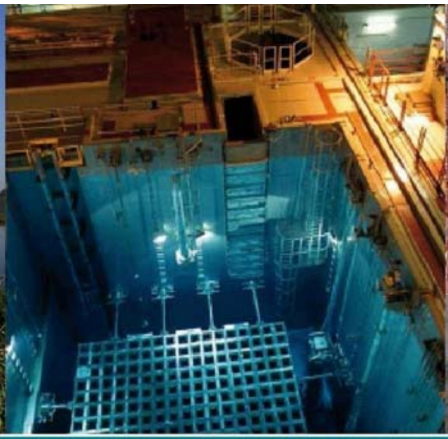

FRANCE

Convention on Nuclear Safety

Sixth National Report for the 2014 Review Meeting

July 2013

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RÉPUBLIQUE FRANÇAISE

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A - INTRODUCTION

1. General remarks

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 to maintaining a high level of nuclear safety worldwide. The convention sets a number of nuclear safety objectives and defines measures to meet them. France signed the Convention on 20th September 1994, the date on which it was opened for signature during the IAEA General Conference, and approved it on 13th September 1995. The Convention entered into force on 24th October 1996.

For many years France has been participating actively in international initiatives to enhance nuclear safety. 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 sixth report, which was drafted pursuant to Article 5 of the Convention and which covers the period 2010 to mid-2013, is to present the measures taken by France in order to fulfil each of its obligations as specified in the said Convention.

1.2 Installation concerned

Since the Convention applies to all nuclear-power generating reactors (see § 6.1) most of this report is dedicated to the measures taken in order to ensure their safety. However, as in previous reports, France has decided in this sixth report also to present the measures that were taken for all research reactors.

First of all, research reactors are actually subject to the same overall regulations as nuclear-power reactors with regard to safety and radiation protection. Then, within 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, in March 2004 approved the *Code of Conduct on the Safety of Research Reactors*, which reiterates most of the provisions of this present Convention.

1.3 Report authors

This report was produced by ASN, the French nuclear safety authority, which coordinated the work on it, with contributions from IRSN (Institute for Radiation Protection and Nuclear Safety) and from nuclear reactor licensees, Électricité de France (EDF), the French Alternative Energies and Atomic Energy Commission (CEA) and the Laue-Langevin institute (ILL). The final version was completed in July 2013 after consultation with the French parties concerned.

1.4 Structure of the report

For this report, France took into account the lessons learned with the five previous reports: it is a self-standing document, which has been developed mostly on the basis of existing documents and reflects the views of the regulatory body and the licensees. Hence, for every chapter in which the regulatory body is not the only entity to express its own views, a three-fold structure was adopted: firstly a description of the regulations by the regulatory authority, followed by an overview presented by the licensees of their measures for regulatory compliance, and finally an analysis by the regulatory authority of licensee measures.

This report is structured according to the Guidelines on National Reports, as revised at the special meeting of August 2012. The presentation progresses “article by article”, with each one giving rise to a separate chapter at the beginning of which the corresponding text of the Convention appears in a box with a half-tone background. After the introduction, which presents certain general aspects as well as national nuclear policy, the summary gives a description of the main changes that have taken place since the fifth national report and the safety prospects for the next three years. Part C covers general considerations (chapters 4 to 6), part D summarises general safety considerations (chapter 10 to 16), part F presents the safety of facilities (chapter 17 to 19), and finally part G presents international cooperation measures (chapter 20). The report is supplemented by eight appendices.

With regard to the steps taken at the national level further to the TEPCO’s Fukushima Daiichi nuclear power plant accident (hereinafter referred to as the Fukushima Daiichi accident), the Officers meeting of 29th October 2012 recommended including a general presentation in a sub-chapter of the Summary.

Finally, further to the meeting of the Officers of the Convention on Nuclear Safety in October 2012, France took the initiative to present an appendix to the National Report presenting France’s actions to support IAEA’s nuclear safety action plan (see Appendix 6).

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 efforts to improve the transparency of its activities, ASN has decided to make the French national report accessible to any interested person. Consequently, this report is available on ASN’s website (www.asn.fr), in French and in English, along with questions/answers concerning the French national report.

2. National nuclear policy

2.1 Nuclear safety policy

The first decision of the French government concerning nuclear energy was, in 1945, to create a public research organisation, called the French Atomic Energy Commission, which became the French Alternative Energies and Atomic Energy Commission (CEA) on 10th March 2010. The first French experimental reactor became critical in December 1948, thus paving the way for 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 today operated by a single licensee, Électricité de France (EDF). All the reactors except one, the high-flux reactor (RHF), operated by the Laue-Langevin Institute (ILL), were built and are operated by CEA.

With regard to nuclear safety, Act 2006-686 of 13th June 2006 concerning transparency and security in the nuclear field, known as the “TSN Act”, plus its implementing texts, extensively overhauled the regulations concerning the nuclear safety of nuclear facilities.

The Government thus stipulates the general regulations applicable to nuclear activities by decree or by order. It issues the few major individual resolutions concerning major nuclear installations, notably the plant creation and decommissioning authorisations. It takes measures based on the opinions of ASN, opinions which are made public at the same time as the measures to which they refer.

The TSN Act created ASN (the French nuclear safety authority), an independent administrative authority, tasked in the name of the State with monitoring nuclear safety and radiation protection, to protect workers, patients, the general public and the environment against the risks associated with civil nuclear activities. The regulation of nuclear safety and radiation protection by ASN is described in chapter 8. Some of these resolutions must be approved by the Minister responsible for nuclear safety (Minister for Ecology, Sustainable Development and Energy).

2.2 Energy policy

Placed under the aegis of Parliament, France’s energy policy is defined by the Government and is supervised by the Ministry for Ecology, Sustainable Development and Energy (MEDDE). The President of the French Republic committed to shutdown Fessenheim Nuclear Power Plant (NPP), the oldest of the French nuclear fleet, and set the objective of final shutdown by the end of 2016. This decision fits in the transition energy policy which sets the objective to reduce the reliance on nuclear energy from 75% to 50% by 2025.

B - SUMMARY

3. Summary

3.1 Suggestions and challenges identified at the 5th Review Meeting

Following the 5th CNS Review Meeting, the challenges below were identified for ASN, in addition to regulation of the reactors in operation:

1. The 3rd ten-yearly outage (VD3) of the 900 MWe reactors associated with their third periodic safety review (see § 6.3.1.1.1);
2. The monitoring and inspection of maintenance work performed by EDF on the steam generators (see § 6.3.1.2.2);
3. With regard to Flamanville reactor No.3 (EPR), give an opinion on the I&C architecture, review and monitor the commissioning tests according to the schedule proposed by EDF and review the commissioning application (see § 18.2.4.2.2 and § 19.1.3);
4. Oversee the construction of new facilities such as the Penly EPR and the ITER and JHR research reactors (see § 18.3.4.2, § 6.1.2, § 18.3.3 and § 17.4.2).

During the course of the discussions held within group 2, a proposal was made that France consider taking steps to align the safety performances of the facilities with those that perform the best. To do this, the safety performance of the NPPs with the least satisfactory results will have to be improved, giving priority to improving management and ensuring higher quality operation and maintenance of equipment (see. §14.2.4.1.2).

3.2 International peer review missions and regulator independence

At the second Extraordinary Meeting of the Convention on Nuclear Safety, the Contracting Parties were asked to ensure that the National Report covers certain topics identified as important in the wake of the Fukushima Daiichi accident. One of these topics concerns the effective independence of the regulatory authority from undue influence, including, as applicable, information about the hosting of IRRS (Integrated Regulatory Review Service) missions. In France, the TSN Act in 2006 created ASN, an independent administrative authority, tasked in the name of the State with monitoring nuclear safety and radiation protection, to protect workers, patients, the general public and the environment against the risks associated with civil nuclear activities, and also to inform the public. ASN's regulation of nuclear safety and radiation protection is described in Chapter 8.

ASN is also closely involved in the IRRS audit missions and itself underwent one of these missions in 2006 and its follow-up mission in 2009. At France's request, ASN will host another "full scope" IRRS audit mission in 2014 (see § 10.4.1).

For many years now, France has asked IAEA to conduct OSART (Operational Safety Review Team) missions to assess operating safety (see Appendix 5) and makes French experts available to take part in such missions abroad. After the Chooz mission in 2013, all French nuclear power reactors will have been subject to an OSART mission.

Moreover, all the French NPPs are audited by the World Association of Nuclear Operators (WANO) by means of peer reviews. As of 2015, each unit will be reviewed every four years, in conjunction with a nuclear inspectorate audit (see § 10.2).

3.3 Main changes since France's 5th national report

During the second Extraordinary Meeting of the Contracting Parties to the Convention on Nuclear Safety, the decision was taken to ensure that the national reports more particularly cover a certain number of subjects of interest that could be directly linked to the steps taken in the wake of the Fukushima Daiichi accident, or measures implemented for continuous improvement of nuclear safety.

3.3.1 Changes to the regulatory framework

Drafting of the regulations applicable to basic nuclear installations (BNIs) is well under way, with the "BNI procedures" decree of 2007; the BNI order published on 7th February 2012 and about a dozen regulatory resolutions currently being finalised: this work was the subject of extensive consultation by the various stakeholders. ASN will have at its disposal a rigorous, comprehensive working framework that is harmonised with that of its European colleagues, as it includes the "reference levels" from WENRA, the Western European Nuclear Regulators' Association (see § 7.1.3.1.2).

The requirements concerning the safety case to be provided by the licensee are broadly based on the IAEA standards.

3.3.2 Transparency and public information

ASN takes part in public information within its areas of competence, notably by making the information in these fields accessible to the greatest number (see § 8.1).

Together with the French Institute for Radiation Protection and Nuclear Safety (IRSN) and the stakeholders, ASN has developed the www.mesure-radioactivite.fr website which gives all environmental radioactivity measurements taken by the licensees, institutional bodies and approved associations (see § 15.1.2.2.3).

ASN attached the greatest importance to ensuring that the entire stress tests approach and the inspections carried out further to the Fukushima Daiichi accident are both open and transparent. Representatives of the stakeholders (CLI, HCTISN) and of several foreign safety regulators were invited, as observers, to attend the technical meetings and take part in the targeted inspections carried out by ASN; these various stakeholders also received the reports transmitted by the licensees. Some observers sent in contributions to the analysis of the licensees' reports, which were taken into account by ASN in its conclusions. At each step in the process, whether European or French, ASN placed the various documents produced on-line on its website www.asn.fr (more specifically the ASN resolutions, the list of nuclear facilities concerned, the stress test reports, the opinions of the Advisory Committees of experts, and so on).

Since January 2013, ASN has been using its website to make public its opinions on important subjects. At the same time, IRSN also makes available the opinions it issues to ASN on the corresponding issues. The position statements issued since the end of 2011 can now be consulted.

With regard to the nuclear facility licensees, transparency and communication measures are taken at various levels to optimise public information about how operation of the facilities, technical events and activities carried out, notably with regard to safety aspects (see §9.2).

3.3.3 Changes following safety reassessments

The main results of the safety reassessments on the nuclear facilities, whether following the periodic safety reviews or the implementation of modifications as a result of lessons learned from operating experience feedback from all the NPP plant series, are presented in § 6.3 and § 14.2.4. The main areas of changes are as follows:

- reinforcement of seismic resistance;
- the risks resulting from explosive gases;

- o site robustness to external natural hazards and electrical disruption;
- o the risk of rapid drainage of spent fuel storage pools;
- o improved severe accident management;
- o equipment qualification in post-accident conditions.

Moreover, following these safety reassessments, ASN gave its general assessment of NPP performance in terms of safety, radiation protection, environment and labour inspection.

- o In 2009, ASN issued an initial generic opinion on the continued operation of the 900 MWe reactors beyond thirty years. This assessment is to be supplemented by an individual opinion for each reactor. After ruling in 2010 on the continued operation of reactor 1 at Tricastin[1] and in 2011 on that of reactor 1 at Fessenheim[2] following their third ten-yearly outage (VD3), ASN in 2012 approved the continued operation of reactor 2 at Bugey[3] beyond its third periodic safety review and, in 2013, on the continued operation of reactor 2 at Fessenheim[4]. In addition, improvements were made to the Bugey 4 and 5, Blayais 1, Dampierre 1 and 2, Gravelines 1 and 3, and Tricastin 2 and 3 reactors, following the periodic safety reviews on the occasion of their third ten-yearly inspections.
- o After the 1300 MWe reactor of Penly 1 and Cattenom 3 reactors in 2011, Golfech 1 in 2012 integrated the improvements resulting from the periodic safety review linked to its second ten-yearly outage (VD2). ASN also analysed the conclusions of the periodic safety reviews on reactors 1 and 2 at Saint-Alban and reactor 2 at Cattenom and set additional requirements to enhance the safety of these sites.
- o After Civaux (1450 MWe) reactor 1 in 2011, Civaux reactor 2 in 2012 integrated the modifications resulting from the periodic safety review on the occasion of its first ten-yearly outage (VD1). As with the 900 MWe and 1300 MWe reactors, ASN will in 2013 rule on the continued operation of each of the reactors of the N4 plant series following examination of the conclusion reports submitted by EDF.
- o As part of the advance review of the future commissioning application for the Flamanville 3 EPR type reactor, ASN and IRSN finalised their examination of the design of the I&C system architecture and continued the civil engineering review of the facility and the detailed design of certain systems important for the safety of the reactor, focusing on innovative systems and the systems involved in reactor protection and safeguard, or in maintaining the three safety functions. ASN also completed its detailed design review of the elements involved in optimising radiation protection and dimensioning of the radiological protection of the reactor building.

