.2 has contributed to the reinforcement of operational quality in research reactors. In fact, the centres were equipped with structured management systems and the different stakeholders made noticeable appropriation efforts in that field. However, ASN considers that such efforts must be pursued especially with regard to the sharing of experience feedback and the effectiveness of its integration. The action of the safety cells, which are in charge of carrying out the second level controls on behalf of centre managers, was reinforced with a view to improving the detection of weak points and selecting the proper objectives to correct them. Co-ordination between the different lines of action, support and control, whether at the local or at the national level, must continue to progress even further in order to make those actions even more consistent and effective.

14. Article 14: Safety assessment and verification

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 ASN requests

14.1.1 Initial request concerning nuclear reactors

When a site is being considered by a potential operator for the construction of a new nuclear power reactor, ASN analyses its characteristics with respect to safety. When such project concerns the construction of a new type of reactor, ASN calls upon the advisory committee for reactors to review the project and informs the potential operator about the elements to be covered in the licence application. In that context, the advisory committee for reactors has held about 40 meetings with regard to the EPR since 1993.

The creation authorisation application is submitted by the industrialist intending to operate a BNI, thus granting him the status of operator once it is submitted to the Ministers in charge of nuclear safety. The application must be accompanied by several documents, including the detailed plan of the installation, the environmental impact study, the preliminary safety report, the risk-control study and the decommissioning plan.

With regard to the orientations of the preliminary safety report, the report for Flamanville-3, for instance, reflects the specific characteristics of the site (weather conditions, hydrogeology, population density around the NPP, seismicity, etc.). In France, ASN does not certify any type of specific reactor that may be operated on different NPP sites. Every individual project must be assessed by ASN before any creation authorisation decree may be signed by the Prime Minister. A public version of the preliminary safety report of the Flamanville-3 EPR is available in French on EDF's Internet site (*http://www.edf.fr/html/epr/rps/index.pdf*).

ASN carries out the review of the licence application in conjunction with the Ministers in charge of nuclear safety, starting with a concurrent period of consultations with the public and technical experts. The impact study is submitted to the opinion of the environmental authority within the MEEDDM's General Council for the Environment and Sustainable Development (CGEDD). The successive reviews by the advisory committee for reactors of the documentation submitted by the operator are carried out on the basis of the analytical reports developed by IRSN. Relying on the conclusions of the advisory committee for reactors, ASN provides its opinion to the Government concerning the possibility of granting the requested licences. The creation authorisation of all BNIs is issued by a decree signed by the Prime Minister and countersigned by the Ministers in charge of nuclear safety.

In preparation for commissioning, the operator submits to ASN a case, including the safety report, the general operating rules, a study on waste management, the on-site emergency plan and the

decommissioning plan. After checking that the installation complies with the objectives and rules prescribed by the 2006 *TSN Act* and the accruing texts for its application, ASN may authorise the commissioning of the installation. The content of the different requested reports is prescribed by the 2007 Procedure Order, which may be consulted on the following Web site:
(*http://www.legifrance.gouv.fr/affichTexte.do?cidTexte=JORFTEXT000000469544*).

A draft regulatory decision detailing the content of safety reports is in preparation.

14.1.2 Continuous monitoring of reactors

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 operators and ASN. In addition, frequent contact, at least by telephone, is maintained between the operator 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 decennial outages

14.1.3.1 General principles

Article 29 of the *2006 TSN Act* requires every operator to proceed periodically with a safety review of his installation. Such periodic safety review are due every 10 years.

The safety review provides an opportunity to carry out an in-depth review of the installation in order to verify that it complies with all safety prescriptions and is consistent with the applicable safety reference system. Its purpose is also to improve the safety level within the installation, especially by comparing the relevant applicable requirements with those for more recent installations. Once completed, the safety reviews followed by a report, pursuant to Article 29 of the 2006 *TSN Act*. After assessing the report, ASN may impose additional technical prescriptions, but, in any case, shall send its analysis to the Ministers in charge of nuclear safety.

As such, safety reviews constitute one of the cornerstones of safety in France by requiring the operator not only to maintain, but also to improve, the safety level of his installation.

14.1.3.2 Specificity of power-reactor safety review

The safety review process is divided into several successive steps, as follows:

- a conformity review consisting of a comparison of the state of the installation with the relevant safety reference system and applicable regulations, including notably its creation authorisation decree and the overall set of ASN prescriptions. Its purpose is to ensure that any evolution in the installation and in its operation, due to modifications or ageing, are consistent with the overall set of applicable regulations and do not undermine the soundness of its safety reference system. The decennial conformity review does not relieve the operator from his constant obligation to guarantee the conformity of his installation, and
- a safety review of the installation with a view to recording and improving its status, by comparing it with:
  - French regulations, and with the most recent safety objectives and practices in France and abroad;
  - the experience feedback from the installation;
  - the experience feedback from other nuclear installations in France and abroad, and
  - the lessons learnt from other hazardous installations or equipment.

After prior consultation with the advisory committee for reactors, if need be, ASN may formulate its opinion on the topics to be investigated by the operator before launching the studies for the safety review, during the so-called “orientation phase of the safety review”.

Once both steps are completed, the operator submits a safety review report to ASN, in accordance with Article 24 of the 2007 Procedure Decree, as modified. The report shall include the following items:

- the operating context of the installation for the upcoming decade;
- the ranking of the topics being addressed during the safety review, together with an analysis justifying that choice;
- the summary of the conformity review presenting the conclusions of that review and identifying all recorded discrepancies, together with a justification of the corresponding measures having been taken to correct them;
- a summary of the safety review presenting the selected methods and its conclusions, together with intended improvements, if need be, and a justification of their interest (potential changes and corresponding work schedule), and
- the justification of the capability of the installation to remain in operation until the next safety review under satisfactory safety conditions.

In his safety review report, the operator takes a formal stand on the regulatory compliance of his installation and on the advantage whether to implement or not the changes under study to improve the safety of the installation.

14.1.3.3 Decennial outages of nuclear power reactors

Decennial outages provide a unique opportunity to proceed with the modifications prescribed by the safety review. In order to schedule decennial outages, EDF must take into account the deadlines for conducting the regulatory hydraulic tests for nuclear pressurised equipment and the frequency of safety reviews referred to in the 2006 *TSN Act*.

The Order of 10 November 1999 requires that every main primary circuit and every main secondary circuit of PWRs be subject every 10 years to a requalification procedure, including a thorough inspection as well a hydraulic test. The thorough inspection aims at verifying the state of the installation over and above the periodical controls being conducted during outages for reloading purposes, and by extending controls to areas, which are not inspected on a regular basis. It is also during such outages that the reactor vessel and its welds are checked, especially within the most irradiated zone located in front of the reactor core.

The hydraulic test for the main primary circuit, which consists in submitting that circuit to a pressure 1.2 times the design pressure, constitutes an overall pressure-resistance test. It does not take into account all load types with which the system in service is confronted, but it does allow for severe defects to be detected in unsuspected areas. That was the case in 1991, when cracks were found in the reactor vessel-head adapters and in 1989 cracks were detected in the pressuriser nozzles of 1,300-MWe reactors.

14.1.3.4 Safety review of research reactors

Most CEA reactors were commissioned between the early 1960s and the early 1980s. The equipment of such installations, with an older design, is ageing. They have also undergone modifications throughout their operation, sometimes without any overall safety review. In fact, ASN considers that it is necessary to proceed periodically not only with an overall compliance review of the equipment in relation to their design and specification requirements, but also with a safety review of the installation in light of the best current practices and requirements. Certain rejuvenating or mitigating measures are sometimes needed to extend the operation of installations over the medium and long terms.

Except in case of a special measure for a given installation, the law provides for safety reviews to be held every 10 years. Hence, recent safety reviews were conducted at the CEA for the CABRI and MASURCA reactors on the Cadarache site. The review of the safety reviews for the ORPHÉE, ÉOLE and MINERVE reactors is under way.

14.1.4 Application of probabilistic risk-assessment methods

With regard to the regulatory requirements concerning probabilistic safety analyses (PSAs), the 2007 Procedure Decree provides that the licence for any new installation depends on two prerequisite conditions, as follows:

- the preliminary safety report must describe the proposed provisions for preventing accidents or limiting the probability of their effects, and
- the risk-prevention study must justify that, with due account of current knowledge, practices and the vulnerability of the installation's environment, the project is able to achieve a risk level as low as reasonably possible under economically acceptable conditions.

In addition, the "technical directives for the design and construction of the next generation of PWRs" require a probabilistic safety analyses to be carried out as early as the design phase. The process was enforced for the EPR Project.

EPSs are developed and performed in accordance with Basic Safety Rule (RFS) 2002-01 on the development and utilisation of probabilistic safety analyses (the RFS is available in English on ASN's Web site (http://www.french-nuclear-safety.fr/index.php/English-version/References). The Rule covers the following aspects:

- the French doctrine about PSAs;
- the scope of PSAs;
- the acceptable methods for performing Level-1 PSAs concerning internal aggressions, and
- the acceptable applications for PSAs.

Pursuant to that RFS, the expected acceptable applications concern safety reviews, the probabilistic analysis of events, projects for new installations, the determination of the significance of safety systems and the technical operating specifications.

In the case of existing reactors, the practice consists in performing a PSA for every series of similar reactors and to update it upon every safety review. ASN has requested EDF to develop each probabilistic safety analysis in accordance with that RFS.

14.2 Safety assessments and verification for nuclear power reactors

14.2.1 EDF's initial review

The safety 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.).

Any creation authorisation application submitted by EDF to public authorities is sent with various documents including an environmental impact study and a hazard study. The preliminary safety report describes the measures adopted to ensure safety in the plant design and construction. In preparation for the commissioning of any installation, EDF presents to ASN, six months before start-up tests begin, a series of documents, which includes notably the preliminary safety report. Those documents contain all necessary details on the actual construction of the installation and on the conditions for its start-up, as well as the general operating rules and the on-site emergency plan. In accordance with regulatory requirements, EDF performs a comprehensive inspection of the installation every 10 years, including especially a control of the reactor's pressure vessel, a full requalification of the main primary circuit and a containment pressure test.

14.2.2 EDF's safety review

The first safety review was launched in 1988 for the first 900-MWe PWRs on the Fessenheim and Le Bugey sites, with a view, among other purposes, to assess those installations by comparing them with subsequent installations of the same 900-MWe series (known as the "CP1-CP2, or CPY series") in order to ensure a uniform overall safety level for all 900-MWe reactors.

The safety review was then initiated for the CPY series in the framework of the activities for the second decennial outage and ended after the restart of the "lead series" reactor, with the approval of the updated safety report. The last of the second outages for 900-MWe units is scheduled at Chinon-B4 in 2010.

The safety review associated with the third decennial outage for the CP0 and CPY series was undertaken as soon as the safety review for the second decennial outage was completed and its content was assessed by the advisory committee for reactors in 2004 and 2005. The closing safety review meeting took place in November 2008. During the third decennial outage for 900-MWe units, the first was performed at Tricastin-1 in 2009 and at Fessenheim-1 in late 2009 and early 2010.

In the case of the 1,300-MWe series, the content of the safety review following the second decennial outage was assessed by the advisory committee for reactors in 2002 and 2003. The closing safety review meeting was held in December 2005. During the second decennial outage for 1,300-MWe units, the first took place at Paluel-2 in 2005 and the last is scheduled at Golfech-2 in 2014.

The safety reviews of the N4 series started with Chooz-B2 in 2009 and will end with the first decennial outage of Civaux-2, which is scheduled in 2012.

Safety reviews are conducted in accordance with the procedure described in §14.1.3.2.

It should be noted that, in accordance with the 2006 *TSN Act* and the 2007 Procedure Decree, EDF must submit for each BNI a specific report containing the conclusions of the relevant safety review.

Concluding reports of safety reviews for the third decennial outage of the Tricastin-1 and Fessenheim-1 reactors and for the first decennial outage of the Chooz-B2 reactor will be transmitted to the Ministers in charge of nuclear safety and to ASN in the course of 2010.

14.2.2.1 Description of the safety reference system

As an example, the reference system for the safety requirements of the 1,300-MWe technical series before the second decennial outage corresponds to the 1998 edition of the safety report and to the edition of the safety report for the second decennial outage after safety review. Similarly, for the 900-MWe technical series, the reference system for the safety requirements before the third decennial visit corresponds to the safety report of the second decennial visit and to the edition of the safety report for the third decennial outage after safety review.

14.2.2.2 EDF's compliance review

Plant compliance with safety requirements is key challenge for responsibility performance of the nuclear operator 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 operator (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.).

In the framework 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 reactors, in addition to pre-existing monitoring measures. For the second decennial 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 (for example: classification of safety-related equipment, qualification for accident conditions, extreme cold weather conditions, seismic resistance, flooding risk, risk of high-energy pipe break, etc.). That programme, in certain areas, enables the establishment of a baseline for the state of the installations (for example civil engineering structures). Implementation of that programme enables identification of deviations, whose treatment is tailored to their safety significance, assessment of the compliance of the reactors, and contribution to the emergence of useful lessons for improving control of installation compliance, with a view to ensuring their durability.

For the safety review associated with the second decennial outage for 900-MWe reactors, the corresponding checks were performed between 1997 and 2000 on the basis of the initial experience feedback from the "lead series" sites. In the case of 1,300-MWe reactors, checks were carried out between 1999 and 2003.

Similarly, the preparations for the third decennial outage for 900-MWe reactors and the first decennial outage for the N4 series led to delineate the scope and procedures of the compliance review programme for reactors. Any non-compliance identified during that review shall be resolved no later than the end of the decennial outage of the reactors involved.

The "additional investigation programme" (PIC) comprises non-destructive examinations (NDE) that are spread over several reactors and carried out during decennial outages, with a view to confirming the validity of hypotheses (degradation modes) on which rely the basic preventive-maintenance programmes. The PIC is implemented at the very beginning of every decennial outage.

14.3 Safety assessments and verifications for research reactors

14.3.1 CEA reactors

14.3.1.1 The PHÉNIX Reactor

Between 2006 and 2010, about 60 files were submitted to ASN, either to respond to its requests (inspections, safety reassessment , etc.) or to apply for specific authorisations (introduction of irradiation experiments, and more rarely for temporary modifications to the general operating rules, etc.).

The first-level control is performed within the NPP. In addition, the control for the second-level control is conducted by the safety service of the Marcoule site, which checks compliance with the safety requirements reference system.

In order to supply ASN with 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 by the Safety service at the Marcoule site, which checks compliance with the safety requirements reference system.

Planned reactor shutdowns were closely overseen by ASN. Before every outage, the operator submitted to ASN a thorough description of the various worksites. Throughout the outage, technical meetings were held between the operator, ASN and IRSN. Lastly, an assessment report was prepared and sent to ASN concerning the lessons learnt during the outage.

The ultimate tests are addressed in §6.4.1.

14.3.1.2 Other CEA reactors

The advisory committee for reactors met several times in 2008 and 2009 in order to review the preliminary safety report of the modified CABRI (research reactor) installation at Cadarache.

That review addressed two issues: first, the design and execution measures being implemented for the installation of the new pressurised-water test loop within the reactor core and, second, the activities carried out in the framework of the safety reassessment of the installation.

Concerning the latter, ASN examined more particularly the following items:

- the project to reinforce BNI buildings in order to ensure their satisfactory behaviour in case of earthquakes;
- the approach implemented to establish inspection programmes for safety-related equipment and its application to the core-cooling system;
- the ventilation system of the reactor building, which has been fully redesigned;
- the selected measures against internal aggressions and notably of uncontrolled reactivity injections during fast power transient tests, and
- the selected measures to ensure the safety of installation shutdown, as well as to ensure the cooling of the core in the event of an earthquake.

14.3.2 The High-flux reactor (RHF) of ILL

After the advisory committee for reactor meeting in 2002, the Refit Management Committee was set up for high-flux reactor (RHF). This Committee 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.

Between 2009 and 2011, the RHF is reinforcing its defence in depth by adding two new protective circuits in order to prevent and to limit the consequences of any core-fusion accident, as follows:

- the ultimate reflooding circuit ensures the control of the water inventory for core-cooling purposes, and
- the seismic deflation circuit ensures the absence of any direct leakage, and consequently of any unfiltered discharge.

14.4 ASN analysis

14.4.1 Safety review of nuclear power reactors

With regard to nuclear power reactors for which the major part of safety review is conducted simultaneously on all reactors of a given series, several important milestones have been crossed since 2006. They concern the safety review following the third decennial outage of 900-MWe reactors, the second and third decennial outages of 1,300-Mwe reactors and the first decennial outage of N4 reactors.

14.4.1.1 Safety review following the third decennial outage of 900-MWe reactors

The third decennial outages started in 2009 at the Tricastin-1 and Fessenheim-1 reactors and will end with the Chinon NPP around 2020. ASN considers that step as vital for the exact knowledge of the state of the reactors and in the analysis of EDF's capability to pursue their operation, as the case may be. No later than one year after the completion of the third decennial outage of 900-MWe reactors, ASN will issue its opinion on the compliance of every installation with regard to safety requirements and the conditions for the continuation of its operation.

The safety reassessment of the periodic safety review following those decennial outages deal particularly with the following topics:

- internal floods;
- explosions due to internal causes;
- fires;
- earthquakes;
- climate aggressions;
- drifting hydrocarbon slicks, and
- external aggressions likely to induce the loss of the cold source and of electrical supply.

ASN considers that the safety review following the third decennial outage of 900-MWe reactors is essential in order to get information on the status of the components, systems and structures and to demonstrate the capability of the operator to continue their operation. In that context, ASN has requested the operator to provide sound elements justifying the capability of the systems and structures to maintain their safety functions in accordance with the relevant operating, maintenance and monitoring procedures concerning specifically the management of the ageing phenomenon. For instance, for components with an estimated service lifetime exceeding 20 years, ASN has requested the operator to test certain representative samples in order to verify that their state remains consistent with the qualification criteria.

Complements were requested from the operator notably on topics, such as:

- reactor autonomy against external aggressions that may affect several reactors on the same site;

- degradation mechanisms (corrosion, vibration fatigue) likely to affect hydrogen ducts;
- operating requirements applicable to the protective equipment of the primary circuit against cold overpressure risks, when the reactor is shut down/out of service;
- the risk of accidental drainage of fuel-storage ponds;
- available instrumentation in the event of a severe accident to detect a potential perforation in the reactor vessel and the risk assessment of the presence of hydrogen in the containment envelope, and
- the carrying out of a reactor modification in order to reduce the core-fusion risk with by-passes of the containment envelope.

In July 2009, ASN took a stand on the generic aspects of continuing the operation of 900-MWe reactors. It did not identify actual elements that questioned EDF's capability to control the safety of such reactors within 40 years of their initial criticality. ASN also considers that both the new safety reference system presented in the generic report on the safety of 900-MWe reactors and EDF's projected changes to the installation will be able to maintain and improve the overall safety of those reactors. ASN's remaining task is to take a specific stand for each of 34 900-MWe reactors, one by one.

With regard to EDF's objective to extend the operating duration of its nuclear fleet over and beyond 40 years, ASN considers that such extension is only possible if it is associated with a self-driven and ambitious safety programme. This programme shall allow to improve the safety of the installations to an extent that goes far beyond the continuous improvements described in the safety objectives for new reactors. In September 2010, ASN, together with IRSN and the advisory committee for reactors, is starting assessing the methodology proposed by EDF in order to justify the operation of its reactors beyond 40 years. ASN will pursue its reflection on the conditions for the extended operation of current reactors in service beyond 40 years, by raising that reflection at the international scale.

14.4.1.2 Safety review during the second decennial outage of 1,300-MWe reactors

Following the safety review of 1,300-MWe reactors in 2006, ASN reacted favourably to the continuation of their operation up to their third decennial outage. The resulting changes to be made in accordance with that safety review will be integrated by 2014 and include the following:

- Improved calculations and monitoring at the level of the vessel used in the framework of the operating procedures in the event of an incident or accident;
- improvements relating to manual operation from the control room for safety injection and containment spray pumps, when the emergency-supplied 6.6-kV panels are supplied by their diesel generators;
- improvements in the commissioning of the 380 V (LLS) generation circuit and recharging of the injection pump at the joints with the primary pumps in the event of a common-cause failure of electric switchboards du 6.6 kV (DCC LH);
- changes to the control and instrumentation system of the unloading line in the volumetric and chemical control circuit, and
- changes in the rationale for the implementation of the auxiliary feedwater (AFW) system in the event of a tube rupture in the steam generator.

Those changes were identified by the safety analysis as appropriate safety improvements, without being necessarily associated with ageing. However, certain anomalies due to an accelerated-corrosion phenomenon were observed on specific components during the compliance checks that were performed on site before the second decennial outage. For instance, a degradation of certain safety-related component anchors, especially in seashore reactors, such as the 1,300-MWe reactors at Flamanville was found. In addition, certain components are verified during decennial outages in the framework of a specific programme, known as programme of additional investigations, with a view to checking certain components that may be affected by ageing phenomena, which have not been taken into account by NPP maintenance programmes.

In 2009, the Belleville-sur-Loire-2 and Nogent-sur-Seine-1 reactors integrated the changes derived from the safety review following their second decennial outage.

14.4.1.3 Safety review during the third decennial outage of 1,300-MWe reactors

In 2009, ASN and IRSN initiated the review of the orientations for the safety review following the third decennial outage of 1,300-MWe reactors. More particularly, ASN ensures that such review, which is the first to be prepared after the adoption of the *2006 TSN Act*, complies with the new legislative requirements. The third decennial outage for 1,300-MWe reactors is expected to start around 2015.

14.4.1.4 Safety review during the first decennial outage of N4 reactors

IN 2008, ASN formulated its opinion on the orientation of the first safety review for N4 reactors with specific regard to Level-1 probabilistic safety analyses and aggression studies. In 2009, the Chooz-B2 reactor integrated the changes derived from by the safety review following its first decennial outage.

14.4.1.5 Inspection and experience feedback from safety reviews

NPP inspections are carried out on the basis of a list of eight 8 generic topics (FOH, operation, containment barriers, pressurised equipment, state of systems and structures, internal and external aggressions and emergency preparedness, radiation protection, environmental protection, as well as transport). That list describes various elements to be inspected every year or within an interval of a few years at every NPP. Safety reviews did not induce any changes in the list. However, the results of safety reviews with regard to certain inspections were processed on a case-by-case basis with a view to furthering the investigations on specific topics.

14.4.2 Steps taken for research reactors

Between 2008 and 2010, the CEA conducted several safety reviews of its reactors in the perspective of the continuation of their operation, in response to ASN's requirement that such reviews be conducted every 10 years in accordance with the 2006 *TSN* Act. In a 2005 guide, in fact, ASN had clearly stated its expectations concerning the safety review of CEA installations with regard to the operator's responsibility and to the review's content and planning. All provisions prescribed by the guide were applied without exception for the first time to the ORPHÉE and ÉOLE-MINERVE installations. Hence, the orientation documents for the safety review of those reactors were reviewed by ASN in 2007. Once the operator completed the review work, the final reports were submitted to ASN in 2009 with regard to the ORPHÉE reactor and in 2010 for the critical mock-ups of the ÉOLE and MINERVE reactors.

Following the 2006 safety review, ASN requested that some rejuvenation work be conducted on the MASURCA reactor, notably concerning the renovation of the electrical supply system of the installation and its seismic resistance. Due to strategic reflections on the future use of that reactor, the required work has been suspended: the reactor remains shut down and its core has been unloaded. Nevertheless, the resumption of experiments will be conditioned by a new safety report of the renovated installation on the basis of an "as-built" description " of it, once the work is completed.

In addition, in the perspective of restarting the CABRI reactor, the safety report of that reactor was analysed by the advisory committee for reactors in 2008 and 2009, with a special focus on the following:

- the state of the installation in the light of inspection and review programme being conducted;
- seismic reinforcements added to buildings and pieces of equipment;
- the capability of the core to undergo future tests, on the basis of new hypotheses derived from the in-depth review of the most solicited fuel pencils;
- the design basis of the water loop with regard to the safety of the reactor;

- the evolution of the control and instrumentation equipment of the reactor's protection system following the implementation of the pressurised water loop, and
- the control of fire risks.

Lastly, the CEA completed in 2009 the safety review of the OSIRIS reactor. In 2008, ASN had requested the CEA to proceed with such safety review as a complement to safety improvement actions in order to confirm, on the basis of controls and tests, that the actual state of the reactor justified its further operation under satisfactory conditions until its final shutdown no later than the end of 2015. In fact, that end-of-operation deadline was proposed by the CEA itself and found acceptable by ASN, on the condition that a significant improvement programme be carried out. That improvement work deals more particularly with reinforcing incident prevention and mitigating the risks induced by accidental situations. The safety review of the installation extends also to all experimental devices considered as perennial by the CEA.

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 ASN requests

The legal framework of nuclear activities was modified extensively over the least few years. The legislative system is now sufficiently complete and although the publication of all application documents is pending, it is very advanced.

15.1.1 The legislative and regulatory framework for radiation protection

15.1.1.1 The Public Health Code

Chapter III dealing with ionising radiation of Title III of Book III of the legislative part of the *Public Health Code* describes all “nuclear activities”, that is, all operations involving a risk of human exposure to ionising radiation resulting either from an artificial source (whether a substance or a device) or a natural source, when natural radionuclides are or have been processed because of their radioactive, fissile or fertile properties. They also include “interventions” aimed at preventing or reducing a radiological risk following an accident, due to environmental contamination.

Article L. 1333-1 of the *Public Health Code* also describes the general principles of radiation protection (justification, optimisation, limitation), which have been laid down at the international level by the International Commission on Radiological Protection – ICPR) and reiterated in EURATOM’s Directive No. 96/29. Those principles are recalled below and guide all regulatory activities for which ASN is responsible.

The *Code* institutes the Radiation Protection Inspectorate to be composed and led by ASN, with a view to the application of its radiation-protection provisions. It also prescribes a specific system of administrative or criminal penalties.

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.

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.

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 *Labour Code* contains various specific provisions applicable to all worker protection, whether employed by the operator or not, who are exposed to ionising radiation. It also transposes in French law EURATOM's Directive No. 90/641 of 4 December 1990 concerning the operational protection of outside workers who are likely to be exposed to ionising radiation during their intervention in a controlled area and EURATOM's Directive No. 96/29 mentioned above.

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. 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 individuals against ionising-radiation hazards

The changes introduced by the *TSN Act* 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. 4451-1 to R. 4457-14 of the *Labour Code* provide for a single radiation-protection system for all workers (whether paid or not), who are likely to be exposed to ionising radiation in the course of their professional activity. Among such provisions, a special mention should be made about the following:

- the application of the optimisation principle to work equipment, processes and organisation (Article R. 4451-7 to 11), with clarifications on the procedures for the fulfilment of responsibilities and the circulation of information between the installation manager, the employer (notably when he is not the installation manager) and the competent radiation-protection officer (RPO);
- dose limits (Articles R. 4451-12 to 15) have been reduced to 20 mSv over 12 consecutive months, except for specific waivers being granted to account for previously-justified exceptional exposures or professional emergency exposures; In addition of that dose limit, known as the "efficient dose" there are, for the different exposed parts of the body, specific dose limits, known as the "equivalent dose" for individual organs or tissues, as follows:
  - 500 mSv for hands, forearms, feet, ankles and skin, in which case the limit applies to the average dose over a total surface of 1 cm^2, irrespective of the exposed surface, and
  - 150 mSv for the crystalline lens (Article R. 4451-12), and
- the dose limit for any pregnant woman (Article D. 4152-5) or more precisely for her unborn child (1 mSv for the period extending between the declaration of pregnancy and the actual birth).

Those provisions are specified in implementing orders.

With regard to the professional dose limit, the period of 12 consecutive months rather than a one calendar year was already in force before the transposition of EURATOM's Directive No. 96/29 in French law, which led to the adoption of a lower dose limit in order to prevent high doses from being received two months in a row (e.g., 19 mSv in December and 19 mSv in January), especially in the case of short-term services.

During or following an operation, for example, any the competent radiation-protection officer *(*RPO*)* who feels that a worker is likely to receive subsequently higher doses than the limit values specified in Articles D. 4152-5, D. 4153-34, R. 4451-12 or R. 4451-13, due to the nature of the work entrusted upon that worker, shall notify immediately the employer and the occupational physician, and the latter shall, in turn, notify the worker involved (Article R. 4453-29 of the *Labour Code*).

If one of the exposure-limit values specified in Articles D. 4152-5, D. 4153-34, R. 4451-12 or R. 4451-13 of the *Labour Code* is exceeded, one of the organisations which is in charge of monitoring worker exposures to ionising radiation and referred to in Article R. 4453-21, shall inform immediately the occupational physician and the employer, while the occupational physician shall inform the worker involved (Article R. 4453-20 of the *Labour Code*).

In addition, the employer shall report to ASN any significant event which has induced or is likely to induce a dose in excess of the limit values specified in Articles D. 4152-5, D. 4153-34, R. 4451-12 or R. 4451--13. In such cases, the employer shall analyse those events in order to prevent their recurrence (Article R. 4455-7 of the *Labour Code*).

ASN centralises and checks all information relating to reported significant events and keeps them at the disposal of the labour inspector.

In addition, ASN requests the operator to declare any unexpected situation that has induced a dose in excess of the regulatory individual annual dose limit by 25% for a one-time exposure, irrespective of the type of exposure.

With regard to its radiation-protection monitoring mission, ASN ensures that the operator's ALARA approach is well implemented. Most operators have already set in place various warning levels (16 and 18 mSv, for instance, at EDF) in order for every worker (including contractors) whose dose exceeds those thresholds, to benefit from a close monitoring with a view to preventing any further doses from exceeding the dose limit.

Human exposures over and above the limit values prescribed by the *Labour Code* may lead to the application of criminal penalties (Articles L 1337-5 to L 1337-7 of the *Public Health Code*).

Zoning

Prescriptions for the delineation of various monitored, controlled and specifically regulated areas (especially controlled areas) applicable to all activity sectors were laid down by the Order of 15 May 2006, which also specified health, security and maintenance rules to be enforced in those areas. The delineation of regulated areas takes into account three levels of protection: the efficient dose for external and, if applicable, internal exposures of the whole body, equivalent doses for the external exposure of extremities and, if need be, the dose rates for the whole body. The order sets reference levels that the installation manager must compare with both the ambient external and internal exposure levels at workstations in order to delineate areas. Two joint circulars from the General Directorate of Labour (DGT) and ASN, dated 18 January 2008 and 21 April 2010 respectively, provide details on implementation procedures.

Competent radiation-protection officer

The missions of the competent RPO were extended and include the delineation of nuclear working areas and the study of exposed workstations and of exposure-optimisation measures. In order to fulfil his missions, the RPO has access to all data on passive and operational doses (Article R. 4456-10 of the *Labour Code*).

The Order of 26 October 2005 relating to the procedures for training competent RPOs and for certifying instructors establishes three different sectors of activity, as follows:

- the "medical" sector groups nuclear and radiological activities in preventive and curative medicine (including medicolegal examinations), dentistry, medical biology, biomedical research and veterinary medicine;
- the "BNI-ICPE" sector encompasses not only establishments consisting of one or several BNIs, but also those that include an installation subject to licensing on environmental-protection grounds, except for nuclear activities pertaining to the medical sector mentioned above, and
- the "industry and research" sector covers all nuclear activities described in Article R. 4451-1 of the *Labour Code*, except for the activities of the "medical" and "INB-ICPE" sectors mentioned above.

Training includes a theoretical module, which is common to all options, and a practical module, which is specific to each sector, together with these two options ("sealed sources and electrical ionising-radiation generators" and "unsealed sources"). Consequently, the timeframe and content of RPO training are modulated in relation with the activity sector whether the officer will be working and to the type of sources in use. The instructor must be certified by a duly accredited organisation by the French Accreditation Committee (COFRAC).

ASN's decision No. 2009-DC-0147 of 16 July 2009 contains the applicable requirements for RPOs when they are not paid staff members of the company where the nuclear activity is taking place. That possibility to call upon an outside RPO is limited to the nuclear activities that are regulated by a declaration system to ASN.

Dosimetry

The procedures for certifying organisations in charge of worker dosimetry are laid down in the Order of 6 December 2003, in its modified version, whereas the procedures for the medical follow-up and the transmission of information on individual dosimetry are specified in the Order of 30 December 2004. ASN is responsible for reviewing the certification applications submitted by dosimetry organisations and laboratories.

Radiation-protection checks

Technical checks are conducted not only on sources and devices that emit ionising radiation, but also on protection and alarm devices, and on measuring instruments. Together with checks of the ambient environment, they may be entrusted upon either IRSN or the competent radiation-protection service of the installation or to certified organisations in accordance with Article R. 1333-44 of the *Public Health Code*. The nature and frequency of technical radiation-protection checks are specified in the Order of 26 October 2005, as modified by the Order homologating ASN's Decision No. 2010-DC-0175 of 4 February 2010 (being published).

Technical checks concern sources and devices emitting ionising radiation, the ambient environment, measuring instruments, protective and alarm devices, as well as the management of sources and of any resulting waste and effluents. Part of those checks are conducted in the framework of the operator's in-house control procedures, while the rest may be entrusted upon outside organisations; in fact, all outside checks without exception must be conducted by IRSN or by a certified organisation in accordance with Article R. 1333-97 of the *Public Health Code*. The certification procedures for those organisations are described in the Order of 9 January 2004. ASN is responsible for reviewing the certification applications submitted by such organisations.

All certified organisations are listed on ASN's Web site (*www.asn.fr*).

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.

Dose limits for the public

The annual effective dose limit (Article R. 1333-8 of the *Public Health Code*) for members of the public due to nuclear activities is set at 1 mSv, whereas the equivalent dose limits for the crystalline lens and for the skin are set at 15 and 50 mSv per year, respectively (average value for any skin surface of 1 cm²). The calculation method for both efficient and equivalent doses, as well as the methods for estimating the dose impact on a population, are described in the Order of 1 September 2003.

Radioactivity of consumer goods and building materials

The intentional addition of natural or artificial radionuclides to consumer goods and building materials is prohibited (Article R. 1333-2 of the *Public Health Code*). However, the Minister of Health, may grant waivers after consultation with the High Council for Public Health (HCSP), except in the case of foodstuff and of any material coming in contact with them, as well as cosmetics, toys and jewellery. The Interministerial Order of 5 May 2009 describes the content requirements for the waiver application and the prescriptions for public-information procedures referred to in Article R. 1333-5 of the *Public Health Code*. Such ban does not concern any radionuclide that is naturally present in the original components (e.g., potassium 40 in milk) or in the additives used in the preparation of foodstuff or in the fabrication of constituent materials of consumer goods or building products.

Furthermore, the use of materials or waste resulting from a nuclear activity is prohibited if they are contaminated or likely to be contaminated by the radionuclides involved in that activity.

For the time being, there are no regulations limiting the natural radioactivity of building materials, when such radioactivity is present in the components used to manufacture them.

Radioactivity of the environment

In 2009, the National Network for Radioactivity Measurements in the Environment (RNM) was created in accordance with Article R. 1333-11 of the *Public Health Code* in order to collect data and to use them to estimate the various doses received by the population. The network encompasses the different results not only of mandatory environmental analyses, but also those performed by State services and their public establishments, as well as those performed by regional communities and those performed upon the request of associations. Results are available to the public since 1 February 2010 and may be consulted on a Web site (www.mesure-radioactivite.fr), which centralises all radioactivity-measurement results of all origins in the environment collected by different organisations, puts them at the disposal of experts and the public and updates them frequently at an average rate of 15,000 newly-added measurements every month. IRSN is in charge of managing that monitoring network in accordance with the orientations set by ASN (Order of 27 June 2005 on the organisation of an RNM and setting forth laboratory-certification procedures).

In order to guarantee the quality of the measurements, all laboratories involved in the network must fulfil certification criteria that include notably cross-comparison tests. The list of certified organisations may be consulted on Internet (www.asn.fr).

Radiological quality of water intended for human consumption

In accordance with Article R. 1321-3 of the Public *Health Code*, all water intended for human consumption is submitted to various checks concerning its radiological quality. The relevant criteria for such checks are detailed in the Order of 12 May 2004 and are consistent with the sanitary control conducted by the Departmental Directorates of Health and Social Affairs (DDASS), which consist of decentralised services of the Ministry of Health. That organisation will be adapted in the context of the upcoming restructuring of regional State services.

The Order of 11 January 2007 on water-quality limits and references introduces four indicators for the radiological quality of water intended for human consumption. Those indicators and the selected limits include the following: the total alpha activity (0.1 Bq/L), the total residual beta activity (1 Bq/L), the tritium activity (100 Bq/L) and the total indicative dose [DTI] (0.1 mSv/year). The circular of 13 June 2007 issued by the Directorate-General of Health (DGS), together with ASN's recommendations, provide detailed information on the underlying doctrine of such regulations.

Radiological quality of foodstuff

Restrictions on foodstuff consumption or marketing may prove necessary in case of accident or other radiological emergency.

In Europe, such restrictions are prescribed by *Council Regulation (*EURATOM*) No. 3954/87 of 22 December 1987*, as modified by *Council Regulation (EEC) No. 2219/89 of 18 July 1989*, setting in that case the maximum admissible levels (MAL) for the radioactive contamination of human foodstuff and cattle feed. The MALs were adopted in order "to protect the health of the population, while maintaining the unit in service".

In case of any recognised nuclear accident, the "automatic" application of that regulation shall, under no exception whatsoever, exceed a period of three months, but may be relayed by specific provisions.

At the international level, all exchanges with third countries (outside European Union) are submitted to the standardised criteria of the *Codex alimentarius* Commission, a joint organisation of the United Nations Food and Agriculture Organisation (FAO) and World Health Organization (WHO), which, in July 2006, revised the indicative limits (IL) for the use of foodstuff contaminated with radionuclides for international-trade purposes in case of nuclear accident or radiological incident. The European regulation needs to be updated in order to integrate the new *Codex* values.

Radioactive waste and effluents

The management of waste and effluents originating from INBs and ICPEs is subject to the provisions of specific regulatory systems for such installations (for INBs, refer to §15.1.3).

Although EURATOM's Directive No. 96/29 mentioned above refers to the notion of a "clearance level", French regulations did not retain such notion for effluents or solid waste (i.e., of a generic radioactivity level below which effluents and waste resulting from a nuclear activity may be eliminated without any check. However, in the case of effluents, discharge licences prescribe maximum limits not to be exceeded, as well as specific discharge conditions and environmental-monitoring procedures. In practice, the elimination of effluents and waste is checked on a case-by-case basis when the activity that generates them is submitted to a licensing system (e.g., BNIs and ICPEs) or may be subject to technical prescriptions, if such activities must be declared. Similarly, French regulations do not refer to the notion of "trivial dose", which appears in EURATOM's Directive No. 96/29, that is, the dose below which no action is considered necessary with regard to radiation protection (10 µSv/year).

The first specific legislation for radioactive waste was the 1991 Bataille Law and was further modified and completed by the 2006 Planning Act.

Preceded by a public debate in 2005, the latter provides a legislative framework for the management of all radioactive waste and materials.

It also instituted notably the National Management Plan for Radioactive Materials and Waste (PNGMDR) and provides for a Research Work Programme on radioactive waste lacking a final management system and its matching implementation schedule.

The PNGMDR presents an overview of the management of radioactive materials and waste with a dual aim: ensuring the existence of adapted management systems for every category of radioactive substances over the short and long terms and improving consistency among such systems. In addition, the decree that specified the relevant prescriptions imposes a clear road map for the implementation of suitable actions to improve the management of radioactive materials and waste. The PNGMDR is the result of exchanges within a pluralistic working group, chaired by the MEEDDM's Directorate General for Energy and Climate (DGEC) – and ASN. The working group is composed of environmental associations, representatives from elected officials and assessment and control authorities, as well as radioactive-waste producers and managers.

15.1.2.3. Protection of the population in the event of radiological emergencies

The protection of the population against the hazards of ionising radiation under accidental conditions or in the event of radiological emergencies is guaranteed by the implementation of specific measures or countermeasures that are adapted to the nature and severity of the exposure. In the particular case of nuclear accidents, those measures have been described in the Interministerial Order of 10 March 2000 on the revision of specific BNI interventions, together with intervention levels expressed in the form of doses. Those levels constitute references for public authorities (prefects) that have to select, on a case-by-case basis, which actions require to be implemented locally.

Reference and intervention levels

Intervention levels were updated in 2009 by ASN Decision No. 2009-DC-0153 of 18 August 2009 and homologated by the Minister of Health and Sports on 20 November 2009, with a reduction of the exposure level to the thyroid. That decision improves the protection of the most sensitive populations (foetus and children up to 18 years old) and harmonises the French practice with that of bordering countries. From now on, the protective actions to be set in place in case of emergency and the corresponding intervention levels include the following:

- sheltering, if the provisional efficient dose exceeds 10 mSv;
- evacuation, if the provisional efficient dose exceeds 50 mSv, and
- administration of stable-iodine tablets, if the provisional efficient dose to the thyroid may exceed 50 mSv.

It should be noted that the fourth distribution campaign of stable-iodine tablets took place in 2009 around 19 French NPPs. All families and communities (schools, town halls, firms, hotels, etc.) located within a radius of 10 km around every French NPP, which include 400,000 homes and 2,000 establishments spread over 500 municipalities, are concerned.

Reference levels for exposures to individuals intervening during radiological emergencies are also prescribed by regulations (Article R. 1333-84 and 86 of the *Public Health Code*) and two groups of interveners have been designated as follows:

- the first group includes all members of staff forming special technical or medical intervention teams, which have been constituted in advance against a radiological emergency. In that capacity, those members of staff are not only submitted to radiological monitoring, a work-capacity test and special training, but they are also equipped with adapted devices to the type of radiological risk involved, and
- the second group is comprised of members of staff that do not belong to special teams, but who intervene in the course of missions within their competence. They benefit from adapted information.

Definition of "radiological emergency" (Article R. 1333-76 of the Public Health Code)

"A radiological emergency arises when an event may induce a release of radioactive materials or a radioactivity level likely to undermine public health, notably with regard to intervention limits and levels prescribed by R. 1333-8 and R. 1333-80, respectively. The event involved may result from the following:

1°) any incident or accident occurring during the performance of any nuclear activity described in Article L. 1333-1, including the transport of radioactive substances;

2°) any act of malicious mischief;

3°) any environmental contamination detected by the RNM, mentioned in Article R. 1333-11, and

4°) any environmental contamination brought to the attention of the competent authority, according to the definition of international conventions or agreements, or to the decisions of the European Community concerning information in the event of a radiological emergency."

Reference levels for individual exposures of interveners are expressed in terms of efficient dose and set as follows:

- the efficient dose likely to be received by staff members who belong to special technical, medical or sanitary intervention teams, which have been constituted in advance against a radiological emergency, is 100 mSv, whereas it is set at 300 mSv, if the intervention is designed to protect human beings, and
- the efficient dose likely to be received by staff members who do not belong to special teams, but intervene in the framework of the provisions within their competence, is set at 10 mSv. Any dose received in excess of reference levels may be authorised in the case of voluntary intervenors who have been duly informed of the risk induced by their intervention.

Public information in the event of a radiological emergency

Procedures for informing the population in the event of a radiological emergency are covered by a specific European directive (Council Directive No. 89/618/Euratom of 27 November 1989 on informing the general public about health protection, measures to be applied and steps to be taken in the event of a radiological emergency). That directive was transposed in the French law system by Decree No. 2005-1158 of 13 September 2005 on off-site intervention plans concerning certain fixed structures or installations and taken pursuant to Article 15 of *Law No. 2004-811 of 13 August 2004 on the Modernisation of Emergency Preparedness*.

Two implementation orders were published accordingly:

- the Order of 4 November 2005 on the information of the general public in the event of a radiological emergency, and
- the Order of 8 December 2005 on work-capacity tests, radiological monitoring, as well as training and information actions for the benefit of the interveners in the management of a radiological emergency.

15.1.2.4 Protecting the population in the event of long-term exposures

Some sites are contaminated with radioactive materials due to a past or obsolete nuclear activity (use of unsealed sources, radium industry, etc.) or industrial activity calling upon the use of raw materials containing non-negligible quantities of natural radioelements of the uranium or thorium family. Most of those sites are listed in the inventory that is updated periodically and distributed by the French Radioactive Waste Management Agency (Andra). The inventory may be consulted on its Web site (www.andra.fr).

The approach used to determine the cleanup thresholds for those sites is described in an IRSN guide, entitled *Guide* methodological guide for sites contaminated with radioactive materials. Version 0 was issued in December 2000.

With due account of current and future uses of lands and premises, the guide proposes a multi-step approach in order to determine rehabilitation objectives in terms of doses. All stakeholders (site owners, elected officials, local residents and associations) are included in the approach. Operational decontamination values may then be established on a case-by-case basis.

The approach is consistent with Article R. 1333-90 of the *Public Health Code*.

ASN and the Ministry for Ecology have requested IRSN to update the methodological guide in order to integrate the changes that have occurred in the field over the last decade or so. In parallel, ASN and the Ministry have set in place in 2009 a pluralistic reflection group with a view to developing a suitable approach to determine cleanup objectives for sites contaminated with radioactivity. The work of that group will nurture the new version of the IRSN's methodological guide, which is currently under way. In addition, following those exchanges and with a view to accounting for the experience feedback collected over the recent years, ASN has recently clarified its policy on that topic and will notify all stakeholders.

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 operator 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 operator 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

In 2009, ASN continued to review the renewal of prescriptions concerning NPP effluent discharges and water intakes pursuant to Decree No. 95-540 of 4 May 1995 on INB liquid and gas effluent discharges and water intakes. Since those prescriptions were issued by the prefects under a previous regulatory system, they include a period of validity, which, in some cases, is nearing its term.

ASN's objective is that the majority of existing prescriptions be reviewed in order to achieve a broader harmonisation among the different sites. Since the publication of the 2007 Procedure Decree, new prescriptions are issued in the form of ASN decisions and are subject to the homologation of the Ministers in charge of nuclear safety and radiation protection, if the provisions concern discharge limits into the environment. It should be noted that, following the adoption by the French National Assembly, on 11 May 2010, of the law on the national commitment towards the environment, known as the "second Grenelle Act", a new provision is now modifying the 2006 *TSN Act* with a view to imposing a public consultation to all projects inducing a significant increase in water intakes or in discharges from any nuclear installation (Article 94 *quater*). That new provision results from an amendment tabled by the Government on the motion of ASN. In fact, the *2006 TSN Act* requires that the public-inquiry procedure be enforced in the case of applications for new nuclear installations, significant changes to the installations or for their decommissioning. On the other hand, when non-significant changes to the installations are involved, procedures call for local consultations with the CLI and the Departmental Council for the Environment and for Health and Technological Risks (CODERST), but no direct public consultation. In certain cases, however, those installations may have a significant impact on the environment. In order to reinforce transparency with respect to public information, ASN has proposed to the government an amendment designed to impose a public-consultation procedure in order to associate the population better with the decision-making process. ASN feels that such measure is in line with the principle to reinforce transparency and public involvement in decision-making processes, as advocated by the *2006 TSN Act*.

Those prescriptions applicable to water intakes and all INB discharges set primarily the quantities, concentrations and monitoring procedures for pollutants likely to be present in discharges and in the environment, in accordance with the Order of 26 November 1999. In the case of those renewals, ASN applies the following principles:

- with respect to radioactive discharges, ASN tends to reduce regulatory limits since the actual NPP discharges keep decreasing and have been much lower than applicable limits until now. It sets new limits by relying on the experience feedback from actual discharges, while integrating the contingencies resulting from the normal operation of the reactors. Hence, discharge limits have been divided by a factor of 1 to nearly 40 for the various fuel management methods, depending on the radioelements involved. However, limits were also increased by a factor of 1.25 for liquid-tritium discharges in the prospect of future fuel-management methods known as "high burnup rate", and
- with regard to non-radioactive substances, ASN has decided to regulate discharges more strictly than previous prescriptions did.

At the end of 2009, once the prescriptions for the Chooz and Civaux NNPs were renewed, revised prescriptions concerning discharges and water intakes already existed for a total of 16 NPPs. Prescription-renewal applications for the other NPPs will spread until 2011.

Every month, the operator must communicate his discharge results to ASN. The NPP-discharge monitoring programme is further detailed in Appendix 4. Those data are reviewed regularly and correlated with the operation of reactors during the period involved. Detected anomalies are the subject of requests for complementary information on the part of the operator.

The calculated radiological impact of maximum discharges on the most exposed population group, as described in the supporting documents of EDF's licence applications, is well under the admissible dose limit for the public. Hence, the annual efficient dose received by the reference group within the population, which is mentioned in licence applications for EDF's effluent discharges and water intakes, is estimated between a few microsieverts and a few tens of microsieverts per year.

For instance, the annual efficient dose corresponding to the value limits imposed upon EDF for the renewal of the Civaux NPP's licences was estimated at 22 µSv/year for the reference group living nearby. Since its actual discharges in 2009 were lower than the imposed discharged limits, the annual efficient dose that same year was lower than that value.

15.2 Radiation-protection measures for nuclear-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.

In order to optimise and to reduce even better the doses received by exposed individuals, EDF launched in 1992 its ALARA-1 policy, which resulted in significant benefits, since the annual collective dose per reactor dropped from 2.4 person-sievert that year to 1.08 person-sievert in 2000 and to 0.69 person-sievert in 2009. Special measures were implemented in order to limit the highest individual doses. The number of interveners (EDF staff and contractors), for whom doses range between 16 and 20 mSv (regulatory limit), amounted to 10 in 2009, and no intervener had a higher individual dose than 20 mSv.

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:

- 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).

Foreign experience feedback from Germany, Japan, the United States, etc., shows that the controlled injection of zinc in the primary circuit reduces surface contamination with cobalt (Co 58 and Co 60). As early as 2004, experiments were undertaken and are still under way on two French PWRs at Le Bugey plant.

According to foreign experience feedback, a 10-15% reduction in surface cobalt contamination per injection cycle may be expected. Hence, after two injection cycles on a reactor delivering high doses, the deposited activity of Co 58 dropped by 20%, whereas the activity of Co 60 remained unchanged. In addition, no negative effect was recorded on the fuel, the effluents or the waste. Most of the depleted zinc (with less than 5% Zn 64) is used by operators to limit the quantity of radioactive zinc in the primary circuit and the impact on the standard waste type.

In addition, since there are disparities in dose results as in any other nuclear fleet, EDF DPI has been offering, since 2003, to help sites understand and deal with radiological pollution.

The successful decontamination operations conducted in 2004 on the Chinon-2 reactor, with the support of the corporate level, was instrumental in validating the method. Since then, the Flamanville-1 unit was cleaned up in 2006, Gravelines-3 in 2007, Le Bugey-2 in 2008 and Le Blayais-4 in 2009.

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.

That dose-analysis process, from the initial assessment to the final optimisation, and concluding with the integration of experience feedback, is now carried through a new computer application, called PREVAIR, which is common to all nuclear plants and the fleet's engineering services, and is currently being extended to contractors.

In the preparation of interventions, the PREVAIR software is used to develop and optimise the assessments provisional doses at every intervention.

During the execution phase, it ensures the automated collection and tracking of the doses received for every job. In addition, working in combination with new electronic alarm dosimeters, which are now in service on nuclear sites, the system reinforces the protection of every intervener by adapting the alarm thresholds of their dosimeter to the forecasted dose of his intervention.

On completion of the intervention, 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.4453-24 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.

- ***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 previous 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 showing a constant decrease.

  The work of insulation fitters, for which the average individual dose is the highest, is the subject of physical and organisational improvements in partnership with contractors. Those initiatives prove beneficial, since no insulation fitters received a dose between 16 and 20 mSv in 2009.

15.2.2 Radiation protection of the public

15.2.2.1 Effluent discharges

Regulations on radioactive-effluent discharges include general texts, orders and specific ASN decisions for every site (refer to §15.1.4).

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 and specific ASN decisions for every 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.

However, the dose impact of radioactive-effluent discharges remains extremely low, since it varies roughly between 1 and a few microsieverts per year, as calculated for the reference group living near an NPP. That value is well below the natural exposure level in France (2,400 µSv/year) and the exposure limit for the public (1,000 µSv/year).

15.2.2.2 Environmental monitoring

The purpose of environmental monitoring is to ensure the efficiency of the measures taken to protect human beings and the environmental, with due account of the various potential discharges from the installation in the air, terrestrial ecosystems (soil, plant life, foodstuff, etc.), groundwaters and surface waters (where the major discharges occur).

Environmental monitoring constitutes a regulatory activity for which the quality of measures relies on the certificates issued by ASN to laboratories in charge of measuring radioactivity in the environment. The environmental monitoring performed by operators fulfils three technical purposes, as follows:

- an alert function;
- a routine-monitoring function, and
- a tracking and study function.

The alert function aims at preventing anomalies in the environment, within a short delay. It focuses on the variation of a measurement that may be directly associated with the operation of the NPP.

For EDF, the alert function relies primarily on the control of ambient gamma radiation right from its emission to its continuous recording around the NPP. The routine-monitoring function comprises all monitoring measurements made in the receiving medium around and perpendicularly to the site. Most of those measurement results are compared either with reference values (either regulatory or set by recognised institutions), indicative values (set by EDF) or in relation to the natural concentration or activity level, otherwise known as the "background". The follow-up and study function is designed to understand the radiological state of the environment and consists notably in conducting radioecological studies (decennial progress report, annual progress report, specific studies, helicopter-borne monitoring, etc.) and hydroecological campaigns.

To those technical functions is added a communication function towards both the authorities and the public.

Following the implementation of the RNM by the French authorities, all nuclear operators must call upon ASN-certified laboratories to carry out monitoring operations. RNM data may be consulted on Internet since the beginning of February 2010 (www.mesure-radioactivite.fr).

In addition, a radioecological follow-up is performed every year on all nuclear NPPs in service. It is part of a monitoring programme described in a framework agreement between the IRSN and the Subatech Laboratory. It has been conducted across the nuclear fleet since 1992 and provides a spatial and chronological overview of the impact of the installations.

Furthermore, NPPs are carrying out decennial assessments, which are comparable to the "baseline measurements" that are performed when the first reactor is commissioned on a plant. Analysis of the results of radioecological tracking and decennial assessments confirms that atmospheric discharges have no impact on the terrestrial environment.

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

15.3 Radiation-protection measures for research reactors

15.3.1 Radiological monitoring at the CEA

At all centres, specialised teams who are in charge of assigning and checking the passive dosimeters of every CEA employee monitor the radiation dose of all workers and send all collected data to the IRSN. Every employee intervening within a controlled area is also equipped with an individual dosimeter in working order with a view to ensuring a continuous and real-time tracking of potential doses.

Subcontractors are monitored by certified laboratories, including the IRSN, which provide them with both the initial dosimetric films and the final results. The tracking process is completed by individual dosimeters, which are delivered and analysed by competent CEA teams on site.

The discharge of gaseous and liquid radioactive effluents 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, discharges have remained significantly below regulatory limits, some of which were revised downwards when authorisations were renewed in 2006.

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 10 TBq per year, and does not exceed 3% of the discharges authorised for normal operation. Thus the dosimetric impact is very small, significantly less than 0.2 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.

In order to ensure the installation and staff monitoring, the PHÉNIX installation's radiation protection service (SPR) provides continuous cover.

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 doses is demonstrated by the dose history of staff members of the PHÉNIX reactor and of external contractors over the last 3 years (2007, 2008 and 2009). In fact, no agent was exposed to an annual dose exceeding 5 mSv and the total dose (personnel and contractors) during that period amounted to 0.062 person-sievert, which corresponds to a total average dose of less than 0.030 person-sievert. The doses involved are very low.

The very low collective doses received during the monitoring of reactor structures constitute another demonstration of the sound practices in force at the NPP.

15.3.1.2 Other CEA reactors

With regard to all CEA research reactors, liquid and gaseous discharges remained low, and in any case, below discharge authorised limits, some of which were revised downwards when they were renewed in 2006.

To ensure that the installation and the personnel are monitored, the radiation protection service (SPR) 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 of staff members of both the installations themselves and outside contractors over the last 3 years (2007, 2008 and 2009), since no agent was exposed to an annual dose exceeding 5 mSv and the total dose (personnel and contractors) during that period amounted to 0.6 person-sievert, thus corresponding to a total average dose of less than 0.20 person-sievert.

15.3.2 Radiological monitoring of the high-flux reactor (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 overall current radiation-protection system is demonstrated by the dose history of BNI personnel, researchers and agents from outside contractors. Over the last three years (2007, 2008 and 2009), no agent was exposed to any annual dose exceeding 5 mSv and the total dose (personnel, researchers and contractors) during that period amounted to 0.49 person-sievert, thus corresponding to a low total average dose of 0.16 person-Sv, with the average individual dose not exceeding 0.4 mSv. The total average dose remains below 0.04 mSv for 2,400 dosimeter bearers.

During 2007, 2008 and 2009, gaseous discharges remained well within authorised limits: 30 to 40% for carbon 14, 10-20 % for tritium and rare gases, and a few percent for other radioelement categories.

Liquid discharges were 40% lower than the authorised limits for tritium and 20% lower than the authorised limits other radioelement categories.

15.4 Regulatory monitoring for radiation protection

According to Article 4 of the *2006 TSN Act,* ASN is entrusted with the mission "to organise a permanent watch regarding radiation protection across the country", in which radiological and environmental monitoring form an integral part.

In that capacity, ASN takes technical regulatory decisions, either of a general scope, if they apply to all BNI operators, or of a more individual scope, if they regulate a specific installation. Within that context, ASN sets the minimal prescriptions for monitoring radioactivity in the environment with a view to ensuring compliance with those prescriptions later on, notably by reviewing the operators' monitoring records and by conducting inspections.

In addition, ASN prescribes the orientations of the RNM and issues relevant certificates to laboratories in charge of measuring radioactivity in the environment, notably in the framework of the regulatory monitoring of nuclear installations. In that capacity, it chairs two entities of the RNM: the Steering Committee and the Measurement Laboratory Certification Committee, whose responsibility is to issue a technical opinion on the certification applications of measurement laboratories.

ASN also plays a major role in public information by ensuring notably that environmental information is available to the public, either directly through ASN publications (Internet site, annual report, *Contrôle* magazine, inspection reports) or indirectly by ensuring that operators comply with the requirement to transmit their data to the RNM or that the public's right of access to environmental information is correctly applied.

Lastly, ASN helps the Ministry of Health to develop technical provisions applicable to the health check for the radiological quality of the waters intended for human consumption and for the certification of laboratories performing control measurements.

The objectives for the radiological monitoring of the environment include the following:

- knowing the radiological state of the environment;
- ensuring the health protection of the public and of the environment by assessing radiological exposures;
- detecting as early as possible any unusual increase of radioactivity in the environment;
- ensuring that nuclear operators comply with regulations, and
- Informing the public.

15.4.1 General environmental monitoring

IRSN is responsible for the overall monitoring of radioactivity in the environment. In addition to that monitoring, INB operators are required by discharge orders or decisions that involve them to monitor the presence of radioactivity close to their installation.

The environment monitoring is performed by IRSN through 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 164 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).

Created in accordance with Article R. 1333-11 of the *Public Health Code*, the RNM aims at providing the public with the monitoring results of radioactivity in the environment and various information relating to the health impact of nuclear energy across France. After having received the opinion of the steering committee it chairs, ASN is in charge of specifying the orientations of the RNM, which is managed by IRSN,

Public access to the monitoring results of radioactivity in the environment and to various information relating to the health impact of nuclear energy across the country relies on the regulatory requirement imposed upon institutional interveners and to nuclear operators to disseminate regulatory-monitoring results on the RNM's Internet site. Any non-regulatory measurements recorded by certified laboratories may be also inputted on that Internet site. In order to guarantee the quality of the measurements made, only those recorded by ASN- or IRSN-certified laboratories are allowed to be made available on the RNM's Web site.

All measurement results are now available to the public on a dedicated Web site (*http://www.mesure-radioactivite.fr*).

15.4.2 Monitoring the environment around nuclear reactors

The monitoring of discharges and environment around nuclear reactors is first and foremost the responsibility of the operator. The discharge authorisations stipulate minimum checks that have to be made by the operator. 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 regulatory measurements must be recorded in registers that are forwarded every month to ASN for control purposes. The results of radioactivity measurements in the environment are also sent to the RNM (refer to §15.4.1) and made public on its Web site.

Throughout the year, operators send also regularly to IRSN for analytical purposes the following series of samples taken from discharges: every year, 7 weekly samples of gaseous effluents per stack and 12 monthly aliquot parts per outlet for liquid radioactive effluents. Those results, known as "cross-checked data", are communicated to ASN.

The crosscheck programme, as specified by ASN, is designed to ensure the soundness of the results achieved by operators.

Lastly, ASN ensures also through unscheduled inspections that operators comply with regulatory requirements. During those inspections, nuclear-safety inspectors, who may be assisted by a technician from an independent specialised laboratory, verify compliance with authorisation, have samples collected from effluents or the environment and have them analysed by that laboratory. Since 2000, ASN performs between 10 and 20 inspections with sampling per year (16 in 2009).

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 prescribed in the order of 6 December 2003. They were supplemented 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 exposures to the population and to the environment

Every year, IRSN publishes the results of radiological monitoring throughout France. Those results, for instance, include the recordings made by networks of continuous measurements of ambient gamma radiation, as they appear in Appendix 4.

For methodological reasons, since most environmental-measurement results remain under the decision thresholds, the radiological impact of nuclear installations is estimated on the basis of those discharges.

15.5.3 Monitoring discharges

INB operators are required to publish an annual report presenting the discharges from their installations. The graphs shown in Appendix 4 illustrate the evolution of NPP discharges from 1995 to 2008.

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

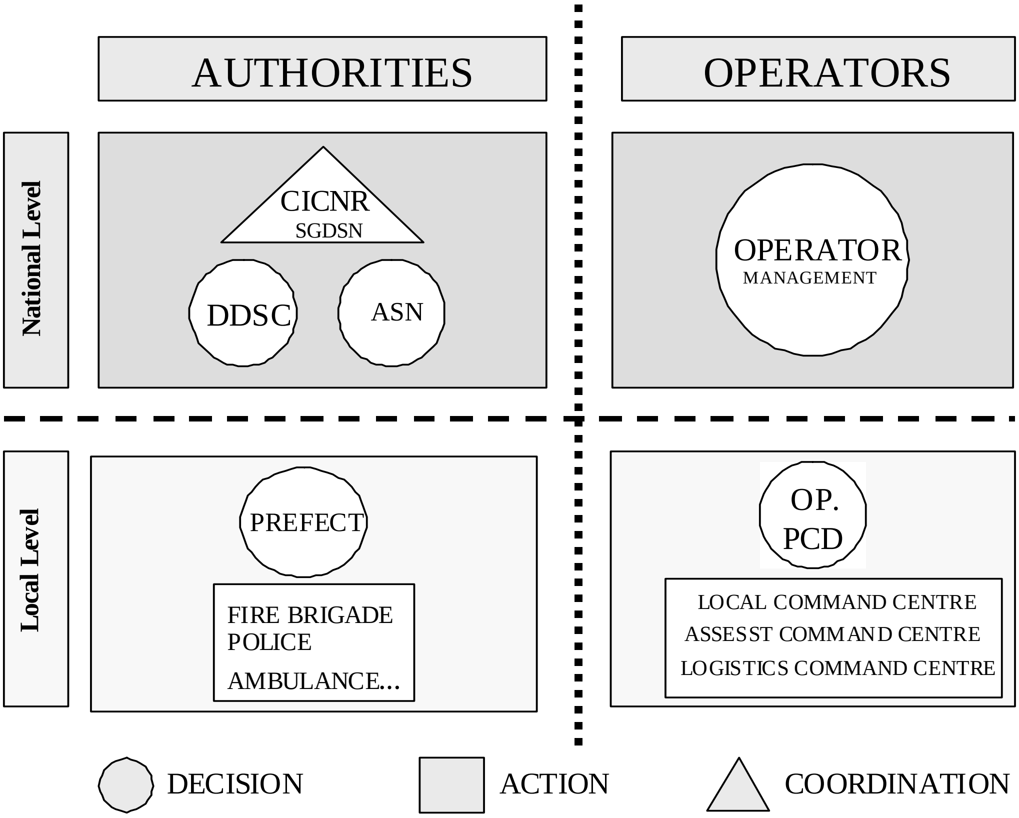
The organisation of the authorities in the case of incident or accident is defined by a number of legal texts concerning nuclear safety, radiation protection, public order and civil defence, as well as by the emergency plans.

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 No. 2005-1158 of 13 September 2005 Concerning Off-site Intervention Plans (PPI).
- 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.

TSN Act 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 § 16.2.1.

The scope of a nuclear emergency and more generally of any radiological emergency, is clarified in the government directives cited below. The response organisation of the authorities and of the operator 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 operator or in the event of an accident involving radioactive material transport.



CICNR: Interministerial Committee on Nuclear or Radiological Emergencies

SGDSN: Secretariat-General for National Defence and National Security

DSC: Directorate for Civil security

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 operator 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 is thus responsible for coordination of the resources committed to the PPI, both public and private, equipment and manpower. He 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 operator, 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.

Major interveners include the following:

- the Ministry for the Interior, in which the Directorate for Civil security (DSC) is in charge of the Operating Centre for Interministerial Emergency Management (COGIC) and of the Nuclear Risk Management Aid Committee (MARN), in order to ensure that the Prefect benefits from suitable equipment and human backups to protect human beings and property;
- the Ministry of Health protects human beings against the effects of ionising radiation;
- the Ministry in charge of nuclear safety, in which the Minister in charge of Ecology co-ordinates also national communications in the event of an incident or accident affecting a nuclear installation under his responsibility or occurring during a shipment of radioactive materials;
- the Prime Minister may set up an emergency-response unit and relies on the Secretariat-General for National Defence and National Security (SGDSN), which is in charge notably of ensuring the interministerial consistency of planned measures in case of accidents, exercise drills and of their assessment. The SGDSN also serves as the Secretariat for the Interministerial Committee on Nuclear or Radiological Emergencies (CICNR), which meets at the initiative of the Prime Minister in the event of a crisis. Its mission is to co-ordinate the government's actions in the event of radiological or nuclear emergencies. In 2009, the CICNR met for a major nuclear-crisis drill, which was designed to simulate a fictitious accident affecting a foreign nuclear installation located off the French shores on 26 November 2009;
- *Météo France* is responsible for assisting public authorities, notably in the event of an actual or potential accidental discharge of hazardous materials into the atmosphere; and
- ASN is associated with the management of radiological emergencies, pursuant to the *2006 TSN Act*. It assists the government regarding all issues within its jurisdiction and informs the public about the safety of the installation where the emergency situation originated. ASN's organisation relies notably on its regional offices and on IRSN, its technical support body.

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 operator, 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 operator 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 operator 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 bases and countermeasures for 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 of 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 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 km radius and evacuate the population within a 5 km 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 rehabilitation of contaminated areas.