3.3.4 Changes in emergency management

In the same way as nuclear safety, the emergency response arrangements must be modified on the basis of acquired experience. The population protection measures are different in the emergency phase and in post-accident situations. With regard to this latter point, the first elements of the doctrine drafted by the CODIRPA were transmitted to the Prime Minister by ASN in November 2012 (see § 16.5.1 and

[1] Only in French: http://www.asn.fr/index.php/content/download/27677/166969/file/2010-AV-0100.pdf

[2] Only in French: http://www.asn.fr/index.php/content/download/30387/194913/file/1Decision-2011-DC-0231.pdf and http://www.asn.fr/index.php/content/download/36249/268239/file/2012-DC-0328.pdf

[3] Only in French: http://www.asn.fr/index.php/content/download/34768/257125/file/2012-AV-0155.pdf and http://www.asn.fr/index.php/Les-actions-de-l-ASN/La-reglementation/Bulletin-officiel-de-l-ASN/Decisions-de-l-ASN/Decision-n-2012-DC-0311-de-l-ASN-du-4-decembre-2012

[4] Only in French: http://www.asn.fr/index.php/Les-actions-de-l-ASN/La-reglementation/Bulletin-officiel-de-l-ASN/Decisions-de-l-ASN/Decision-n-2013-DC-0342-de-l-ASN-du-23-avril-2013

§ 16.5.3). Work will continue in order to take account of lessons learned from the Fukushima Daiichi accident, as well as to address certain issues still outstanding further to the first phase of the CODIRPA work.

3.3.5 Changes following implementation of post-Fukushima measures

Following the Fukushima Daiichi accident, ASN considered that it was necessary to perform stress tests (referred to in France as complementary safety assessments (CSA))[5] on the French civil nuclear facilities, with respect to the type of events which led to the Fukushima Daiichi accident. These stress tests are in response to the requests made by the Prime Minister on 23rd March 2011 and the European Council on 24th and 25th March 2011 (see § 14.2.1.6 for details on the stress tests approach). In September 2011, the licensee presented ASN with the stress tests for their facilities in extreme situations, plus an initial batch of modifications to be implemented in the short to medium term. These stress tests were reviewed by the Advisory Committees for nuclear reactors and for laboratories and plants in November 2011.

On 26th June 2012, ASN issued 32 resolutions[6] instructing the licensees to take additional measures. For the NPP reactors, these measures are presented in § 6.3.1.3 and then in § 18.3.2.2, § 18.3.4.3, § 19.4.2 and § 19.4.4. These measures are a means of dealing with external risks and preventing accidents and, were an accident to occur, of mitigating the effects and avoiding long-term off-site contamination.

These new requirements entail considerable amounts of work and large-scale investments, which are beginning in 2012 and will be spread over several years:

- o for all the facilities, the creation of a "hardened safety core" of material and organisational measures for managing the basic safety functions in extreme situations, with the aim of preventing a severe accident, of limiting large-scale radioactive releases if an accident cannot be controlled and enable the licensee, even in extreme situations, to perform its emergency management duties[7]. The equipment which is to be part of this "hardened safety core" must be designed to withstand major events (earthquake, flood, etc.) on a scale far in excess of that considered when determining the resistance level of the facilities, even if they are considered to be implausible. This equipment must also be protected against the on-site and external hazards induced by these extreme situations, such as falling loads, impacts from other components and structures, fire, explosion. For the EDF nuclear power plants, the "hardened safety core" shall comprise an additional "bunkerised" ultimate emergency diesel generator for each reactor (see § 18.3.2.2), a diversified

[5] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments

[6] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-resolutions

[7] The licensee must in particular set requirements concerning:

- the emergency situation management rooms, so that they are highly resistant to hazards and remain permanently accessible and habitable, even for long-duration emergencies, including in the event of radioactive releases. These rooms shall enable the emergency response teams to diagnose the condition of the facilities and control the hardened safety core resources;
- the availability and operability of the mobile resources vital to management of the emergency;
- the means of communication essential to management of the emergency, more specifically including the means of alerting and informing the emergency crews and the public authorities, plus if necessary the systems for alerting the populations if the off-site emergency plan is triggered during the reflex phase and if ordered by the Prefect;
- the availability of parameters for diagnosing the condition of the facility, as well as meteorological and environmental measurements (radiological and chemical, inside and outside the emergency management rooms) so that the radiological impact on the workers and general public can be assessed and predicted;
- operational dosimetry means, radiation protection measurement instruments and individual and collective protective equipment. This equipment shall be available in sufficient quantities.

emergency water supply system (see § 18.3.2.2), as well as an emergency management centre able to withstand a large-scale event affecting several facilities simultaneously (see § 16.3.1.1);

- as of 2012, the gradual deployment of the "Nuclear Rapid Intervention Force" (FARN) proposed by EDF (see §16.3.1.2), a national intervention system, devoted to the licensee, comprising specialised personnel and equipment[8], which can take over from the personnel on a damaged site and deploy additional emergency intervention means within 24 hours after operations begin on a site, less than 12 hours after they are mobilised. This arrangement may be common to several of the licensee's nuclear sites. The system has been partially operational (for intervention on one reactor of each of the sites) since the end of 2012 and will be fully operational in late 2015 (Gravelines – for 6 plant units);
- a new on-site emergency plan (PUI) baseline has been deployed on all EDF sites since 15th November 2012. It takes into account accident situations simultaneously affecting several facilities on a given site (see § 19.4.4);
- for the fuel pools in the different facilities, the setting up of reinforced measures to reduce the risks of the fuel becoming uncovered. In addition to particular studies and modifications, EDF proposed an emergency water make-up system to be installed as of 2015, jointly with deployment of an ultimate backup diesel generator on all units (see § 18.3.2.2 and § 19.4.2).

ASN has decided to initiate an action plan to take account of experience feedback from the Fukushima Daiichi accident for the internal organisation of emergency situations. This led to the identification of strong points and areas for improvement, the implementation of which began in 2012 (see 16.5.4.1). A steering committee was set up to run experience feedback from the Fukushima Daiichi accident (see 16.5.4.2). This committee also follows-up the steps taken as of 2011 in the wake of the accident.

Based on the in-depth experience feedback from the Fukushima Daiichi accident, ASN will review the baseline safety requirements of the nuclear facilities, particularly with regard to the "earthquake" and "risks associated with other industrial activities" aspects (see § 17.4.1). In April 2013, ASN also published guidelines for protecting nuclear facilities against external flooding, detailing recommendations designed to evaluate and quantify the risk of external flooding faced by these facilities and to determine the appropriate means of protection against it.

In addition to the normal inspection programme, the topics addressed by the stress tests were also covered by 38 targeted inspections in 2011 on the nuclear sites considered to be high-priority. In 2012, ASN carried out follow-up inspections to check the corrective measures requested following the inspections performed in 2011 on all the nuclear facilities[9] (see § 6.3.1.4 for the nuclear power generating plants).

ASN published the national action plan for France concerning the implementation of the recommendations resulting from the European stress tests conducted in 2011 and, more generally, all the actions decided further to these tests[10].

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[8] These crews must be large enough to be able to intervene on all the reactors of the site and have measurement instruments that can be deployed as soon as they arrive. The licensee will specify the organisation and size of these crews, more specifically the activation criteria, their duties, the material and human resources at their disposal, the individual protection equipment, the system set up for maintenance of these material resources and their permanent operability and availability, plus the training of their personnel and the skills currency and refresher training processes.

[9] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/Targeted-inspections

[10] http://www.french-nuclear-safety.fr/index.php/English-version/News-releases/2012/European-stress-tests-ASN-publishes-its-national-action-plan

3.3.6 Organisational and human factors

ASN coordinates the Social, Organisational and Human Factors Steering Committee (COFSOH), which is the forum for cross-disciplinary exchanges set up to ensure progress in the three priority areas identified in the ASN opinion of 3rd January 2012 on the stress tests, that is renewal of the workforce and the skills of the licensees, the organisation of the use of subcontracting and research on these topics (see Chapter 12).

3.4 Safety perspectives for the next three years

ASN work and regulation will be focused on the following main elements.

3.4.1 Regulation of NPPs in service

This will remain a priority for ASN, which considers that maintaining the reactors in a safe state will require that EDF continue its efforts with regard to maintenance and preparation for operational work. With regard to environmental protection, ASN will continue to examine the discharge and water intake modification files and will set discharge limits on the basis of the best available techniques, ambient environment protection targets and lessons learned from the plants in service.

Finally, in 2013, ASN will also rule on the study and work programme proposed by EDF with a view to extending the operating life of its reactors beyond 40 years and will share its work internationally.

3.4.2 Experience feedback from the Fukushima Daiichi NPP accident

Following on from the actions of 2012, ASN will pay particular attention to how EDF learns lessons from experience feedback from the accident at the Fukushima Daiichi NPP. ASN will ensure specific monitoring of the steps necessary for implementation of the additional safety measures required following the stress tests and will in particular rapidly issue an opinion on EDF's proposal to implement a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations.

3.4.3 Regulation of the construction of the EPR Flamanville 3 reactor

Regulation will continue throughout the construction of the EPR Flamanville 3 reactor. At the peak of the systems erection activity, ASN intends to focus its oversight on EDF's check of the quality of work and the prevention of occupational accidents. At the same time, ASN will continue to review the elements necessary for the commissioning application, more specifically the methods used to study accidents, plus the facility operating principles. ASN will notably develop the regulatory tools necessary for managing the preparation and inspection of the start-up tests. It will aim to cooperate as extensively as possible with its foreign counterparts, particularly within the framework of the MDEP group, with the goal of achieving harmonised positions.

C – 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 : Presentation of reports

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 sixth French report submitted for review in compliance with article 5 of the Convention.

6. Article 6 : Existing nuclear installation

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

6.1.1 Nuclear power reactors

6.1.1.1 The existing NPPs

The NPP reactors currently covered by the scope of the Convention include 58 PWR reactors, built in successive standardised series, which were coupled to the grid between 1977 and 1999 and are all in service.

In 2012 the PWR reactors produced 404.9 TWh, or about 75% of the electricity generated in France (421 TWh and 77.7% respectively in 2011; 407.9 TWh and 74% in 2010). They are grouped in 19 NPPs in operation, all of which are on the whole similar. They each comprise from two to six reactors of the same type (PWR) amounting to a total of 58 reactors built by the same supplier, Framatome, which is today known as AREVA NP. The following reactor series are usually identified (refer to the location map in Appendix 1):

Among the thirty-four 900 MWe reactors:

- the CP0 series, comprising the two reactors at Fessenheim and the four reactors at Bugey (reactors 2 to 5);
- the CPY series, comprising the other 900 MWe reactors, subdivided into CP1 (18 reactors at Dampierre, Gravelines, Blayais and Tricastin) and CP2 (10 reactors at Chinon, Cruas and Saint-Laurent-des-Eaux).

Among the twenty 1300 MWe reactors:

- the P4 series, comprising eight reactors at Paluel 1/2/3/4, Flamanville 1/2 and Saint-Alban 1/2;
- the P'4, series, consisting of the 12 reactors at Belleville-sur-Loire 1/2, Cattenom 1/2/3/4, Golfech 1/2, Nogent-sur-Seine 1/2 and Penly 1/2.

The N4 series, which consists of four 1450 MWe reactors: Chooz 1/2 and Civaux 1/2.

In December 2012, the average age of the reactors, based on the dates of the first reactor criticality phases, stood as follows:

- 31 years for the thirty-four 900 MWe reactors;
- 25 years for the twenty 1300 MWe reactors;
- 15 years for the four reactors of the N4 plant series.

Because of the 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 Bugey and Fessenheim) in building design, in the addition of an intermediate cooling system between that used for containment spraying in the event of an accident and that containing river water, and in a more flexible control.

Significant changes in relation to the CPY plant series were made in the design of the core protection circuits and systems for the 1300 MWe reactors and in the buildings housing them. The power increase involves a reactor coolant system with four steam generators, thus with higher cooling capacity than on the 900 MWe reactors, which are equipped with three steam generators. Furthermore, the reactor containment comprises a double concrete wall instead of a single wall with a steel leak tightness liner, as on the 900 MWe reactors. The reactors of the P'4 series differ slightly from those of the P4 series, particularly with regard to the fuel building and systems.

Finally, the N4 series differs from the previous series in the more compact steam generator design and the primary pump design, and in the use of a computerised interface for reactor operations.

6.1.1.2 The Flamanville 3 EPR reactor

Construction of an EPR type reactor began on the Flamanville site in 2007.

As at the end of 2012, 94% of the main civil engineering work was complete and EDF is now concentrating on completing construction of the reactor building containment, the north diesel building and the access tower. Electromechanical assembly is 39% complete and the main components in the turbine hall are in place. Manufacture of most of the large NSSS mechanical components is finished or nearing completion. 2011 and 2012 were marked by the detection of numerous defect indications in the welds on the vessel head adapters, which are under repair.

With regard to the EPR I&C architecture, examination of the ability of the SPPA-T2000 platform to perform the F2[11] and F1B[12] classified safety functions continued. In a letter of 4th April 2012, ASN considers that the answers provided by EDF concerning on the one hand the conformity of the SPPA-T2000 platform with the technical requirements associated with classification level F1B and, on the other, the requests concerning reinforcement of the existing robustness measures for the I&C architecture, are satisfactory. In these conditions, ASN considers that the SPPA-T2000 platform is able to perform the F1B functions and therefore logically the F2 class functions.

6.1.2 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 are subject to 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, these figures take account of the number of installations shut down, either temporarily for renovation or modification, or permanently, pending decommissioning (case of Phénix, see below).

The vast majority of research reactors in France are also of the pool type. Only the Masurca reactor, a critical mock-up intended for neutron studies for fast-neutron reactor technology, is air-cooled. The Phénix fast neutron reactor, which was used for research and produced electricity, was taken off the grid in 2009, ceased all operation at power that same year and has been kept shut down.

Most of those reactors were commissioned between the 1960s and the 1980s, but have generally undergone extensive work since then.

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[11] According to the Flamanville 3 preliminary safety assessment report: "The safety functions needed to achieve and maintain a final state for the RCC-A event sequences, are classified F2"

[12] According to the Flamanville 3 preliminary safety assessment report: "all the safety functions necessary, once the controlled state has been reached, in order to achieve safe shutdown state and maintain it after an internal PCC-2 to PCC-4 event are classified F1B"

Among these 11 research reactors, 10 are operated by CEA at its Cadarache, Saclay and Marcoule sites.

The High-flux Reactor (HFR) is located close to CEA's Grenoble site and is operated by the *Institut Laue-Langevin* (ILL), a research institute grouping several European partners.

CEA, EDF and AREVA, together with a number of European partners, have started the construction of the Jules Horowitz Reactor (JHR), owing to the ageing of the European irradiation reactors currently in service and their shutdown scheduled for the short to medium term. This new pool type irradiation reactor, will help meet R&D needs until about 2050.