16.2 ASN's role and organisation

16.2.1 ASN's missions in emergency situations

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

- ensure that sound measures are taken by the operator;
- 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 operator actions

In the same way as in normal operating conditions, operator actions are supervised by ASN in an emergency situation. In this particular context, ASN must ensure that the operator 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 operator in implementing the technical measures to deal with the accident. In particular, when several action strategies are available to the operator to control the accident, some of which could have substantial environmental consequences, ASN must monitor the conditions under which the operator 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 operator, etc.);
- information of the authorities: ASN keeps the Ministers informed, together with the SGDSN, 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 notification and 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 Function of the competent authority with regard to 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, § 16.1). 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 with regard to nuclear safety

16.2.2.1 The different action centres

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

AT NATIONAL LEVEL

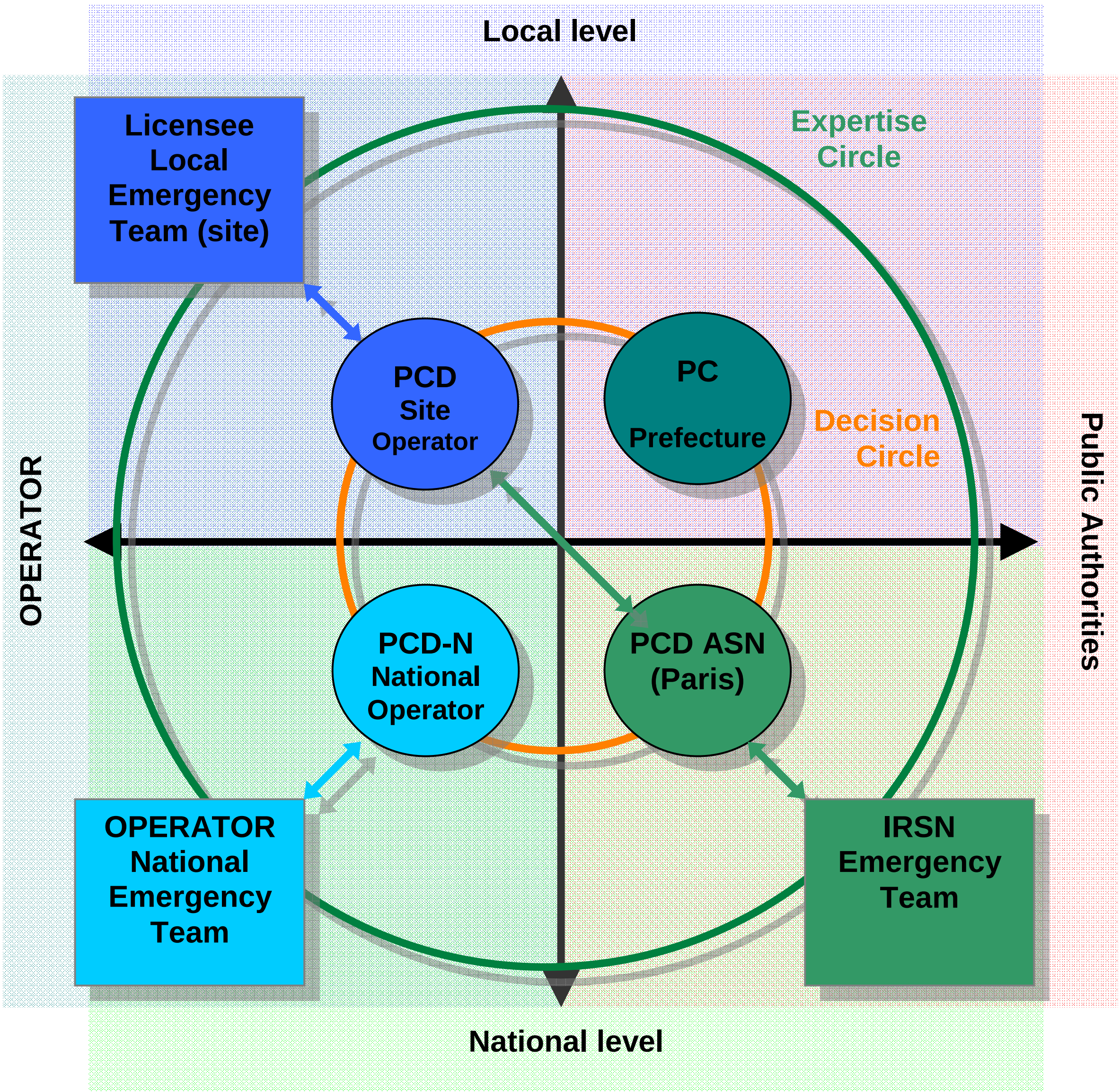
- a decision-making body or command centre (called PCD ASN), located in ASN’s emergency management centre in Paris. This body is managed by the Director General of ASN or his representative. Its role is to adopt a stance or make decisions, but not to undertake technical analysis of the accident in progress. 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;
- 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 operator’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.

AT LOCAL LEVEL

- a local team at the prefect’s office, 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 operator’s decisions, but ensures that the operator 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 operators 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 operator. It shows that the operator 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.



PC or **PCD** : Command and control station

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 carry out its missions, ASN has its own emergency centre, which is equipped with communication and computerised tools in order:

- to alert promptly ASN agents;
- to alert or to inform the IAEA, the European Commission and the other countries, and
- to exchange information under reliable conditions with its multiple partners involved.

Since 2003, the emergency response centre has operated under actual conditions on many occasions, the details of which are provided in the following table.

Activation of ASN's emergency response centre in real situations

Date	Site	Alert	Event
2-3 December 2003	Cruas NPP, then Tricastin NPP	General	Violent weather conditions in the Rhône Valley.
16 May 2004	Cattenom NPP	General	Fire in a non-nuclear area.
30 September 2005	Nogent-sur-Seine NPP	General	Incident on one of the reactors, following water aspersion of the reactor's electrical cabinets.
27 October 2005	Le Blayais NPP	General	Pressure increase in the reactor's core-cooling system.
20 June 2006	Lorraine	Restricted	Increase in radioactivity (triggering of the detector on 18 June 2006 at Nancy and rumour at Metz's Military Hospital).
8 December 2006	CEA, at Cadarache	General, then restricted	Fire in one ICPE cell.
5 April 2007	RN4 at Fère-Champenoise NPP (Marne Department)	Restricted	Traffic accident involving a light-duty vehicle carrying a radioactive package.
10 April 2007	Dampierre-en-Burly NPP	General	Incident at Unit No. 3 following a failure in power supply.
16 April 2007	Saône-et-Loire	Restricted	Drop during transport by road of a package containing contaminated material from the Dampierre-en-Burly NPP to nuclear maintenance facility .
6 April 2008	Cruas NPP	General	Smoke emission from the reactor No. 3 due to the heating of a rolling bearing in a ventilator.
24 January 2009	Le Blayais NPP	General	Flood risk due to very strong winds on the Gironde River.
9 February 2009	Le Blayais NPP	General	Flood risk according to weather forecasts.
5 July 2009	CEA, at Cadarache	General, then restricted	Forest fire close to the site fence.
1 December 2009	Cruas NPP	General	Shutdown of the reactor No. 4 following a loss of cooling circuit due to the clogging of the water intake by a cluster of plant residues
27 December 2009	Fessenheim NPP	General	Reduction of the water flow in cooling circuits due to the gradual clogging of heat exchangers.
27 February 2010	Le Blayais NPP	General	Flood risk according to weather forecasts.

As demonstrated by these events, the ASN alert system allows swift mobilisation of ASN staff and of 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 operator of the nuclear installation in which the alert originated. It also sends the alert to the staff of the DSC, the SGDSN 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 IRSN's CTC. The PCD also makes use of computer 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 ASN's role in the preparation of emergency plans

16.2.3.1 Approval and oversight of PUIs

Since January 1990, along with the safety analysis report and the general operating rules, the on-site emergency plan (PUI) is one of the safety documents which the operator 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 (PPI)

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 Role and organisation of reactor operators

16.3.1 EDF's role and organisation

The establishment of an emergency response organisation (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 operator 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 (Departmental fire and emergency service -SDIS, Mobil emergency and intensive care service -SMUR, French emergency medical service 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 external-aggression situations due to weather conditions or human beings are also taken into account and, in such cases, the appraisal of the existing structure against those events is predetermined (e.g., flooding risk under extreme weather conditions, loss-of-heat-sink in case of pollution by a drifting hydrocarbon slick or malevolent acts). For those hazards, the emergency structure, which is set at both the local and corporate levels, must be designed in order to manage any event affecting several units of the same NPP or several sites, and
- within the framework of the integration of the evolution of its industrial environment or a new threats, the DPN has implemented new emergency structures, as follows:
  - hence, the rising influenza or other pandemic risk required an adapted response to be developed in line with the action of public authorities. In general, the defensive plan focuses on the protection of human beings and on the designation of essential jobs to pursue the activity, and
  - similarly, the implementation of monochloramine treatment plants for the cooling water of the installation's secondary circuit led the operator to set up a specific emergency structure, with due account of the potential presence of an ammonia cloud, whose harm is known.

EDF's emergency structure against such situations since the very first start-up of its NPP fleet relies on the human and physical means that may be mobilised 24 hours a day and seven days a week at the call from an NPP to the Director for National Emergency Response (i.e., Director of DPN or one of his representatives). The unit manager or his representative is responsible for triggering the PUI or the specific structure against the situations mentioned above, based on predetermined triggering criteria.

The emergency structure activated after the PUI has been triggered involves a corporate level (Group managers, top managers of the nuclear fleet and senior engineers) and a local level (senior managers of every NPP). That organisation is structured in teams (or control stations PC) covering the four essential areas for crisis management (expertise, decision, action and communication).

EDF's emergency structure and the missions of the different cells may be described as follows:

Local level

The unit manager or his representative is responsible for managing the emergency response. As the emergency response director, he leads the local management emergency centre (PCD), which helps him to assess situations, define strategies for action, inform the corporate emergency centre (PCD-N) 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 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 reactor 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 between EDF, ASN and IRSN, both the local emergency response team and the assessment control centre team provide information to national technical teams (within EDF and IRSN) and inform regularly the local PCD about events likely to modify the crisis-management strategy (i.e., loss or recovery of a back-up system; detection of a radioactive discharge into the environment).

The local PCD relies also on a local resource-control centre (PCM), whose mission is to ensure all logistical actions at the site in support of emergency response. The PCM provides the local PCD with information regarding its overall actions, the availability of additional resources and the employees' working or living conditions. The PCM also takes action at the request of the local PCD in order to implement mobile means or specific alignments. Its actions cover also the following areas:

- personnel protection and the management of muster points;
- management of telecommunications for all PCs;
- organisation of work and specific tasks on equipment, and
- logistical support to external emergency services and to emergency-response teams.

National level

The PCD-N is led by the Head of the Nuclear Generation Division. Working in permanent contact with the local PCD, it co-ordinates the actions taken by EDF's overall emergency-response structure, advises the relevant NPP management by determining appropriate management strategies for all technical, organisational and media aspects of the event) and provides information to the President of EDF, national public authorities and other NPPs.

The PCD-N maintains contact with the President of the EDF Group who may activate its emergency-response unit. It is also in contact with the experts of the national technical emergency-response team (ETC-N).

The ETC-N has two major functions, as follows:

This team has two main tasks:

- it provides technical support to the PCD-N. This involves continuous analysis of the situation, the status of the affected reactor, and discharges (situation diagnosis) as well as short- to medium-term forecasts (prognosis). It maintains continuous contact with the local emergency response team and IRSN emergency response team in order to compare results and provide additional information to the PCD-N;
- 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 operator.

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 CEA's role and organisation

The CEA's emergency organisation forms part of the general organisation described in § 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 diagram in § 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 IRSN emergency response centre.
- The CEA's Head Division management (national 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 local management emergency station (PCD-L) and the emergency coordination centre (CCC).

- The centre's director, or his 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 Head Division Chairmain, or his representative, is responsible for the emergency coordination centre. 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 responsibility for the director of the establishment or his 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 triggered, the role of the Director or his representative is:

- to direct and coordinate the initial security actions;
- to inform immediately the local authorities, the nuclear safety authorities and the CEA Head Division 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.

Depending on the severity of the event, the Chairman or his representative may decide to activate the emergency coordination centre.

Application to CEA centres

In June 2008, a CEA exercise involving the ORPHÉE reactor provided notably an opportunity to test the triggering of the PUI, the activation of the PCs, the evacuation of injured individuals and the mobilisation of intervention teams from the Saclay Centre.

In June 2009, a similar internal exercise was held at the OSIRIS reactor and was followed in September 2009 by another national exercise with public authorities. The scenario included a discharge of rare gases and of fission products at the stack, thus requiring the implementation of the PUI and PPI. Its purpose was:

- to test the triggering of the national emergency-response structure at both the level of the CEA and of public authorities;
- to assess the CEA's capability to request back-up means;
- to measure population-sheltering capabilities in order to limit risk exposures, and
- to grasp the problem of "measurements" (taking them promptly, processing them and drawing results). In that regard, it allowed for testing a new mechanism for recording measurements and transmitting them in real-time to the different emergency-response PCs.

16.3.3 ILL's role and organisation

The emergency-response structure at the ILL is consistent with the general structure described in §16.1.

As shown on the diagram in §16.2, the ILL plays a role at both the local level (the emergency site) and national level (via the CEA's top management).

In the event of an incident or accident, the ILL would inform the CEA-Grenoble immediately and, according to circumstances, implement the measures specified in its PUI, which was entirely updated at the end of 2004.

That organisation relies on the following:

- a command and control station, known as Intervention PCD in the PUI, and
- a technical control station for reactor.

16.3.3.1 The ILL Command and control station

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 representative.

The person managing this PCD coordinates generally his 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 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 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 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 Technical control station for reactor

This technical control station is managed by the installation manager or his representative, and carries out the operation and safeguard functions. The technical control station reports to the ILL PCD and sends relevant information to the ILL ETC.

The reactor technical control station is located in a technical area (reactor control room or the PCS) 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 Structure implemented by CEA-Grenoble

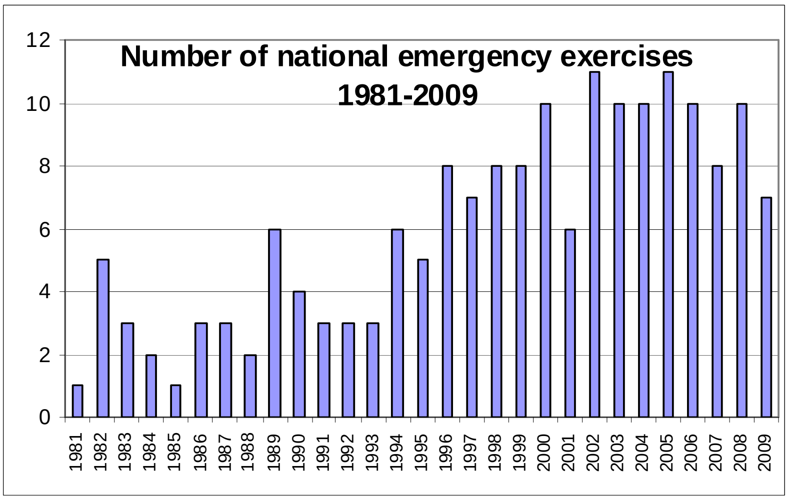
If an incident or accident occurs at the ILL, and on the request of the ILL's Director (or his deputy), the Director of the CEA in Grenoble (or his deputy) may provide the ILL with technical and human resources appropriate to the situation, in the following areas:

- emergency premises for managing the emergency;
- response personnel.

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. For that purpose, exercises are held on a regular basis not only to train emergency teams, but also to test resources and structures, and hence to identify potential discrepancies. In addition to the exercises organised by operators to test their own internal structure, a national triennial emergency-response exercise on every site that includes a BNI seems to be a fair compromise between staff training and the lead-time to ensure the required evolution in the structures. The number of national exercises conducted since 1980 is 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 2009, announced to the prefects in a circular of 12 January 2009, 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.

In addition, an exercise including a safety aspect was also held in November 2009 on the Tricastin site, with a scenario involving an intrusion by terrorists armed with assault rifles and explosives. The main objectives of the exercise were to test the following:

- the operator’s alarm system for populations and stakeholders;
- the triggering, the power build-up and the co-ordination of control stations;
- the co-ordination among the operating staff of the site;
- the conduct of radioactivity measurements and the drawing of results;
- the management of communication crisis at the local level (prefecture and operator), and
- emergency management, associating a security related event with a nuclear-safety incident and associated interfaces.

The exercise was rich with lessons to be learnt by all stakeholders and placed the emergency-response structure in a rather unusual situation. The involvement of high-level stakeholders contributed to the quality of the exercise.

During most of these exercises, simulated media pressure is placed on the main stakeholders 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 2009 that involved reactors: each site with nuclear power reactors performs an exercise every three years.

Nuclear site	Date of exercise	Exercise target	Particular characteristics
Belleville-sur-Loire (EDF)	29 January 2009	Civil defence	Effective sheltering of volunteers within a 2-km radius.
Le Bugey (EDF)	26 March 2009	Nuclear safety	Warning of populations by PPI and SAPPRE, post-accident aspects on the issue of maintaining or evacuating populations.
CEA Cadarache	2 June 2009	Civil defence	Mixed civil and defence exercise; accident scenario of a defence BNI, with an impact on a civilian BNI.
Transport of radioactive materials	9 June 2009	Civil defence	Co-ordination between departmental and national levels in emergency management, simulated media pressure and organisation of the measurement unit.
CEA Saclay	19 September 2009	Civil defence	Test of master plan of measurement, test of communal protection plans, sheltering and (fake) ingestion of stable-iodine tablets, communication.
Major SECNUC exercise	21 October 2009	Nuclear safety	Impact management in France of an accident affecting a foreign country.
Tricastin (EDF)	26 November 2009	Nuclear safety	Co-ordination among the territorial departments and among the operators of the different BNIs of the relevant site following a malevolent act.

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 supplemented by telephone-based alert.

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 operator and the public authorities.

16.4.2 International exercises and co-operation

ASN maintains international relations in order to exchange the good practices that were observed during foreign exercises. Hence, in 2008 and 2009, ASN:

- participated in the preparation and conduct of an international Convex-3-type exercise, which was organised by the IAEA on a foreign accident having consequences for the nationals and interests of other countries, and
- greeted foreign delegations as observers of the exercises organised by France (Czech Republic, South Africa, Switzerland, United Kingdom, and auditors of the IRRS follow-up).

ASN is a member of the IAEA's National Competent Authorities Co-ordination Group (NCACG) and participates notably in the work aiming at implementing an action plan by competent authorities to improve international information exchanges in the event of a radiological emergency. In the framework of that action plan, ASN partakes in the development of a future consolidated notification system.

In addition, concerning international assistance, ASN has constituted a data bank, which includes all technical and human means available in the event of an accident or radiological emergency and which forms, since August 2008, an integral part of the competent authorities that recorded the French means of international assistance with the RANET network.

Lastly, the preparation of protocols for information and assistance exchanges with the safety authorities of bordering countries is under way.

16.4.3 Lessons learnt 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 is now being 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 the exercises also highlights actions or procedures that need improvement. All stakeholders integrate those elements and seek actively to find appropriate solutions. For that purpose, ASN requires that they meet twice a year in order not only to identify good practices, but also to point out required improvements. As an example of good practice, certain nuclear-accident scenarios are likely to generate radioactive discharges in the atmosphere over the short term (less than 6 h). In that framework, it is necessary to warn immediately all residents within the PPI area, also known as the “reflex area”. Since the experience learnt from training shows the significance of reducing warning lead-times for residents, the Prefect may now delegate his authority to the operator of the nuclear site involved, thus entitling the latter to warn residents much faster.

With regard to improvement areas, experience shows that it is necessary to achieve and to optimise a sound frequency in the rhythm of so-called “decisional” audio-conferences between technical teams, PCs and the communication units implemented in the framework of the national emergency-response structure. A fruitful use of audio-conferences is achieved when the Prefect meets alone with a limited number of his collaborators in order to avoid lengthy exchanges and role confusions.

16.5 Developments in nuclear-emergency management

As in the case of other areas of nuclear safety, it is necessary to modify the emergency-response structure in relation to newly-gained experience. The main sources of experience in France include the exercises themselves, major events in France and abroad, as well as exchanges with foreign countries. Hence, ASN has met several times with foreign safety authorities and visited their command emergency station between 2007 and 2009 with a view to identifying good practices in the organisation and management of emergency preparedness.

16.5.1 Protection measures for the population

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;
- ingestion 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 Stable-iodine tablets

The fourth preventive-distribution campaign started in 2009 around all NPP sites (Circular of 27 May 2009 on implementation procedures for iodine-distribution campaigns within PPI perimeters). In the framework of such campaigns, ASN distributed an information flyer on the monitoring of nuclear safety and radiation protection to 400,000 homes and 2,000 establishments open to the public.

The selected method consisted in launching an initial phase involving the distribution of boxes of tablets around NPPs operated by EDF. The method was based on a system of personal letters addressed to named individuals on letter-head paper and signed by the DSC, ASN and the French Order of Pharmacists . A personal exchange voucher was enclosed in every 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 mailing directly a box of tablets to households that had not picked up their own. Lastly, boxes are available at all times in every pharmacy in the area.

Since approximately 50% of the residents concerned have recovered their own box of tablets from a pharmacy, that means that more than 338,000 boxes have already been distributed.

The purpose of that method is to regulate distribution better, since it ensures a precise knowledge of the individuals who have received their own box of tablets. Hence, the final coverage rate is close to 100%. In addition, it sets up a reinforced partnership with pharmacists, thus providing an opportunity to create identical and clearly-identified contact points throughout all areas.

Lastly, at the government's request, Prefects planned the constitution of inventories in every department in order to cover the entire country.

16.5.3 Post-accident management

The so-called "post-accident" phase encompasses the handling of the various economic, sanitary and social consequences over the short and medium terms, and even the long term, in order to ensure the return to a situation that is considered as acceptable.

Pursuant to the Interministerial Directive of 7 April 2005, ASN, in association with the ministerial sections involved, is responsible for "establishing the framework, and for specifying, preparing and implementing relevant provisions in response to the post-accident situation". The Steering Committee for Post-accident Situations (CODIRPA) was instituted and various activities were conducted on different post-accident topics between 2005 and 2009. It is led by ASN and consists of representatives from the SGDSN, the Ministries for Agriculture and Fisheries, Budget, National Defence, Ecology, Health, Industry and Interior, as well as agencies, such as the French Agency for Food Safety (AFSSA), the French Agency for Health Safety, the Environment and Labour (AFSSET) and the Health Watch Institute (InVS) and IRSN. It also associates the CLIs, as well as various associations and elected officials.

In 2009, the CODIRPA set up a new structure by instituting two commissions, the first being dedicated to the study of the transition phase, and the second to the study on the long term.

The work of the Committee then continued in the following areas:

- the consolidation of the first doctrinal elements;
- consultations with stakeholders (decentralised State services and civil society), and
- the broadening of work, with due account of other accident scenarios (plutonium scenario and accident abroad).

A stakeholder-consultation process at both the local and national levels is under way in order to compare proposals that reflect the actual situation on site. The first results of that consultation have been integrated especially with regard to the zoning proposed by the working groups. That zoning was further simplified into two major areas in relation to the management concerning post-accident consequences.

The Commission 1 of CODIRPA is preparing a guide on management plans at the end of an emergency phase. That operational guide will provide local public authorities with some useful elements for preparing their local plan at the end of an emergency phase (actions to be conducted during the first week, during the transition phase, etc.).

In 2009, the first elements of the post-accident doctrine were tested during national radiological or radiological emergency exercises. Hence, the exercise which was performed on 26 March 2009 at Le Bugey NPP covered notably the issue whether to relocate residents or not after an accident.

An international seminar will be held in early 2011 in order to share once again the work of CODIRPA with the French and foreign experts and organisations concerned.

16.5.4 Recent events

At the request of the Minister of Health, ASN has developed a "new iodine doctrine" oriented towards the most sensitive populations and harmonised henceforth with that of bordering countries. In fact, the transborder work conducted with Belgium, Germany, Luxembourg and Switzerland have converged towards a common value of 50 mSv (equivalent dose to the thyroid) for the intervention level concerning the intake of stable-iodine tablets. Consequently, ASN proposed that the value be reduced from 100 to 50 mSv in France. That new doctrine was presented to the Minister who agreed to it in January 2009 and entrusted upon ASN to take those new provisions into account and to implement it.

After receiving the opinions of IRSN, of the Delegate for the Nuclear Safety and Radiation Protection in Defence-related Installations and Activities (DSND) and of the Ministry for the Interior, ASN decided on 18 August 2009 to set the intervention level at 50 mSv with regard to the equivalent dose to the thyroid for the administration of stable-iodine tablets. The Minister of Health homologated the decision on 20 November 2009.

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 procedure for application

Well before applying for a BNI creation authorisation, the prospective operator must inform the administration of the site(s) on which he plans to build the installation. The review deals notably with the socio-economic and safety aspects. ASN analyses the safety-related characteristics of the sites: seismicity, hydrogeology, industrial environment, cold-water sources, etc.

Any industrialist wishing to operate a BNI may request ASN's opinion, even before undertaking the licensing procedure, on all or some options he has selected to ensure the safety of the future installation. ASN's opinion is notified to the inquirer and must contain any complementary studies and justifications that will be required for the potential creation-licence application.

Afterwards, safety options will need to be included in the preliminary safety report of the licence-application case.

ASN normally calls upon a competent advisory committee to review the project. The advisory committee's opinion is then sent to the prospective operator in order for him to know for which questions to account in the creation authorisation application.

That preparatory procedure does not replace the further regulatory reviews, but rather aims at facilitating them.

Pursuant to Articles L. 121-1 *sqq*. of the *Environmental Code*, the creation of a BNI is subject to the public-debate procedure, if the project involves a new nuclear-power-generation site or a new site costing more than 300 million euros, and in certain cases, a new site costing between 150 and 300 million euros.

The public debate addresses the timeliness, objectives and characteristics of the project.

Public debates were organised in 2006 for the construction of an EPR at Flamanville and the implementation of an ITER research reactor at Cadarache.

In addition, the construction of any BNI is subject to a building permit issued by the competent prefect according to the procedures referred to in Articles R. 421-1 *sqq*. of the *Urban Planning Code*.

17.2 Practice during the period under consideration

17.2.1 Nuclear-power reactors

Choice of Flamanville for the site of the new EPR

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 "lead series" EPR. 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 reactors;
- 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 reactor 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 (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).

Launching of the Penly-3 Project

At the meeting of 1 April 2009, EDF's Board of Administration decided to launch the relevant process leading to the construction of a third nuclear reactor for power-generation on the Penly site (Seine-Maritime Department), involving a PWR of the EPR type.

On 26 May 2009, EDF called formally upon the National Public Debate Commission (CNDP), in accordance with applicable regulations. At the meeting of 1 July, the CNDP decided that the project would involve a public debate to be organised by the Commission itself. The public debate started in March 2010.

If the project is confirmed after the public debate, the Penly-3 reactor will be managed by a partnership in the form of a project company in which EDF will be the majority shareholder with 50% of the shares, plus one. GDF SUEZ and TOTAL will be associated in the operation. EDF has also undertaken various discussions in order to invite other power-generating companies to partake in the project, especially the National Italian Electricity Board (*Ente nazionale per l'energia elettrica* – ENEL), with which EDF has already signed a co-operation agreement for nuclear projects in Italy and France and which already participates in the Flamanville-3 EPR Project; other discussions are also under way with E.ON, the second largest nuclear operator in Europe. The founding principle of that partnership is to have at Penly a second project involving the construction of a nuclear-power-generation unit involving a similar EPR to Flamanville-3.

With regard to the governance of the project, the government intends to entrust upon EDF the operation of that second EPR-type nuclear reactor once the current public debate is over, if the decision is made to proceed with the project. According to the 2006 *TSN Act*, the nuclear operator is responsible for the safety of his installation, not only as far as technical aspects are concerned, but also for the management of the required human and financial resources. EDF will have to ensure that responsibility for the safety of the Penly-3 Unit with the same rigour as for its own nuclear fleet. Once created, the Penly-3 Project Company will sign a contract with EDF with a view to building the NPP and then a second one, to operating it. According to that scenario, construction is scheduled to begin (first reactor concrete) in 2012 and the new reactor should be commissioned by 2017.

17.2.2 Research reactors

The site chosen by the CEA for the Jules Horowitz reactor (RJH***)*** at Cadarache was examined by ASN in 2003 in the framework of the review of the safety-option report of that reactor project.

Various complementary geotechnical and hydrogeological activities were carried out in order to acquire additional information on the quality of the rock massif supporting sensitive buildings and to calculate the basis for sizing the water-drainage system in the event of a groundwater rise.

In accordance with the National Public Debate Commission’s (CNDP) recommendation, the CEA conducted a consultation on the RJH Project in 2005 with a view to ensuring that the public be well informed and able to express its views thanks to the implementation of various means. Four public meetings were held in different communes around the Cadarache Centre.

Questions from the public dealt mainly with the socio-economic impacts of the RJH Project, such as the infrastructures associated with road traffic or the inflow of new residents. Environmental aspects were also addressed, and especially water management.

In 2008, the CEA submitted a report in accordance with Article 37 of the *EURATOM Treaty*. The European Commission issued a positive opinion in December 2008 on the overall data pertaining to the project for radioactive-effluent discharges originating from RJH.

17.3 ASN’s analysis

In May 2006, after about 10 years without any nuclear reactor being built in France, EDF submitted to the Ministers in charge of nuclear safety and radiation protection, a authorisation application to build a 1,600-MWe EPR on the site of Flamanville, where two 1,300-MWe reactors already exist.

The EPR, developed by AREVA NP, consists of a PWR design based on an “evolutionary” design, compared to the reactors currently in service in France, thus allowing for reinforced safety objectives to be fulfilled.

The government authorised its creation by Decree No. 2007-534 of 10 April 2007, after having received the ASN’s positive opinion, which followed the regulatory body’s technical review in consultation with its technical support bodies.

Once the creation authorisation decree (DAC) and the building permit were issued, the construction of the Flamanville-3 reactor started in September 2007 for a period of about 5 years. The first concrete-pouring operations for the buildings of the nuclear island took place in December 2007. Since then, reinforcement-installation and concreting operations have been under way. In parallel with worksite activities on the Flamanville site, the manufacturing of pressurised equipment, notably those constituting the primary circuits (vessel, pressuriser, pumps, valves and fittings, pipes, etc.) and the secondary circuits (steam generators, valves and fittings, pipes, etc.), is under way in the manufacturers' workshops.

17.3.1 Pre-commissioning steps

Pursuant to the 2007 Procedure Decree, the introduction of nuclear fuel within the perimeter of the installation and the start-up of the latter are subject to ASN's authorisation. In accordance with Article 20 of the same Decree, the operator must submit, no later than one year before the scheduled commissioning date, an a supporting case including the safety report, the general operating rules, a management study on the waste originating from the installation, the PUI and the decommissioning plan of the installation.

Without waiting for the full commissioning application to be received, ASN launched, together with IRSN, an anticipated review of certain topics requiring a long analysis.

In parallel with that anticipated technical review, ASN is also supervising the construction of the installation in preparation for the commissioning licence, with a view to deciding whether the construction quality of the installation and its capability to fulfil specified requirements are satisfactory.

17.3.2 Anticipated review of regulatory documents

The anticipated review conducted by ASN and IRSN deals essentially with the content of the safety report and the changes of the general operating rules compared to those applicable to current reactors, and concerns notably the following:

- the methodologies and calculation software used by EDF to model incident and accident transients likely to occur within a reactor;
- the principles and methods to develop general operating rules in accordance with the regulatory framework, and
- the organisational principles, as well as the human and technical means planned by EDF for the operation of the Flamanville-3 reactor, for which ASN will solicit the advisory committee's opinion in December 2010.

17.3.3 Review of the creation conditions for the Penly EPR

Public-debate procedures relating to the creation of an EPR on the Penly site started during the spring of 2010. Together with its partners in that project (GDF SUEZ, Total, ENEL and E.ON), EDF submitted for that purpose and in its capacity as the client, a file to the *Ad Hoc Commission on Public Debate*. At that stage, the operator, as defined by the *2006 TSN Act*, is still not officially designated. While specifying that the arrival of a new operator in France may improve the safety level of nuclear reactors in France by the introduction of new working methods, ASN has already emphasised how important it was to determine clearly the governance of the project. It considers that the operator must have the required technical and financial resources in order to manage fully the overall project and maintain its control at all times. The organisation chart between the various actors must be robust.

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 an operator 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 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 Creation authorisation decrees

18.1.2.1 Submission of the creation authorisation application

The creation authorisation application for a BNI is submitted to the Ministers in charge of nuclear safety by the industrialist who would be responsible for operating the future installation, thus acquiring the status of operator. The application must be accompanied by a case consisting of several documents, including the detailed plan of the installation, the impact study, the preliminary safety report, a risk-prevention study and the decommissioning plan.

ASN ensures the review of the case, in conjunction with the Ministers in charge of nuclear safety, thus launching a period of parallel consultations with the public and technical experts.

The impact study is subject to the opinion of the Environmental Authority within the General Council for the Environment and Sustainable Development (CGEDD).

18.1.2.2 Public consultation

The authorisation may only be delivered after a public inquiry as specified in article 29-I of the act of 13 June 2006. 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.

The Prefect launches the public inquiry in every commune whose territory is located partly within a radius of 5 km of the installation. The supporting documents submitted by the operator are integrated in the public-inquiry case. However, since the safety report (which includes the risk inventory of the installation, an assessment of the associated risk-prevention measures and the description of the relevant measures to limit the probability of accidents and their impact) is a bulky document, which is hard to understand for non-specialists, it is replaced in the public-inquiry case by the risk-prevention study, which has the same purpose, but is written in preparation for various consultations. The safety report, on the other hand, is available to all individuals upon request.

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.

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 (CLI)

Article 22 of the 2006 *TSN Act* formalised the statute of CLIs for BNIs. Those committees, which are established by the President of the CGEDD, include elected officials, associations, trade unions, qualified public figures and representatives from the economic sector. Their general mission involves monitoring, information and consultation activities with regard to nuclear safety, radiation protection, as well as the impact of the nuclear operations of installations upon human beings and the environment within their jurisdiction. A CLI may be created as early as the submission of the creation authorisation application for a BNI. In any case, it must be in effect once the authorisation has been issued.

18.1.2.4 Consultation of technical organisations

The preliminary safety report appended to the creation authorisation application is transmitted to ASN, which submits it in turn for review to one of its supporting advisory committees, following a report from IRSN.

After conducting its review and noting the results of its consultations, ASN proposes to the Ministers in charge of nuclear safety the terms of a draft decree authorising or denying the creation of the installation.

18.1.2.5 Creation authorisation decree

The Ministers in charge of nuclear safety provide the prospective operator a copy of the draft decree authorising or denying the licence and a maximum period of two months for submitting his comments.

After consultation with the prospective operator, the Ministers in charge of Nuclear Safety finalise the draft decree and submit it, together with the public-inquiry case, to the Consultative Committee on BNIs (CCINB) for advice.

The CCINB must provide its opinion within a period of two months after referral. The Ministers in charge of nuclear safety must also seek ASN's opinion on the final draft of the decree authorising or denying the creation authorisation, which may have been modified in the meantime in order to account for CCINB comments.

The creation authorisation for a BNI is issued by a decree signed by the Prime Minister and countersigned by the Ministers in charge of nuclear safety.

The creation authorisation decree (DAC) delineates the perimeter and characteristics of the installation, as well as the specific rules with which the operator must comply. It also determines the term of the authorisation and the commissioning lead-time of the installation. Furthermore, it designates the essential components that require protective measures regarding public security, health and sanitation or the protection of nature and the environment.

Most creation authorisation decrees, which are currently in effect, were taken in the framework of the system that existed before the *2006 TSN Act* and was ruled by Decree No. 63-1228 of 11 December 1963 on Nuclear Installations and Decree No. 95-540 of 4 May 1995 on NBI liquid and gaseous effluent discharges and water intakes. Consequently, their structure is not always consistent with the new rules, but they remain valid until their next amendment.

18.1.2.6 ASN prescriptions for the **DAC enforcement**

With regard to the DAC enforcement, ASN specifies the prescriptions pertaining to the design, construction and operation of the BNI, that it deems necessary for nuclear-security purposes.

Those prescriptions concern notably the quality of design, construction and operation of the installation, its protection and security systems, contingency means, ventilation and discharge circuits and anti-seismic protection, together with the radiological protection of the environment and of workers, the transport of radioactive products, and finally all changes to the installation, its final shutdown and its decommissioning.

More particularly, ASN sets forth the requirements relating to the BNI's water intakes and to the radioactive materials originating from the BNI. Specific prescriptions establishing the BNI's discharge limits into the environment must be homologated by the Ministers in charge of nuclear safety.

In the previous system enforced by the *2006 TSN Act*, water intakes and discharges were authorised separately from the creation of the installation. Hence, BNIs had independent authorisation orders for discharges and water intakes. A certain number of those orders are still valid, but will be superseded by new ASN prescriptions.

18.1.2.7 Changes to the installation

The operator must notify ASN of any change to the installation that requires an update of the general operating rules (RGEs) or the PUI.

A new authorisation for which the application must be reviewed in accordance with the procedure for creation authorisation applications described before must be issued, if the operator changes, if the perimeter of the installation is modified or if a significant change is made to it.

A change is considered as significant, if it involves:

- either a change in the nature of the installation or an increase in its maximum change capacity regarding the essential components for the protection of the interests referred to in Paragraph I of Article 28 of the *2006 TSN Act*, as reiterated in the licensing decree,
- or the addition, within the perimeter of the installation, of a new BNI, as referred to in Paragraph III of Article 28 of the *2006 TSN Act*, whose operation is associated with the installation involved.

18.1.2.8 Other installations located within the BNI perimeter

Within the perimeter of a BNI, there coexist two types of installations, as follows:

- all equipment and facilities that form an integral part of the BNI and constitute required components for its operation; technically speaking, they may be assimilated, depending on their nature, to classified installations, but, as BNI components, they are subject to the same procedure applicable to BNIs, and

- classified equipment and facilities, which are not linked with the BNI.

All required equipment for the operation of the BNI is subject to the BNI regime, as prescribed by the 2007 Procedure Decree. The other equipment is subject to another regulation (water or ICPE), but since it is located with the BNI perimeter, it remains regulated by that BNI regime, although the competent authority for individual decisions shifts from the Prefect to ASN.

18.2 Description of current projects

18.2.1 Nuclear power reactors

The EPR is an evolutionary PWR, which was initially developed by a group of French and German industrialists and power utilities (Framatome, Siemens, followed by AREVA NP, with EDF and a group of German power utilities). In terms of safety, the project includes a significant reinforcement of the defence in depth compared to current reactors.

The review of the safety options of the project began in 1993 through a Franco-German technical co-operation project. The successive recommendations formulated by the French and German expert groups were approved jointly by the regulatory bodies of both countries, and since the end of 1998, by ASN alone.

The review process continued and went through the following steps:

- in 1997, the transmission to the French and German regulatory bodies of the “Basic Design Report”, consisting of a detailed preliminary project, followed by an update in February 1999, and
- the drafting of “Technical Guidelines”, consisting of a set of recommendations concerning the main safety options of the EPR Project.

The final version of that compendium describing the main safety options of the French-German EPR project was validated by the advisory committee for reactors in October 2000, in consultation with German safety experts.

Preliminary safety report and creation licence

In late 2003, the EPR was selected as the design for Finland’s fifth reactor, which is currently under construction by AREVA NP.

In France, meanwhile, Parliament came out in favour of the construction of an EPR in June 2004, following a debate on the future orientations of the French energy policy. The project involved a public debate in 2005 pursuant to Articles L. 121-1 *sq*. of the *Environmental Code* and to Decree No. 2002-1275 of 22 October 2002.

The creation authorisation application was submitted in May 2006. The public inquiry was held from 15 June to 31 July 2006.

In accordance with decree 63-1228 of 11 December, 1963, as amended, on nuclear installations and decree 85-453 of 23 April 1985 (articles R123-6 of the environment code), the creation 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 minutes report sent by the inquiry commission.

The creation 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.

Construction of the Flamanville-3 EPR

Preparatory work started during the summer of 2006 and consisted of earthworks and the improvement of the prospective site for the new EPR, the preparation of the excavations for the construction of the buildings, as well as the construction of certain buried auxiliary structures, such as technical connecting drifts, cooling-water pipes and the pre-stressing drift of the nuclear island.

The construction of the buildings of the EPR plant block itself began during the summer of 2007 after the publication of the DAC. The major steps of the construction so far have included the following:

- December 2007: pouring of the first concrete of the nuclear island, corresponding to the initial concreting of the bottom slab of the reactor building;
- December 2008: pouring of the group table in the engine room;
- spring 2009: pouring of the gusset of the reactor building and beginning of the construction of both reactor containments;
- summer 2009: completion of the engine room's main structure, beginning of electromechanical assemblies in the buildings of the conventional island; launching of the excavation of the under seabed discharge drift,
- spring 2010: first activation of electrical systems and control and instrumentation systems; beginning of electromechanical assemblies in the buildings of the nuclear island in parallel with the construction of the civil-engineering components of buildings.

Fabrication of equipment

Fabrication is under way for the boiler equipment (vessel, steam generators, branch lines of the primary circuit, pressuriser, etc.). The large forgings constituting the vessel, including the nozzle-support ring and steam generators have been manufactured in advance. Major fabrication stages included the following:

- 2007 and 2008: initial arrival of the forgings of the pressuriser and the castings of the volute casing of primary pumps. Initiation of the fabrication of the vessel and steam generators (inner stainless-steel lining of vessel forgings and of the primary section of steam generators, etc). The first forging assemblies were welded in 2008;
- 2009: welding of eight 8 vessel nozzles on the nozzle-support ring and of core shells between them. The lower sections of steam generators were assembled together, as well as upper sections, and
- 2010: installation of tube support plates and of tube bundles in the steam generators. The first helium tests on steal generators are scheduled. The lower and upper sections of the pressuriser will be assembled.

The fabrication of the equipment for the engine room (turbine, alternator, exchangers, condenser, etc.) started in 2007 (forgings of low-pressure rotors, pouring of the high-pressure cylinder of the turbine, etc.). The major steps included the following:

- 2008: high and low-pressure rotor forgings of the turbine, forging of the alternator rotor, fabrication of high-pressure heaters, etc., and
- 2009: delivery of the first condenser components and of the feedwater tank, installation of 20-t and 300-t cranes, etc.

Review of the safety case

Once the DAC was published in the French *Journal officiel (*Official Gazette) in April 2007, the next major milestone in the planning of the project is the commissioning licence, corresponding to the first loading of nuclear fuel in the reactor.

In order to prepare that next regulatory step, an important review programme was set up between ASN and IRSN. It was launched during the first quarter of 2007 and maintained at a sustained rhythm throughout 2008 and 2009. The programme is monitored on a regular basis by ASN and IRSN, notably through monthly progress meetings with EDF.

The 2008 review was particularly intensive concerning civil-engineering issues, the doctrine and methodology for developing RGEs or control and instrumentation systems. It also involved many other topics, such as accident studies, reference systems for internal and external aggressions, man-machine interface, radiation protection, the qualification approach, the organisation of the operating team, the primary source term and the drop of fuel bundles.

In 2009, the review dealt especially with control and instrumentation systems, the development methodology and the content of future RGEs, accident studies or civil-engineering issues. Other topics were also reviewed, including reference systems for aggressions, man-machine interface, primary pumps and probabilistic safety analysis (PSA) methodology.

Pursuant to the *2006 TSN Act* and the 2007 Procedure Decree:

- in accordance with Article 18 the of the Decree, ASN notified EDF about a first series of prescriptions relating to the design and construction of the Flamanville-3 reactor and for the operation of the Flamanville-1 and 2 reactors;
- in accordance with Article 21 of the Act, EDF issued and distributed to the public the first BNI annual report of the Flamanville-3 reactor for fiscal year 2007, and
- in accordance with ASN's technical prescriptions, EDF also issued the safety policy of the Nuclear Engineering Division.

In order to prepare its decisions, ASN relies on the opinions and recommendations of its advisory committees. The advisory committee for reactors met several times over the last few years in order to address various topics concerning the EPR, such as the reference system for equipment qualification under accident conditions; ruptures of the shutdown cooling system; pool accidents in the fuel building; effluents and waste; reference system for external floods; clogging risk in the filtration chain of safety injection systems and emergency containment cooling systems; the protection approach against aggressions and reference systems for aggressions (fire, internal explosion, lightning, cold spell); architecture and platforms of control and instrumentation systems; calculations of the radiological impact of accidents without core melt, etc.

In June 2009, the advisory committee for reactors reviewed the EPR's computerised control and instrumentation systems. In order to ensure safety, the EPR's system includes two independent and complementary systems designed to run the reactor under all circumstances, as follows:

- the first system (Téléperm XS platform) is dedicated to the reactor's automated protective and shutdown functions in the event of an incident and to its return to safe operating conditions, in support of the highest safety-classification functions, and
- the second system (SPPA T2000 platform), which acts as a complement , is designed to run the reactor directly from the control room under safe conditions during normal operation and for management purposes over the long term in the event of an accident.

In a letter addressed to EDF on 15 October 2009, ASN noted that EDF had presented the necessary elements in order to demonstrate the capability of the first system to bear the highest safety-classification functions. In addition, ASN also felt that the technological diversity of both systems, which represents a significant component for the robustness of the architecture and the reliability of the control and instrumentation systems, was satisfactory. However, ASN also noted that conformity with the safety classification level of the second system had not been demonstrated so far, not only for automated controls, but also for operating controls (man-machine interface). Furthermore, ASN felt that the strong interconnection of control and instrumentation systems (via the communication network) calls for the reinforcement of the existing robustness specifications for their architecture (backup measures in the event of a failure in part of the functions of control and instrumentation systems). Besides the continuation of the qualification programme for that system, ASN also requested EDF in the same letter to study various design options, if that qualification were refused.

Following the review conducted by ASN and IRSN, its technical supporting body, of the first elements provided by EDF in response to ASN's letter mentioned above, ASN concluded, in a letter addressed to EDF on 9 July 2010 that the ability of the SPPA T2000 platform to assume some protective functions for the reactor was yet to be demonstrated. Hence, it requested EDF to implement a change in the T2000 platform in order to improve robustness and to authorise its use for EPR-type reactors. That change consists in duplicating on the Téléperm XS platform a certain number of protective functions of the reactor, which are borne by the SPPA T2000 platform.

For ASN's review of control and instrumentation systems, EDF will have to present the detailed elements of that evolution in the design and the impact on the demonstration of the reactor's safety by the end of 2010.

Quality of on-site construction and assemblies

Pursuant to Article 4 of the 1984 Quality Order, EDF is responsible for monitoring the quality of major safety-related activities, and particularly of activities relating to the study, construction and *in-situ* assembly of significant safety-related components.

EDF monitors itself the construction and all assemblies on the worksite. As for ASN, it carries out inspections on the worksite on an average of twice every month (unscheduled or scheduled inspections (refer to §18.3.1.5 and 18.3.1.6).

Year 2008 was marked by a flaw in civil-engineering operations, when a total of 61 support pins were forgotten in the reinforcement of the bottom slab of an electrical building, thus suspending the concreting of safety-related structures for about three weeks.

The analysis of the incident highlighted a number of malfunctions in the management of the project and forced EDF's planning teams on site to implement an action plan based on the following two objectives:

- to reinforce the safety culture of all interveners, and
- to improve rigour in the conduct and monitoring of the construction.

On the other hand, considering the important rate of weld repairs carried out on the bottom of the liner of the reactor building in 2009, ASN has requested EDF to implement an action plan designed to improve significantly the quality of welds and, in the meantime, has ordered that all welding operations be suspended.

The action plan has already been launched by both the contractor and EDF, as follows:

- the contractor is responsible for optimising welding conditions, setting in place training sessions for the welders, reinforcing monitoring indicators, reinforcing the internal supervision of the subcontractor installing the liner, as well as supervising the worksite, and
- EDF is responsible for reinforcing monitoring and checking all radiographic-control films.

The durability of the new organisation has been secured over the long term. In the light of the improvements that were observed during the welding of the first lining ring, EDF was able to return to random monitoring on the subsequent rings, as prescribed by the *EPR Technical Code for Civil Works* (ETC-C Code).

Manufacturing quality for the EPR

The monitoring of EPR-component manufacturing encompasses the technical supervision and monitoring of the manufacturing steps, from the upstream review of the contractual conformity of the contractors' technical documentation up to the *in-situ* inspections of the plants and on the Flamanville-3 construction site.

EDF holds monthly meetings for its manufacturing teams in order to review industrial schemes, to provide updates on fabrication activities, to analyse corresponding critical paths and to assess most particularly all problems being encountered.

Those meetings have been instrumental in ensuring the relevant manufacturing "quality and delay" co-ordination and monitoring, as well as the related progress reports.

The manufacturing monitoring of the Flamanville-3 EPR reached its full charge in 2009. In comparison to 2008, year 2009 was marked by a considerable increase in monitoring efforts on the project (in the order of 40% or 25,000 h).

In 2009, the overall manufacturing monitoring of mechanical equipment involved 625 contractors among a panel of about 800 who are subject to the monitoring plan. The "contact" with the industrial fabric throughout the year was materialised by about 4,000 visits in France and abroad. Overall, the volume of monitoring actions in plants tended to increase by 25% in 2009, compared to 2008.

In the framework of those activities in response notably to the regulatory-monitoring requirements prescribed by Article 4 of the 1984 Quality Order, more than 400 discrepancies (about 60% of which dealt only with the Flamanville-3 EPR) were formally recorded by inspectors over the last 12 months in the form of discrepancy slips and notified to contractors for information and rectification purposes.

ASN's supervision

ASN carries out its own inspections on the organisation of the project or of engineering activities (for instance, the organisation and guidance for the qualification of equipment under accident conditions or EDF's supervision of its subcontractors, etc.), or even the fabrication of equipment on the builders' premises.

In addition, the mission of ASN nuclear pressure equipment department (DEP) is to regulate the manufacturing of Level-1 nuclear pressurised equipment (refer to §18.3.1.7).

Preparation for the operation of the Flamanville-3 EPR

The Flamanville-3 unit in charge of operating the reactor was created in June 2009. During the same year, the structure of the unit was set up and agents were grouped on the Flamanville site during the second half of the year.

Monitoring and guidance authorities, which are all chaired by a member of the EDF Steering Committee, are now set in place in order to ensure managerial consistency and leadership.

The various services have initiated their reflection by delineating their own jurisdiction, clarifying their mission and their interface management among themselves. In addition, every service has committed itself to the provisional management of jobs and skills.

At the end of 2009, the Flamanville-3 unit included 277 employees. Six "trade academies" had already been held. Nearly 150 people have been trained. Operational training sessions started first in classrooms, but moved eventually to simulators in early 2010, while training on information systems also began.

The required structures for developing operating documents were implemented in 2009 and the drafting of the actual operating documents began immediately afterwards in relation to the study documents already received.

Nuclear safety is integrated as a priority within Flamanville-3 as early as the pre-operational phase. Concrete actions in 2009 in that field dealt notably with the following aspects: skill development, independent safety system, RGEs and PUI.

The continuation of the preparations for the reactor operation focuses on the following topics:

- designation and training of operating teams;
- drafting of operating documents and of RGEs for the start-up of the reactor, and
- contributions to detailed technical design guidelines in order to ensure the expected operating behaviour.

18.2.2 Research reactors

CEA, EDF and AREVA NP, together with some of their European partners (CEN-SCK in Belgium, UJV in the Czech Republic VTT in Finland and CIEMAT in Spain) consider that a new reactor, known as the Jules Horowitz reactor (JHR), should be built because the European irradiation reactors in use are ageing and will be shut down over the medium or long term. The new irradiation reactor would meet research and development requirements until around 2050. Its commissioning is currently scheduled in 2014.

The reactor's primary objectives include the irradiation of materials and fuels in support of international nuclear-power programmes, the production of artificial radioelements for medical-diagnosis and cancer-treatment purposes, as well as 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.

In the summer of 2003, ASN indicated that based on the safety options 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 decommissioning.

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 authorisation application (DARPE), in compliance with decree 95-540 of 4 May 1995.

In September 2006, ASN stated that the public-inquiry documentation in support of the applications for the creation authorisation and for effluent discharges and water intakes was receivable. The public-inquiry procedure was launched by the Prefect in eight municipalities around the Cadarache site in November and December 2006.

In addition, the preliminary safety report of the RJH was examined by the advisory committee for reactors at eight meetings that were held between June 2007 and June 2008. The review focused particularly on the following safety topics:

- 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;
- Human and organisational factors.

The overall process led to the presentation of a draft DAC of the reactor to the Consultative Committee on BNIs (CCBNI) on 16 March 2009.

The DAC for the RJH was signed by the Prime Minister on 12 October 2009 (Decree No. 2009-1219).

18.3 ASN's analysis

18.3.1 Design and construction of nuclear-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 advisory committee for nuclear reactors 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 non-nuclear risk consideration with the current procedure in the other industrial installations.

Hence, ASN made sure that the supporting documentation of the application submitted on 9 May 2006 complied with the specified regulatory provisions, safety objectives and technical guidelines for the EPR.

In February 2007, ASN submitted a favourable opinion to the government concerning the authorisation of the reactor.

18.3.1.1 Integration of defence in depth during the EPR design and construction stages

The safety of the EPR was implemented at the design stage and relies on a defence-in-depth system covering five levels, as follows:

- the first level combines specific margins concerning design, quality assurance and inspection activities in order to prevent abnormal or defective operating conditions;
- the second level consists in the implementation of protective measures in order to detect discrepancies from normal operating or system-failure conditions. That defence level is prescribed in order to ensure the integrity of the fuel cladding and of the primary cooling system, and consequently, to prevent accidents;
- the third level is achieved by protection or back-up systems and operating procedures designed to control the impact of potential accidents, by containing radioactive substances, in order to prevent the situation from evolving towards a severe accident;
- the fourth level includes measures designed to preserve the integrity of the containment and to control severe accidental conditions, and
- the fifth level includes, in the event of a malfunction or of the ineffectiveness of the above-mentioned provisions, all relevant measures to protect the public against significant discharges.

A very high safety level is sought for the EPR, firstly by facilitating its operation and maintenance, secondly by reducing immediate or deferred potential consequences of its operation, in relation to its close environment (particularly with regard to neighbouring populations) and the operating staff. In addition, research and development activities, which are conducted especially in the field of hypothetical severe accidents, contribute to the understanding of the phenomena involved and, thus, to the improvement of safety.

At the design stage, the approach consisting in verifying the consistency of the design with the different lines of defence in depth is described in the preliminary safety report, which was submitted to ASN and the High Level Defence Servant for security aspects in support of the creation authorisation application for a third reactor on the Flamanville site.

Control of simple triggering events

The safety demonstration is based not only on a limited number of representative events and of incident or accident scenarios to be taken into account at the design stage of the reactor, among those that are likely to occur during its operation, but also on the various physical states of the reactor (in operation, various shutdown situations). Transient-triggering events are grouped under several categories according to the estimation of their frequency of occurrence and on their impact on the environment. On that basis, there are four categories of events (categories of operating conditions of the reactor) as follows:

- Category 1 includes all normal operating situations;
- Category 2 groups all transients likely to occur at a rate varying between 1E-2 and 1 per year per reactor;
- Category 3 covers incidents likely to appear at a rate varying between 1E-4 and 1E-2 per year per reactor, and

- Category 4 refers to accidents likely to occur at a rate varying between 1E-6 and 1E-4 per year per reactor.

The identification of such events and their classification into categories are used for the design of the primary and secondary circuits, as well as of the back-up and protection systems used to control those situations and, consequently, to prevent unacceptable consequences for the installation and its environment.

On the basis of the design of the installation and of guidance principles, the management of the main operating conditions in the event of an accident (up to the assessment of associated radiological effects) are analysed in the preliminary safety report.

Risk mitigation and prevention of potential situations leading to the core melt

In parallel to the control of simple triggering events and on the basis of probabilistic safety analysis (PSA) design results, an analysis of situations likely to lead a core melt complements the procedures to prevent core-melt situations.

Risk-reduction category A (RRC-A) includes the combination of prevailing events (from a probabilistic standpoint), called “sequences”, which may lead core-melt situations due to the multiple failures they induce. The list of conditions for multiple failures, which is proposed in that analysis, may be revised during the detailed analyses performed in the framework of the PSA update.

From a technical point, additional back-up systems have been designed and installed in order to prevent core-melt events during such sequences. RRC-A sequences are analysed in the preliminary safety report.

Risk mitigation and control of core-melt situations

The control of core-melt situations constitutes the second step in risk mitigation; it relies on the safety analysis of the scenarios involving core-melt sequences at low pressure, while the other core-melt scenarios are subject to specific provisions allowing for the exclusion or the “practical elimination” of their occurrence.

The analysis of all such scenarios, including the assessment of related radiological effects, is developed in the preliminary safety report. The analysis identifies suitable means to ensure and protect the containment function (retention and cooling of the melted core outside the reactor vessel in order to prevent any penetration through the bottom slab; extraction of residual heat from the containment, management of hydrogen risk, etc.). It also designates the instrumentation required by the operator and the emergency team to manage that type of situation and to specify the relevant qualification conditions for the equipment to be used to demonstrate that safety objectives are met.

All analyses presented in the preliminary safety report during the design stage (with due account of various representative fuel-management methods) will be submitted to a new review in the supporting safety report for the commissioning authorisation application. That safety report will integrate the detailed design and particularly, the fuel-management method (which will be formalised before the installation is commissioned) and the RGEs.

18.3.1.2 Qualification of key safety-related components: the EPR case

The EPR belongs to the third PWR generation, which seeks to reach a very high safety level. That gain in safety relies on the integration, within an evolutionary design and in the framework of an approach of continued progress, of all expertise and experience acquired during the operation of several thousands of reactor-years. Within the context of the safety analysis, national and international experience feedback is analysed systematically in order to identify the positive elements and the weak points to be taken into account with regard to EDF reactors. The results of those analyses have led to design and operational changes on the existing reactors and to design developments for the EPR.

All EPR components required to ensure a safety function must be attributed a safety classification level and must be qualified. The purpose of such qualification is to prove that the equipment is able to maintain its function under ambient conditions and solicitations that appear after accidents. Qualification requirements are determined and taken into account at the level of the equipment design by relying on technical operational specifications, according to its safety-related role and the conditions under which the required equipment is used throughout its operating lifetime. As in the case of operating conditions, qualification procedures account for ageing effects (i.e., the cumulative effects of ambient conditions corresponding to normal operating conditions before an accident) and, if need be, the effects of ambient conditions resulting from an accident and the impact of seismic solicitations for the equipment that must be qualified for the earthquake, due to their involvement under accident conditions.

Several methods are used for the qualification procedure, such as:

- qualification by testing, which consists in submitting a representative equipment of the kind being installed in the reactor to representative stimuli of the ambient operating conditions and of solicitations under which it must maintain its function;
- qualification by calculations, which consists in demonstrating that the ambient conditions and solicitations imposed on the equipment have acceptable consequences on it;
- qualification by operating experience, which consists in establishing the capability of the equipment to fulfil its safety functions; it relies on the historical analysis of its industrial operation (in practice, that method is rarely implemented alone; it is used in order to complete and to confirm the behaviour of a component whose qualification has been demonstrated by using other methods), and
- qualification by analogy, which consists in making a comparison based on the logical rules of the equipment to be qualified with “similar” equipment that is already qualified.

Combinations of the methods presented above may sometimes be used and may vary in relation to the equipment involved.

With regard to innovative devices relating to the management of severe accidents, the design of the core catcher was justified on the basis of a large number of experiment results.

18.3.1.3 Construction-control objectives

ASN is faced with multiple challenges with regard to controlling the construction of the Flamanville-3 reactor. They include notably the following:

- setting construction control within the new regulatory framework prescribed by the *2006 TSN Act*;
- controlling the construction quality of the installation proportionately to the challenges pertaining to safety, radiation protection and environmental protection, and
- capitalising the individual experience acquired by every stakeholder during the construction of the new reactor.

In order to achieve those goals, ASN fulfils its control and inspection mission. With regard to the DAC enforcement, ASN has developed various prescriptions relating to the design and construction of the Flamanville-3 reactor In the case of the DAC enforcement, it has also established prescriptions concerning the design and construction of the Flamanville-3 reactor and the operation of the adjacent Flamanville-1 and 2 reactors.

The principles and procedures for controlling the EPR construction cover the following steps:

- the detailed design for which relevant studies specify the required data for its achievement, and
- the activities involved in its execution, which encompass the preparation of the site after the issue of the DAC, as well as fabrication, construction, qualification assembly of structures, systems and components either on the worksite or on manufacturers’ premises.

That control covers also the prevention of risks pertaining to construction activities on adjacent BNIs (Flamanville-1 and 2 reactors) and to the environment. Since a nuclear-power reactor is involved, ASN is responsible for labour inspections on the construction site.

Lastly, in parallel with the construction of reactor buildings, ASN ensures also the control of the manufacturing of nuclear pressurised equipment that will form part of the primary and secondary circuits of the nuclear boiler.

18.3.1.4 Review of the detailed design

ASN reviews the detailed design with IRSN's technical support and on the basis of a review of the relevant documentation. In 2009, ASN requested the advisory committee for reactor's opinion on the design of the digital control and instrumentation system and of the physical platforms for the corresponding software. The architecture of that system includes two platforms; the first was developed specifically for nuclear industry, whereas the second is an industrial component.

In the latter case, the conformity demonstration with requirements relating to nuclear safety proves to be more difficult than for elements whose design accounted for those requirements right from the start. EDF was notified about ASN's request. The British and Finnish safety authorities, HSE and STUK respectively, share ASN's conclusions of the architecture analysis of the control and instrumentation system. In the framework of an international co-operation project, that position gave rise to a common statement, issued on 2 November 2009.

(*http://www.asn.fr/index.php/S-informer/Actualites/2009/Systeme-de-controle-commande-du-reacteur-EPR*).

As a complement to the technical review of detailed design studies carried out with IRSN's support, ASN conducted nine inspections in 2009 in the engineering services in charge of preparing them and of monitoring fabrication activities on contractors' premises. Hence, ASN has controlled the implementation of the requirements of the Order of 10 August 1994, especially those relating to contractor management and monitoring, the identification and management of quality-related activities, discrepancy management, experience-feedback management and the integration of FOHs on the worksite. Compliace with those requirements was checked at both the level of engineering services and of the Flamanville-3 worksite.

During inspections, ASN noted that the existing structure in the different EDF monitoring services was generally satisfactory. However, traceability gaps in EDF's monitoring activities were detected. In addition, ASN considers that EDF must improve its document-control system for manufacturing systems, structures and components, in order to ensure that the version in use has been duly validated. Furthermore, it seemed appropriate for EDF, with the support of specialists in the field, to adopt a more systematic approach for analysing and improving in terms of Human and organisational factors the sensitive activities implemented on the worksite.

18.3.1.5 Supervision of building activities on the Flamanville-3 site

On the construction site, ASN, together with IRSN's support, has performed 24 inspections that covered especially the following technical topics:

- civil engineering, including activities relating to the implementation of the metal liner of the internal containment of the reactor building;
- the first electromechanical-assembly activities;
- electrical systems;
- non-destructive controls and radiation protection;
- safety structure and management on the worksite, and
- the impact of the worksite on the safety of the Flamanville-1 and 2 reactors.

Following the 2009 inspections and the discrepancy review, ASN considers that the Bouygues Company, which holds a civil-engineering contract, has improved the quality of its documentation and of its internal technical audit. ASN also noted that many construction derogations in the field of civil engineering with regard to the applicable reference system had been used and feels that rigour in the identification and justification of such derogations ought to be reinforced. ASN also commented on the fact that the first civil-engineering assembly activities are not benefiting fully yet from the experience feedback pertaining to the civil-engineering activities for the implementation of the provisions of the 2004 Quality Order, notably in the case of the prerequisite identification of activities likely to affect the safety of the future reactor.

In addition, ASN has undertaken, together with IRSN, a detailed review of the origin and remediation of the most significant safety-related discrepancies that occurred in 2009, including the following:

- in late 2008, ASN detected high repair rates following welding operations on the elements forming the metal liner of the internal containment of the reactor building. On 4 February 2009, ASN requested EDF to implement an action plan in order to improve drastically the behaviour quality of those welds and, in the meantime, to extend radiographic controls to all welds. At the end of July 2009, EDF reduced that control rate in the light of the noticeable improvement it had achieved in the welds of the metal liner over several weeks;
- over several inspections, ASN and IRSN noted not only that the quality of construction joints was not satisfactory, but also that the processing methods for performing those construction joints were not specified by the applicable construction reference system. ASN requested EDF to justify the use of different methods from the specifications of the construction reference system. Pending those justifications, EDF is restricting the use of such methods to operations where the methods referred to in the construction reference system are not suitable and carrying out a reinforced control of their application, and
- during the inspection of 28 May 2009 dedicated to the bottom slab of the internal structures of the reactor building, inspectors alerted EDF about the significant number of tasks to be performed before the scheduled concreting phase. Following that phase, the review of the discrepancies detected by EDF and the contractor shows notably various insufficiencies in the concrete volume being poured in certain locations, as well as changes in the casings during concreting operations. Those discrepancies do not compromise the safety of the structure, but highlight a significant pressure on the construction schedule. ASN requested EDF to take appropriate measures in order to prevent the recurrence of similar discrepancy-generating situations.

18.3.1.6 Work inspection on the construction site of the Flamanville-3 reactor

Since the signature of the DAC, labour inspections have been conducted by ASN’s Caen office. The actions carried out in 2009 included the following:

- participation in meetings of the Intercompany College on Security, Safety and Working Conditions and of the Committee Against Illegal Work;
- performance of security controls on the worksite;
- conduct of investigations on worksite accidents;
- response to direct solicitations from paid employees, and
- response to requests concerning risk-prevention plans on worksites requiring a large number of interveners.

In 2009, ASN’s labour inspectors controlled more particularly conformity with the provisions of the *Labour Code* that are applicable to firms intervening on the worksite, with regard to the declaration of foreign workers, working periods, risks pertaining to interference between activities, equipment or the installations of the various interveners, as well as the integration of experience feedback from the reactor fleet in service during the design of that reactor.

18.3.1.7 Supervision of the fabrication of nuclear pressure equipment

Nuclear pressurised equipment (ESPN) designates the components of a nuclear installation that are under pressure, such as the vessel, pipes, steam generators, etc., and whose failure may generate radioactive emissions. The control of their fabrication is regulated by the Order of 12 December 2005, which adds to regulatory prescriptions applicable to the fabrication of conventional pressurised equipment (Decree of 13 December 1999) further requirements concerning security, quality and radiation protection. In fact, ASN considers that the quality of the nuclear pressurised equipment must be flawless, since it conditions the safety of nuclear installations. In that framework, ASN assesses conformity with the regulatory prescriptions of every major ESPN, except for small-diameter pipes. The conformity of the other ESPNs is also assessed by certified control organisations. ASN applies its controls throughout the various ESPN-design and fabrication stages in the form of documentary reviews and inspections on the premises of manufacturers, and of their contractors and subcontractors. In addition, when a fabricated component involves heterogeneity risks in the characteristics associated with the development of the materials or with the complexity of fabrication operations, ASN also requests the manufacturer to demonstrate that he knows how to control those risks. As a matter of fact, the manufacturer must identify all causes of potential heterogeneities of the components he produces (risk analysis based on the development process) and demonstrate that the manufactured components will have the required quality.

In 2009, ASN reviewed a large number of cases relating to the equipment design and fabrication for the EPR's primary and secondary circuits (vessel, primary pumps, pressuriser, steam generators and valves). ASN has also conducted or has made conducted by certified control organisations more than 1,600 equipment inspections on the premises of the manufacturer (i.e., AREVA NP), its contractors and their subcontractors. During those inspections, ASN detected discrepancies that often resulted from the anticipated manufacturing before the achievement of the equipment detailed design.

From 14 to 18 September 2009, ASN conducted an inspection in order to review AREVA NP's activities relating to the fabrication of ESPNs (reactor vessel, primary-circuit pipes, etc.) with regard to safety management. That type of large-scale inspection allows ASN to proceed with a thorough review of a site or of a series of activities in order to provide a more extensive overview of the actions and results of a specific manufacturer or operator over a given topic.