The main aims of the reactor are to irradiate materials and fuels to support international nuclear-power generating programmes, to produce artificial radionuclides for medical diagnosis and cancer treatment, and to produce doped silicon.

Based on the preliminary safety analysis report and the public inquiry files, the creation authorisation application for the JHR BNI was sent to the public authorities in March 2006, accompanied by the effluent discharge and water intake license applications, pursuant to decree 95-540 of 4th May 1995.

The public inquiry procedure called for by the Prefect was held in eight communes surrounding the Cadarache site in November and December of 2006.

The JHR preliminary safety analysis report was examined by the Advisory Committees for nuclear reactors (GPR) during the course of eight meetings held from June 2007 to June 2008. The principles of the Convention were applied to the safety of this installation right from the design stage.

The process as a whole led to the presentation of the draft reactor creation decree to the BNI consultative committee on 16th March 2009. The JHR creation decree was signed by the Prime Minister on 12th October 2009 (decree 2009-1219).

The civil engineering work is continuing and reactor commissioning is currently scheduled for 2016.

In France the regulations applicable to research reactors are the same as those which apply to other nuclear facilities, in particular power reactors. The analysis of their safety case and the steps taken to guarantee it are the result of a "graduated approach" consisting in adapting the resources to be implemented to the various risks potentially presented by these facilities. When relevant, ASN can call on requirements which apply specifically to research reactors, or to certain types of operations performed in them. These are however simply adaptations of regulatory requirements that exist elsewhere.

The list of French research reactors in service, along with a map showing their locations, is given in Appendix 1.

To these reactors can be added the ITER (International Thermonuclear Experimental Reactor) project, which concerns an experimental facility designed to provide scientific and technical demonstration of control of thermonuclear fusion obtained by magnetic confinement of a deuterium-tritium plasma, during long-duration experiments with significant power (500 MW for 400 s).

6.2 Main significant events over the past three years

The analysis of significant events over the period 2010-2012 and ASN's assessment, are given in §19.6. The main significant events (INES level 1 or 2) are described below:

Generic significant safety event notified on 16th February 2011 concerning the emergency diesel generator sets for the 900 MWe plant series

On 22nd October 2010, a periodic test carried out at the Blayais NPP revealed a failure of an emergency generator set. The analysis initiated showed faster than expected deterioration of the connecting rod bushings, which are mechanical components designed to minimise friction between the moving parts of the diesel engines.

On the French NPPs, 27 electricity generating sets are equipped with bushings of the same type and liable to be affected by the same defect.

The corrective action plan presented by EDF comprises the installation of new bushings, the implementation of a new operating procedure for the generating sets concerned and reinforced surveillance and maintenance.

As part of the search for the root causes of this anomaly requested by ASN, EDF carried out analyses and appraisals jointly with the manufacturers of the generator and the bushings affected. These identified localised excess thickness of the bushing surface layer, which disrupted the cooling oil flow, locally generating excessive temperature.

In order to deal with this defect, EDF had a new type of connecting rod bushing developed, incorporating geometrical modifications to facilitate cooling. ASN approved the deployment of this modification in early 2013.

On all the EDF sites, other than Tricastin, where this type of bushing is installed (Blayais, Bugey, Chinon, Cruas, Dampierre, Gravelines and Saint-Laurent), each reactor has at least one generator set, either its own or a general site set, equipped with bushings of another brand and which are unaffected by this defect. The deviation was thus rated by ASN at INES level 1 for these sites. However, the deviation was rated by ASN at INES level 2 for Tricastin reactors 3 and 4, because the two generator sets and the additional generator set common to all the site's reactors, are equipped with these same vulnerable bushings.

Significant safety event notified on 18th January 2012 concerning the cooling pipes for the Cattenom NPP spent fuel storage pools

On 18th January 2012, EDF notified ASN of the absence of a “siphon-breaker” orifice on the cooling pipes of the waste or spent fuel storage pools for Cattenom NPP reactors 2 and 3. This significant safety event, detected during an internal inspection, was rated at INES level 2.

Further to the analysis of this event, ASN asked EDF to systematically check that “siphon-breaker” were present on all the spent fuel storage pools of the reactors in operation.

On the reactors of the 1300 MWe - P’4 plant series, these checks revealed that the “siphon-breaker” fitted to the pipes of the pools at Belleville 1 and Golfech 1 had diameters of 15 and 17 mm respectively, rather than the design diameter of 20 mm; these “siphon-breaker” were therefore rectified. For the pipes on the pools at Nogent 1 and Penly 2, EDF demonstrated that the diameters of the “siphon-breaker” measured at between 19 and 20 mm were such as to enable them to perform their role in an incident situation.

For the 1300 MWe - P4 plant series, the design of these systems is different: from the outset, the design diameter was smaller, about 10 mm. The diameters measured on the reactors concerned are in conformity with this design requirement.

Moreover, in order to increase the robustness of the facilities to situations which were not envisaged at the design stage (for example, complete rupture of a pipe), ASN asked EDF – as part of the on-going periodic safety reviews – to make provision for a “siphon-breaker” modification to increase the dimensions. Implementation of this modification began in 2011. Following the stress tests carried out further to the Fukushima Daiichi accident, ASN asked EDF to speed up this process in order to guarantee implementation on all the reactors of all the plant series no later than March 2014.

Significant safety event of 5th April 2012 concerning the reactor trip of Penly reactor 2 and leaks from seal No.1 of a reactor 2 primary pump

On 5th April 2012, reactor 2 tripped following shutdown of primary pump No.1 and the appearance of several alarms in the control room. Later on in the day, while the EDF operators were following the incident instructions, an abnormally high value for the leak rate collected at seal No.1 on this pump was identified. This situation led EDF to apply incident operating procedures to bring the reactor to "cold shutdown" state.

The reactor reached stable shutdown state on the morning of 6th April. ASN immediately took steps which can be broken down into the following three phases:

- in the short term, ASN activated its emergency organisation and ensured that the event required no particular measures to protect the populations;
- in the medium term, ASN carried out the checks needed to understand the incident and identify any problems encountered by the licensee. ASN thus carried out six inspections and asked the licensee to take a number of steps prior to restarting the reactor;
- in the longer term, ASN initiated a detailed analysis of the incident, to identify any generic improvements that could be made to the facilities, organisations and operating procedures, to prevent the recurrence of similar incidents.

This incident led to the scheduled outage of the reactor being brought forward and then extended until 3rd August, so that important maintenance and repair work could be performed. In the light of the results of the work and appraisals carried out during the reactor outage, ASN authorised the restart of Penly reactor 2. ASN also asked the licensee to implement specific monitoring during the next operating cycle, more specifically on the primary pump lubrication system and requested additional appraisal data on the equipment disassembled further to the event.

This event was rated at INES level 1.

6.3 Safety reassessment of nuclear facilities

The safety reassessments mechanism is presented in Chapter 14. The main safety improvements currently being implemented or which have already been made to the nuclear facilities since France's previous report, are summarised in the following sections.

6.3.1 Measures taken on nuclear power reactors

6.3.1.1 Periodic safety reviews

Over the period 2007-2012, the main projects concerned the 900 MWe reactors (deployment of VD3 modifications), the 1300 MWe reactors (deployment of VD2 modifications and preparation for VD3) and the 4 reactors of the N4 series (deployment of VD1 modifications).

6.3.1.1.1 Third ten-yearly outage of the 900 MWe reactors (VD3)

In preparation for the third ten-yearly outage (VD3) on the 900 MWe reactors, ASN asked EDF to submit a precise review of the state of ageing for each of the reactors concerned, and to demonstrate that operation could be continued beyond thirty years in satisfactory safety conditions. EDF drew up a programme of work concerning management of the ageing of the 900 MWe reactors.

The main changes made following adoption of the 900 MWe VD3 safety baseline requirements include:

- strengthening of seismic resistance; the work mainly concerns the Bugey site;
- greater consideration given to the risk arising from explosive gases. Premises comprising an explosive atmosphere risk were equipped with hydrogen detectors and/or explosion-proof equipment;

- enhanced site robustness to external natural hazards, mainly by improving the long-term reliability of the diesel generators;
- consideration of the risk of rapid drainage of spent fuel storage pools. The purpose of the modifications to be implemented is to increase the time available to the operator to return the fuel assemblies to a safe position during handling: automatic shutdown of pool pumps at very low level and measurement of emptying rate;
- improved severe accident management, notably by increasing the reliability of the reactor coolant system depressurisation device with the pressuriser valves, even in the event of severe accidents generated by a station black-out situation;
- improving reactor performance and addressing the obsolescence of the I&C hardware through the renovation of certain equipment which would be unable to reach a 40-year service life.

Tricastin 1

In a resolution of 27th May 2011, ASN issued thirty-two additional requirements to EDF, applicable to Tricastin reactor 1, following its third ten-yearly outage.

These new requirements cover all operations and in particular reinforce the level of the specifications applicable to site protection against external natural hazards (flooding, earthquake, fire). For example:

- one requirement concerns implementation of site protection against the external flooding risk, before the end of 2014;
- one requirement concerns the number and positioning of the hydrogen recombiners installed in the reactor building;
- five requirements reinforce the seismic specifications;
- three requirements concern the capacity, safety and effectiveness in an accident situation of the reactor's spent fuel storage pool cooling system;
- between 2013 and 2015, two requirements require a new inspection on the area of the reactor vessel in which defects have been identified and are being monitored, along with installation of a water heater on the emergency cooling system, to minimise the scale of the thermal loadings to which the vessel could be subjected in the event of an accident.

These requirements were issued without prejudice to the conclusions of the stress tests performed following the accident that occurred on the Fukushima Daiichi NPP.

Fessenheim 1

In a resolution of 4th July 2011, ASN issued forty additional requirements for Fessenheim reactor 1 following its third ten-yearly outage. These include the following two main requirements:

- reinforce the reactor basemat before 30th June 2013, to increase its corium resistance in the event of a severe accident with vessel melt-through. After review of the file submitted by EDF, ASN on 18th December 2012 authorised EDF to carry out the proposed modification subject to a number of additional conditions designed to ensure the radiation protection of the personnel carrying out the work and to ensure compliance with the safety objectives set. The modification is designed to increase both the thickness and the surface area of the corium spreading area in the event of a severe accident with vessel melt-through. The basemat was reinforced during the reactor outage in the spring of 2013 and no problems were encountered.
- before 31st December 2012, implement emergency technical measures for long-term removal of residual heat in the event of loss of the heat sink. The work was completed in late 2012.

Bugey 2

In an opinion of 10th July 2012, ASN concluded its analysis of the results of the third periodic safety review of this reactor. It also takes account of the initial lessons learned from the Fukushima Daiichi accident and the conclusions of the stress tests.

Pursuant to the regulations currently in force, ASN issued new additional instructions designed to increase the safety of the Bugey NPP reactor No.2. These instructions in particular include requirements applicable to facilities with more recent safety goals and practices.

Fessenheim 2

In a resolution of 23rd April 2013, ASN issued new instructions to EDF following the third periodic safety review of the Fessenheim NPP reactor 2, as it had done for reactor 1 in 2011. Having set these requirements, ASN has no objection to the continued operation of Fessenheim reactor 2 beyond its third ten-yearly periodic safety review.

As it had already done for reactor 1 in its resolution of 4th July 2011, ASN thus required reinforcement of the safety of reactor 2 by increasing the ability of its basemat to withstand corium in the event of a severe accident with reactor vessel melt-through, plus the addition of an emergency cooling water make-up system: these two projects should be completed by 31st December 2013 for reactor 2. Generally speaking, the identical design of the two reactors on the same site led to requirements being applied to reactor 2 that were similar to those applied to reactor 1. ASN's resolution also includes a number of requirements specific to reactor 2 and linked to individual deviations or modifications.

6.3.1.1.2 Second ten-yearly outage of the 1300 MWe reactors (VD2)

In 2006, ASN declared itself to be in favour of continued operation of the 1300 MWe reactors beyond their second ten-yearly outage, provided that the modifications decided on during this review were effectively implemented. The improvements arising from this safety review will be integrated by 2014, on the occasion of the second ten-yearly outage. The most significant modifications include:

- optimisation of the filtered containment venting system (sand filters) in the event of a loss of heat sink and steam generators feedwater supply;
- diversification of the means of monitoring water level of the steam generators feedwater tank;
- start-up of the safety injection and containment spray systems by means of a secure command;
- improved reliability and robustness of the ebulliometer;
- modification of the I&C on the chemical and volume control system letdown line;
- improved start-up of the emergency turbine generator with resupply of the test pump;
- increased reliability of the cooling function by the residual heat removal system.

The first 1300 MWe VD2 outage was that of Paluel 2 in 2005. Operating experience feedback from this reactor was able to validate the batch of modifications for the entire plant series.

At the end of 2012, 17 (of 20) VD2 1300 had been carried out, with the end of deployment being scheduled for late 2014.

6.3.1.1.3 First ten-yearly outage on the reactors of the N4 plant series

In 2008, ASN issued a resolution on the guidelines for the first periodic safety review for the 1450 MWe reactors. They in particular concern the level 1 probabilistic safety assessments and the hazard assessments. This periodic safety review focuses on ensuring conformity of the plant series with changes to the baseline requirements since coupling of the reactors and not included in the initial safety analysis report. The conclusions of the 1300 MWe VD2 and 900 MWe VD3 periodic safety reviews transposable to the N4 plant series, were also incorporated. These ten-yearly outage began in 2009 and ended in 2012.

The following modifications specific to the N4 plant series aim at:

- completing the equipment upgrades linked to qualification for post-accident environmental conditions;

- o increasing the reliability of tripping of the reactor cooling pumps in the event of a degraded atmosphere, as well as the seismic qualification of the control rod drive mechanisms' cooling system;
- o reduce the probability of fuel damage by modifying the sequences brought to light by the probabilistic safety assessments (PSA).

The last two reactors, Civaux 1 and 2, incorporated the modifications resulting from this review in 2012. ASN will send the Minister responsible for nuclear safety its opinion on the continued operation of the two reactors after examining EDF's conclusions report.

6.3.1.1.4 Third ten-yearly outage of the 1300 MWe reactors (VD3)

In 2011, ASN defined the guidelines for the periodic safety review associated with the third ten-yearly outage for the 1300 MWe reactors.