The inspection team, which consists of seven ASN agents, examined the measures taken by AREVA NP in order to ensure the quality of the fabricated equipment on which relies the safety of the NPPs under construction. The inspection took place on AREVA NP's premises in Paris-La Défense and at the Chalon-sur-Saône Plant. The following topics were examined in more detail: quality system organisation, decision-making and arbitration procedures, as well as the update of the documentation on regulations and on contractor certification and monitoring.

The inspection was conducted in a constructive context and detected several good practices and strong points in the structure, notably with regard to various key processes for ensuring production quality: audits, internal inspections and treatment of discrepancies. ASN inspectors also emphasised the sound qualification level of the auditors and internal inspectors, as well as the overall quality of their reports.

However, ASN considers that the highest safety level should be sought for nuclear installations. Consequently, a manufacturer of nuclear pressurised equipment must seek the highest possible quality under the operator's supervision. In that context, ASN detected various potential progress areas at the manufacturer AREVA NP.

ASN noted that the roles and missions of the staff members in charge of quality within AREVA NP must be clarified. It considers that decisions being made within the company may be formalised better. Hence, ASN requested AREVA NP to improve a number of process specifications for the certification and the monitoring of contractors and to take better account of the lessons to be learnt from the discovery of an anomaly. Moreover, ASN requested AREVA NP to progress in the field of regulatory documentation.

In addition, ASN's involvement in 2009 was marked by three major anomalies that were recorded during the fabrication of a number of ESPNs for the Flamanville-3 EPR.

A fabrication anomaly, which was detected by AREVA NP on a component of a steam generator in late 2008, consisted in the erroneous implementation of a nozzle coming out from the steam generator. AREVA NP proposed to ASN that the component be replaced by another, whose fabrication was already completed, but not fully identical with the initial one. ASN reviewed the proposal throughout 2009. Thanks to the justifications provided by AREVA NP and to the tests and inspections carried on the proposed component, it was possible to pursue the compliance review of the steam generator involved.

Furthermore, during an inspection on the fabrication of the pressuriser, in late 2008, ASN detected a non-conformity with the fabrication procedures for mechanical forgings at an Italian contractor of AREVA NP. The discrepancy, which consisted in using equipment that was not in compliance with the standards for conducting mechanical tests designed to verify the quality of the manufactured parts, resulted from the incorrect implementation of the applicable documentation. That discrepancy led ASN, in 2009, to refuse a number of pressuriser components and to request that further mechanical tests be conducted on the previously-accepted components in order to demonstrate their compliance with the standards. Lastly, a reinforced monitoring of that contractor was implemented at ASN's request in the form of an inspection by a certified organisation of all major quality-related fabrication steps.

Lastly, in October 2009, the Finnish power utility (TVO) and AREVA NP detected significant non-conformities relating to the fabrication of primary pipes for the Olkiluoto-3 reactor in Finland and notably to welding repairs that were made by a French firm without being approved by the technical reference system for construction and especially without being formalised by the quality system. The detection of those anomalies led the Finnish Nuclear Safety Authority (STUK) and ASN to wonder about the acceptability of the components involved and the existence of other undetected discrepancies on other older equipment. In Mars 2010, ASN and STUK conducted a joint inspection of the contractor involved. The American and British nuclear safety authorities, NRC and HSE respectively, were associated in that inspection as observers. Over and above the implementation of the action plan proposed by AREVA NP and its contractor to resolve the detected discrepancies, the inspectors requested further information on the quality of the risk analysis, the implementation of the internal inspection system, the formalisation of quality-improvement measures and the operational deployment of the requirements relating to the quality system and to the fabrication reference system. In the light of that information, ASN has authorised fabrication to resume provided that AREVA NP ensures the full monitoring of the fabrication activities of its contractor.

18.3.2 Design and construction of research reactors

The period between 2008 and 2010 was marked by the review of the preliminary safety report of the RJH, whose DAC was issued in October 2009 and whose criticality step is scheduled in 2013 or 2014. Thanks to its neutron power of 100 MW, the RJH will perform similar activities to those conducted today by the OSIRIS reactor. However, it will include significant changes with regard to experiments and safety.

In 2007 and 2008, the advisory committee for nuclear reactors met for about 10 days in order to review the project. At those meetings, it addressed mostly the analysis of the sizing hypotheses and, more particularly, those relating to a severe explosive BORAX-type accident, which includes the abandonment of the all-inclusive approach with regard to released energies. That change in approach is completed by further ASN requests concerning both the demonstration being provided and the prevention of identified initiating events of that accident. As an innovation for a French research reactor, the RJH will be based on a system of para-seismic supports.

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. 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 reactor materials. ASN therefore has no particular concerns about the safety of the ITER reactor, but it is working to ensure the international organisation which will be the operator of the ITER BNI, will be subject to the same nuclear safety and radiation protection obligations as the other French nuclear operators, and that consequently ASN will be able to apply its regulatory oversight as comprehensively as for the other BNIs.

The first DAC for the ITER was submitted in July 2008, for which ASN requested further documentation. The revised application was submitted in early 2010.

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 Authorisation process and regulations

19.1.1 Commissioning authorisation

Commissioning corresponds to the first operation of radioactive materials within the installation.

In preparation for commissioning, the operator must send to ASN an application containing the safety report, the RGEs, a waste-management study, the PUI and the decommissioning plan.

It is only after checking that the installation actually complies with the objectives and rules prescribed by the 2006 *TSN Act* and its implementation texts taken that ASN may authorise the installation commissioning.

ASN's authorisation is mentioned in its official bulletin. ASN notifies also its decision to the operator and forwards it to the Ministers in charge of nuclear safety and to the Prefect. It may also decide to notify the CLI involved.

Before the actual authorisation procedure or its completion, partial commissioning may be authorised by an ASN decision for a limited period of time in the event of one of the following operations:

- the carrying out of specific operating tests requiring the introduction of radioactive materials, and
- the introduction of nuclear fuel in the perimeter of the reactor before the first loading of fuel in the reactor.

19.1.2 Final-shutdown and decommissioning authorisation

The technical specifications applicable to the installations that an operator wishes to shut down permanently and decommission must be consistent with the general regulations relating to nuclear safety and radiation protection, notably with regard to the external and internal exposure of workers to ionising radiation, the generation of radioactive waste and effluent discharges into the environment, in order to limit accident risks and their effects. Safety-related challenges, that is, the protection of human beings and of the environment, may be significant during active cleanup or dismantling operations and must never be neglected during passive monitoring phases.

Once having decided to stop operating his installation in order to proceed with its final shutdown and decommissioning, the operator ceases to be regulated by the DAC and to be subject to the safety-related reference system associated with the operating phase. In accordance with the *2006 TSN Act*, the final shutdown and subsequent decommissioning of a nuclear installation are authorised by a new decree, which may be taken only upon ASN's opinion.

In 2003, ASN detailed in a guide the regulatory framework of decommissioning operations for BNIs, following significant work to clarify and simplify administrative procedures, while improving the integration of safety and radiation protection. A totally revised version of the guide, which was developed in order to integrate the regulatory changes induced by the publication of the *2006 TSN Ac*t and the 2007 Procedure Decree, and by WENRA, was finalised in 2009. The major objectives of the guide, which is designed for nuclear operators, include the following:

- to provide a detailed version of the regulatory procedure prescribed by the application decree of the *2006 TSN Act*;
- to specify ASN's expectations with regard to the content of certain components of the authorisation application for final shutdown and decommissioning, and notably for the decommissioning plan, and
- to provide detailed information on the technical and regulatory aspects of the different decommissioning phases (preparation for final shutdown, dismantling and decommissioning).

ASN requires decommissioning to follow immediately the shutdown of the installation.

The guide describes the general policy, which gave rise to a large consultation and may be consulted on ASN's Web site.

19.1.2.1 Authorisation process for final shutdown and decommissioning

No later than one year before the scheduled date for the final shutdown of the installation, the operator must submit to the Ministers in charge of nuclear safety the relevant licensing application. The operator must send a copy of his application together with the relevant case for its review.

The authorisation application for final shutdown and decommissioning is subject to the same procedures as consultations and inquiries for BNI creation-licence applications, as follows:

- the authorisation application must contain provisions relating to shutdown conditions, to decommissioning and waste-management procedures, as well as to further monitoring and maintenance of the installation site, and
- the authorisation is issued by a DAC, which is taken on the basis of ASN's opinion specifying the decommissioning specifications, the lead-time before the actual decommissioning and the types of operation entrusted upon the operator after decommissioning.

19.1.2.2 Implementation of final shutdown and decommissioning

In order to prevent the splitting up of decommissioning projects and to improve their overall consistency, the supporting case of the licensing application for final shutdown and decommissioning must describe explicitly the entire set of contemplated activities, from the final shutdown to the approval and delivery of the final state. It must also describe in detail and for every step the nature and scope of the risks induced by the installation, as well as the means, which have been implemented to control them. The final-shutdown and decommissioning phase may be preceded by a preparatory phase to final shutdown within the framework of the initial operating authorisation. That phase is designed for evacuating all or part of the source term, and for preparing decommissioning operations (layout of premises, preparation of worksites, training of teams, etc.). It is also during that preparatory phase that the installation may be characterised through radiological maps and the collection of relevant data (history of operation) in preparation for decommissioning, etc.

19.1.2.3 Declassification of installations

Once dismantled, the nuclear installation is ready for declassified. It is therefore removed from the BNI list and ceases to be regulated under its BNI status. In support of his declassification application, the operator must submit a case demonstrating that the final expected state of the installation has effectively been achieved and including a description of the state of the site after dismantling (analysis of the state of remaining soils, buildings or equipment, etc.). In relation to the final state to be achieved, public-utility easements may be established according to forecasts concerning the subsequent use of the site and/or of its buildings. Those forecasts may involve a certain number of routine prescriptions (e.g., limitation to industrial use) or of precautionary measures (radiological measurements in the event of undermining, etc.). ASN may decide to subject the declassification of a BNI to the implementation of such easements.

19.1.2.4 Decommissioning funding and radioactive-waste management

Article 20 of the 2006 Planning Act implements a device designed to secure the expenses associated with the decommissioning of nuclear installations and to the management of radioactive waste. That article is also quoted in Decree No. 2007-243 of 23 February 2007 and in the Order of 21 March 2007 on the secure funding of nuclear charges. Both texts were the subject of two favourable opinions by ASN, (Nos. 2007-AV-0013 and 2007-AV-0014), dated 1 February 2007.

The purpose of the legal mechanisms constituted by those texts is to secure the funding of nuclear charges, while applying by the “polluter-payer principle”. It is therefore up to the nuclear operators to take over such funding, via the constitution of an asset portfolio dedicated to foreseen expenses. That activity is made under the direct control of the State, which analyses the situation of operators and may prescribe appropriate measures in the event of recorded insufficiency or inadequacy. In all cases, nuclear operators remain responsible for the financing of their long-term charges.

Hence, plans call for operators to assess conservatively the decommissioning costs of their installations, or in the case of radioactive-waste disposal facilities, their final-shutdown, monitoring and maintenance charges. They must also assess the management costs for their spent fuel and radioactive waste (Paragraph I of Article 20 of the *2006 Planning Act*). In accordance with Decree No. 2007-243 of 23 February 2007, ASN issues an opinion on the consistency of the strategy for decommissioning and the management of spent fuel and radioactive waste submitted by the operator with regard to nuclear security.

19.1.3 Authorisation for liquid and gaseous effluent discharges and water intakes

The normal operation of nuclear installations generates radioactive effluents. Their discharge into the environment is submitted to strict conditions, which are specified in the regulatory authorisation in order to protect workers, the public and natural environments. That authorisation concerns liquid and gaseous radioactive effluents. It takes into account radioactivity, as well as the chemical characteristics of both types of radioactive effluents.

In addition, the operation of most nuclear installations entails, if required, water intakes and the release of non-radioactive liquid and gaseous discharges into the surrounding environment.

Pursuant to the DAC, ASN determines the prescriptions relating to the BNI’s water intakes and to the radioactive materials originating from it. Specific prescriptions setting the BNI’s discharge limits into the environment are subject to the homologation of the Ministers in charge of nuclear safety.

The draft law, which involves a national commitment for the environment (called “Grenelle II”), is currently under review by Parliament. It includes a provision, which is supported by ASN, with a view to instituting a public-consultation procedure for proposals to increase certain types of discharges that do not correspond to significant changes to the installation.

In the system that preceded the *2006 TSN Act*, water intakes and discharges were authorised separately from the creation of the installation. Consequently, BNIs had independent authorisation orders for discharges and water intakes. Some of those orders still exist, pending their replacement by new ASN prescriptions.

19.1.4 Operational documents

For the operation of NPPs, staff members refer to various documents, including some relating to safety, which are of particular interest to ASN.

First and foremost, they include the RGEs, which describe the measures being implemented during the operation of reactors; they complete the safety report, which deals essentially with the measures taken during the reactor-design stage. More particularly, the 2007 Procedure Decree imposes upon the operator to provide both documents in support of his BNI commissioning-authorisation application.

RGEs include a certain number of chapters, which are approved by ASN and whose topic is listed in §19.2.2 for nuclear-power reactors. More particularly, a chapter describes operating limits in the form of technical operating specifications (STE).

19.1.5 Incident follow-up

In its Articles 12 and 13, the 2004 Quality Order mentioned above prescribe specific measures regarding anomalies and incidents. Any non-conformity to a specific requirement concerning the execution or the result of a quality-related activity, any situation likely to compromise the set quality or any situation justifying a corrective action from a safety standpoint is designated as “an anomaly or an incident” in that 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.

Except in the event of a confirmed emergency, a delay of two working days is tolerated after the detection of an event in order to declare such events to ASN pursuant to the guide of 21 October 2005 concerning the procedures for declaring significant events in nuclear installations and during the transport of radioactive materials. The guide also specifies the 10 applicable declaration criteria, as follows:

1. automatic reactor shutdown;
2. activation of backup systems;
3. non-compliance with STEs or event likely to lead to a non-compliance to the STEs, if the same event has already occurred when the installation was in a different state;
4. internal or external aggression;
5. malevolent act or attempt of such act likely to affect safety;
6. transition into fallback state in accordance with STEs or operating procedures under accidental conditions following an unforeseen behaviour of the installation;

7. event having caused or likely to cause multiple failures: unavailability of equipment due to the same failure or affecting either all pathways of a redundant system or the same type of equipment in several safety systems;
8. specific event or anomaly to the major primary circuit, the second primary circuit or pressure devices of connected circuits, leading or likely to lead to an operating state, which is not taken into account at the design stage or which would not be covered by the existing operating instructions;
9. anomaly involving design, plant fabrication, on-site assembly or operation of the installation with regard to the equipment and other functional systems than those covered by criterion 8 above, leading or likely to lead to an operating state, which is not taken into account and would not be covered by existing sizing conditions and operating instructions, and
10. any other event likely to affect the safety of the installation, which is considered as significant by the operator or ASN.

The operator must forward to ASN an account of the analysis of the incident within two months after being declared.

Incidents are systematically rated on the INES scale. ASN has been applying the 2008 INES scale since May 2010.

The procedures pertaining to ASN actions are described in §7.3.

19.1.6 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 operator 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).

The Order of 31 December 1999 is part of the revisions referred to in §7.2.2.2. A decision by ASN will follow in order to further the provisions relating to the management procedures for the waste generated by BNIs.

19.2 Measures taken for nuclear-power reactors

19.2.1 Commissioning of EDF reactors

Commissioning tests are carried out in accordance with test procedure programmes 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 which specifies the methods for carrying out each test and its acceptance criteria.

Commissioning tests include the following:

- preliminary tests: blank tests (wire-by-wire tests, compliance of sequences with logic diagrams), pump-rotation tests, cleaning of circuits, and
- overall tests at the different stages of progress during commissioning.

Test procedures accompanied by record sheets and test results are known as test records (REE). Test record analysis sheets 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 operator, who is responsible for archiving them. The tests are coordinated and scheduled by a group comprising the operator and the manufacturers.

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 meets at each important transition between overall test phases. This committee is made up of EDF representatives, the manufacturers 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 reactor from the first loading of nuclear fuel into the core.

19.2.2 Technical operating specifications for EDF reactors

The installations must be operated in compliance with general operating rules (RGE), a regulatory document comprising ten chapters.

Chapter I: Organisation in operation

Chapter II: Organisation of quality

Chapter III: Operation technical specifications

Chapter IV: Organisation of industrial safety and radiation protection

Chapter V: Procedures for liquid and gaseous radioactive discharges

Chapter VI: Incident and accident operating procedure

Chapter VII: On-site emergency plan

Chapter VIII: Operating instructions

Chapter IX: Periodic tests on safety-related systems

Chapter X: Physics tests relating to the reactor core

That RGE structure is evolving in accordance with the *2006 TSN Act* and the 2007 Procedure Decree.

Chapter III 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 reactor 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 operator;
- 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 reactor 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 state, fallback (initiation) time or repair time.

The fallback state is a reactor mode in which the event either does not affect the safety of the reactor, or affects it to a lesser extent. The transition from the initial operating mode to the fallback state is made by applying normal operating procedures.

The actions for making the transition to the fallback state 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 state. 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 request for RGE temporary modification 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 Inspections, maintenance and testing of EDF reactors

19.2.3.1 Inspections and tests

Chapter IX 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 operator to shut down the reactor in order to restore the failed function.

Periodic tests enable the following to be assured during reactor 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 IX of the general operating rules (RGE) concern plant systems that are classified 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 (daily, weekly, monthly, annually, every thirty equivalent full power days etc.). Use of this tolerance must not lead to the schedule for the next test being shifted back in time.

Chapter X 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 launched an action plan designed to enhance the quality of periodic testing programmes and to improve the integration of measurement inaccuracies, by calling upon the experience feedback from 20 years of operation. The last documentary evolutions relating to those improvements are integrated during the multi-annual revisions of the periodic testing programmes.

19.2.3.2 Maintenance

The purpose of EDF's maintenance organisation, as a nuclear operator, is to ensure the operation of its equipment in accordance with safety requirements and the best production conditions for safe, clean and competitive kilowatt-hour for its customers.

The maintenance policy is structured in such a way as to ensure the required reliability level for equipment and systems, to enhance competitiveness and to prepare for the future by anticipating the maintenance of equipment with a view to extending the operating lifetime of the reactor fleet much beyond 40 years and to opening up the option up to 60 years.

The policy rests on a maintenance-management system whose objective is to control and to optimise, both technically and economically, the maintenance of the nuclear fleet for the continuous improvement of performance in terms of safety, availability and operating lifetime of the installations.

The structuring of that system is based on eight operational objectives, as follows:

1. developing maintenance programmes in order not only to establish and make maintenance specifications available to NPPs, but also to ensure the required reliability of the equipment throughout the operation of the reactors;
2. controlling documentary changes in order to guarantee the availability of consistent operational elements with the technical and documentary state of the installations (documents, illustrations, data);
3. maintaining and supervising equipment in order to ensure the performance of activities relating to maintenance and to the quality follow-up of equipment and systems, while fulfilling programmes;
4. resolving technical problems by ensuring the review and guidance of events and programmes, while taking budgetary arbitrations into account;
5. analysing the technical experience feedback in order to guarantee that detected situations do not reoccur, to prevent (or to anticipate) emergencies and to implement sound technical practices;
6. modifying installations in order to optimise their reliability level;
7. ensuring the availability and required skills of interveners in order to guarantee constant adequacy in terms of quality and quantity of resources and means with maintenance activities, and
8. managing the spare-part system in order not only to constitute and to optimise the spare-part inventory, but also to provide a logistical response to all required needs formulated by stakeholders or concerning maintenance activities.

By applying those eight objectives, EDF aims at putting in place an optimised maintenance system designed to prevent all failures on all equipment considered critical, thus contributing to the constant improvement of safety and reactor availability by improving the reliability of all equipment and systems.

Maintenance activities

In the field of maintenance, constant questioning is essential and provides added value to the standardisation of the nuclear fleet and to the experience feedback of EDF and foreign operators. Historically speaking, that approach has matured over several steps at EDF, thus associating within an iterative process the revision of maintenance activities and of their periodicity, as well as a better integration of supervisory and diagnostic activities relating to equipment. It was enhanced by new maintenance methods over time, such as: reliability-centred maintenance, conditional maintenance, maintenance by control devices, etc.

That iterative approach over time has led EDF, since 2009, to apply gradually a methodology known as the “AP-913 Advanced Process”, which was designed by the Institute of Nuclear Power Operations (INPO) in order to ensure excellence in the reliability of all critical NPP components and systems, and has been implemented in many installations throughout the world.

Conduct of maintenance activities

Maintenance is at the core of the nuclear operator’s trade. The internal preservation of relevant skills is essential in order to control all activities at all times.

Concurrently, the solicitation of contractors is also necessary with due account of the following:

- the activity peaks resulting from reactor outages;
- the need for rare skills in specialised activities, particularly in the case of some equipment, and
- the reciprocal implication interest of the contractors for the activities in which they may provide the practices and methods of other industries and, thus, enrich those of the nuclear operator.

With due account of the latter element, the solicitation of contractors and the appropriate approach to involve them are directly related to the richness of the industrial network of every activity sector. Overall, the subcontracting of activities is evolving towards multi-annual and multi-site contracts, with an adapted grid and in accordance with the spirit of "doing things together".

Maintenance supervision over time

Operating a nuclear site over a long period of time requires that special care be paid to the preservation of the capabilities to ensure that maintenance not only in terms of interventions and spare parts, but also of skills. Hence, significant work is carried out on equipment obsolescence and the perpetuation of industrial capabilities. In addition, the knowledge of the behaviour of equipment and systems with regard to ageing phenomena conditions the relevancy of the maintenance activities being carried out and may be particularly decisive in the choice of exceptional maintenance, as shown by the operations involving the change of vessel and steam-generator covers and those dealing with the renovation of the control and instrumentation system, etc.

19.2.4 Management of incidents and accidents at 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 VI 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 reactor 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 state);
- 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.

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, reactor 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 reactor 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 severe accident response guide.

The decision to apply the severe accident response guide, which marks the abandonment of state-oriented approach procedures, is taken by the command and control station on the basis of core outlet temperature and in-containment dose rate criteria.

The control actions defined in the severe 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 reactor 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 Evolution of the organisation for nuclear engineering

In 2006, EDF launched 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 operator 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.

Reflections towards such closer co-operation efforts have led to the development of an operational-engineering guide, which became effective on 1 January 2007 and specified new responsibilities for NPPs and engineering units, as follows:

- for every series, a site is designated as the “pilot series”: Tricastin for the CPY; Paluel for the 1,300-MWe series, and Civaux for the N4 series. Fessenheim and Le Bugey will assume that mission for the CP0 series. The “pilot series” site is the sole spokesperson of engineering units in order to develop joint change projects and to determine their impact on the operation; it will co-ordinate, in conjunction with engineering units, the joint drafting of all operating documents among NPPs;
- All NPPs, including those “pilot-series”, will have a local integration structure regarding changes and documentation, which will be in direct connection with the “pilot-series” site.

Enabling design engineers and operators 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.

The revision of the operational-engineering guide is under way since mid-2009 with a view to benefiting from more than 2.5 years of experience feedback (with a few more specificities associated with the N4 series’ control and instrumentation system to be introduced in that capacity) and to integrating the impacts referred to in the *2006 TSN Act* and in the 2007 INB Decree, notably with regard to operating procedures with ASN.

The publication of the new version of the guide, awaited by ASN, is scheduled in the second half of 2010.

19.2.6 Declaration by EDF of major anomalies or events

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 events 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 INES (the July 2008 version applicable in France since 2010) are the subject of external communication for the media, web network, local public authorities and local information committees (CLI). Such communication meets the requirements of the *TSN act* 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 1,500 reactor-years. The volume of information generated by the 58 reactors 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 700 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 90 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.

Work has been undertaken aimed at improving consideration of low-level events and precursors. Rollout of the associated actions took 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 § 12.2).

In addition, a common typology has been in place since 2006 on all NPP sites for analysing events from a human-factor standpoint.

In 2010, a project to reorganise experience feedback was designed at the DPN. In that framework, a diagnosis of the operation of DPN's experience feedback was established and orientations are being consolidated in the second half of 2010.

From a technical standpoint, a significant landmark in terms of experience feedback for safety's sake and of impact on production was due to a clogging phenomenon that occurred on the steam generators of some 900 and 1,300-MWe reactors.

That phenomenon was observed for the first time by EDF during the autumn of 2006 at the Cruas NPP. Thanks to the analyses conducted by EDF in 2007, it was possible to estimate the scope of the phenomenon: it was confirmed that it extended to 15 reactors (i.e., eight 1,300-MWe and seven 900-MWe reactors) out of a total of nuclear fleet of 58 reactors and required that the steam generators involved undergo a chemical cleanup. By the end of 2008, the steam generators of nine reactors had already been cleaned up (four in 2007, five in 2008) and the six remaining reactors are scheduled for cleanup over the next two or three years.

In addition, EDF has established a national programme to replace steam generators, thus increasing the annual replacement rate from one to two reactors starting in 2010, in comparison to 2009, when the steam generators of a single reactor were replaced. Between 1990 and 2009, 18 reactors had already undergone that type of intervention.

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 may be solid (rags, paper, cardboard, vinyl films or bags, wood or metal items, rubble, intervention gear, etc.) or liquid (oils, solvents, decontamination effluents, including chemical-cleanup effluents).

The most radioactive intermediate-level (IL) residues are conditioned into concrete containers and disposed of at Andra's disposal facility for low-level and intermediate-level waste (CSFMA) in the Aube Department. Filters, evaporator concentrates, liquid sledges and technological waste are embedded or immobilised in a hydraulic binding agent in fixed installations (the nuclear auxiliary building BAN or the treatment building for NPP waste). For the final conditioning of ion-exchanging resins, EDF relies on the MERCURE process (embedding in an epoxy matrix), which is applied by using two identical mobile machines. With regard to the most recent NPPs, EDF also has a mobile machine for conditioning sludges and advocates that evaporator concentrates be incinerated (see below).

Low-level (LL) solid residues are:

- either compacted on site in 200-L metal drums and shipped directly to the CSFMA for further compaction and final disposal after concreting in 450-L drums,
- or compacted in 200-L plastic drums and shipped to the SOCODEI's CENTRACO plant for incineration purposes. Incineration ashes and clinker are conditioned in 450-L metal drums and disposed of permanently at the CSFMA

In addition to its incineration unit, which also deals with liquid waste (oils, solvents, evaporator concentrates, chemical-cleanup effluents, etc.), the CENTRACO Plant for the treatment and conditioning of LL waste is equipped with a melting unit for metal waste, which produces 200-L ingots that will be disposed of permanently at the CSFMA or the disposal facility for very-low-level waste

[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.

(CSTFA) (see below), if their specific activity allows it. With regard to recovery, part of the melted metal waste is recycled in the form of biological shields used for the packaging of other more radioactive residues in concrete-made hulls.

VLL residues, which consist primarily of metal waste and rubble, are shipped to the dedicated site (CSTFA) mentioned above. Located in Morvilliers, it is also managed by Andra and was commissioned in 2003.

19.3 Measures taken for research reactors

19.3.1 Operating documents for research reactors

Pursuant to regulations, operators must provide several types of documents to ASN, as follows:

- 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.

ASN may also take complementary technical prescriptions.

The above-mentioned documents to be submitted to ASN are completed by a series of procedures and instructions that are managed by the relevant services in order to ensure that all operations are conducted in accordance with applicable rules with which contractors must also comply.

These rules apply also to service providers, and the operator 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 controlled.

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.

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 Inspections, maintenance and testing

In order to verify the sound operation of safety-related components in every installation and to ensure their availability, they are subject to periodic checks and tests. Their frequency is clearly specified and may be date- or event-driven.

If these tests are carried out at the defined frequency and have a satisfactory outcome, then the items concerned are declared formally available. The safety-related components 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 when they analyse the installation's alarms and measured operating parameters, as relayed to the control room.

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 the RGE.

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 reactor operators 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.

There were only a few significant incidents to be declared in research reactors over the last three years. Those incidents include notably the following:

- the limited loss of local ventilation on various occasions during stormy weather;
- the use of a control rod over and above its normal authorised limit during the criticality of a reactor;
- a malfunction in periodic checks and tests management and execution;
- 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 Saclay site.

All these events were declared to ASN. They are analysed in detail in significant event reports.

In addition, the protection and nuclear safety directorate (DPSN) 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 ASN's analysis on the operation of nuclear-power reactors

19.4.1 Operation of nuclear power reactors

Even though the period between 2008 and 2010 was rather satisfactory with regard to nuclear safety, a strong action was necessary in order to ensure that operators maintained the required rigour. In 2008, for instance, ASN prepared a report and, pursuant to the *2006 TSN Act*, sent a formal notice to EDF concerning a regulatory violation, which had been detected on the Cruas site concerning the transport ducts for explosive fluids.

ASN considers EDF's preparedness for emergency management to be satisfactory. The national emergency structure was triggered four times in 2009 and EDF was able to control the situation in every case. An experience feedback on the triggering of those measures has been requested.

The structure set in place by EDF in NPPs to process experience feedback is generally satisfactory. However, ASN feels that EDF must improve the quality and thoroughness of its analyses. In 2009, for instance, the repetition at the Tricastin NPP of an identical incident involving the jamming of a fuel assembly, which had also occurred the year before in the same NPP, is a good illustration of the problem at hand.

Together with maintenance and equipment-replacement programmes, the safety-review approach and the correction of identified conformity anomalies all contribute to maintain NPP equipment under generally satisfactory conditions. However, ASN notes that EDF did not anticipate early enough some problems that now require extensive and delicate corrective maintenance operations on steam generators in order to ensure their safety. The lack of anticipation in the maintenance and equipment-replacement programmes is also reflected on some steam generators by the need for very significant control and expertise programmes, which are essential for deciding upon the state of that equipment before authorising its return to service.

The following paragraphs deal with the major pending cases with regard to the analysis of the operational safety of nuclear-power reactors.

19.4.1.1 Internal authorisations

ASN has requested EDF to submit some operating activities, which ASN deemed relevant for the sake of nuclear safety and radiation protection, to a system of internal authorisations (refer to §7.3.2.2). That system was approved by ASN for the following activities:

- the lowering of the water level of the primary system to the "low working range" of the residual heat-removal system (mid-loop operation) with the core loaded, and
- the restart of reactors after outages without any significant maintenance.

In both cases, authorisations may only be issued by EDF management or site management, once the situation has been reviewed by an internal independent entity involving the officers responsible for nuclear safety and quality. In addition, EDF controls the execution of those processes and is accountable to ASN for them.

In 2008 and 2010, ASN inspected the DPN on the topic of internal authorisations with a view to verifying compliance with applicable provisions. ASN carried out also several other inspections in NPPs that were authorised to implement an internal-authorisation mechanism.

19.4.1.2 Maintenance

Maintenance practices

ASN considers that the maintenance policy constitutes an essential line of defence for preventing anomalies and ensuring the conformity of an installation with its safety reference system.

Since the mid-90s, EDF has committed itself to a policy involving the reduction of maintenance tasks. Its objective is to reinforce the competitiveness of the reactors within the nuclear fleet, while preserving their safety level. It involves essentially refocusing operations on pieces of equipment, whose failure involves major challenges with regard to nuclear safety, radiation protection or operation. The policy has encouraged EDF to let its structure evolve and to adopt new maintenance practices.

In line with a common practice in the aeronautical and military industries, EDF has developed a method called "reliability-centred maintenance" (OMF). Based on the functional analysis of a given system, the method is designed to specify the applicable type of maintenance in relation to the contribution of its potential failure modes to challenges relating to safety, radiation protection and operation.

In addition, benefiting from the standardisation of nuclear reactors, EDF is developing a maintenance concept by "pilot equipment", which is based on the constitution of homogeneous technical families of similar equipment used the same way throughout the nuclear fleet. For EDF, the selection and thorough control of a limited number of those pieces of equipment, which play the role of pilot equipment within those families in that case, makes it possible to avoid having to control the overall equipment of the family, if no failure is detected.

ASN supervises EDF's maintenance policy and verifies that all required operations and controls to ensure maintenance and the improvement of the safety level of the reactors (including older ones) are duly performed.

ASN, for instance, considers that the third decennial outages are absolutely essential in order to provide a sound knowledge about the state of the components, systems and structures (CSS) for 900-MWe reactors and to demonstrate the operator's ability to continue their operation. In that context, ASN has requested that the operator submit the relevant information to demonstrate the capability of the CSSs to ensure their safety function through the implementation of relevant operating conditions. With regard to the integration of the ageing phenomenon, specific maintenance and monitoring actions must be reinforced. More particularly, in the case of components with an estimated operating lifetime exceeding 20 years, ASN has demanded the operator to test various representative samples with a view to verifying that their properties remain consistent with qualification requirements.

In that context involving major methodological changes and with due account of the ageing factor of nuclear reactors, ASN has called upon the advisory committee for reactors advice on EDF's maintenance policy and its site implementation. On 27 March 2008, the advisory committee for nuclear reactors met on that topic.

On the basis of that review, ASN considers that the methods implemented by EDF to optimise maintenance programmes for safety-related equipment are acceptable. Those methods, which focus on equipment monitoring, help first of all in the prevention of risks associated with interventions on the equipment and also in the limitation of the dose received by interveners. However, ASN has reminded EDF that such methods may not detect new or unexpected failures and demanded EDF, for the sake of defence in depth, to ensure that the application of those methods for certain pieces of equipment be supported by periodic and systematic inspections.

Furthermore, ASN has reminded EDF that the implementation of such maintenance methods for the pressure equipment of the main primary and secondary circuits within nuclear reactors must be consistent with the prescriptions of the Order of 10 November 1999 concerning the operational monitoring of those circuits and, consequently, involve only areas where no known degradation if foreseen. ASN has also set a very strict framework for the use of such approach by insisting especially on the required extension of controls in the event of a new failure being discovered.