These follow on from the studies carried out for the 900 MWe VD3 and take account of international operating experience feedback and the lessons learned from R&D. Examples include:

- o the reactor operating conditions, the management of severe accidents, the radiological consequences of accidents (excluding severe accidents) and the confinement of radioactive substances in all operating conditions;
- o the validity review of the safety assessments, verification of reactor robustness to external or internal electrical disturbances and the criticality risks, as well as the risks linked to the storage of fuel in their storage pool;
- o the level 1 probabilistic safety assessments concerning the probability of core melt, the scope of which was more specifically expanded to include risks associated with fire, on-site flooding and earthquake, and level 2 assessments concerning the radiological consequences of a severe accident;
- o the reassessment of the risks of internal hazards and the risks of external natural hazards linked to the climate, to earthquakes, to the environment, or to human activities. Verification that the protection measures are sufficient and effective, with the definition of new measures as and when necessary.

This safety review will consider the currently ongoing studies, notably the conclusions of the stress tests.

Paluel reactor 2 is scheduled to be the first to undergo its third ten-yearly outage, in 2015. ASN ensures that this periodic safety review, which is the first to be prepared subsequent to the TSN Act, complies with the requirements of the Act.

6.3.1.2 Modifications made in the light of operating experience feedback from all plant series

Following the events affecting the NPPs in service, modifications were started, with short completion schedules, outside the scope of the normal periodic safety review processes. The main modifications are described below.

6.3.1.2.1 Protection against external climatic hazards

Flooding

Following the flooding on the Blayais site in December 1999, EDF initiated a reassessment of the protection of the sites against external flooding risks. This covers:

- o the revision of the flood safety level (CMS)[13];

[13] This level is the water level to be considered when designing the protection systems, according to the situation of the site. The design hypotheses are mainly the thousand-year flood levels, plus 15%, for riverside sites and a tidal coefficient of 120 combined with a wind of 120 km/h for coastal sites.

- o the integration of additional unexpected events that may lead to flooding on a site;
- o reactor operating procedure to be applied.

For all sites, following protective measures were adopted: protection works, implementation of appropriate alert and operating procedures, deployment of a local and national emergency response organisation.

The stress tests showed that the reassessments performed were able to provide the facilities with a high level of protection against the risk of flooding. However, not all the measures designed to meet these requirements have as yet been implemented. ASN instructed EDF to complete all of this work before the end of 2014.

Heat sink

The clogging and partial loss events affecting the heat sinks at Cruas and at Fessenheim in December 2009 were an indication of their vulnerability, which led EDF to initiate an action plan to increase their robustness. EDF initiated a design review of all heat sinks and the detailed conclusions for each site were transmitted in 2012. This design review details the safety recommendations made to remedy the weak points detected.

Heatwave and drought

In the summers of 2003 and 2006, the whole of France experienced exceptionally high temperatures. These heatwave conditions led to high air and heat sink temperatures, as well as low water flow rates at the end of the season. These parameters affect the performance of the safety auxiliaries, but also the energy production auxiliaries and the authorised thermal discharge conditions.

In 2003 and 2004, EDF initiated a number of short-term corrective measures: appropriate alert and operating procedures, local and national emergency response organisation supplemented by material measures such as the use of additional chillers and increased exchange capacity for the backup heat sinks on the most vulnerable sites.

Since then, the robustness of the reactors to high temperatures has also been reassessed.

In 2009, ASN issued an initial opinion concerning the “extreme heat” baseline requirements proposed by EDF for the 900 MWe reactors. In 2012, for the 900 MWe reactors, ASN approved the implementation of the necessary material modifications. ASN also issued a new opinion on EDF’s answers in 2013.

The design and deployment schedule for the modifications on the various plant series is as follows:

- o 900 MWe - CPY series: additional protection measures have been defined, some of which are being deployed;
- o 900 MWe - CP0 series: the deployment of additional protection measures is scheduled as of 2015. The possibility of early implementation of certain measures is being examined at the same time;
- o 1300 and N4 series: studies have been completed for the 1300 MWe series and are ongoing for the N4 series, with the aim of deploying additional protection measures timed to coincide with the 1300 MWe VD3 and 1450 MWe VD2. The possibility of early implementation of certain measures is being examined at the same time.

During the transitional period preceding implementation of these additional measures, steps were taken to increase the robustness of the facilities to a heatwave.

6.3.1.2.2 Replacement of the steam generators

The integrity of the steam generator tube bundles is a major safety issue, since deterioration of a bundle can cause leaks from the primary to the secondary system. Furthermore, a tube rupture of one of the bundle tubes (SGTR) would lead to bypassing of the reactor containment, which is the third confinement barrier. Steam generator tubes are subject to several types of deterioration such as corrosion, wear or clogging. The steam generators are the subject of a special in-service monitoring programme, established by EDF, reviewed periodically and examined by ASN. After inspection, tubes that are too badly damaged are plugged to remove them from service. Moreover, to prevent or minimise the impact of the deposition of iron contained in the NPP secondary system feedwater system on the tubes and the surface internals, remedial or preventive chemical cleaning is performed for each reactor concerned by such phenomenon.

Since the 1990s, EDF has been running a steam generator replacement programme called RGV, conducted during the reactor ten-yearly outages. This programme concerns the SGs equipped with tube bundles made of an Inconel 600 type alloy that is not heat-treated. Operating experience feedback has shown the susceptibility of this material to a number of corrosion phenomena leading to deterioration of the tubes. During checks on steam generator n° 1 of the 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 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.

The 900 MWe series SG replacement programme will be completed in 2014. This will be followed by the RGV for the 900 and 1300 MWe reactors for which the tube bundle is made of heat-treated inconel, which is less susceptible but nonetheless remains vulnerable to cracking at the base of the tubes.

The RGV for the 900 and 1300 MWe plant series will be carried out no later than the fourth ten-yearly outage. They will begin with Cruas 4 in 2014 and Paluel 2 in 2015 respectively.

ASN always carries out an inspection on the occasion of each steam generator replacement. It also monitors the manufacture of the spare steam generators.

6.3.1.3 Steps taken following the stress tests

After the stress tests on the priority nuclear facilities (see § 14.2 for details of the approach), ASN considers that the level of safety of the facilities examined is sufficient for it not to demand the immediate shutdown of none of them. This approach also concerned the Flamanville 3 EPR type reactor currently under construction (see §14.1.4.2).

Their continued operation does however require that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible. ASN therefore imposed a series of measures on the licensees designed to give the facilities the means enabling them to deal with:

- a combination of natural phenomena of an exceptional scale and exceeding the phenomena considered in the design or the periodic safety review of the facilities;
- severe accident situations consecutive to prolonged loss of electrical power supplies or cooling systems, and which could affect all the facilities on a given site.

On 26th June 2012, ASN issued resolutions, each one setting some thirty complementary requirements for each NPP. These measures will lead to a significant increase in the safety margins of the facilities beyond their design basis and will thus oblige the licensees to conduct a considerable amount of work, involving significant investments in human resources and skills. The work has started and will take place over several years. For the more complex measures, whose completion dates lie further in the future, the resolutions stipulate interim measures.

The new main measures are:

- Requirement ECS-01: for all the facilities, the creation of a "hardened safety core" of material and organisational measures for managing the basic safety functions in extreme situations, with the aim of preventing a severe accident, of limiting large-scale radioactive releases if an accident cannot be controlled and enabling the licensee, even in extreme situations, to perform its emergency management duties[14].The equipment which is to be part of this hardened safety core must be designed to withstand major events (earthquake, flood, etc.) on a scale far in excess of that considered when determining the resistance level of the facilities, even if they are considered to be implausible. This equipment must also be protected against the on-site and external hazards induced by these extreme situations, such as falling loads, impacts from other components and structures, fire, explosion. For the EDF nuclear power plants, the “hardened safety core” shall comprise an additional “bunkerised” ultimate emergency diesel generator for each reactor, a diversified emergency feedwater supply system, as well as an emergency management centre able to withstand a large-scale event affecting several facilities simultaneously.

In 2012, the licensees sent ASN the content and specifications of a “hardened safety core” for each facility. On 13th December 2012, the Advisory Committee for reactors met to give its opinion on:

- the objectives associated with the hardened safety core and its functional perimeter,
- the types and levels of initiating events considered when defining the hardened safety core,
- the choices adopted when considering the events that these initiating events induce on the facility and the hardened safety core,
- the implementation conditions for the hardened safety core, more specifically the facility states in which it can be used,
- the requirements associated with the equipment of the hardened safety core,
- the methods and criteria used to demonstrate compliance with the requirements,
- the integration of organisational and human factors for the implementation of the hardened safety core provisions,
- the emergency management provisions planned to meet the requirements of the hardened safety core.

ASN will issue an opinion on these points in 2013.

- Technical requirement ECS-36: as of 2012, the gradual deployment of the “Nuclear Rapid Intervention Force” (FARN) proposed by EDF (see §16.3.1.2), a national intervention system, devoted to the licensee, comprising specialised personnel and equipment[15], which can take

[14] See Prescription [ECS-01] dedicated to « hardened safety core ». The licensse shall issue stipulations concerning:

- the emergency situation management premises, so that they offer greater resistance to hazards and remain accessible and habitable at all times and during long-duration emergencies, including in the event of radioactive releases. These premises shall enable the emergency teams to diagnose the status of the facilities and control the resources of the hardened safety core
- the availability and operability of the mobile devices vital for emergency management;
- the means of communication essential to emergency management, in particular comprising the means of alerting and informing the emergency teams and the public authorities and the arrangements for alerting the population if the off-site emergency plan reflex phase is triggered by order of the Prefect;
- the availability of parameters used to diagnose the status of the facility, as well as meteorological and environmental measurements (radiological and chemical, inside and outside the emergency situation management premises) enabling the radiological impact on the workers and general public to be evaluated and predicted;
- the operational dosimetry resources, radiation protection measuring instruments and individual and collective protection resources. These resources shall be available in sufficient quantities.

[15] These crews must be large enough to be able to intervene on all the reactors of the site and have measurement instruments that can be deployed as soon as they arrive. The licensee will specify the organisation and size of these crews, more specifically the activation criteria, their duties, the material and human resources at their disposal, the individual protection equipment, the system set up for maintenance of these material resources and their permanent operability and availability, plus the training of their personnel and the skills currency and refresher training processes.

over from the personnel on a damaged site and deploy additional emergency intervention means within 24 hours after operations begin on a site, less than 12 hours after they are mobilised. This arrangement may be common to several of the licensee's nuclear sites.
The facility modifications envisaged by EDF for connection of the emergency mobile resources brought in by the FARN shall be examined specifically by ASN and the IRSN. In 2012, ASN approved the creation of tappings on certain systems. Examination of the modifications planned by EDF will continue in 2013.
The system has been partially operational (for intervention on one reactor of each site) since the end of 2012 and will be fully operational in late 2014 (Gravelines – for 6 plant units).

- Requirement ECS15 and requirement ECS-22: for the fuel storage pools in the different facilities, the implementation of reinforced measures to reduce the risks of the fuel becoming uncovered (see § 18.3.2.2 and § 19.4.2).
- Requirement ECS-27: feasibility studies with a view to setting up technical arrangements, such as geotechnical containment or other system with an equivalent effect, with the aim of protecting the ground and surface water in the event of a severe accident.
  End of 2012: EDF transmitted the feasibility study concerning the installation of technical systems to prevent the transfer of radioactive contamination to the groundwater in the event of a severe accident leading to reactor vessel melt-through by the corium. This study is currently being examined.

Finally, based on the in-depth experience feedback from the Fukushima Daiichi accident, ASN will review the baseline safety requirements of the nuclear facilities, particularly with regard to the "earthquake" and "risks associated with other industrial activities" aspects. In April 2013, ASN also published guidelines for protecting nuclear facilities against external flooding, detailing recommendations designed to evaluate and quantify the risk of external flooding faced by these facilities and to determine the appropriate means of protection against it.

6.3.1.4 Steps taken following the programme of targeted inspections performed as part of the Fukushima Daiichi accident experience feedback process

Targeted inspections performed in 2011 as part of the Fukushima Daiichi accident experience feedback process

These inspections, carried out in 2011 in all the NPPs, comprised field checks on the conformity of the licensee's equipment and organisation with the existing baseline safety standards.

The topics covered by these inspections were as follows:
- protection against external hazards, in particular seismic resistance and protection against flooding,
- loss of heat sinks,
- loss of electrical power supplies,
- operational management of radiological emergencies.

The main measures that had to be implemented by EDF are summarised below.

1. Earthquake (see § 17.2.1 and § 17.4.1.1.1): the inspections revealed that there were shortcomings on several sites and that in general progress is needed on all the sites. It is important to carry out exercises simulating an earthquake so that the planned procedures can be implemented and the staff prepared for this type of situation. Greater account must also be taken of the "seismic interaction" approach in the procedures and in the day-to-day operation of the plant units. Finally, EDF will have to ensure compliance with RFS I.3.b concerning seismic instrumentation, notably with regard to the staff's familiarity with the equipment, its upkeep and its calibration. Overall, this subject requires permanent

vigilance on the part of EDF, in order to avoid losing sight of the potential issues of this hazard during the day-to-day running of the reactors.

2. Flooding (see § 17.2.2 and § 17.4.1.1.2) : the conclusions of the inspections are mixed and vary from site to site. The organisation set up to manage the flooding risk complies satisfactorily with the regulatory requirements. However, the management of volumetric protection has to be improved on several sites. EDF will also need to define and carry out exercises to test the equipment and teams in this type of situation and take account of the experience feedback from these exercises. Finally, progress is needed in order to improve the strict application on the sites of the special operating rules in the event of flooding, the monitoring of meteorological, flood and tide parameters, the scheduling of the work decided on following experience feedback from the partial flooding of the Blayais site in 1999 and management of the mobile pumping resources.

3. Heat sink (see § 18.3.2.2) : the recent clogging and partial loss events on the heat sinks at Cruas and at Fessenheim in December 2009 in particular indicated their vulnerability, which led EDF to initiate an action plan to increase their robustness. EDF initiated a design review of all heat sinks and its detailed site-by-site conclusions were transmitted in 2012. The inspections carried out in 2011 showed that the general condition of the facilities was good but that there were still a certain number of deviations on some sites. As a general rule, rigorous operation and maintenance, equipment and structure condition monitoring, and exhaustive application of national directives, are areas for improvement on numerous sites. On many sites, maintenance of the essential service water system needs to be improved.

4. Electrical power supplies (see § 18.3.2.2): the situation remains on the whole satisfactory but could nonetheless be improved, more specifically with regard to the rigorousness of the operating and maintenance documents, the physical condition of certain fuel oil storage equipment, the management of the fluids needed by the generating sets and the periodic inspection of the combustion turbines on certain sites.

5. Management of accident situations (see §16): accident situation operations could be improved. The PUI (see § 16.1.3) organisation adopted by the sites is satisfactory. ASN considers that EDF needs to improve its management of secondary control rooms and certain agreements concluded with off-site organisations.

Inspections carried out in 2012 to check integration of the requests resulting from the targeted inspections performed in 2011 (follow-up inspections)

The general impression further to these follow-up inspections is a positive one. The organisation defined and put into place by EDF to deal with the corrective action requests further to the 2011 targeted inspections is in the whole satisfactory (earthquake, flooding, heat sink, electrical power supply and accident management). Most of the steps needed to address the commitments or progress actions have been completed or are well under way.

There are still however a number of points on which additional work is needed or which will be subject to a close watch by ASN, more specifically those concerning processes that are lengthy or which require continuous attention: management of the seismic risk during maintenance work, maintain staff skills concerning specific risks in long-term, quality of operational baseline documentation.

ASN notes that the licensee has clearly identified the issues linked to the heat sink and to the leaktightness of the premises housing safety classified functions, notably volumetric protection. Corrective measures have been started on those sites which fell short.

A few weak points have been identified on several sites. The management of mobile safety equipment and application of the licensee's internal baseline requirements still need to be improved on a large number of sites. For the Dampierre site in particular, it was considered that management of this equipment as a whole needed to be improved. Training documentation and follow-up need to be improved on some sites. Finally, additional requests were issued concerning the organisation or layout of the secondary control rooms on certain sites.

6.3.2 Measures taken for research reactors

6.3.2.1 CEA reactors

Periodic safety reviews

The periodic safety reviews were conducted on the Eole and Minerve critical mock-ups. The provisions of the ASN guidelines (2005), concerning requirements in terms of responsibility, content and planning, were implemented.

As all the elements have been transmitted, it will be possible to conclude the examination of the periodic safety review on the Eole and Minerve facilities in 2013.

The review of the Orphée reactor was discussed at two GPR meetings, on 9th September and 7th October 2010. Following the second periodic safety review, CEA initiated an action plan. CEA in particular began to replace the devices subjected to irradiation. ASN regularly monitors the progress of these actions.

Stress tests

CEA's installations underwent the stress tests process (see. § 14.2 for details), following the nuclear accident at Fukushima Daiichi. A first batch concerned 5 priority CEA facilities, including 4 reactors: Osiris, Jules Horowitz, Masurca and Phénix. A second batch concerns 9 facilities (including the Cabri, Rapsodie and Orphée reactors) and 2 CEA centres.

On completion of the stress tests on the priority nuclear facilities, ASN considers that the level of safety of the research reactors examined is sufficient for it not to demand the immediate shutdown of none of them.

As with the NPP reactors, their continued operation does however require that their robustness to extreme situations be increased beyond their existing safety margins, as rapidly as possible.

On 26th June 2012, ASN issued resolutions setting some complementary requirements for each priority BNI. In addition to the common request applicable to all BNIs, for the definition and implementation of a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations, the main requests concerned:

- no later than 31st December 2014, the removal of the fissile material from the Masurca facility to a facility with a satisfactory seismic design, as CEA had promised to do previously;
- improvements to the facilities concerning the flooding or sodium fire control risk, for the Phénix reactor;
- improvements concerning the loss of cooling risk for the Osiris reactor;
- improvements concerning the risks of flooding and loss of cooling and the behaviour in the event of an earthquake, for the Jules Horowitz reactor.

These new requirements entail considerable amounts of work and large-scale investments, which have begun in 2012 and will be spread over several years.

For the JHR, ASN also set additional requirements in the light of the conclusions of the stress tests, in its resolutions of 26th June 2012. Although the JHR is of a very recent design that integrates lessons learned from operating experience feedback from the other experimental reactors, the stress tests process has resulted in the CEA identifying possible improvements that could be implemented relatively easily, as it is still in the construction phase. In September 2012, CEA proposed its "hardened safety core" for the JHR and this is currently being examined.

The stress tests on ITER, required as part of the experience feedback from the Fukushima NPP accident, was transmitted in September 2012 by ITER Organisation. It will be reviewed by ASN in 2013.

At the same time, ASN has initiated a programme of targeted inspections on the research reactors, on the same topics as the inspections carried out on the NPP reactors. These inspections, scheduled between June and October 2011, were followed in 2012 by follow-up inspections to ensure compliance with the requests made further to the previous inspections.

6.3.2.2 The Institute Laue-Langevin high-flux reactor (RHF)

Periodic safety reviews

The last periodic safety review took place in 2007 following implementation of the steps defined by the 2002 periodic safety review, one key subject of which was the seismic strength of the facility with regard to the 2001 Basic Safety Rule concerning the seismic hazard.

Between 2009 and 2011, the RHF also strengthened its defence in depth, by adding a new backup system to prevent and mitigate the consequences of a core melt accident. This ultimate reflooding system is designed to guarantee management of the core cooling water inventory.

Stress tests

Between 2012 and 2016, the ILL will continue to reinforce its defence in depth, with the performance of work defined following the post-Fukushima stress tests and thus create a “hardened safety core” of emergency equipment. More particularly:

- a seismic depressurisation system to prevent any direct leaks and thus any unfiltered releases;
- a groundwater system to guarantee the long-term water inventory;
- an emergency command post will enable the facility to be monitored and the backup systems to be controlled, even after rupture of all the dams located upstream and after an earthquake far larger than the design-basis earthquake;
- the creation of emergency management rooms during the 2013-2014 winter outage and of several new systems to allow emergency cooling and mitigation of radioactive releases.

6.4 Continued reactor operations

6.4.1 Nuclear power reactors

6.4.1.1 Justification of in-service strength of reactor vessels

In operation, the mechanical properties of the vessel’s metal change, making it more susceptible to thermal shocks under pressure, or to sudden pressure rises when cold. The demonstration of the vessel’s ability to withstand sudden fracture must therefore be periodically reviewed, in particular for the vessels of the 900 and 1300 MWe reactors, on which stable manufacturing defects had been detected.

To prevent any risk of rupture, the following steps were taken as of commissioning:

- an irradiation monitoring programme: test pieces made of the same metal as the vessel were placed inside it and are used to perform mechanical tests.
- periodic inspections are used to verify the absence of defects or, if manufacturing defects are indeed found, to check that they are stable and do not develop.

ASN regularly examines the vessel files transmitted by EDF.

Thus the file concerning the in-service behaviour of the 900 MWe reactor vessels for the ten years following their third ten-yearly outages was presented to the Advisory Committee for nuclear pressure equipment in June 2010. ASN considered that operation of these vessels for the time considered was acceptable, provided that EDF conducts further investigations and provides additional data to reinforce the guarantees obtained. ASN more specifically reissued its request for re-inspection every 5 years of the Tricastin 1 vessel, which comprises 20 defects under the liner and asked EDF to maintain or install heating of the safety injection system on the Tricastin 1, Fessenheim 2 and St Laurent B 1 reactors, in order to minimise vessel loadings in the event of an accident situation. ASN is at present examining the first answers supplied by EDF on this matter and is preparing to examine the file concerning the in-service strength of the 1300 MWe reactor vessels beyond their third ten-yearly outages.

6.4.1.2 Continued operation of the 900 MWe reactors beyond 30 years of service

On 1st July 2009, ASN considered that the conclusions of the generic studies carried out by EDF for continued operation of the 900 MWe NPPs for 40 years were satisfactory. This generic position was and will be supplemented by an ASN opinion, reactor by reactor, following their third ten-yearly outages.

The latest requirements issued by ASN also take account of the initial lessons learned from the Fukushima Daiichi accident and the conclusions of the stress tests (see § 6 and § 17.4.1.1, § 18 and § 19).

ASN considered that the Tricastin 1, Fessenheim 1 and 2 and Bugey 2 and 4 reactors were able to be operated beyond their third ten-yearly outages (see § 14.2.4.1.2).

Similarly, in the light of the results of the third periodic safety review of Fessenheim reactor 2 and the inspections carried out by its personnel, ASN considered that the licensee's actions must be regulated by additional requirements. ASN thus issued several requirements applicable to EDF. Having set these requirements, ASN has no objection to the continued operation of Fessenheim reactor 2 beyond its third ten-yearly periodic safety review.

In 2013, ASN will also be issuing an opinion on the suitability for continued operation of Dampierre reactor 1, for which the third ten-yearly outage was completed in March 2012.

6.4.1.3 Continued operation of other plant series

1300 MWe series

After the Penly 1 and Cattenom 3 reactors in 2011, Golfech 1 in 2012 integrated the improvements resulting from the periodic safety review linked to its second ten-yearly outage. ASN also analysed the conclusions of the periodic safety reviews on reactors 1 and 2 at Saint-Alban and reactor 2 at Cattenom and set additional requirements to enhance the safety of these sites.

N4 series

After Civaux reactor 1 in 2011, Civaux reactor 2 in 2012 integrated the modifications resulting from the periodic safety review on the occasion of its first ten-yearly outage. As with the 900 and 1300 MWe reactors, ASN will in 2013 rule on the continued operation of each of the reactors following examination of the conclusion reports submitted by EDF.

6.4.1.4 Continued reactor operations beyond 40 years

In 2009, EDF stated that it wished to extend the operating life of its reactors beyond 40 years. In France, the operating lifetime of a reactor is not limited by the regulations, but its ability to continue to operate must be periodically reviewed and its safety reassessed. In this respect, operation of a reactor beyond 40 years is a significant milestone. In 2010, ASN in particular requested that safety reassessment studies and the associated radiological objectives be considered in the light of the safety objectives applicable to new reactors, such as the EPR, in accordance with the position adopted by the WENRA association of western European nuclear safety regulators.

At the request of ASN, the GPR met on 18th and 19th January 2012 to state its position on the orientations of the EDF study programme associated with the project to extend reactor operations beyond 40 years. On the basis of the IRSN report, the GPR more particularly examined the steps taken or planned by EDF on the one hand to verify reactor conformity with the applicable baseline safety requirements and ensure that this is maintained in the future and, on the other, to improve the level of safety of existing reactors, with a view to achieving reactor operations of up to 60 years.

ASN will in 2013 rule on the orientations of this study programme dedicated to the reactor operation extension project.

6.4.2 Research reactors

The Phénix reactor was uncoupled from the grid on 6th March 2009 and the rods were dropped for the last time on 1st February 2010. The reactor has now been finally shut down.

D – LEGISLATION AND REGULATIONS

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 BNI legal system was extensively overhauled by the TSN Act and its implementing decrees, more specifically the BNI procedures decree, but also, at a technical level, by the order of 7th February 2012 setting the general rules for BNIs, which will be supplemented by about fifteen ASN regulatory resolutions. Since 2012, the provisions of the three main Acts specifically concerning BNIs – the TSN Act, Programme Act 2006-739 of 28th June 2006 on the sustainable management of radioactive materials and waste (known as the "waste" Act) and Act 68-943 of 30th October 1968 on civil liability in the nuclear energy field (known as the "RCN" Act) – are codified in the Environment Code.

The provisions of the Environment Code are thus the basis for the BNI authorisation and regulations system today.

The provisions of the Environment Code, which codify the TSN Act, their implementing decrees and the order of 7th February 2012, some of which predated the directive, transpose into French law the directive 2009/71/Euratom of 25th June 2009 establishing a Community framework for the nuclear safety of nuclear facilities.

7.1.1 Principles

The BNI legal system is said to be "integrated", because it aims to prevent or manage all risks and detrimental effects a BNI is liable to create for humans and the environment, whether or not these are radioactive. It confirms that the four main principles of environmental protection apply to nuclear activities: prevention, precaution, polluter-pays, and public participation. In this regard it reproduces the environmental Charter, which is now part of the Constitution. It refers to the Public Health Code's radiation protection principles: justification, optimisation and limitation. It lays down the fundamental principle of the prime responsibility of the licensee for the safety of its facility, enshrined in international law, applicable on a day-to-day basis and essential to ensuring that each party, licensee and regulatory authority, is fully aware of its responsibilities.

The Act also reinforces the role of the staff with regard to risk prevention in BNIs.

7.1.2 Regulatory provisions

The legislative provisions of the Environment Code are implemented by about fifteen decrees, the main ones being:

- Decree 2007-830 of 11th May 2007 concerning the BNI list;

- Decree 2007-831 of 11th May 2007 setting the procedures for appointing and qualifying nuclear safety inspectors;
- Decree 2007-1557 of 2nd November 2007 relative to BNIs and to the regulation of the transport of radioactive materials in terms of nuclear safety (with regard to procedures);
- Decree 2007-1572 of 6th November 2007 concerning technical inquiries into accidents or incidents concerning a nuclear activity;
- Decree 2008-251 of 12th March 2008 concerning BNI local information committees;
- Decree 2010-277 of 16th March 2010 concerning the High Committee for Transparency and Information on Nuclear Security (HCTSIN).

7.1.3 Technical rules applicable to BNIs

7.1.3.1 Ministerial and interministerial orders

7.1.3.1.1 Pressure equipment

BNIs comprise two types of pressure equipment: that which is specifically nuclear, pressure equipment specially designed for BNIs (known as nuclear pressure equipment (ESPN)), in other words which contains radioactive products, and conventional equipment not specific to nuclear facilities but which is installed in them.

The applicable regulations are detailed in the following table.

Table 1: ESPN regulations

<table>
<tr><td rowspan="2"></td><td colspan="3">Nuclear field</td><td rowspan="2">Conventional field
Main primary system of PWRs</td></tr>
<tr><td>Main primary system of PWRs</td><td>Main secondary system of PWRs</td><td>Other equipments</td></tr>
<tr><td rowspan="2">Construction</td><td>• Decree of 2nd April 1926
Order of 26th February 1974(1)</td><td>• Decree of 2nd April 1926
• RFS II.3.8 of 8th June 1990(1)</td><td>Construction</td><td rowspan="2">• Decree of 2nd April 1926
Order of 26th February 1974(1)</td></tr>
<tr><td colspan="3">or Order of 12th December 2005</td></tr>
<tr><td>Operation</td><td colspan="2">• Order of 10th November 1999</td><td>• Decree of 2nd April 1926
• Decree of 18th January 1943(1)</td><td>Operation</td></tr>
</table>

(1) As of 2011, the order of 12th December 2005 applies to the construction and operation of nuclear pressure equipment, except for the operational aspects of the main primary and secondary systems of PWRs.