Lastly, ASN feels that the process set in place by EDF in order to capitalise the experience feedback ensures the sound evolution of the maintenance programmes. ASN will ensure that EDF duly takes into account the experience feedback concerning the behaviour of the equipment concerned by those changes, particularly with regard the nature and frequency of the controls.

Maintenance implementation on sites

ASN considers, however, that the overall implementation of EDF's maintenance policy is perfectible. Recurrent observations are made. The maintenance reference level is in perpetual evolution. That complexity increases persisting integration delays throughout the nuclear fleet and tends to scatter requirements.

The quality of risk analyses in the preparation of maintenance interventions and their appropriation by interveners remains unsatisfactory and must be drastically improved on practically all sites. The management of spare parts must also be improved, because they are not always available or do not have the required specifications.

ASN noted that EDF had neither anticipated early enough some issues nor taken into account the relevant international experience feedback, thus leading to a situation, which now requires extensive and delicate corrective maintenance operations on steam generators in order to ensure their safety.

With regard to the performance of maintenance activities, ASN notes that some operations carried out by EDF or its contractors may have been marred by qualify flaws, which EDF must prevent better. Improving the quality of maintenance interventions also involves a better understanding of human and organisational factors during preparations.

Most maintenance activities on site are entrusted upon contracting firms, which are selected on the basis of a qualification and assessment system. ASN feels that the principle of that system is satisfactory, but that it is necessary for EDF to assess its industrial policy regarding maintenance and the use of contracting firms to apply it. In fact, ASN considers that EDF's supervision of contracting firms is lacking. ASN notes more particularly some insufficiencies in the field monitoring of activities performed by contracting firms and considers that such supervision must be improved and enhanced. In that sense, EDF must verify that adequate resources are allocated to monitoring activities, both in quantity and quality, with regard to subcontracted activities and with due account of the challenges involved for the sake of nuclear safety, radiation protection and environmental protection.

As it was the case in previous years, ASN notes that physical resources are sometimes insufficient or ill-adapted, which led in certain cases to degraded working conditions for interveners regarding security and radiation protection.

The methods implemented by EDF in order to optimise the maintenance programmes for the safety of major equipment are acceptable. However, it is important to ensure that appropriate human and physical means, especially spare parts, are in place in accordance with the prescribed objectives of that policy.

EDF's involvement in the field of maintenance is crucial, notably in the light of the high industrial and financial challenges at stake. In the context of the ongoing operation of older reactors, the adequacy of maintenance with the ageing stage of the equipment is essential, and correcting the obsolescence of certain pieces of equipment is necessary.

Monitoring and maintenance of the main primary and secondary circuits (CPP and CSP)

When designing the systems, the manufacturer assesses how the situations experienced by the reactor 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 reactor.

In order to ensure that the operator of a NPP has assimilated the manufacturer's recommendations and adapted its operating conditions accordingly, the regulations require the compilation of “reference files” for the circuits.

The operator must also monitor the circuits during operation and set up a documentation system including the reference files and all the events marking the life of reactor.

Reference cases files

The order of 10 November 1999 requires the operator to compile and update all circuit design, manufacturing and operation documents which contribute to providing evidence of circuit 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, 1,300 MWe and 1,500 MWe), breaking them down into files for each individual reactor. In particular, the files include documents on maintenance, faults and events that occurred on the reactor concerned.

Situation accounting

Throughout the time that the reactor is in service, the operator must check that the equipment of the steam supply system (SSS) is not placed under worse conditions than its design calls for. More particularly, he must include and record in his document system all actual situations to which the main circuits of the reactor were exposed in order to ensure that safety margins are maintained throughout its operation.

Qualification of inspection methods

Article 8 of the Order of 10 November 1999 specifies that the non-destructive test techniques used for the in-service monitoring of the equipment of the main primary and secondary circuits of nuclear reactors must be qualified, before their first use, by an entity whose competency and independence have already been duly recognised.

That accreditation entity, which is called the Qualification Commission, was granted by COFRAC in 2001. The re-accreditation will be reviewed in 2011.

The role of the Commission is to assess the representativeness of both the demonstration mock-ups and the defects being introduced. On the basis of qualification results, it certifies that the examination method achieves actually the expected performance. Depending on the case involved, the purpose is either to demonstrate that the control method being used is able to detect a degradation referred to in the specifications or to provide a detailed account on the sound performance of the method.

At the international scale, qualification requirements may vary among countries with regard to the controls involved. On the other hand, operators benefit from more or less significant transient periods for implementing their respective programmes.

Until now, 90 applications have been qualified pursuant to in-service inspection programmes. New applications are being developed and qualified in order to meet new needs. They concern primarily the Flamanville-3 reactor for which 41 applications must be qualified for the first complete visit. For dose-reduction purposes, preference is given to ultrasound rather than to radiographic applications.

19.4.1.3 General operating rules

19.4.1.3.1 Technical operating specifications (STE)

Chapter III of the RGEs describes the reactor's technical operating specifications (STE), whose role is to prescribe the following:

- the limits of the installation under normal operating conditions in order to remain within the design and sizing hypotheses of the reactor;
- the required safety functions for the control, protection and back-up of barriers, in relation to the state of the reactor involved, and the implementation of operating procedures in the event of an incident or accident, and
- the specific behaviour to adopt in the event that a limit under normal operating conditions would be exceeded or that a required safety function would prove unavailable.

PERMANENT CHANGES TO STES

EDF may be led to modify the STEs in order to integrate its experience feedback, to enhance the safety of its installations, to improve its economic output or to take into account the impact of physical changes.

In 2009, ASN reviewed several documents that will modify the STEs on a permanent basis and which led either to an agreement or requests for additional justifications. One of those issues involves the integration of changes that will be enforced for the Galice fuel management in 1,300-MWe reactors.

TEMPORARY CHANGES TO STES

Under exceptional circumstances when EDF must deviate from the normal behaviour prescribed by the STEs during an operational phase or an intervention, it must declare a temporary change of the STEs to ASN, which, in turn, reviews the change and may approve it on the condition, as the case may be, that additional compensating measures be implemented, if ASN feels that those proposed by the operator are insufficient.

ASN ensures that temporary changes are fully justified and runs a comprehensive review every year on the basis of a status report prepared by EDF. Hence, EDF is required:

- to re-examine periodically the soundness of temporary changes in order to identify those that would justify a request for a permanent change to the STEs, and
- to identify any generic change, notably those associated with the implementation of national physical changes and of periodic testing.

FIELD INSPECTIONS RELATING TO OPERATION UNDER NORMAL CONDITIONS

During NPP inspections, ASN focuses its activities on checking the following:

- compliance with the STEs and, if need be, with the compensating measures associated with temporary changes;
- the quality of documents referring to normal operating conditions, such as instructions and alarm slips, and their consistency with the STEs, and
- the training of agents for the operation of the reactor.

19.4.1.3.2 Periodic tests

In order to verify the sound operation of safety-related equipment and the availability of back-up systems that might be solicited in the event of an accident, period tests are conducted pursuant to the programmes referred to in Chapter IX of the RGEs.

In 2009, ASN approved the following periodic-test programmes:

- the evolution of periodic-test rules for 1,300-MWe reactors for the implementation of the "Galice" fuel management;

- the periodic-test programmes relating to the physical changes that will be integrated gradually during the third decennial outage of 900-MWe reactors, and
- the periodic-test programmes relating to the physical changes that were integrated during the first decennial outage of the "lead series" reactor of the N4 series.

In addition, ASN is also pursuing the review of the design doctrine for the EPR's periodic testing.

In parallel, ASN is also required on a regular basis to provide a formal opinion concerning the declarations of changes to periodic-test programmes.

19.4.1.4 Operating procedures under incident or accident conditions

According to the French doctrine, the operator is responsible for developing guides for the management of severe accidents, including assistance procedures and means in reaction to them and for proposing changes with a view to improving the safety of the reactor.

Those guides are assessed by ASN and IRSN. The conclusions of that assessment, the comments and the improvement requests are forwarded to the operator in order to be taken into account during the revision of procedures. The formal approval of the procedures is not required. There are currently various management guides for severe accidents at every reactor series (900 MWe, 1,300 MWe and N4). They were transposed in the form of operating procedures and implemented at the level of the reactors. Any phenomenon that might affect the integrity of the containment has been assessed by the advisory committee for nuclear reactors and resulted in the following measures: in 2008, passive autocatalytic recombiners were installed on all reactors; corium-detection means will also be installed in case of vessel rupture; sturdier bolts still need to be installed on the closure system of the equipment-hatch cover in order to correct a potential failure of the containment in the event of a severe accident (under way for the 900-MWe reactors during the third decennial outage).

State-oriented approach (APE)

In case of incident or accident occurring in a reactor, the teams have operating documents that should allow them to return the reactor back to a stable state and to maintain it as such.

In the case of nuclear-power reactors that are currently in service, the operating procedures used in the event of an incident or accident are based on a state-oriented approach, which consists in developing operating strategies in relation to the identified physical state of the nuclear steam supply system, regardless of the events that led to that state. Should that state deteriorate, continuous diagnosis would enable the procedure or sequence in progress to be aborted and a better adapted procedure or sequence to be applied.

The purpose of the operating procedures specified by EDF in the event of an incident or accident is to achieve a broader APE coverage than the event-based approach.

Historically, the APE was created following the accident at Three-Mile Island and gradually enforced in France in order to replace procedures that relied on the event-based approach.

For the time being, some procedures of the event-based approach are still used by EDF. They are detailed in the so-called "H" rules concerning the management of events that are not taken into account at the design stage; the so-called "U" rules covering severe accidents and the "I14" rule, which is used to control the reactor from the fallback station.

In the event of an incident or accident, EDF teams first implement the APE documentation in order to diagnose the different functions of the relevant states. Subsequently, those functions may be directed by those documents towards a residual event-based procedure (resulting from Rules H, U, etc.) or an APE procedure.

In addition, some incidents are managed by specific operating rules (RPC), which are considered as normal operating procedures for two reasons: first and foremost, the safety of the installation is not affected, and second, an APE procedure would not optimise the required delay for processing the incident. Those specific procedures are in line with a similar underlying principle to event-based procedures, according to which the event or the incident is clearly identified and the strategy focuses on the initiator.

Operating documents are prepared on the basis of operating rules in case of incident and accident that form chapter VI of the RGEs. The enforcement or modification of those documents must be declared to ASN. In 2009, ASN continued to review the changes to the operating rules as proposed by EDF for nuclear reactors in service and approved the implementation of the cases relating to decennial outages for every series of nuclear reactors. Some changes to the APE procedures result from the physical changes that will be integrated during decennial outages, whereas others result from the experience operating feedback or respond to ASN’s request to improve safety.

In line with the project called “Operation under incident or accident conditions” (CIA), whose analysis started in 2006, ASN reviewed in 2009 the work relating to the information used in the CIA and to the coverage of events by operating procedures referred to chapter VI of the RGEs. The CIA project was launched by EDF following reflections on the impact of the frequency of changes to APE procedures on recorded incidents that are not managed according to optimal methods through the APE approach (e.g., partial losses of electric power) and in order to ensure the preservation of skills when operating under incident or accident conditions. However, it is important to note that EDF does not intend to further the APE by an event-based approach in the framework of that project.

In order to prepare the review of the commissioning-authorisation application for the Flamanville EPR, some topics pertaining to the regulatory documents listed in Article 20 of the 2007 Procedure Decree and provided by the operator when submitting his commissioning-authorisation application, are reviewed in advance. Pending their integration in the RGEs concerning operation under incident or accident conditions, the matching operating principles form an integral part of those topics. During 2009, ASN and its technical supporting body reviewed the CIA principles for the closed and non-closed states of the main primary circuit (CPP) of the reactor, the operating principles of the aggressions covered by the CIA, the interface between the CIA and the handling of a severe accident, as well as the operating principles in relation to the different man-machine interfaces.

Inspections concerning the operation of a reactor in the event of an incident or accident are conducted on a regular basis. During such inspections, the review covers notably the management of operating documents referred to in chapter VI (transposition of national reference documents into local documents, reproduction, diffusion, etc.), the management of the specific equipment used during operation under accident conditions, as well as the training of operating agents. In the light of the inspections conducted in 2009, ASN considers that the *in-situ* appropriation of operating rules in case of incident or accident is generally satisfactory.

Operation of reactors in the event of a severe accident

If, following an incident or an accident, the operation of the reactor ever prevented its return to a stable state and if the scenario generated by a series of failures ever led to a degradation of the core, the reactor would enter into a situation known as a “severe accident”.

Confronted with such very hypothetical situations, various measures are taken to help operators handle the operation of the reactor, together with the assistance of emergency teams, and ensure the containment of radioactive materials in order to minimise the consequences of the accident. Emergency teams may rely notably on the “Intervention Guide During Severe Accidents” (GIAG). The review of the GIAG and of its changes is under way by ASN and its technical supporting body. Every type of known severe accidents is taken into account by EDF in that framework. Dedicated devices (recombiners, filters, etc.) or procedures are implemented in order to minimise the consequences of such accidents or to prevent corresponding phenomena.

In 2009, ASN issued a positive assessment of the changes brought by EDF to its risk-integration approach with regard to severe accidents, following the advisory committee for nuclear reactor’s review in 2008. Nevertheless, ASN has requested EDF to complete its reference system through a better integration of the long-term management of such an accident, to reinforce the requirements concerning the necessary equipment for managing such a situation and to further the optimisation of its water-management strategy in the reactor pit in order to control the evolution of the accident.

In addition, the advisory committee for nuclear reactor reviewed on 25 June 2009 the potential means to counter the water-borne dissemination of radioactive products, or in other words, the potential contamination of groundwater tables with liquid radioactive discharges.

19.4.1.5 Incident analysis and experience feedback

19.4.1.5.1 Generic aspects

Experience feedback constitutes a source of improvement for nuclear safety, radiation protection and the environment. That is the reason why ASN requires EDF to declare significant events occurring in NPPs. Specific criteria such declarations to public authorities were set accordingly in a document entitled "Guide on declaration procedures and the codification of criteria for significant events involving safety, radiation protection and the environment applicable to BNIs and the transport of radioactive materials". Hence, ASN rates every significant event on a scale of 0 to 7 on INES.

ASN also examines at both the local and national levels the overall series of significant events being declared. In some cases considered as more important for safety due to their outstanding or recurrent nature, ASN relies on IRSN to proceed with a more comprehensive analysis. Certain significant events may also be the subject of a declaration in the IAEA's Incident Reporting System (IRS) Data Bank.

ASN supervises the method used by EDF to process the experience feedback from significant events and to benefit from it in order to improve nuclear safety, radiation protection and environmental protection. During its inspections in NPPs, ASN examines the structure of the sites and the actions being conducted for handling significant events and integrating experience feedback.

ASN also ensures that EDF draws lessons from significant events that occurred in foreign countries, notably on the basis of the reports declared in the IAEA's IRS Data Bank.

Lastly, at ASN's request, the advisory committee for nuclear reactors examines periodically the experience feedback relating to the operation of PWRs. The advisory committee for nuclear reactors met in December 2007 in order to review highlight events between 2003 and 2005, concerning notably significant events with regard to radiation protection, the operation of safety-related equipment of the control and instrumentation system in 1,300-MWe reactors, the operation of ventilation systems and the assessment of operational rigour in relation to given situations and interventions.

ASN will also call upon the advisory committee for nuclear reactors to analyse the events that occurred between 2006 and 2008, at a meeting scheduled in late 2010.

In general, the structure set in place by operators in NPPs to handle experience feedback is satisfactory, since it is well formalised and processed. The sharing of information between EDF's local and corporate levels is efficient. The actions enforced in 2008 and 2009, for instance, were leading in reducing significantly the number of automatic reactor shutdown.

However, ASN feels that EDF must improve the quality and thoroughness of its analyses, which are often insufficient. In 2009, an incident involving the jamming of a fuel assembly for the second year in a row at the Tricastin NPP is a good illustration of the fact that the implementation of the conclusions of such analyses and the application of corrective actions after the event are still perfectible.

Furthermore, ASN notes that its communications with the sites need improvement. Formal declarations often take more than two days to reach destination and ASN is sometimes forced to modify the event rating proposed by the operators.

In accordance with the rules for declaring events relating to nuclear safety, radiation protection and the environment, EDF has declared an average of close to 700 significant events on INES every year (from

2008 up to 2010), 90% of which were rated as Level 0. Of those events, 13% were rated on account of radiation protection (compared to 20% between 2004 and 2006), and 1.5%, due to uncontrolled discharges of radioactive materials in the environment.

Events that are declared on account of environmental protection, but involve neither nuclear safety nor radiation protection, are not rated on INES. In 2008 and 2009, 86 and 109 events, respectively, were declared as such, compared to about 20 between 2004 and 2006.

The proportion of events rated as Level 1 on INES is in the order of 10% and refers almost exclusively to nuclear safety. ASN's final rating as Level 1 may result directly from the basic rating level as Level 1 or from the application of an additional factor above a basic rating as Level 0. The basic rating is representative of the impact on safety. The number of events directly rated as Level 1 is short and has remained stable over the last five years. The application of the additional factor is prevailing. It is important to recall that INES is a tool designed to facilitate the perception of the significance of nuclear incidents and accidents by the media and the public. It does not constitute an assessment tool, however, and is unable, under any circumstances, to serve as a base for international comparisons. More specifically, there is no univocal relation between the number of non-significant incidents being declared and the probable occurrence of a severe accident in a BNI. Hence, neither ASN nor EDF is implementing specific measures to reduce the probability or the number of events rated as Level 1.

Between 2008 and 2010, ASN rated three NPP incidents as Level 2 on INES, as follows:

- on the night of 1 December 2009, a loss of the water sink of Reactor No. 4 at the Cruas NPP;
- during a gammagraphy weld check performed at EDF's Flamanville site on 29 September 2009, the accidental irradiation of a worker from the ABC Company (GIE Horus), and
- during a cleanup activity at the bottom of a pool in the fuel building of the B4 reactor at Chinon NPP, on 23 April 2010, the accidental irradiation of a worker, which EDF and one of its contractors had proposed to rate as Level 2 and which ASN confirmed.

19.4.1.5.2 Inspection and maintenance activities on steam generators

Over the last few years, the controls performed on steam generators during maintenance and reloading outages or following unscheduled events have detected degradations. Some of them, which were significant and had not been anticipated, required EDF to implement large-scale maintenance measures on a numerous of reactors of the French nuclear fleet. Those measures were not without impact on the availability rate of the reactors. ASN ensures that the safety of those steam generators remains satisfactory.

1. Measures taken against recently observed phenomena on steam generators

- Clogging of steam generators:

  The clogging of tube support plates consists in the gradual obstruction of apertures, which is due to oxide deposits, allowing the flow of water and leads to changes in the water flow in steam generators. Between 2004 and 2006, three leaks affected steam-generator tubes. Since those degradations were determined to be associated with that phenomenon, EDF implemented a chemical-cleanup strategy for steam generators, which is monitored by ASN.

  Together with IRSN, its technical support body, ASN is assessing the justifications provided by EDF concerning the understanding of that phenomenon and its impact on the safety of reactors over the long term. In addition, ASN requested EDF to submit solutions with a view to limiting the presence and development of oxide deposits;

- Tube-support anomalies:

  Anti-vibration bars support a certain number of tubes. Any unsupported tube, which is in violation of the equipment design, is considered to be a "support anomaly". In February 2008, a leak formed on an unsupported steam-generator tube in the Fessenheim-2 reactor, although that tube had not been identified as sensitive to vibration fatigue. Following that event and at ASN's request, EDF proceeded with sealing all unsupported tubes of 900-MWe reactors and those presenting the most risky of 1,300-MWe reactors. EDF also had to revise its vibration-fatigue studies, the results of which are expected in 2011 and will be reviewed by ASN and IRSN. The most urgent measures have been taken in order to prevent all risks over the short term;

- Corrosion cracks:

  Some types of steam generators consist of corrosion-sensitive alloys and are monitored more closely. During checks on steam generator No. 1 of the Le Bugey-3 reactor, in May 2009, EDF detected small cracks with new features and a significant defect that was only identified during the extraction of the tube for assessment purposes. After several months of assessment and review, EDF decided to replace all steam generators of the Le Bugey-3 reactor earlier than expected.

  The phenomenon was due to the corrosion of the tube at the level of the tube support plate and concerns a type of steam generator, which is still found in reactors in France. Other assessments were carried out on the same type of steam generator, which is found at the Fessenheim-2 reactor, and revealed the presence of corrosion that had not been properly detected by the control processes in use.

  Additional control operations are scheduled on all steam generators likely to be concerned. Preventive sealing activities were also conducted on the Fessenheim-2 and Gravelines-3 reactors at ASN's request and will ensure from now on the integrity of the tubes during the next operating cycle.

2. Monitoring of EDF's corrective measures

In order to ensure the integrity of the nest of tubes of steam generators against degradations, large-scale corrective measures were set in place and further improved, with EDF being responsible for demonstrating its full control and for ensuring at all times that they have no impact on the safety of reactors. Consequently, ASN pays careful attention to the experience feedback from their use.

SEALING OF STEAM-GENERATOR TUBES

Any tube, which is affected by a significant defect, is sealed by a mechanical plug. In May 2008 and February 2009, it was found that two plugs had moved after being installed. At ASN's request, EDF launched in July 2008 a programme to verify the presence of plugs in all steam generators within the nuclear fleet.

EDF has also set a specific criterion in order to ensure that plugs are installed properly; all recorded parameters during installation are duly available. From now on, after every tube-sealing intervention, EDF will perform reinforced and systematic controls. Those data are forwarded for review to ASN, which decides in turn whether the reactor should restart operation or not. ASN also requested EDF to carry out investigations with a view to understanding the origins of the phenomenon; results are under review.

CHEMICAL CLEANUP OF STEAM GENERATORS

Chemical cleanup is a solution against the clogging of steam generators. In spite of the confirmed effectiveness of that method, ASN feels that cleanup processes are not impactless, whether the internal structures of steam generators or the nest of tubes are subject to corrosion during treatment. Deposits on the tubes, whose origin is not readily identifiable, may also be observed after cleanup.

ASN ensures that processes keep improving by taking experience feedback into account, thus helping EDF reduce the corrosion level of steam generators. Several tubes were also removed for assessment purposes, notably from the Chinon-B2 reactor in 2008. Those checks are instrumental in determining the nature and impact of the deposits that were eliminated by decoppering during the reactor outage in 2009.

3. Prospects

A programme to replace the oldest steam generators was launched by EDF in the early 90s and continues at a rate of one or two reactors every year. By 2014, steam generators made of thermally-untreated Inconel 600, which are the most sensitive to corrosion and are still found in eight reactors, should all have been replaced. ASN requested EDF to conduct a comprehensive review of the monitoring and design of steam generators in order notably to ensure that such replacement operations are scheduled early enough, thus avoiding excessive degradations from affecting that equipment. ASN will also ensure that future maintenance programmes take those new degradations into account.

19.4.1.6 Waste management

Waste-management operations

Most operations associated with the management of the waste generated by the operation and maintenance of reactors in nuclear auxiliary buildings (BAN), auxiliary conditioning buildings (BAC) and effluent-treatment buildings (BTE). Following the inspections during which waste management was found to be unsatisfactory with regard to the containment of radioactive materials, fire prevention and radiation protection, ASN requested EDF to improve its waste-management methods on its sites and to specify an operational waste-management reference system in BANs, BACs and BTEs. EDF drew a physical inventory of the buildings, compared current and design practices and operated gradual reductions in the quantities of waste in the buildings. In 2009, EDF completed its waste-management reference system, which now remains to be enforced on the sites.

ASN notes that EDF's efforts with regard to conditioning and evacuation in order to reduce the quantities of stored waste and will now ensure that de-storage activities and the enforcement of the waste-management reference system continue on site.

Waste with no management system

A certain quantity of waste originating from contamination areas (monitored areas, controlled areas), such as batteries and electronic devices, are currently awaiting for a dedicated evacuation system.

Most of that waste was produced in the past. In the meantime, optimisations in the orientation of the waste towards either conventional or nuclear systems together with the classification of the waste made it possible to minimise in part the production of that waste, including batteries and electroluminescent lighting devices.

ASN requested EDF to establish a physical inventory of the nuclear fleet in order to provide a listing of all types of waste concerned and estimates of the quantities present on the sites in comparison to storage capabilities. EDF undertook various actions with Andra in order to develop acceptance files. Those exchanges are expected to continue in 2010.

Lastly, since the quantity of electronic waste is expected to increase due to the rising use of equipment, hardware and electronic components, ASN requested EDF to undertake promptly the necessary investigations in order to estimate future waste quantities.

19.4.2 Operation of research reactors

19.4.2.1 Internal authorisations

In 2002, CEA was authorised to enforce an internal-authorisation mechanism (refer to §7.3.2.2), whose framework used to cover about 15 installations, reactors, laboratories or "support" installations. The updating procedures of the safety reference system were specified in two ASN guides.

The experience feedback accumulated over close to 10 years has improved the application criteria and enhanced the robustness of the process. It also confirmed the effectiveness of that system and did not detect any significant or deliberate malfunction.

The internal-authorisation system is now regulated by the 2007 Procedure Decree and by ASN Decision No. 2008-DC-106 of 11 July 2008, which specifies its generic requirements. In accordance with the prescriptions of that Decision, CEA submitted a file in March 2009 in order to present the implementation specificities of that operator. ASN approved it in March 2010.

For research-reactor operators, the internal-authorisation system provides more flexibility in the management of the changes to be brought to their installations, which sometimes prove necessary for certain experiments, by ensuring a better control in the evolution of the delivery process of some authorisations.

However, ASN considers that CEA must continue to improve its perception of the safety challenges of the different changes to its installations. Since efforts involve justifying the fact that contemplated operations remain within the safety demonstration and ensuring consistency among the various cases, the reference documentation system and the history of the installation must therefore be pursued.

19.4.2.2 Safety of experimental devices

Some research reactors undergo regular core-configuration changes due to the experiments they host. Others accommodate specific experimental devices designed for the conduct of certain types of experiments. One of ASN's challenges is to allow new experiments to be conducted on a regular basis, while ensuring that they are run under the relevant safety conditions.

All conditions pertaining to design, performance and irradiation authorisation of the experimental devices have been the subject of many exchanges between ASN and CEA for several years. In 2003, they led to the publication of a technical guide listing a series of requirements.

Its application was the subject of an inspection campaign in 2005, followed in 2006 by the integration of experience feedback by both ASN and CEA in its analytical guide for the safety of experimental devices prescribed by the above-mentioned guide.

In 2010, ASN intends to analyse the application of the approach des cribbed in that technical guide concerning the case of an experimental device that has been submitted to the recent periodic review. In addition, measures and requirements about experimental devices will also be reassessed in the framework of the design of those intended for the future RJH at Cadarache.

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.

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 2010.

The table below lists all of the missions carried out or scheduled by the IAEA in France as at the end of October 2010.

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
4-15 May 1992	ASSET	Fessenheim
15 March – 2 April 1993	OSART	Gravelines 3 and 4
15-19 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
17-29 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-sur-Loire
14-31 January 2002	OSART	Tricastin
13-17 May 2002	OSART follow-up	Belleville-sur-Loire
20 January 6 February 2003	OSART	Nogent-sur-Seine
12-28 May 2003	OSART	Civaux
17-21 November 2003	OSART follow-up	Tricastin
24 November – 3 December 2003	PROSPER	EDF Corporate
15-19 November 2004	OSART follow-up	Nogent-sur-Seine
29 November – 15 December 2004	OSART	Penly
6-10 December 2004	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
25 November - 14 December 2006	OSART	Saint Laurent-des-eaux
27 November – 14 December 2007	OSART	Chinon
6-10 October 2008	OSART follow-up	Saint Laurent-des-eaux
24 November – 11 December 2008	OSART	Cruas
23 March – 8 April 2009	OSART	Fessenheim
7 November - 7 December 2009	OSART follow-up	Chinon
20 September – 7 October 2010	OSART	Saint-Alban

The reports for these missions are made public, and are available on the ASN website.

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-des-eaux
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
2009	Bugey, Cattenom
2010	Gravelines, Golfech, Dampierre-en-Burly

20 Planned activities to improve safety

20.1 National measures

France is constantly seeking potential means to protect the safety of nuclear installations.

20.1.1 ASN's objectives

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;
- increasing the general synergy between nuclear safety, radiation protection, work safety and compliance with social laws, as well as environmental protection, in the framework of an integrated approach;
- ensuring better consideration of environmental problems, in particular when renewing discharge authorisation;
- anticipating ageing problems, in particular through exhaustive preparation of the decennial 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 decennial 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 operator will be greater and more uncertain.
- clarifying the role and structure of skills in the control of nuclear activities in order to ensure the quality of that control over time;
- acting as a driving force in building nuclear safety and radiation protection in Europe at a shared high performance level and in constituting an international reference, and
- promoting and encouraging public exchanges and debates involving ASN (EPR, operating lifetime, etc.) in order to improve public information and help ASN learn from the discussions in order to take the best decisions.

20.1.2 Objectives of operators

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 operator's key objectives relate to operation, as well as to its generating assets.

Operating objectives

- 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 reactors comply with the safety requirement reference system through rigorous and appropriate treatment of deviations from requirements.
- 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.

Objectives concerning generating assets

- achieving the highest standards in the general state of the installations in order to ensure the durability of industrial facilities, implementing rigorous operating conditions and instilling a feeling of ownership among personnel;
- securing and extending the operating lifetime of the reactors under optimal safety conditions, and more particularly, succeeding in the preparation and performance of periodic safety reviews, controlling equipment ageing, reinforcing the future operation of reactors by drawing all possible lessons from experience feedback (including foreign), carrying out projects associated with that experience feedback notably concerning climate aggressions;
- preparing for the renewal of the NPP fleet, by building an EPR with due account of the experience feedback from close to 1,500 reactor-years' operation, and
- ensuring the reliability of the fuel and increasing the potential availability of reactors by improving the efficiency of fuel management and the behaviour of the fuel product.

20.1.2.2 CEA's objectives

In order to guarantee maximum safety in the operation of its installations, CEA never ceases to work not only on safety, but also in the areas of radiation protection, the environment and quality.

Priority objectives, which are specified in CEA's final improvement plan, include the following:

- successful appropriation by outside firms of CEA's security culture and requirements;
- improvement of approaches and harmonisation of criteria for setting dose objectives;
- reinforced implication of competent radiation-protection services in their assistance missions;
- reinforcement of the radiation-protection culture of CEA's exposed workers;
- classification of radiation-protection interfaces of contractor firms;
- promotion of safety culture for operators or outside workers in installations;
- compliance control of structures with safety requirements on civil-engineering worksites for new installations;
- provision of effective safety guidance (self-assessment approach, analysis of experience feedback and handling of discrepancies, indicators for objective follow-up and second-level control in every installation),
- consolidated implementation and operation of CEA with regard to organisational human factors.

20.1.2.3 ILL's objectives

High-flux reactor safety, both intrinsic and in operation, is subject to a process of continuous improvement. Particular stress has been placed over the last six 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).

It may also be interesting to note that an ultimate reflood circuit was commissioned in 2010 and that a seismic-deflation circuit of the reactor containment will be installed in 2011.

20.2 International co-operation measures

20.2.1 ASN's international activities

20.2.1.1 General policy

The set of nuclear installations 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 *TSN Act* 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 to which IAEA is warden (§ 20.2.1.4).

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 heads.

20.2.1.2 Multilateral relations

20.2.1.2.1 European Union

Today, with the Treaty setting up EURATOM and its accruing legal instruments, in addition to WENRA's activities, the EU is at the very heart of the regulatory efforts in the fields of nuclear safety and radiation protection. Consequently, ASN is actively involved in the various European working groups and partakes extensively in discussions on the integration of nuclear safety at the European Community level and that activity ranks as one of ASN's top priorities.

Western European Nuclear Regulators' Association (WENRA)

Thanks to the work performed by WENRA, an association composed of the top managers of all safety authorities within the expanded European Union and Switzerland, the regulatory harmonisation of safety-related matters for all reactors in service in Europe should be enforced in 2010. In addition, in 2009, the meetings of the Association were open to the safety authorities of the ten European countries that have no nuclear-power reactor.

EUROPEAN NUCLEAR SAFETY REGULATORS' GROUP (ENSREG)

In 2008, the European Nuclear Safety Regulators' Group (ENSREG), previously known as the High-level Group and consisting of the top managers of the safety authorities of the European Union, was created at the invitation of the European Council, in March 2007. Based on the orientations provided by the Council of Ministers, the Group undertook a reflection on the safety of installations, the management of waste and spent fuel, as well as nuclear transparency throughout Europe. The Chairman of ASN is a member of ENSREG, and ASN assumes the vice-presidency of the Group on the Safety of Installations.

ENSREG's activities were echoed especially during the French presidency of the European Union (second half of 2008), with the first debates concerning a directive on nuclear safety, which was adopted on 25 June 2009. It constitutes a stringent community framework for nuclear safety and contributes to the harmonisation of safety requirements in Member States.

HEAD OF EUROPEAN RADIATION CONTROL AUTHORITIES (HERCA)

In the field of radiation protection, the work performed by the Head of European Radiation Control Authorities (HERCA) has reinforced European co-operation. The progress made by that committee and its working groups since their inception in 2007 is noteworthy.

On 29 May 2007, ASN organised in Paris the first meeting of the top managers of the European authorities responsible for the control of radiation protection, which was followed by three more, again in Paris, in May and December 2008 and December 2009, respectively.

Among the many issues of common interest, the members of HERCA discussed notably with the European Commission about a draft directive on basic standards, which should supersede the 1996 Directive on Basic Standards. It was also decided to constitute a reflection group on suitable means to improve HERCA even further and to ensure better communication about its activities.