With regard to devices installed in a BNI, the 28th October 1943 Act on pressure equipment (whether or not nuclear), amended by Act 2009-526 of 12th May 2009, states that the control and enforcement of this Act and its implementing regulations shall be ensured by the staff of the services placed under the authority of and designated by the ASN Chairman.

7.1.3.1.2 Order of 7th February 2012

Further to the publication of the "TSN" Act in 2006, the Minister responsible for nuclear safety and ASN initiated a complete overhaul of the general regulations relative to BNIs that also incorporates the principles ("reference levels") of the common baseline requirements developed by WENRA, the Western European Nuclear Regulators' Association. The order of 7th February 2012 setting the general rules relative to BNIs, called the "BNI Order", is an important step in this process.

This order significantly reinforces the regulatory framework applicable to BNIs, as it details a large number of requirements and provides a legal basis for several of the requirements expressed by ASN further to the analysis of the stress tests demanded of the licensees following the Fukushima Daiichi accident.

The “BNI” order implements a legislative provision of the Environment Code and defines the essential requirements applicable to BNIs for protection of the interests enumerated by the act: public health and safety, protection of nature and the environment.

This order gives a legal basis for certain ASN practices or gives regulatory weight to requirements that had hitherto been the subject of individual resolutions.

It reiterates and reinforces the provisions of 3 orders abrogated at the time it entered into force:

- the order of 10 August 1984 relative to the quality of the design, construction and operation of BNIs, known as the “quality” order;
- the order of 26th November 1999 setting the general technical requirements relative to the limits and conditions of BNI water intake and discharges subject to authorisation;
- the order of 31st December 1999, setting the general technical regulations intended to prevent and mitigate off-site detrimental effects and risks resulting from BNI operations;

It was published in the Official Journal of 8th February 2012 and most of its provisions entered into force on 1st July 2013.

7.1.3.1.2.1 General provisions

This part stipulates that the order applies throughout the existence of the BNI, from design through to delicensing. It specifies that the goal is to protect all the interests mentioned in Article L. 593-1 of the Environment Code, beyond simply preventing accidents (called “nuclear safety”): this is the concept of “integrated safety”.

7.1.3.1.2.2 Organisation and responsibility

The main subjects addressed are:

- technical capabilities: the licensee must indicate how it organises its technical capabilities, that is to say whether they are held internally, in subsidiaries or through third parties with whom formal agreements must be made; the most fundamental capabilities must be held by the licensee or one of its subsidiaries;
- monitoring of outside contractors: this can no longer be subcontracted, but the licensee can obtain assistance;
- the licensee's policy now extends to integrated safety and puts into application the WENRA levels;
- the integrated management system: the existing principles, extended to include integrated safety, are reapplied, with the added obligation of analysing national and international experience feedback;
- public information: the provisions supplement those concerning environmental information of the public as determined by the Environment Code, clarifying certain aspects of public access to information.

7.1.3.1.2.3 Demonstration of nuclear safety

This part defines the requirements concerning the demonstration of the control of accident risks (whether or not radiological) that the licensee must provide. The required approach is largely inspired by the IAEA standards, and the ASN technical directives for the latest generation of reactors (EPR). The main new requirements are:

- o general application to all BNIs of the principles applied to reactors, such as the probabilistic assessments in addition to the deterministic assessment;
- o consideration of internal and external hazards, and combinations thereof;
- o the licensee must demonstrate that accident scenarios leading to large-scale, rapid releases are precluded.

7.1.3.1.2.4 Control of detrimental effects and impact on health and the environment

This part governs water intake and effluent discharges, monitoring of said intakes and discharges and of the environment, the prevention of pollution and detrimental effects, and the conditions in which the authorities are informed. The main new provisions are:

- o use of the best available techniques within the meaning of the ICPE (installations classified on environmental protection grounds) regulation;
- o limiting discharges and noise emissions to the level of the thresholds in the general regulations applicable to ICPEs;
- o a ban on the discharge of certain hazardous substances and discharge into the water table;
- o implementation of monitoring of emissions and the environment (aligned with ICPE regulations whenever relevant);
- o the application, in general, of a number of ICPE ministerial orders to the equipment necessary for BNI operation;
- o the production of an annual discharge forecast and an annual impact report by the licensee.

7.1.3.1.2.5 Pressure equipment designed specifically for BNIs

This part refers to the applicable interministerial orders pending modification of the provisions in effect.

7.1.3.1.2.6 Waste management

Over and above the general principles taken from previous orders in force and from the WENRA levels, this part contains some new requirements concerning waste packaging:

- o application of the acceptance specifications of the disposal facilities for which the packages are intended;
- o for waste for which the disposal route is still being studied: packaging subject to ASN approval;
- o for legacy waste: repackaging as soon as possible to make it suitable for disposal;

These requirements are supplemented by Part 8 which also contains provisions applicable to storage facilities for waste from BNIs.

7.1.3.1.2.7 Preparedness for and management of emergency situations

This part specifies the licensee's responsibilities in an emergency situation, the emergency management means that must be available, and the requirements of the on-site emergency plan. It introduces the possibility of the on-site emergency plan being shared by several BNIs, or even with ICPEs operated by the same licensee.

7.1.3.1.2.8 Particular provisions

This part defines the particular provisions (see Figure 1) applicable to certain categories of facilities or to certain activities within a BNI:

- o the nuclear power reactors (concerning the containment and the probabilistic assessments);
- o the on-site transportation of dangerous goods (if it does not comply with the general regulations governing the transportation of hazardous materials, it must comply with the provisions of the general operating rules which are subject to ASN approval);
- o decommissioning (particularly regarding the updating of the decommissioning plan);

- o the storage of radioactive substances (including waste and spent fuel), as an independent BNI or within a BNI (in particular, definition of acceptability criteria, of a storage time, possibility of retrieving substances at any time, etc.);
- o radioactive waste disposal facilities.

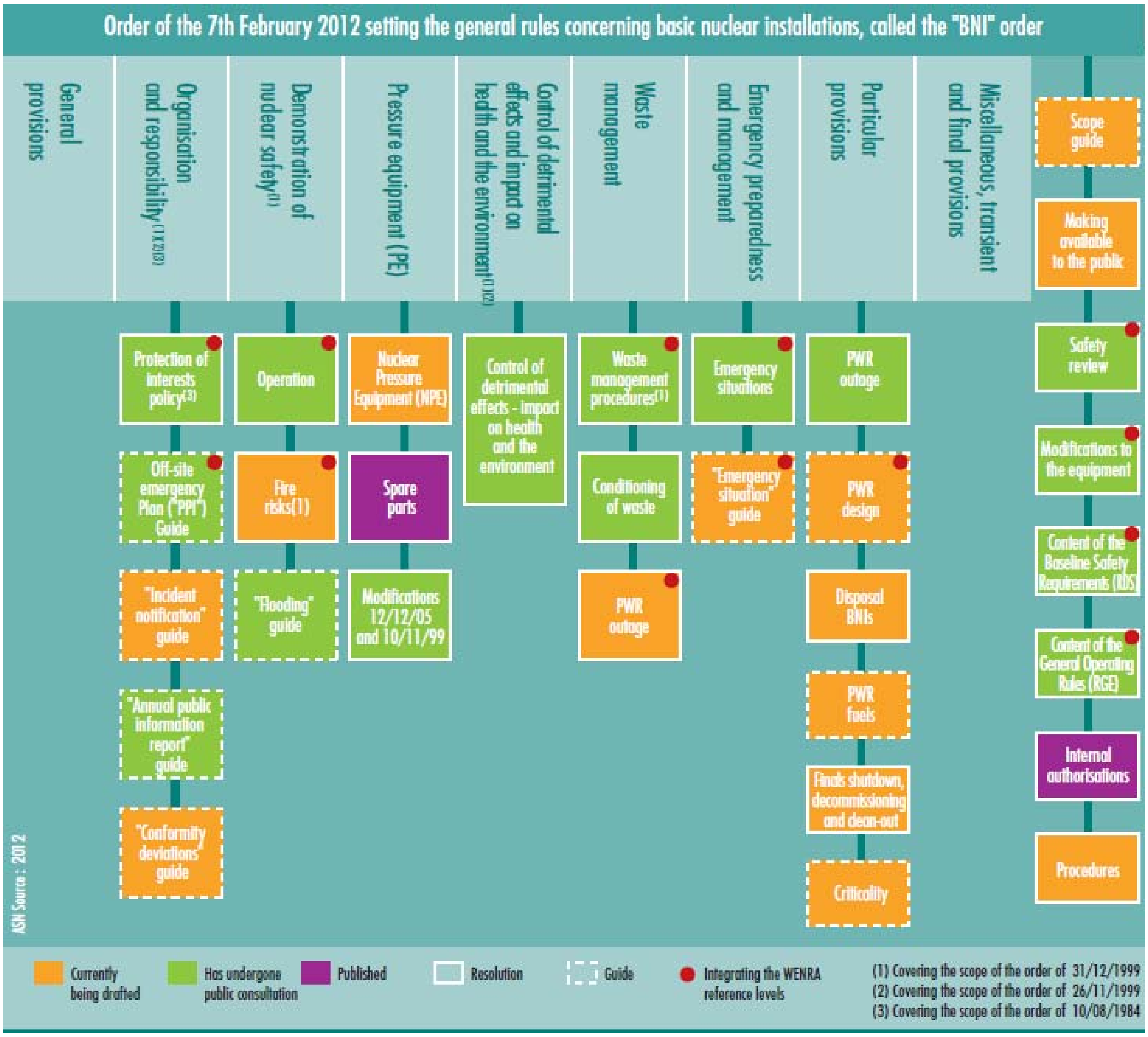

Figure 1: Structure of the draft new technical regulations

7.1.3.2 Technical regulatory resolutions issued by ASN

Pursuant to Article L. 592-19 of the Environment Code, ASN can adopt regulatory resolutions to clarify the decrees and orders relating to nuclear safety and radiation protection, which are subject to approval by the Minister in charge of nuclear safety or radiation protection.

ASN defined a programme of regulatory resolutions which clarify decree 2007-1557 of 2nd November 2007 or the order of 7th February 2012 setting out the general rules applicable to BNIs ("BNI" order).

ASN's first resolution for implementing the BNI procedures decree was resolution 2008-DC-106 of 11th July 2008 concerning the procedures for use of the system of internal authorisations within BNIs.

About fifteen ASN regulatory resolutions will detail some of the conditions of application of this order for various subjects (see Appendix 2 – table 12). This order is nevertheless stand-alone and is applicable without the adoption of said resolutions.

After a first series of consultations in 2010 and 2011, the draft resolutions were revised in the light of the observations made and of the order of 7th February 2012. The new versions of the draft resolutions have been or will be submitted for consultation in 2013 or 2014 prior to their adoption.

7.1.3.3 Basic safety rules and ASN guidelines

ASN has developed basic safety rules (RFS) on various technical subjects concerning both PWRs and other BNIs. These are recommendations which clarify safety objectives and describe practices ASN considers to be satisfactory to ensure compliance with them.

They are not strictly speaking regulatory texts. A licensee may not follow the provisions of an RFS if it can demonstrate that the alternatives it proposes implementing are able to attain the safety objectives it sets.

As part of the on-going restructuring of the general technical regulations, the RFS are being replaced by ASN guidelines.

There are at present about forty RFS and other technical rules from ASN which can be consulted on its website. The list of RFS and of the guidelines is given in Appendix 2 – § 2.3.4.

7.1.3.4 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 decommissioning and delicensing of BNIs in France. They are designed to promote and explain ASN doctrine.

7.1.3.5 French nuclear industry professional 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. They thus facilitate 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, civil engineering structures and mechanical equipment.

Production of these documents is the responsibility of the manufacturers, not ASN. ASN may nevertheless sometimes recognise their acceptability by adopting a resolution or publishing a guide.

7.2 Authorisation procedures

French legislation and regulations prohibit the operation of a nuclear facility without authorisation. BNIs are currently regulated by part IX of book V of the Environment Code. This part makes provision for a creation authorisation procedure followed by a series of authorisations issued during the main steps in the life of a BNI: creation, commissioning, possible modification of the facility, final shutdown and decommissioning.

Any licensee who operates a facility, either without the required authorisations or in breach of these authorisations, may be subject to administrative and penal sanctions as stipulated in the Environment Code.

The procedures are specified by the BNI procedures decree.

7.2.1 Safety options

The licensee envisaging operating a BNI may, even before initiating the authorisation procedure, ask ASN for an opinion on all or some of the options it has adopted to ensure the safety of its facility. The applicant is advised of ASN's opinion, which may provide for additional studies and justifications that may be necessary for a possible creation authorisation application. ASN generally asks a competent Advisory Committee (GPE) to review the project (see 14.1.4.3 on the analysis of the ATMEA1 reactor safety options).

The safety options must then be presented in the authorisation application file in a preliminary version of the safety analysis report or the preliminary safety analysis report (PSAR).

This preparatory procedure does not take the place of the review of the subsequent authorisation applications, but is designed simply to facilitate them.

7.2.2 Creation and final shutdown and decommissioning authorisations

The BNI creation authorisation application is submitted to the Minister responsible for nuclear safety by the company which intends to operate the facility, which then acquires the status of licensee. The application is accompanied by a file comprising a number of items, including the detailed plan of the facility, the impact assessment, the preliminary safety analysis report, the risk management study and the decommissioning plan.

With regard to a BNI final shutdown and decommissioning application the licensee sends the Minister responsible for nuclear safety a file which notably contains the updated decommissioning plan, an impact assessment, a preliminary version of the safety analysis report and a risk management study concerning the final shutdown and decommissioning operations for the facility, as well as the general surveillance and upkeep rules to be observed.

Radioactive waste disposal facilities are subject to the same system of authorisations. When it ceases to receive waste, the facility is considered to be finally shut down and the licensee must obtain an authorisation for final shutdown and transition to the surveillance phase.