ASSISTANCE TO EASTERN EUROPEAN COUNTRIES – NEW INSTRUMENTS IPA-INSCI

Since the creation of the Programme of Community Aid to the Countries of Central and Eastern Europe (PHARE) and the Technical Aid Programme to the Commonwealth of Independent States (TACIS) by the European Commission, ASN has been an active participant.

Both programmes were replaced in 2007 by the Instrument for Pre-Accession Assistance (IPA) and by the Instrument for Nuclear Safety Co-operation (INSC), respectively, both of which extend to all countries around the world, irrespective of geographic boundaries.

In order to collect opinions and advice on the assistance requests formulated by third countries, the European Commission instituted the Regulatory Assistance Management Group (RAMG), which envolves the nuclear-safety and radiation-protection authorities within EU countries.

ASN co-ordinates the programmes being conducted in Egypt, Kazakhstan and Ukraine, and participated in regulatory assistance projects for those three countries as well as for the Russian Federation.

20.2.1.2.2 International relations

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 the called "Safety Standards", describing safety principles and practices which can then be used by Member States as a basis for their national regulations.

  That activity is supervised by the Commission on Safety Standards (CSS), which was created in 1996. France is represented within the CSS by one of ASN's Deputy Director-General. The President of ASN was re-elected as the CSS Chairman at the beginning of 2008 for a second mandate. In 2009 were held the 25th and 26th meetings of the CSS.

That 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, which meet twice a year.

Among the many achievements at hand, two projects are worthy of mention: the integration of the revision under way of the *Basic Safety Standards*, which is a prescriptive document in radiation protection, and the integration of the aspects relating to nuclear security. With regard to the latter, the search for a better synergy between safety standards and security guides was addressed at several meetings in 2009 between the CSS and the committee dedicated to the security of nuclear installations, known as AdSec, and

- the availability to Member States of "services" designed to provide advice on specific aspects relating to nuclear safety and radiation protection.

  In that category, are included the IRRS and OSART missions. In November 2006, ASN greeted an IRRS mission, the very first full-scope audit in the world, and in March 2009 a follow-up mission (refer to Appendix 5).

  In 2009 ASN partook also in several IRRS missions successively in Peru, Canada, Lebanon, the Russian Federation and the United Kingdom. ASN also feels that the generalisation of such audits should promote the constitution of a network of experts from national regulatory bodies and hence, contribute to the harmonisation of practices.

  As mentioned in §19.5.1, France continues to rely extensively on OSART missions. Corresponding reports are available in English on ASN's Web site.

HARMONISATION OF COPMMUNICATION TOOLS

ASN has strongly contributed to the enhancement of the international-consultation process with a view to furthering INES by a radiation-protection criterion designed to correlate the radiation exposure dose or the exposure volume being received with the severity index of an incident or accident involving radiation protection.

That new feature of INES relating to radiation-protection incidents is applicable to BNIs and radioactive shipments in France. The French proposal resulted in the adoption by IAEA State Members of the new feature. The new English version of the INES users' guide was published in June 2009.

ASN wishes also for INES to integrate eventually the radiological protection of patients, thanks to a classification system for radiotherapy events, which was developed jointly by ASN and the French Oncological Radiotherapy Society (SFRO) under the name of the "ASN/SFRO scale". The Working Group on the Classification of Events Involving Patients, which was formed at France's initiative, met in Paris in December 2008 and October 2009.

OECD NUCLEAR ENERGY AGENCY (NEA)

Within the NEA, ASN participates in the activities of the Committee on Nuclear Regulatory Activities (CNRA), the Committee of Radiation Protection and Public Health (CRPPH), the Radioactive Waste Management Committee (RWMC) and of a few other working groups of the *Committee on the Safety of Nuclear Installations* (CSNI). ASN participated notably in the development of the Joint 2010-14 CNRA/CSNI Strategic Plan.

MULTINATIONAL DESIGN EVALUATION PROGRAMME (MDEP)

The MDEP programme is an international co-operation project designed to develop innovative approaches in order to pool the resources and knowledge of regulatory bodies that will be in charge of the regulatory assessment of new reactors. Regulatory bodies from ten countries participate in the MDEP, including seven NEA members: Canada, Finland, France, Japan, the Republic of Korea, the United Kingdom and the United States, in addition to China, the Russian Federation and South Africa. NEA provides also secretariat services to the MDEP. An ASN agent was seconded to NEA in order to provide secretariat support to the MDEP programme.

The MDEP"s strategic committee, which is chaired by the Chairman of ASN, met in early 2009. At that meeting, it was decided neither to increase the number of participating countries nor the number of topics to be addressed, in order to maintain the efficiency of the initiative. Furthermore, with due account of MDEP objectives and the work projects that have been launched, the participants decided to extend the programme to five years.

In order to maintain a durable dialogue with other stakeholders, an MDEP conference on the design of new reactors was held in Paris, on 10-11 September 2009. It provided an opportunity to present the first results and to discuss with industrialists and body regulators. The MDEP will also need to implement well-suited information channels towards body regulators, industrialists and the public. At the end of the conference, it was agreed that a similar gathering would be organised within the next two years.

INTERNATIONAL NUCLEAR REGULATORS" ASSOCIATION (INRA)

The International Nuclear Regulators' Association (INRA), which comprises the top managers of the nuclear body regulators in Canada, France, Germany, Japan, the Republic of Korea, Spain, Sweden, the United Kingdom and the United States, met in April and October 2009. Those meetings enhanced the leadership of the Association, whose members have reviewed in depth several significant topics to reinforce nuclear safety throughout the world. More particularly, in April 2009, INRA took a stand on an issue relating to the import of metals contaminated with radioactive materials and wrote a letter accordingly to the Chairman of the review meeting for the *Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management*.

In 2010, INRA met in London under the chairmanship of the top executive of HSE.

UNITED NATIONS SCIENTIFIC COMMITTEE FOR THE STUDY OF THE EFFECTS OF ATOMIC RADIATION (UNSCEAR)

The United Nations Scientific Committee for the Study of the Effects of Atomic Radiation (UNSCEAR), which was created in 1955, is responsible for summarising all scientific data concerning radiation sources and the associated risks of those radiations on health and the environment. The activity is supervised by the annual review of the national delegations of Member States, consisting of high-level experts, including ASN's. The reports of that scientific entity serve as international references and deal with various topics, such as the hereditary effects of ionising radiation or the consequences of the Chernobyl accident.

20.2.1.3 Bilateral relations

ASN works with many countries pursuant to various signed bilateral agreements, such as:

- government agreements, and
- administrative arrangements between ASN and its counterparts.

20.2.1.3.1 Staff exchanges between ASN and its foreign counterparts

A better knowledge of the actual operation of foreign nuclear-safety and radiation-protection regulatory bodies allows for relevant lessons to be learnt for the benefit of ASN's operation and for broadening the training of staff members. One of the means selected to achieve that goal is the exchange of staff members.

Several provisions were established for exchanges, such as:

- very-short-term actions (one or two days) with a view to proposing cross-inspections and joint nuclear and radiological emergency exercises to our foreign counterparts. In 2008, approximately

30 joint inspections took place concerning nuclear safety and radiation protection. In 2009, 30 joint inspections were also organised. They were held either in France or in countries inviting ASN inspectors. They were conducted in Belgian, Chinese, Finnish, German, Japanese, Spanish Swiss and France NPPs. Part of those joint inspections also dealt with radiotherapy activities in Switzerland and France. In addition, ASN participated in an emergency exercise in Japan and the United States in 2008 and 2009, respectively;

- short-term assignments (from three weeks to six months) in order to study a specific technical topic. In 2008, ASN welcomed a public servant from the Austrian Ministry in charge of the environment for a six-month training session. In 2009, a public servant from the Hungarian Safety Authority spent one month in various ASN units, and
- long-term exchanges (from one to three years) with a view to acquiring an in-depth knowledge of the operation of foreign nuclear-safety and radiation-protection authorities.

In addition, the appointment of representatives of foreign regulatory bodies in advisory committees is worthy of mention. In fact, ASN has implemented that practice in order to allow experts from other countries not only to participate in such advisory committees, but also to ensure that that they might be elected as their chairman or vice-chairman. That strong implication of experts from foreign nuclear regulatory bodies made it possible notably to publish a joint position by ASN, STUK and HSE after the advisory committee for reactors meeting held in 2009 on the control and instrumentation system of the EPR-type reactor at Flamanville-3.

20.2.1.3.2 Actions to support nuclear regulatory bodies

Within a context where new nuclear-power programmes are announced and launched, ASN pays close attention to those projects and has established a realistic and efficient framework to respond to the requests it receives. The implementation of that framework, together with the matching human means, should help ASN carry out that new mission with a view to maintaining a high level of nuclear safety throughout the world.

20.2.1.4 International conventions

Besides the *Convention on Nuclear Safety*, France is a Contracting Party to the following other conventions:

- the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, which France signed on 29 September 1997 and which entered into force on 18 June 2001. The presentation of the French report at the third meeting of the Convention in 2009 was made by the Director-General of ASN, together with the participation of the Director-General of Andra. Concerning that report, the representatives of the Contracting Parties identified significant challenges, such as the disposal of historical waste, the implementation of new systems for the treatment of low-level, intermediate-level and high-level waste, and for the development of an international approach for the technical and social aspects of deep geological waste repositories;
- the *Convention on Early Notification of a Nuclear Accident* and the *Council Decision of the European Communities concerning urgent radiological information exchange*, which France signed on 26 September 1986 and which entered into force on 6 April 1989. ASN is the competent national authority in France, and
- the *Convention on Assistance in Case of a Nuclear Accident or Radiological Emergency*, which France signed on 26 September 1986 and which entered into force on 6 April 1989. ASN is the competent authority for the application of that international convention in France and, in that capacity, has performed several assistance missions.

20.2.2 IRSN's international activities concerning reactor safety

Within the scope of the duties assigned to it by the public authorities, The 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.

Those 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 presented 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 (International Source Term Programme), the behaviour of highly-irradiated fuel in reactivity accidents in PWRs (CABRI-REP programme) and the fire propagation in elementary multi-room scenarios for nuclear installations (PRISME at NEA programme).

IRSN also participates in many research projects abroad, including the study of ex-vessel corium behaviour (MCCI-2 programme at NEA), the study of the results of thermal-hydraulic experiments to resolve the uncertainties concerning combustible hydrogen and the behaviour of fission products, notably iodine and aerosols (THAI programme at NEA), or the projects of the EU Framework Programme for Research and Development dedicated to severe accidents. In that regard, a special mention should be made about the co-ordination of the SARNET-2 Network of Excellence by IRSN under the 7th programme for research and development, one objective of which is to establish the ASTEC integrated code as the European reference for "severe-accident" codes.

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 Contribution 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 in the framework of the MDEP programme is an example of harmonisation of safety regulatory requirements. 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 European Bank for reconstruction and development 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 Japanese, Indian, Eastern European, Moroccan and Vietnamese partners.

20.2.2.4 "European Clearing House"

With regard to nuclear safety, the European Commission's Joint Research Centre (JRC) created in 2008 an exchange forum, called the "European Clearing House", whose mission is to analyse incidents that occurred at nuclear installations within the EU and to draw recommendations from them. The primary objective is to implement a communication platform among the relevant regulatory bodies (with the eventual support of their technical support bodies, State Members and the JRC. In that context, IRSN contributes also to the improvement of nuclear safety in European countries through its presence at the Technical Board of the European Clearing House. In consultation with its counterparts at GRS, IRSN analyses its experience feedback with a view to distributing the results to the other members of that entity, which reports to the Petten JRC.

20.2.3 EDF's international activities concerning 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 holds a 45% share in the German company EnBW, which operates notably four NPPs (Neckarwestheim 1-2 and Philipsburg 1-2). EDF and EnBW have developed a fruitful co-operation in the nuclear sector. A joint working group, for instance, was created on nuclear safety. Safety-management systems and safety indicators have been the subject of regular comparisons. Information relating to safety-related events are exchanged on a regular basis;

- EDF holds a 50% share in the Tihange-1 reactor in Belgium, thus providing a framework for productive exchanges and the sharing of experience notably on significant safety-related events;
- in early 2009, the EDF Group acquired British Energy, which runs eight NPPs in the United Kingdom, seven of which belong to the advanced gas-cooled-reactor type (Dungeness-B, Hartlepool, Heysham-1, Heysham-2, Hinkley Point-B, Hunterston-B, Torness) and include two reactors each plant, and one to the PWR type (Sizewell-B with a single reactor). Since then, co-operation and exchange actions have been launched between British Energy and EDF, notably on safety-related issues. Those reactors are now operated by EDF Energy, a branch of EDF;
- on 21 December 2009, EDF and its Chinese partner, the China Guangdong Nuclear Power Company, which operates four reactors at Daya Bay and Ling Ao, received the final approval for creating a joint venture, called the Taishan Nuclear Power Joint Venture Company. The purpose of the joint venture, which was signed in November 2007, is to build and operate two nuclear EPRs at Taishan, in Guangdong Province. EDF's share in Taishan Nuclear Power Joint Venture Company is set at 30% for 50 years. Following approval by the Chinese government, the construction of the first nuclear island began with the pouring of the first concrete. The commissioning of the first two units of the Taishan NPP on the model of the EPR under construction at Flamanville is scheduled in late 2013 and 2014, respectively. A significant milestone in the construction of the first unit was reached last November with the pouring of the first concrete of the bottom slab of the first reactor;
- in the United States of America, EDF and Constellation Energy signed in July 2007 a strategic partnership agreement ("Joint venture 50/50 UniStar Nuclear Energy") in order to develop, build, own and operate jointly EPR-type NPPs in that country, with the objective being to develop four EPRs, including two before 2020. That project is under way and the certification application for an EPR was submitted to NRC in December 2007. The first EPR is scheduled on the Calvert Cliffs production site, in Maryland. The combined construction and operating authorisation application (COLA**)** was accepted for review by NRC. The project was selected by the U.S. Department of Energy, together with other nuclear projects, as a candidate for a Federal Loan Guarantee. In addition, the Group finalised in November 2009 the acquisition of 49.99% of the nuclear assets of the Constellation Energy Group, which is equivalent to a self-owned capacity of 3,839 MWe between the Calvert Cliffs NPP, in Maryland, and those of Nine Mile Point and R.E. Ginna in New York State;
- in Italy, the Italian government announced in late 2008 its intention to launch a nuclear programme and to begin the construction of the first NPPs as early as 2013. On 24 February 2009, France and Italy signed a nuclear co-operation agreement covering the entire system, opening up the Italian market to French nuclear operators, prescribing the involvement of Italian groups in the development of civil nuclear energy in France and promoting Franco-Italian co-operation for the export of nuclear technology towards third countries. In that framework, EDF and ENEL signed an agreement with a view to creating a 50/50 consortium between themselves in order to perform feasibility studies for the development of at least four EPRs in Italy;
- in Poland, EDF and the Polish Group of Energy, the first Polish power utility, signed a memorandum of understanding in November 2009 in order to establish a co-operation project about nuclear energy in the form of feasibility studies for the development of EPRs in Poland and the construction of the first EPR before the end of 2020, and
- in the Republic of South Africa, due notably to the international economic crisis, ESKOM, the public electricity utility, decided in 2008 to suspend its project to build two nuclear reactors.

20.2.3.2 Exchanges of experience/bilateral relations

The development of international nuclear projects helps EDF to give added value to an improved reciprocal experience feedback and develop synergy actions within the Group, notably with regard to safety.

For instance, a visit was made by EDF's Inspector-General for nuclear safety concerning a handling incident that involved a brand-new fuel assembly at the advanced gas-cooled reactor (AGR) of Dungeness NPP, and inversely two engineers from British Energy (U.K.) and Constellation Energy Group (USA), respectively, participated in an audit in France, together with EDF teams, concerning the incidents involving the jamming of fuel assemblies during the lifting of the upper internals of the core, which occurred in 2008 and 2009 at Tricastin-2.

In addition, exchanges on bilateral experience are generally made through twinning agreements between NPPs or foreign operators. Several agreements between operators also generate regular exchanges.

In 2005, a twinning agreement was signed between the Saint-Laurent-des-Eaux NPP and the South Ukraine NPP. In 2006, another twinning agreement was signed between the Flamanville NPP and the Finnish operator of the Olkiluoto NPP, which includes two boiling-water reactors (BWR) and one EPR under construction.

Visits organised around specific topics as well as periodic reciprocal meetings provide a platform for direct exchanges of information between operators from different cultures who perform the same trade in different environments. Such exchanges mainly concern specific activities such as outages, maintenance, safety management, radiological cleanliness and installation condition.

In 2009, an exchange agreement was finalised with the Japan Nuclear Technology Institute. Lastly, EDF maintains exchange relations with operators in the Republic of Korea, the Russian Federation, the United States, etc.

20.2.3.3 International organisations

International organisations promote dialogue and exchanges between nuclear operators. EDF makes extensive use of such organisations with the aim of achieving overall improvements in the safety and reliability of nuclear plant operation.

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:

- experience feedback;
- peer reviews;
- technical and professional development (seminars and workshops), and
- exchanges and technical support (including good practices, performance indicators, exchanges among operators and assistance missions).

EDF is associated with the WANO Centre in Paris where nine engineers are seconded on a permanent basis for a period of three years.

EXPERIENCE FEEDBACK

EDF inputs information on a permanent basis into WANO's experience feedback data bank. For instance, 73 events that occurred in EDF NPPs were published on the Association's Web site in 2007 (accessible to all WANO members), 82 in 2008 and 96 in 2009. EDF also uses events having occurred in foreign NPPs in the analysis of EDF's internal experience-feedback process at a rate of 31 and 22 on 2008 and 2009, respectively.

PEER REVIEWS

Peer reviews carried out at French NPPs are listed in §19.5.2.

In addition, 56 EDF agents have been participated in 2007 in peer reviews organised by the four WANO centres, compared to 22 in 2008 and 45 in 2009; 38 are scheduled in 2010. Those EDF agents work as engineers and occupy various positions within NPPs or the DPN's central divisions. It is important to note that the participation in missions, such as peer reviews, is also part of the professionalization process of future division heads in NPPs.

TECHNICAL AND PROFESSIONAL DEVELOPMENT (SEMINARS AND WORKSHOPS)

EDF hosted a WANO workshop in 2007 (fire protection), one in 2008 (safety culture), two in 2009 (obstruction of the cooling-water intake at Flamanville NPP and human factors at Penly NPP). It also plans to host a new one in 2010 on experience feedback.

A total of 40 EDF agents, including site managers participated in workshops in 2007, 85 in 2008, 109 in 2009; plans call for the participation of 117 EDF agents in 2010.

TECHNICAL SUPPORT AND EXCHANGE

EDF hosted nine support or assistance visits in 2007, 14 in 2008 and 21 in 2009; plans call for 27 in 2010.

A total of 13 EDF agents, participated in support or assistance visits in foreign NPPs in 2007, 17 in 2008 and 30 in 2009; the participation of 31 EDF agents is scheduled in 2010.

IAEA

For many years now, France requests IAEA to conduct every year an OSART mission on the assessment of operating safety.

French experts participate also in OSART missions abroad. Hence, in 2007, five experts joined in different OSART missions; there were four in 2008 and four again in 2009, which included a former site manager.

Two EDF agents are working at IAEA: the first is in charge of the OSART reference system and takes actions as team leader for the conduct of OSART missions, whereas the second partakes in activities relating to the harmonisation of safety standards.

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.

WESTINGHOUSE OWNERS GROUP (WOG)

EDF is also a member of the Westinghouse Owners Group. 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-authorised plants in the USA for the purpose of experience feedback. In particular, some American reactors, being older than EDF reactors, are interesting precursors.

ELECTRIC POWER RESEARCH INSTITUTE (EPRI)

EDF is a member of the Electric Power Research Institute, which has become a leading body in R&D for the electricity industry, not only in the USA but also at world level (about three-quarters of all NPPs in operation around the globe are members of EPRI). 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.

INSTITUTE OF NUCLEAR POWER OPERATORS (INPO)

EDF is a member of the Institute of nuclear power operators, 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 with INPO.

GERMAN ASSOCIATION OF LARGE POWER PLANT OPERATORS (VGB)

EDF representatives participate in different working groups of the German Association of Large Power Plant Operators, which also serves as an exchange forum for reinforcing the safety and reliability of NPP operation, radiation protection and experience feedback.

EUROPEAN NUCLEAR INSTALLATIONS SAFETY STANDARD INITIATIVE (ENISS)

The European Nuclear Installations Safety Standard Initiative, which groups European nuclear operators, formed under the aegis of FORATOM to serve as WENRA's spokesperson for 17 West European regulators. EDF is particularly active in that mission.

Over the last few years, ENISS commented on the *Reference Levels* published by WENRA not only on the safety of reactors in service, but also on waste disposal and decommissioning. At the beginning of 2008, WENRA published a new version of the *Reference Levels* for reactors; with due account of ENISS comments. In 2007, ENISS was granted an observer status at the meetings of the committees on IAEA safety standards, such as the Nuclear Safety Standards Committee, the Waste Safety Standards Committee and the Radiation Safety Standards Committee. Since then, it has contributed actively in the development of those standards by participating in editorial groups or technical committees and by gathering the remarks of European nuclear operators on IAEA's text proposals. In addition, ENISS has been part of the consultation process, which was launched by European Commission on a draft safety directive in Europe, which was finally published in July 2009.

WORLD NUCLEAR ASSOCIATION (WNA)

The World Nuclear Association is an international organisation that was created in 2001. Its purpose is to promote the development of nuclear energy throughout the world and to provide support to industry stakeholders. Initially centred on uranium industries (the former Uranium Institute), it developed WNA gradually to encompass all nuclear challenges, while including also issues relating to reactors, radiation protection and the back-end of the fuel cycle. EDF is a member of WNA, which now gathers the major industrialists, vendors and power utilities concerned by the development of nuclear energy.

WNA activities rely on working groups dealing with different topics to specify the position of the nuclear industry against major challenges (economy, environment and sustainable development, industrialists, etc.), to encourage the exchange and promotion of good practices and to favour high-level training (World Nuclear University). WNA represents the industry in IAEA entities dealing with safety standards.

More particularly, WNA's Group on Cooperation in Reactor Design Evaluation and Licensing (CORDEL) was instituted with a view not only to promoting the standardisation of reactors and the harmonisation of safety standards, but also to serving as spokesperson for the MDEP, which was created by regulatory bodies in line with that approach (see below).

20.2.3.4 Consulting and service activities

- EDF's commitment to the operators of Daya Bay in China and China Guangdong nuclear power company continues on the basis of a co-operation agreement, which was signed in December 2000 by the DPN Director and the managers of the Guangdong and Ling Ao NPPs. For several years now, a team of four or five engineers has been conducting an assistance mission not only in technical fields, nuclear safety, training and engineering, but also with regard to the structure of the new company called Daya Bay Nuclear Management Company, which operates four reactors (Daya Bay-1 and 2 and Ling Ao-1 and 2) on the structural basis of French sites with four reactors.

Thanks to twinning agreements, the Gravelines and Tricastin NPPs support the expatriated team with regard to operation, training and maintenance. In addition, many DPN and Nuclear Engineering Division units share their skills with Chinese operators through seminars and specific missions, and

- EDF provides assistance to the operator of the Koeberg NPP (South Africa) by seconding two or three engineers within the NPP's engineering department. The Le Blayais and Gravelines NPPs are also twinned with the Koeberg NPP. Technical missions are organised in France and at Koeberg in various technical areas (safety, civil engineering, training, chemistry, etc.).

20.2.3.5 Planning for future reactors and technology watch

EDF's international activity in the planning for future reactors and technological watch is reflected essentially through its participation in the organisation of European Utility Requirements (EUR) and in the CORDEL's group of the world nuclear association.

It is important to recall that the objective of European Utility Requirements is to update a common record of specifications in all European electricity utilities for the supply of future reactors and to assess the compliance of the models proposed by builders with the prescriptions of those specifications.

During the last three years, the work of the group of operators participating in EURs, which is chaired by EDF, has dealt with the completion of the compliance assessment of Westinghouse's AP 1000 and AEP Moscow's AES 92 models with EUR requirements. A thorough update of the EPR's compliance has also been undertaken. The first exercise took place in the late 90s, but, with due account of the publication of Revision C of Volume 2 of the EUR in 2002 and of the design evolutions brought on the EPR since then, that an update was necessary. The work was completed in the spring of 2009. In addition, EUR has compared its safety requirements with WENRA's Reference Levels in preparation for the upcoming update of Volume C. Consistent with the same line of thought; a comparison of the current version of EUR and EPRI's utility requirement documents was undertaken. Similarly, complements are under way to integrate the ageing of installations as early as the design stage.

A special mention should also be made about the fact the EUR Group accepted two new operators, České Energetické Závody (ČEZ) and Magyar Villamos Művek Zrt., which are the Czech and Hungarian power utilities, respectively.

The CORDEL Group, which was created in 2007 within world nuclear association, gathers all reactor designers and major operators around the world. Its purpose is to promote the standardisation of reactor models throughout the world. It serves as the spokesperson for the MDEP programme that was created in 2005 by about 10 regulatory bodies under the aegis of OECD. Over the last three years, the Group published two reports: one the benefits of standardisation, notably with regard to safety, and a more recent proposing a three-step roadmap with a view to achieving ultimately an international certification for reactor models. During the fall of 2009, the latter report was presented before different international authorities, including at the first public conference organised by MDEP, in September, in Paris.

20.2.4 CEA's international activities concerning nuclear 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 severe 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-neutron reactors, it is in close contact with Russia, India and Japan.

Since 2005, the PHENIX reactor has run a school on the safety and operation of fast reactors, sharing the CEA's experience of sodium fast-neutron reactors with operators developing such systems abroad.

20.2.5 ILL's international activities concerning nuclear 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.

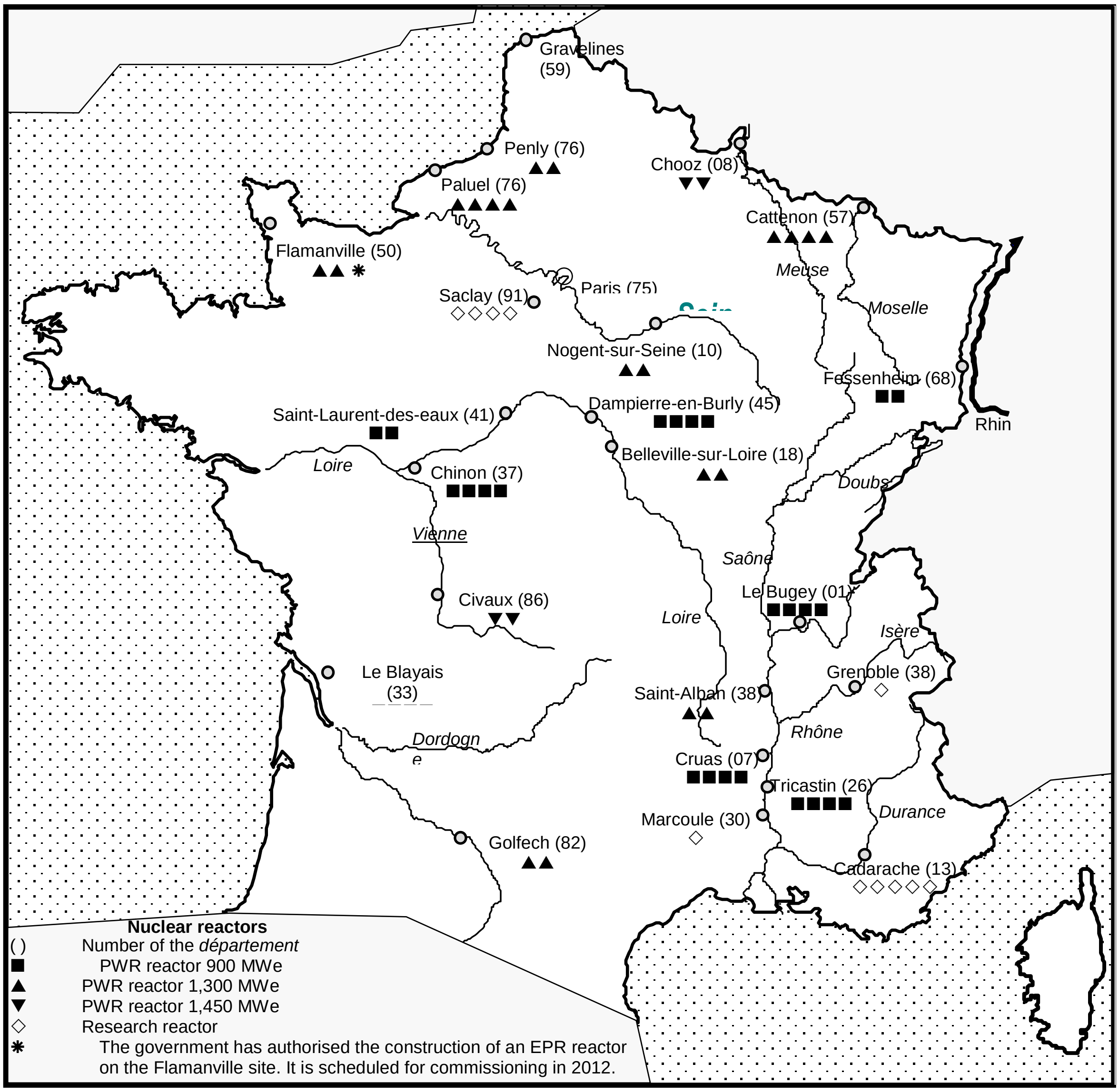
APPENDICES

APPENDIX 1 – List and location of nuclear reactors in France

1.1 Location of nuclear power reactors

On 31 July 2010, there were 58 nuclear power reactors and 11 research reactors in service, administratively speaking, throughout France, as indicated on the map below. Furthermore, a nuclear power reactor and a research reactor were also in construction.

Map of France showing the location of nuclear power reactors in service and under construction



The total installed generating capacity is about 64,000 MWe.

The 58 pressurized water reactors located on 19 sites are operated by EDF.

The PHÉNIX prototype fast reactor, (shutdown but still subject to regulatory process of an operating installation) and 9 other pool-type research reactors are operated by the CEA. The RHF research reactor is operated by the Max von Laue – Paul Langevin Institute (ILL).

1.2 List of nuclear power reactors

The nuclear power reactors in operation and in construction are the following BNIs:

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Authorised 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-DES-AUX 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	OPERATOR	Type of installation	Declared on:	Authorised 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 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 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 Modification Decree of 02.11.07 O.G. of 03.11.07
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	OPERATOR	Type of installation	Declared on:	Authorised 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-SUR-LOIRE NUCLEAR POWER PLANT (reactor 1) 18240 Léré	EDF	1 PWR reactor P'4 1300 MWe		15.09.82	16.09.82	
128	BELLEVILLE-SUR-LOIRE 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-SUR-SEINE 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-SUR-SEINE 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 1500 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	OPERATOR	Type of installation	Declared on:	Authorised on:	Official Gazette (O.G.) of:	OBSERVATIONS
144	CHOOZ B NUCLEAR POWER PLANT (reactor 2) 08600 Givet	EDF	1 PWR reactor N4 1500 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
167	FLAMANVILLE NUCLEAR POWER PLANT (reactor 3) 50830 Flamanville	EDF	1 EPR PWR reactor 1600MWe		10.04.07	11.04.07	In construction

1.3 List of nuclear research reactors

The nuclear research reactors in operation, administratively speaking, are the following BNIs:

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Authorised 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 Fast reactor (Marcoule) 30205 Bagnols-sur-Cèze	CEA	Reactor 563 MWth (350 MWth since 1993)		31.12.69	09.01.70	Shutdown
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	
172	JULES HOROWITZ (RJH) REACTOR(Cadarache) 13115 Saint-Paul-lez Durance Cedex	CEA	Reactor 100 MW		12.10.09	14.10.09	Decree n°2009-1219 O.G of 14.10.09

APPENDIX 2 – Main legislative and regulatory texts

2.1 Laws, acts, codes and regulations

Public Health Code: Articles L. 1333-1 and R. 1333-1 to 12 relating to the general protection of human beings against the hazards of ionising radiation.

Labour code: Articles L. 4451-1, R. 4451-1 sqq. relating to the protection of workers against the hazards of ionising radiation.

Defence Code: Articles D. 1333-68 and 69 relating to the Interministerial Committee for Nuclear or Radiological Emergencies.

Act No. 2006-686 of 13 June 2006 on Transparency and Security in the Nuclear Field; also known as the "2006 *TSN Act*".

Planning Act No. 2006-739 of 28 June 2006 on the Sustainable Management of Radioactive Materials and Waste; also known as the "2006 Planning Act".

Decree No. 2007-830 of 11 May 2007 on the Nomenclature of Basic Nuclear Installations.

Decree No. 2007-831 of 11 May 2007 Setting the Appointment and Certification Procedures for Nuclear Safety Inspectors.

Decree No. 2007-1557 of 2 November 2007 on Basic Nuclear Installations and the Control, with Regard to Nuclear Safety, of the Transport of Radioactive Substances (on procedures); also known as the "2007 Procedure Decree".

Decree No. 2007-1570 of 5 November 2007 on the Protection of Workers Against Ionising Radiation and Modifying the Labour Code.

Decree No. 2007-1572 of 6 November 2007 on Technical Investigations on Accidents or Incidents Involving Nuclear Activities.

Decree No. 2007-1582 of 7 November 2007 on the protection of individuals against the hazards of ionising radiation and modifying the Public Health Code.

Decree No. 2008-251 of 12 March 2008 on Local Information Committees for basic nuclear installations.

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 equipment.

* Those orders are part of the texts that are subject to the recasting referred to in §7.2.2.2. That recasting should lead to a ministerial order and to decisions and guides referred to in the following table.

Topic	Type of text	Consultations
Procedure-related texts		
Safety options	Decision	**
Safety review	Decision	Initiated on 18/03/10 by post and on 18/04/10 on Web; WENRA on 26/03/10 (by email)
Processing of physical changes	Decision	Initiated on 18/03/10 by post and on 18/04/10 on Web; WENRA on 26/03/10 (by email)
Safety report (content)	Decision	*
Impact study (content)	Decision	**
RGE (content)	Decision	*
Internal audits	Decision	
Decommissioning	Guide	
Decommissioning plan (content)	Decision	**
Public consultation procedures	Guide	
Various provisions on procedures	Decision	**
Hearing of operators and CLIs	Decision	*
Technical texts		
All technical areas		
Regulations applicable to BNIs	Order	Initiated on 10/02/10; Web on 22/02/10; WENRA on 15/03/10
Organisation and management system		
Safety-management policy	Decision	*
Safety-management policy	Guide	
Control of accident and nuisance risks (except waste)		
PWR design	Decision	*
BNI operation	Decision	*
PWR fuel	Decision	**

Reloading outage for PWRs	Decision	Initiated on 30/03/10 by post and on 18/04/10 on Internet; WENRA on 09/04/10 (by email)
Reloading outage for PWRs	Guide	
Design and operation of waste-disposal installations	Decision	**
Design and operation of waste-disposal installations	Guides	
Protection of BNIs against outside floods	Guide	
Control of fire hazards and miscellaneous risks	Decision	**
Contrail of nuisances and of environmental impacts	Decision	*
Waste management and elimination		
Content of the study on BNI waste	Decision	*
Content of the study on waste	Guide	
Approval procedures for waste conditioning	Decision	*
Approval procedures for waste conditioning	Guides	
Design and operation of internal waste storage facilities	Decision	*
Design and operation of internal waste storage facilities	Guide	
Management of emergency situations		
Management of emergency situations	Decision	*
Management of emergency situations	Guide	
Urbanisation control around BNIs	Internal guide	
Information of the authorities and of the public		
Declaration of incidents	Guide	
Annual report on public information	Guide	2009 (consultation with CLIs)
Pressurised nuclear equipment (ESPN)		
Primary and secondary system spare parts	Decision	*
Regulations applicable to ESPN	Decision	**
Regulations applicable to ESPN	Guide	
Conformity assessment	Guide	

** Scheduled consultations during the second half of 2010.*
*** Scheduled consultations in 2011.*

2.2 Basic Safety Rules and Guides

As mentioned in §7.2.2.3.2, RFSs are being modified in the form of guides, pursuant to the current restructuring framework of the general technical regulations.

There are currently approximately 40 RFSs and other technical rules published by ASN, all of which may be consulted on its Web site.

2.2.1 PWR rules

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.I.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 for 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).

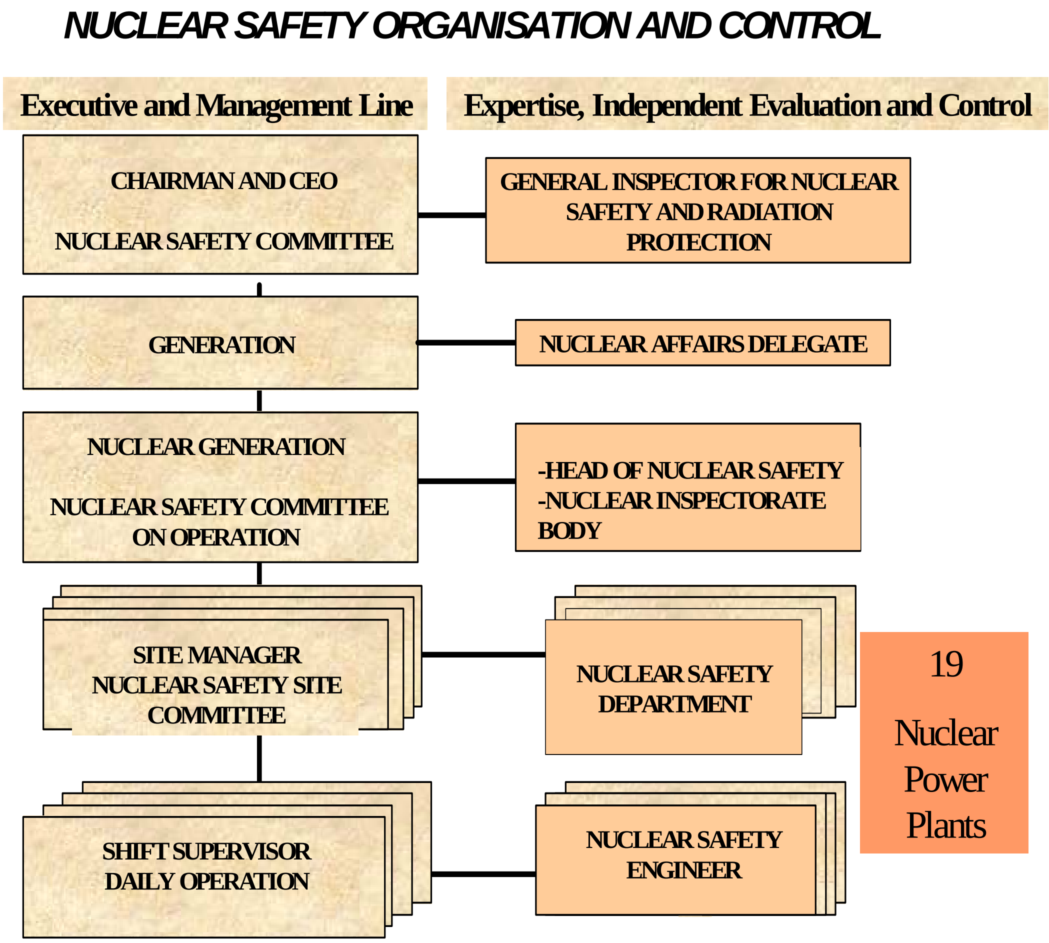
2.2.4 Guides

Title	Date
Safety guide on the final disposal of radioactive waste in a deep geological formation.	12/02/2008
Guide on regulatory requirements applicable to the transport of radioactive materials in airports.	01/02/2006
Recommendations for the preparation of annual reports on public information concerning BNIs.	Project
Self-assessment of risks by external-radiotherapy patients.	15/10/2008
Reference system for the management of security and quality in radiotherapy care. Implementation guide for quality-assurance obligations in radiotherapy.	15/10/2008
Final shutdown, dismantling and decommissioning of French BNIs.	Project
Applicant's guide concerning shipment-approval requests and certification applications for package-model or the road transport of radioactive materials for civilian uses.	07/04/2009
Conformity assessment of nuclear pressure equipment.	31/03/2009
Guide concerning the Order of 31 December 1999. Topic: fires.	01/04/2006
Guide on the involvement of CLIs in the framework of the third decennial outages of 900-MWe reactors.	24/02/2010
Guide on the declaration procedures and on the codification of criteria relating to significant events in the field of radiation protection non related to BNIs and to the transport of radioactive materials.	07/10/2009
Guide on the declaration procedures and on the codification of criteria relating to significant events involving safety, radiation protection or the environment applicable to BNIs and to the transport of radioactive materials.	21/10/2005
Guide on the elimination of effluents and of waste contaminated with radionuclides	Project
Guide on full cleanup methods in French BNIs.	Project

APPENDIX 3 – Organisation of nuclear reactor operators

3.1 EDF's structure

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.



Regarding facilities operated by subsidiaries of the EDF Group, responsibility for nuclear safety and radiation protection lies with the operator 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 Chairman and Chief Executive Officer

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 Executive Vice-President for the Generation and Engineering.

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 regulatory body. 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 and 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 operator. In this respect, the Senior Executive Vice President, Generation & Engineering makes major choices in the area of investment and asset 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 operator, 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 operator 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 unto him by the Senior Executive Vice President, Generation & Engineering of the EDF Group and under his supervision, the Director of the Nuclear Engineering Division is in charge of developing, in consultation with the Director of the Nuclear Power Operations Division, the reference system for the design of installations. He is responsible for its integration in the construction of the installations. With regard to the current fleet in service, the evolution of the reference system for the design of installations falls under the jurisdiction of the Director of the Nuclear Engineering Division in consultancy with the Director of the Nuclear Power Operations Division. This last Director is responsible for integrating the changes to the reference system for the operation of installations and relies for that purpose on the support of the Director of Nuclear Engineering Division and the Director of the Nuclear Fuel Division.

Lastly, the Director of the Nuclear Engineering Division is also in charge for the implementation of the deconstruction programme approved by the Executive Director for Production and Engineering of the EDF Group with regard to the strategy, technical and industrial options, budget, general planning, etc. All corresponding choices that have an impact on nuclear safety and radiation protection are made with the approval of the Director of the Nuclear Power Operations Division who remains the representative of the nuclear operator EDF S.A for the installations under deconstruction, unless an exception applies.

In the exercise of its missions, the Director of the Nuclear Engineering Division organises the supporting tasks provided by the study and engineering units of his division to 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 operator. 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 operator 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

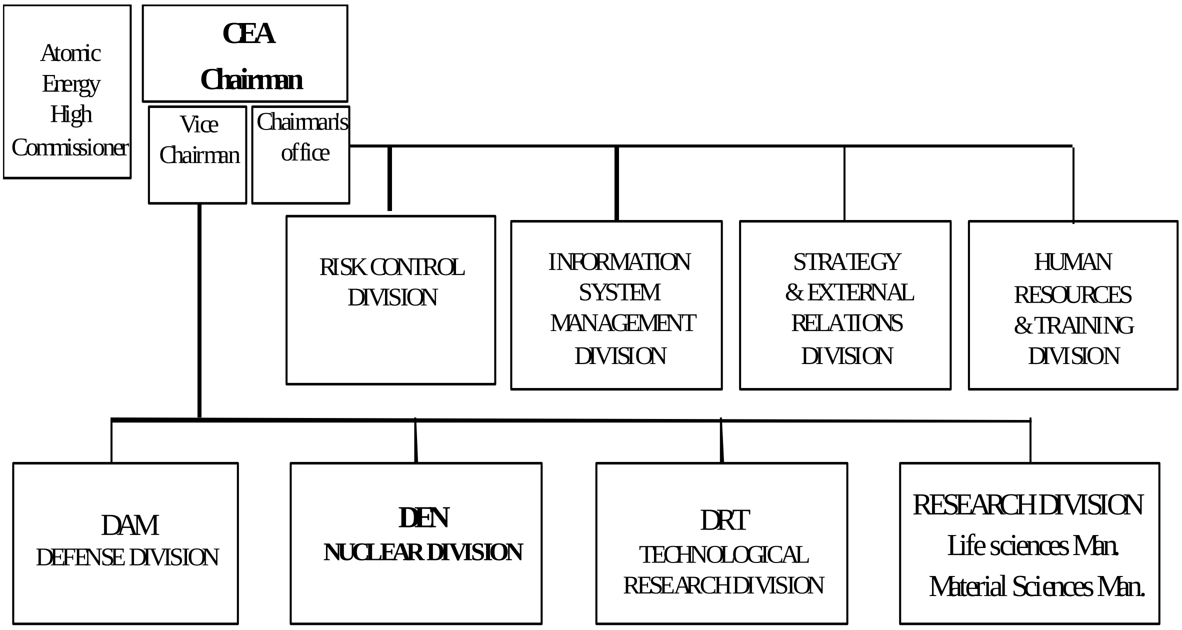
As the representative of EDF S.A. as the nuclear operator in respect of the installations for which responsibility is delegated to him by the Director of his Division (Nuclear power generation, nuclear installation deconstruction), and under the latter's authority, the unit manager takes all measures 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 operator 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 CEA's structure

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.

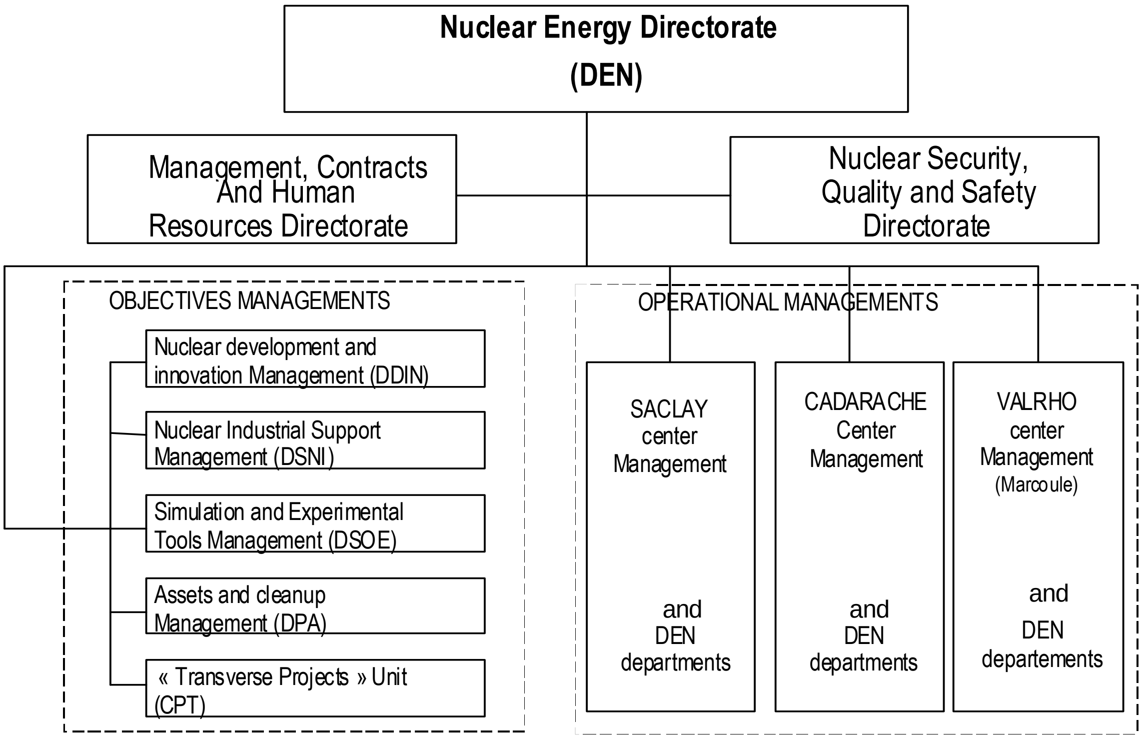
Each operational division is provided with resources (general management, objectives departments, internal functional resources) that it uses to develop, plan and control all its activities.



Nuclear reactors, which are the subject of this report, are grouped in the nuclear energy sector (Nuclear Energy Directorate) with regard to civil engineering.

On 10 March 2010, CEA changed its name to the French Commission for Atomic and Alternative Energies (*Commissariat à l'énergie atomique et aux énergies alternatives*).

The functional Division in charge of security, quality and nuclear safety is part of the Nuclear Energy Directorate, which is organised according to the following organisation chart:



3.3 ILL's structure

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 Radiation Protection and Environmental Monitoring Service, which also includes conventional security, reports directly to the Director of the Institute.

With regard to the management of the BNI and of other facilities referred to in the safety report, the Director delegates his responsibilities as operator to the Head of the Reactor Division, who serves as the Director's deputy with regard to their safety and management. In that capacity, he is responsible for deciding without appeal about the safety of the operating conditions of the reactor, of instruments and experimental devices.

APPENDIX 4 – Environmental monitoring

4.1 Monitoring of NPP discharges (based on the most recent authorisation issued by ASN)

4.1.1 Regulatory monitoring of NPP liquid discharges

ORIGIN AND TYPE	REGULATORY SAMPLINGS AND CHECKS TO BE CARRIED OUT BY OPERATORS
T tanks Process effluents, Service effluents, Steam-generator blown-down	– sampling from every tank, after mixing: – pre-discharge analyses: pH, α_G, β_G, γ_G, ^3H, γ spectrometry – post-discharge analyses: ^{14}C – continuous measurement of γ activity on the discharge pipe upstream from 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
EX tanks (turbine-hall effluents)	– sampling from every tank, after mixing – pre-discharge analyses: β_G, ^3H – at the end of the month, preparation of a pooled monthly average sample – analyses: pH, α_G, β_G, γ_G, ^3H, γ spectrometry
Wastewaters, rainwaters	– one-off water sampling – analyses: β_G, potassium, ^3H – samples from deposits in collection systems, at least once a year – analyses : γ spectrometry

α_G, β_G, γ_G activity = total α, β, γ activity

4.1.2 Regulatory monitoring of NPP gas discharges

ORIGIN AND TYPE	REGULATORY SAMPLINGS AND CHECKS TO BE CARRIED OUT BY OPERATORS
Continuous measurement with recording of β_G activity in every stack	
CONTINUOUS DISCHARGES (ventilation)	instantaneous weekly gas samplings and analyses: γ spectrometry (rare gases) continuous tritium samplings and weekly analyses (setup under way) continuous gas-halogen samplings and weekly analyses: γ_G, γ spectrometry continuous aerosol samplings and weekly analyses: α_G, β_G, γ spectrometry continuous ^{14}C samplings and quarterly analyses (setup under way)
PLANNED DISCHARGES (tank draining, reactor-building air, etc.)	pre-discharge analyses: – gases – analyses: γ spectrometry (rare gases), ^3H – gaseous halogens – analyses: γ_G, γ spectrometry - aerosols – analyses : α_G, β_G, γ spectrometry

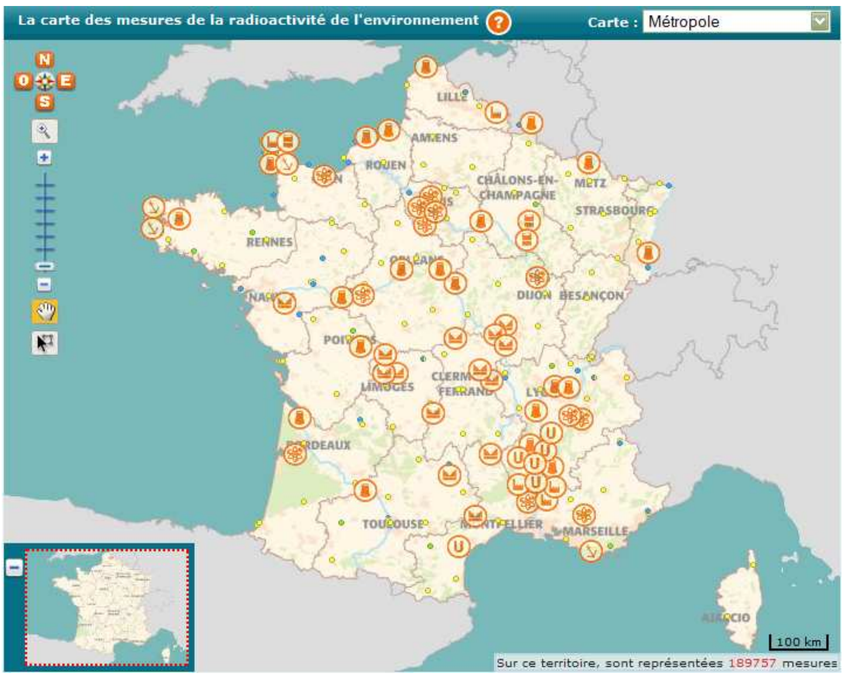
4.2 Environmental monitoring around NPPs

Monitored medium or type of check	NPP
Air at ground level	▪ 4 continuous fixed-filter atmospheric dust-sampling stations with total daily β measurements (β_G) ; γ spectrometry, if β_G > 2 mBq/m^3. ▪ 1 continuous sampling station downwind of the prevailing winds with weekly ^3H measurement
Ambient γ radiation	▪ 4 detectors at 1 km with continuous measurements and recordings ▪ 10 detectors with continuous measurements on the site boundary (monthly reading) ▪ 4 detectors at 5 km with continuous measurements
Rainfall	▪ 1 station downwind dominant (monthly collector) with measurements of β_G and ^3H on monthly pool
Outlet of liquid discharges	▪ upstream river sampling at mid-time for every discharge (for riverside NPPs) or sampling after dilution in the cooling water and semi-monthly samples at sea (for coastal NPPs): measurements of β_G, (K) and ^3H ▪ continuous ^3H sampling (daily average pool) ▪ annual samplings in sediments, aquatic fauna and flora with measurements of β_G, K and ^3H, γ spectrometry
Groundwaters	▪ 5 sampling points (monthly check) with measurements of β_G, K and ^3H
Soil	▪ 1 annual sampling of topsoil with γ spectrometry
Plants	▪ 2 grass-sampling points (monthly check) with measurements of β_G, K and γ spectrometry; measurement of ^{14}C and total carbon (quarterly) ▪ Annual campaign on major agricultural produce with measurements of β_G, K, ^{14}C and total carbon, and γ spectrometry
Milk	▪ 2 sampling points (monthly check) with measurement of β activity (^{90}Sr), of K and, every year, of ^{14}C

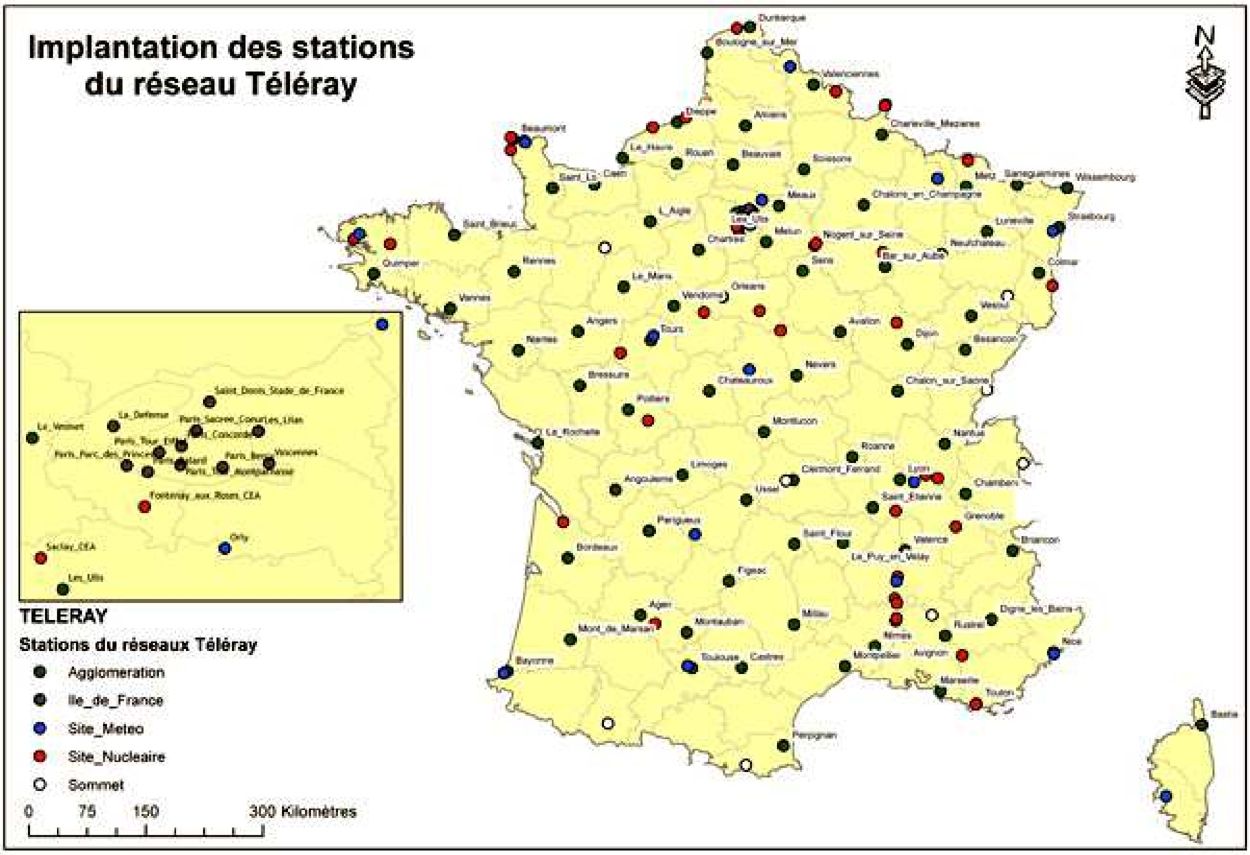
β_T = total beta

4.3 Monitoring the exposures of the population and of the environment (examples)

The national measurement network (*www.mesure-radioactivite.fr*) – Telephone: +33 1 40 19 86 56; Fax: +33 1 40 19 87 90

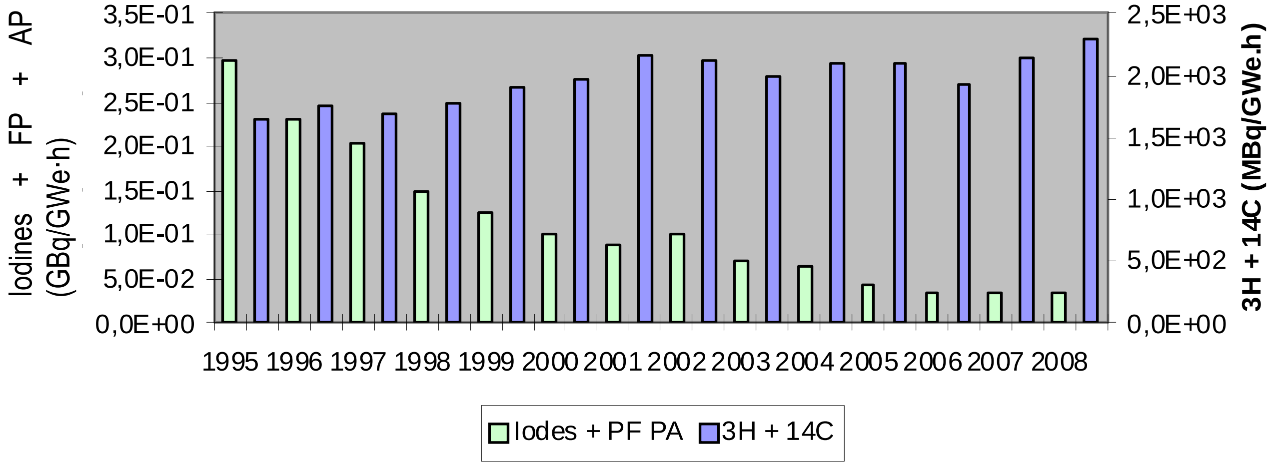


Location of the network of Téléray stations in 2009 (Source: IRSN)



4.4 NPP discharges (1995-2008)

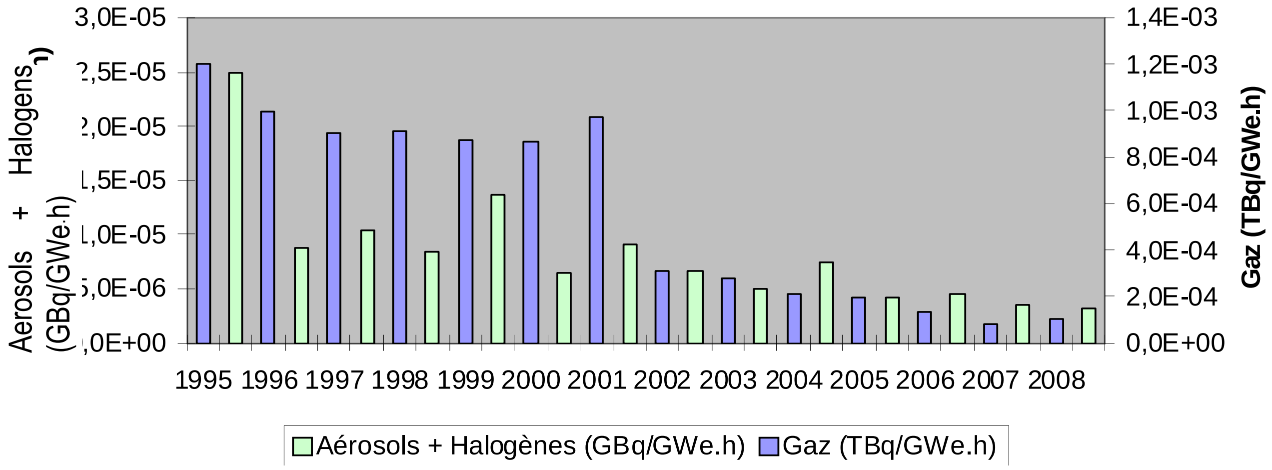
Summary of liquid discharges from NPPs



FP: other fission products

AP: other activation products

Summary of gas discharges from NPPs



Aerosols + Halogens (GBq/GWe·h) Gas (TBq/GWe·h)

APPENDIX 5 – IRRS follow-up mission hosted by ASN in 2009

AIEA provides national nuclear-safety authorities with an assessment service for the application of its standards in the form of IRRS missions, which are performed by expert teams from the safety authorities of other countries.

Within a continuous-improvement rationale, ASN welcomed in 2006 an IRRS mission, which was conducted by a team of 16 peers coming from other national safety authorities under the co-ordination of six AIEA experts. It involved a "full-scope" coverage of the issues pertaining to IRRS missions with regard to nuclear safety and radiation protection, thus constituting a world premiere. ASN's objectives were threefold:

- to rely on the assessment of its peers in order to ensure that its structure and practices are consistent with international standards and to improve the relevancy of its action and its effectiveness;
- to present to its peers a certain number of its practices that, in its view, exceed IAEA's recommendations, and
- to promote a positive reaction of all authorities in favour of soliciting in turn an IRRS.

Since then, a large number of IRRS missions were conducted throughout the world and have contributed to a fruitful cross-comparison between national safety authorities and an upward harmonisation of structures and practices.

The 2006 IRRS was the subject of a report, which was made public by ASN on its Web site (www.asn.fr). It included 40 good practices, 49 suggestions (discrepancies with IAEA guides) and 35 recommendations (discrepancies with IAEA Standards). Those observations encouraged ASN to develop a specific action plan on improvement.

From 29 March to 3 April 2009, an IRRS follow-up mission was held by IAEA, upon ASN's request, with a view to assessing the progress achieved in the implementation of its action plan. A total of 12 international experts took part in that mission and considered that ASN has responded satisfactorily at a rate of 90% to the recommendations and suggestions formulated in 2006. In many fields such as inspections, emergency preparedness, public information or ASN's international role, they felt once again that ASN's activity ranks among the best practices around the world. In addition, the follow-up mission highlighted the quality of the work achieved by ASN with regard to:

- promoting the harmonisation of nuclear-safety requirements throughout Europe;
- developing relations at the national level to ensure the efficient control of nuclear safety and radiation protection;
- ensuring the durability of nuclear safety and radiation protection over the long term, and
- implementing the prescriptions of the 2006 *TSN Act*.

International experts have identified a few improvement areas, including the management of ASN skills, the control of its funding, the IRRS of its major technical supporting body (IRSN) and the implementation of the prescribed measures for the security control of radioactive sources, once it will have been entrusted with that mission by the government.

ASN will take advantage of the conclusions of that mission to reinforce the consistency of its practices and of its structure with the best international standards. Similarly to the previous mission, this report may be consulted on ASN's Web site (*www.asn.fr*).

APPENDIX 6 - References

6.1 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/ Nuclear law – legislation and regulation - N°1791 Journal officiel (official gazette), July 2006.

/5/ Annual Report: Nuclear Safety in France in 2007, April 2008.

/6/ Annual Report: Nuclear Safety in France in 2008, April 2009.

/7/ Annual Report: Nuclear Safety in France in 2009, April 2010.

/8/ EDF – The Inspector General's report on nuclear safety and radiation protection, 2007.

/9/ EDF - The Inspector General's report on nuclear safety and radiation protection, 2008.

/10/ EDF - The Inspector General's report on nuclear safety and radiation protection, 2009.

/11/ EDF – Generation and Engineering Directorate – Annual safety and radiation protection reports 2007 and 2008.

6.2 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)
- IRSN: www.irsn.fr
- SFRO: www.sfro.fr
- CEA: www.cea.fr
- EDF: www.edf.fr
- Website concerning the information available on EPR Flamanville-3
http://energies.edf.com/edf-fr-accueil/la-production-d-electricite-edf/-nucleaire/le-nucleaire-du-futur/epr-flamanville-3/flamanville-3-en-images-120266.html
- ILL: www.ill.fr
- ANDRA: www.andra.fr
- IAEA: www.iaea.org

APPENDIX 7 – List of main abbreviations

ASN	Autorité de Sûreté Nucléaire (Nuclear Safety Authority)
BNI	Basic Nuclear Installation
CEA	French Atomic and Alternative Energies 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
CSS	Commission on Safety Standards
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
DIN	Nuclear Engineering Division - EDF
DPN	Nuclear Power Operations Division - EDF
DRIRE	Regional Directorate for Industry, Research and the Environment
EDF	Électricité de France
ENSREG	European Nuclear Safety Regulators Group
EU	European Union
GPE	Advisory Committee of Experts (GPR = Advisory Committee for Nuclear Reactors)
GRS	Gesellschaft für Anlagen-und Reaktorsicherheit
HOF	Human and organisational factors
IAEA	International Atomic Energy Agency
ICPE	installations classified for environmental-protection purposes
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
IRRS	Integrated regulatory review service
JRC	European Commission's Joint Research Centre
MDEP	Multinational Design Evaluation Programme
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
PSA	Probabilistic safety analyses
PUI	On-site emergency plan
PWR	Pressurised Water Reactor
RAMG	Regulatory Assistance Management Group
RCC	Rules for design and construction
RFS	Basic safety rule
RGE	General Operating Rules
RHF	High flux reactor
RNR	fast-neutron reactors
SAMU	French emergency medical service
SDIS	*Département* fire and emergency services
SFRO	French Oncological Radiotherapy Society

Appendix 7 – List of acronyms

SGDN	General Secretariat for National Defence
SMUR	Mobile emergency and resuscitation services
STE	Operating Technical Specifications (= OLC : Operating Limits and Conditions)
UNSCEAR	United Nations Scientific Committee on the Effects of Atomic Radiation
VD'n'	PWR decennial outages N°. 'n'
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association
WNA	World Nuclear Association

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General view of the EPR under construction at Flamanville	EDF/ A. MORIN
Assembly of new fuel	EDF/ D. CHARFEDDINE
Replacement operation of a steam generator	EDF/ O. BLAISE

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