ASN examines the files jointly with the Minister responsible for nuclear safety. The consultations and inquiries provided for by law and conducted in parallel with the public and the technical experts are the same for the three types of authorisation.

The impact assessment is subject to the opinion of the Environmental Authority within the General Council for the Environment and Sustainable Development.

7.2.3 Public inquiry

In addition to a possible public debate, as presented in § 17.1.5 or the consultation of the member States of the European Union (see § 7.2.5), the BNI creation and then decommissioning authorisations are issued following a public inquiry.

The purpose of this inquiry is to inform the public and obtain public assessments, suggestions and counter-proposals, in order to provide the competent authority with all the information it needs prior to any decision.

The Prefect opens the public inquiry in every commune whose territory is located partly within a radius of 5 km of the installation. This inquiry shall last at least one month and no more than two. The file submitted by the licensee to support its authorisation application is made available. However, as the safety analysis report is a bulky document and hard for non-specialists to understand, it is supplemented by a risk management study.

Since June 1st 2012, the main documents making up the inquiry file are made available to the general public electronically by the Authority responsible for opening the inquiry. This approach aims to make it easier for the public to understand the projects, in particular those who do not live where the inquiry is being held. Using this means of providing access to information and the possibility of also submitting observations in electronic format, should significantly facilitate and improve the public's ability to express an opinion.

7.2.4 Formation of a Local Information Committee (CLI)

A Local Information Committee (see § 8.2.4) can be created as soon as the BNI creation authorisation application is submitted. In any case, it must be in effect once the authorisation has been issued.

7.2.5 Consultation of other countries of the European Union

Pursuant to article 37 of the treaty instituting the European atomic energy community and the "BNI procedures" decree, it is only possible to authorise the creation of a facility liable to discharge radioactive effluent into the environment after consulting the European Commission.

7.2.6 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 refusing the creation of the installation.

7.2.7 The creation authorisation decree (DAC)

The Minister responsible for nuclear safety sends the licensee a preliminary draft decree granting or refusing creation authorisation. The licensee has a period of two months in which to present its comments. The Minister then obtains the opinion of ASN.

The BNI creation authorisation is issued by a decree signed by the Prime Minister and countersigned by the Minister responsible for nuclear safety.

The creation authorisation decree (DAC) determines the perimeter and characteristics of the facility. It also sets the duration of the authorisation, as applicable, and the time until commissioning of the facility. Furthermore, it designates the essential components that require protective measures regarding public health and safety or the protection of nature and the environment.

7.2.8 ASN requirements for DAC implementation

For implementation of the DAC, ASN defines requirements relatives to BNI design, construction and operation, that it deems necessary for nuclear safety.

ASN defines requirements concerning BNI water intake and discharges. The specific requirements setting the BNI environmental discharge limits must be approved by the Minister responsible for nuclear safety. Pursuant to the Environment Code, BNI modification projects that could cause a significant increase in its water intakes or effluent discharges to the environment are now made available to the public. This arrangement entered into force on 1st June 2012. ASN has nonetheless required this of the licensees since 2008 and it has been implemented on several occasions, for example the revision of the limits and provisions of the discharge license for the Cadarache site in 2010.

An ASN regulatory resolution will specify how the procedure for making project information available to the public is to be implemented.

7.2.9 BNI modifications

Any significant modification of the facility must undergo a procedure similar to that for a creation authorisation application.

A modification is considered to be "significant" in the cases mentioned by the BNI procedures decree:

- a change in the nature of the facility or an increase in its maximum capacity;
- a modification of the key elements for protection of the interests mentioned in the first paragraph of Article L.593-1 of the Environment Code, which are included in the authorisation decree;
- the addition, within the perimeter of the facility, of a new BNI, the operation of which is linked to that of the facility in question.

Furthermore, when a BNI licensee envisages modifying its operating provisions or makes changes to its facility which are not considered to be significant as defined by the above-mentioned criteria, it must first notify ASN accordingly. It may not implement them until a renewable period of six months has expired, unless first expressly approved by ASN. If it so considers necessary, ASN may stipulate requirements so that the envisaged modifications are reviewed or accompanied by additional measures to guarantee the protection of the interests mentioned in the 1st paragraph of Article L.593-1 of the Environment Code.

7.2.10 The other facilities located within a BNI perimeter

The following are located within the perimeter of a BNI:

- the BNI;
- the equipment and installations necessary for BNI operations; depending on its type, this equipment may technically be comparable to conventional installations but, as a part of the BNI, it is subject to the BNI regulations;
- classified equipment and installations which do not necessarily have a direct link with the BNI.

The equipment required for operation of the BNI is covered in full by the BNI regime as stipulated in the "BNI procedures" decree of 2nd November 2007. The other equipment within the perimeter of the BNI and by its nature subject to an administrative regime (water or ICPE) remains subject to this regime. ASN nonetheless has competence to take individual measures and monitor and regulate it.

7.2.11 Commissioning authorisations

The authorisation to commission a BNI is issued by ASN. It is detailed in § 19.1.

7.3 Regulation of nuclear activities

Regulation of nuclear activities is one of ASN's fundamental duties. This regulation consists in verifying that all parties in charge of a nuclear activity assume their responsibility in full and comply with the requirements of the regulations concerning nuclear safety and radiation protection. It contributes to assessing the performance of a licensee and to estimating the issues and implications associated with a nuclear activity.

In the case of BNIs, ASN regulation of nuclear safety and radiation protection extends to include protection of the environment and, in the NPPs, to labour inspectorate duties.

Regulation covers several levels:

- Before the licensee carries out any activity subject to authorisation, by means of a review and analysis of the files, documents and information supplied by the licensee to justify its actions. This regulation aims to ensure that the information supplied is pertinent and adequate;

- o During operation, by means of visits and inspections on all or part of the facility, by documentary and field checks during important interventions such as scheduled nuclear reactor outages and by analysing significant events. This regulation involves sampling and analysis of the justifications provided by the licensee concerning the performance of its activities.

As and whenever necessary, ASN receives the support of IRSN.

Although historically focused on verifying the technical conformity of installations and activities with regulations and standards, regulation now encompasses a broader dimension taking in human and organisational factors.

In order to consolidate the credibility and quality of its actions, ASN:

- o has defined a qualification system for its inspectors based on recognition of their technical skills;
- o has adopted a number of foreign practices identified during the course of inspector exchanges between regulatory authorities;
- o promotes the openness of its inspectors to other inspection practices.

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 regulation is commensurate with the issues in terms of nuclear, health and environmental safety.

7.3.1 Scope of regulation

7.3.1.1 Nuclear safety regulation

Nuclear safety concerns all technical and organisational provisions taken at all stages of the operating life of nuclear facilities, from design to decommissioning, 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 effluents are usually included in nuclear safety provisions.

In its regulatory duties, ASN is required to look at the equipment and hardware in the installations, the individuals in charge of operating it, the working methods and the organisation, from the start of the design process up to decommissioning. It reviews the steps taken concerning nuclear safety and the monitoring and limitation of the doses received by the individuals working in the facilities, and the waste management, effluents discharge monitoring and environmental protection procedures.

7.3.1.2 Radiation protection regulation

In BNIs, ASN ensures that the regulations for the protection of individuals against ionising radiation are implemented. In the same way as for nuclear safety, this work continues throughout the life of nuclear facilities. 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 equipment

A large number of systems contain or carry pressurised fluids and are consequently subject to the regulatory requirements applicable to pressure equipment, regulation of which is the responsibility of ASN in the BNIs.

Of the BNI pressure equipment regulated by ASN, the main primary and secondary systems of EDF's pressurised water reactors (PWRs) are particularly important. Owing to the fact that in normal conditions they operate at high pressure and temperature, their in-service performance is one of the keys to the safety of the NPPs. ASN thus pays particularly close attention to the regulation of these systems.

This regulation in particular applies to the in-service surveillance programmes, non-destructive testing, maintenance work, handling of deviations affecting the systems and periodic system requalification.

7.3.1.4 Working conditions in BNIs

Regulating the application of all provisions relating to labour regulatory framework (in particular concerning occupational safety or social measures to protect the personnel) is the responsibility of the staff of the labour inspectorate.

There are three main labour inspectorate duties – control, information and advice – dealing with working conditions and worker protection. They draw their legitimacy not only from international standards (more specifically Standard n° 81 from the International Labour Office) but also from the national texts regulating the inspection services.

In NPPs, regulation actions regarding nuclear safety, radiation protection and labour inspection very often deal 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 accordingly by the Chairman of ASN from among ASN staff. They 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 nuclear safety and radiation protection approach that is more attentive to the importance of people and organisations.

7.3.2 BNI regulation procedures

The operator is required to provide ASN with the information necessary for its regulatory duties. 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 actions reveal breaches of compliance with safety requirements, penalties (see § 7.4) 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 facility until corrective measures are taken.

7.3.2.1 Technical review of files submitted by the licensee

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 one form of ASN's regulatory duties.

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 these checks necessitated by changes in installations or their operating procedures, ASN requires the operators to conduct periodic safety reviews (see § 14.2.1.3), to reinforce safety requirements according to changes in techniques and doctrine on the one hand and to experience feedback on the other.

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

7.3.2.1.1 Evaluation of the information provided

The purpose of the files provided by the licensee is to demonstrate that the objectives set by the general technical regulations, or those set by the licensee itself, are met. ASN checks the completeness of the file and the quality of the demonstration.

Whenever it considers it necessary, ASN requests an opinion from technical support organisations (see § 8.1.3), the most important of which is IRSN. The safety assessment involves the collaboration of many specialists and effective coordination in order to identify the essential safety issues. IRSN assessment relies on research and development programmes and studies focused on risk prevention and improved understanding of accidents. It is also based on in-depth technical exchanges with the licensee teams responsible for designing and operating the facilities.

For the more important issues, ASN requests the opinion of the competent advisory committee, while for other matters, the safety assessments are given in IRSN opinions transmitted directly to ASN.

7.3.2.1.2 The 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 licensee. This information mainly concerns the work programme and any incidents occurring during the outage. During worksite inspections, the inspectors carry out spot checks on the conditions in which the various works in progress are conducted. Approval of the outage programme is the responsibility of ASN.

OTHER INFORMATION SUBMITTED BY THE LICENSEES

The licensee submits periodic activity reports and summary reports on water intake, liquid and gaseous discharges and the waste produced.

Similarly, there is a considerable volume of information on specific topics, such as the installation’s seismic behaviour, fire protection, PWR fuel management, relations with contractors, etc.

7.3.2.2 Internal authorisations

The licensees of nuclear facilities are, in all cases, responsible for the safety of the activities they perform.

ASN however considers that the operations taking place in the BNIs with the highest nuclear safety and radiation protection implications must be subject to prior authorisation. Conversely, it considers that operations with limited implications should remain the sole responsibility of the licensee (see § 9.1).

In the case of intermediate operations with major nuclear safety and radiation protection implications but which do not call into question the safety hypotheses adopted with respect to BNI operation or decommissioning, the Environment Code allows the licensee to authorise them, provided that it sets in place a reinforced and systematic internal check mechanism with sufficient guarantees of quality, independence and transparency. The decision on whether or not to perform the operations must be formally authorised by the licensee’s personnel that it has duly qualified for this purpose. This organisation is called the “internal authorisations system”. It can be presented to the BNI's CLI.

This system of internal authorisations is governed by the BNI procedures decree and by ASN resolution 2008-DC-106 of 11th July 2008 which specifies the requirements ASN sets for the licensees for implementation of such a system.

ASN obviously ensures regular and careful oversight of the system right from its inception through site inspections or evaluation of the information files submitted by the operator. It maintains disciplinary powers and notably has the right to suspend authorisation to use the system of internal authorisations if a licensee fails to meet its obligations.

ASN shall also be notified of the operations intended for internal authorisation, so that it can schedule any necessary inspections.

Operations concerning the system of internal authorisations may, for instance, involve renovation work on the facilities, less significant decommissioning activities, periodic safety reviews of experimental devices or experiments complying with predetermined conditions.

This internal authorisations system is currently in place with several licensees, including EDF, AREVA, ANDRA and CEA.

7.3.2.3 Use of experience feedback

A system of deviation notification complying with the requirements of the BNI order is in force[16]. This requires the licensee to implement a reliable system for detection of the deviations which could occur, such as equipment failures or operating rules application errors. This system should allow early detection of any deviation from normal operations.

The significant event notification and processing procedures are described in more detail in §19.6 and 19.7. Significant event notification should not be confused with radiological emergency situations, for which a different organisation is put into place, or with a system designed to penalise errors by the licensee or an individual.

7.3.2.4 Inspection

7.3.2.4.1 Principles and objectives

In order to take account of health and environmental issues and the licensee's nuclear safety and radiation protection performance, ASN identifies the activities and topics with the greatest implications, on which it focuses its inspection efforts.

In order to assess these issues, ASN relies on state-of-the-art scientific and technical knowledge, on information resulting from external inspections, on the review of the files submitted by the licensees and on the results of its regulatory oversight duties. ASN may at all times revise its assessment of the issues in the light of changes to these elements and of significant events that have occurred in France or elsewhere in the world.

Compliance with the baseline safety requirements by the nuclear licensees is verified by spot inspections in order to check effective implementation of the provisions concerning safety, radiation protection and the related fields regulated by ASN.

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[16] BNI order: order of 7th February 2012 setting general rules for basic nuclear installations

Inspection is the primary means of verification available to ASN. Without being systematic or exhaustive, it is a means of detecting individual anomalies or any drift indicative of a deterioration in the safety of the facilities.

During the inspections, the licensee is notified of factual reports concerning:

- anomalies in the facility or points which, in the opinion of the inspectors, require further substantiation;
- discrepancies between the situation observed during the inspection and the regulatory texts or documents drawn up by the licensee pursuant to the regulations.

Deviations identified during the inspection can lead to administrative or penal sanctions.

ASN draws up an annual programme of inspections. This programme is not communicated to the nuclear facility licensees. It defines priorities for reinforced controls on topics or activities with the most significant implications. It also allows adequate distribution of ASN's resources in a manner commensurate with the potential implications of the various facilities.

The licensee is notified of the visit a few weeks beforehand, although some inspections (about 20%) are unannounced. They mainly take place on the nuclear sites. They may also concern the head office departments (or design departments) of the main nuclear licensees, the workshops or design offices of the subcontractors, the construction sites, the plants or workshops manufacturing various components that are important for safety.

The inspections are generally performed by two inspectors, one of whom is more specifically in charge of directing the operations, and can be assisted by an IRSN representative specialising in the facility visited or the technical topic of the inspection. ASN performs different types of inspections:

- routine inspections;
- in-depth inspections taking several days and requiring a full team of inspectors, with the purpose of carrying out detailed examinations;
- inspections including sampling and measurements, for spot checks on discharges that are independent of those of the licensee;
- inspections carried out further to a significant event;
- worksite inspections during reactor outages or particular works, especially during the decommissioning phase.

Within 21 days of completion, each inspection is the subject of a follow-up letter which is made public on the ASN website.

7.3.2.4.2 Inspection practices in 2012

In 2012, 802 nuclear safety inspections were carried out in the BNIs, including more than 381 on the nuclear power reactors.

7.3.3 ASN organisation for BNI regulation

7.3.3.1 Inspection in the BNIs

In order to achieve its goals, ASN has inspectors duly appointed and certified by the ASN Chairman, as defined by decree 2007-831 of 11th May 2007, provided that they have acquired the required level of legal and technical competence through their professional experience, tutoring or training. They carry out their inspection activities under the authority of the ASN Director General and have access to practical inspection tools that are regularly updated. They swear an oath and are bound by professional confidentiality.

As at 31st December 2012, there were 224 nuclear safety inspectors, with 134 in the ASN regional divisions and 90 in the head office departments. These inspectors oversee most of the inspections in the BNIs. Labour or radiation protection inspectors can also intervene in these facilities for inspections on these specific topics.

Table 2: Number of inspections performed by ASN in the BNIs

Year	Total	Unannounced inspections (all facilities)	Scheduled and unannounced (reactors)
2010	737	181	460
2011	749	157	368
2012	802	205	381

7.3.3.2 Regulation of pressure equipment

Regulation of the design and manufacture of the main primary and secondary systems is performed directly by ASN. Regulation of the design and manufacture of other nuclear pressure equipment is carried out by organisations approved and monitored by ASN.

73 inspections were carried out in this field in 2012.

7.3.3.3 Significant events

Article L.591-5 of the Environment Code stipulates that in the event of an incident or accident, whether or not nuclear, with an actual or potential risk of significant consequences for the safety of the facility or transport operation or, owing to significant exposure to ionising radiation, of prejudice to persons, property or the environment, the licensee of a BNI or the person responsible for a transport operation involving radioactive substances, is required to immediately notify ASN of this incident or accident, along with the State's representative in the *département* in which it occurred and, if necessary, the State's maritime representative.

Analysis of a significant event covers compliance with the significant event detection and notification rules in force, the immediate technical measures taken by the licensee to maintain the facility in or bring it to a safe state and, finally, the pertinence of the significant event reports supplied by the licensee. The review and analysis of these events at a later date by ASN and its technical support organisation, IRSN, are described in detail in §19.7.

Table 3: Number of significant events notified by the BNI licensees

Year	Pressurised water reactor	Other BNIs	Radioactive materials transport
2010	717	169	62
2011	747	191	27
2012	830	202	59

7.3.3.4 Technical inquiries in the event of an incident or accident concerning a nuclear activity

Article L.592-35 and following of the Environment Code give ASN powers to initiate a technical inquiry in the event of an incident or accident concerning a nuclear activity. This inquiry consists in collecting and analysing all useful information, without prejudice to the judicial inquiry, in order to determine the circumstances and certain or possible causes of the event and, if necessary, to formulate the necessary recommendations. It is carried out by an investigation team which, in addition to ASN staff, may include duly designated outside members.

This arrangement covers both incidents and accidents occurring within BNIs and during the transport of radioactive substances, as well as those which could occur during activities comprising a risk of human exposure to ionising radiation, more specifically activities carried out for medical purposes.

Given that ASN was already investigating incidents or accidents in accordance with its regulatory duties, the main contribution of the Environment Code in this respect is to give ASN powers to constitute the inquiry investigation team, to determine its composition, to define the subject and scope of the investigations and to access the relevant elements in the event of a judicial inquiry.

7.4 Penalties

When ASN regulatory actions reveal breaches of compliance with safety requirements, penalties can be imposed on the licensees, if necessary after formal notice has been served. These penalties can include prohibition of restart or suspension of operation of a nuclear facility until corrective measures are taken.

If a violation is observed, the Environment Code provides for a graduated scale of administrative penalties following formal notice and defined in Articles L. 596-14 to L. 596-22:

- 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 licensee's expense, with the possibility of using the sums previously consigned to pay for the work concerned;
- suspension of operation of the facility or of the on-going action until the licensee has restored conformity.

The licensee is required to present its comments on these penalties to the ASN Commission.

The law also makes provision for interim measures to protect public health and safety or to protect the environment. ASN may therefore:

- in the event of severe and imminent risks, provisionally suspend operation of a BNI, immediately informing the Minister responsible for nuclear safety;
- at all times, prescribe the performance of assessments and the implementation of the steps necessary if the above-mentioned interests are threatened.

Any violations are recorded in reports drawn up by the nuclear safety inspectors and sent to the public prosecutor's office, which then decides on whether or not further action is justified.

The Environment Code makes provision for penalties, as detailed in Articles L. 596-27 to 596-30; these penalties comprise fines of from €7,500 to €150,000 € plus a possible prison term of from 1 to 3 years, depending on the nature of the violation. For legal persons found to be criminally liable, the amount of the fine can reach €1,500,000.

The number of administrative measures (formal notice, prescription, activity suspension, etc.) issued by ASN and the number of formal notices served on the licensees between 2010 and 2012 are shown in the following table.

Table 4: Administrative measures and formal notices transmitted to the public prosecutor's office

Year	Administrative measures	Formal notice transmitted to public prosecutor	Number of labour inspection formal notices
2010	6	18	4
2011	12	33	4
2012	9	22	11

8. Article 8: Regulatory body

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.

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.

8.1 The French Nuclear Safety Authority (ASN)

Act 2006-686 of 13th June 2006 (codified in the Environment Code) created an independent administrative authority, ASN, tasked with regulating nuclear safety and radiation protection in all civil nuclear activities.

The Act gives ASN competence to issue regulatory resolutions to clarify the decrees and orders relating to nuclear safety and radiation protection, which are subject to approval by the Minister in charge of nuclear safety or radiation protection. It also gives ASN authority to impose prescriptions on the licensee throughout the lifetime of the facility, including during decommissioning, for example to request correction of an anomaly or prevent a particular risk.

The Government retains the power to stipulate the general regulations applicable to nuclear activities by decree or by order. It issues the few major individual resolutions concerning major nuclear installations, notably the plant creation and decommissioning authorisations. The Government is also responsible for civil protection in emergency situations.

ASN must be consulted by the Government on general regulatory texts within its areas of competence and on the major individual resolutions. It prepares draft regulatory texts for the Government and clarifies regulation by means of technical resolutions. The nuclear safety and radiation protection inspectors designated by ASN ensure monitoring and regulation of nuclear activities. Labour inspectorate duties in the NPPs is entrusted to ASN inspectors placed under the authority of the Minister responsible for labour for the purposes of these duties.

ASN contributes to information of the public. Finally, it contributes to operational management of radiological emergencies.

On technical matters, ASN relies on the expertise provided primarily by IRSN and by the Advisory Committees of experts (GPE).

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.
  For more details, see § 7.1;
- ASN examines BNI authorisation, creation and decommissioning authorisation applications and makes proposals to the Government concerning the decrees to be issued in these areas. It defines the requirements applicable to these facilities with regard to the prevention of risks, pollution and detrimental effects. It authorises commissioning of these facilities and pronounces their delicensing following decommissioning.
  ASN also issues the authorisations for small-scale nuclear facilities (group together sereval areas using ionising radiations such as medicine, human biology, etc.) provided for by the

Public Health Code and the authorisations or approvals for the transport of radioactive substances.
For more details, see § 7.2;

- 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 facilities, the transport of radioactive substances, and nuclear activities outside BNIs. It issues the required approvals to the organisations participating in the verifications and monitoring concerning nuclear safety or radiation protection.
For more details, see § 7.3;
- ASN is involved in the management of radiological emergency situations. It provides the competent authorities with technical support in order to develop appropriate measures, within the framework of the emergency organisation plans, taking due account of the risks resulting from nuclear activities. When such an emergency situation arises, it assists the Government on all relevant issues within its areas of competence. It submits its recommendations on the measures to be taken concerning medical, health or civil security aspects, it informs the public about the situation, about potential releases into the environment and their consequences.
These measures are detailed in Chapter 16;
- ASN takes part in public information within its areas of competence, notably by making the information in these fields accessible to the greatest number. It regularly reports on its activity, notably by submitting its annual activity report to Parliament, to the Government and to the President of the Republic. It also uses various channels and written media (monthly ASN newsletter, *Contrôle* magazine, annual report), website (www.asn.fr), public information and documentation centre, press conferences, seminars and exhibitions.

8.1.1 Organisation

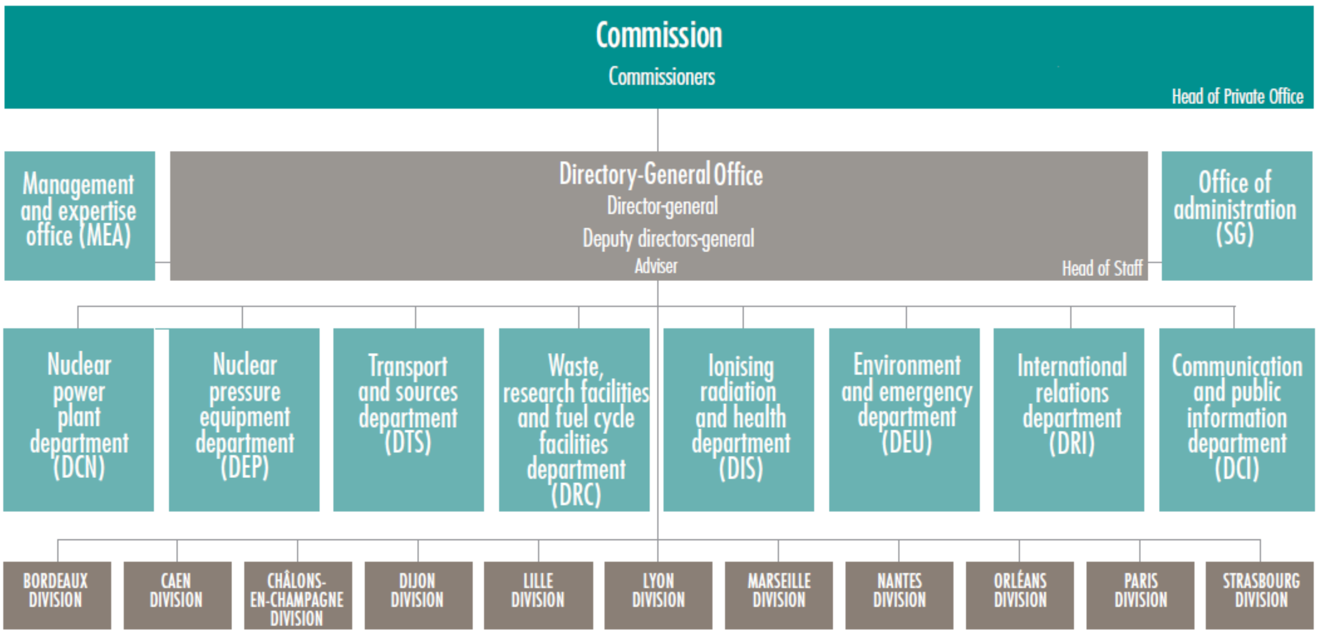

Figure 2: ASN - General Organisation

8.1.1.1 The ASN Commission

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

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

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

The duration of the mandate of the members is six years. It is non-renewable. A member's functions may only be terminated in the event 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 the event of severe breach of duty.

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

Pursuant to the TSN Act, the Commission submits ASN opinions to the Government and issues ASN's main resolutions. The members of the Commission act with complete impartiality, receiving no instructions either from the Government or from any other person or institution.

8.1.1.2 ASN head office departments

Under the authority of the ASN Chairman, the Director-General organises and manages ASN's head office departments and its eleven regional divisions.

The head office departments comprise 8 thematic departments, an Office of Administration and a Management and Expertise Office. The role of the ASN head office departments is to manage national matters concerning the activities for which they are responsible. They take part in defining the general regulations and coordinate the work of the teams in the regions responsible for field inspection of facilities and activities. Each ASN entity contributes to public information on nuclear safety and radiation protection.

8.1.1.3 The ASN regional divisions

ASN's regional divisions operate under the authority of the regional representatives. The divisions conduct most of the direct regulation of nuclear installations, radioactive material shipments and other small-scale nuclear activities. They review most creation authorisation application files submitted by operators within their geographical jurisdiction. In addition, they support ASN's head office departments 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 contribute to the public information mission entrusted to ASN by law.

8.1.2 ASN operation

8.1.2.1 Human resources

On 31st December 2012, ASN's total workforce stood at 471 staff, including 251 in head office departments, 217 in the regional divisions and 3 abroad.

On 31st December 2012, the average age of the ASN staff was 44.6 years old. This 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, bringing younger staff on-board and the transmission of knowledge guarantee the required level of expert know-how.

Competence is one of ASN's four key values. A tutoring system, allied with initial and ongoing training, whether general, associated with nuclear techniques, or in the legal or communication field, constitute essential aspects of the professionalism of ASN staff. The management of its staff's' skills is based notably on a formalised series of technical training sessions. In 2012, about 4,520 days of training were provided to the ASN staff. The financial cost of the courses provided by organisations other than ASN amounted to €580,000.

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. For 2012 the full-cost budget of ASN is approximately €75 million.

Moreover, as stipulated by the TSN Act, ASN relies on IRSN for technical expertise, backed up whenever necessary by research. The corresponding amount was €84 million in 2012.

Lastly, in 2012, the French Public Accounts Office conducted an audit of ASN, the conclusions of which have been provided to ASN in January 2013.

8.1.2.3 Quality management system

To guarantee and improve the quality and effectiveness of its action, ASN defines and implements a quality management system derived from the ISO and IAEA international standards and built around:

- a multi-year strategic plan and shared annual objectives;
- an organisation manual containing organisational notes and procedures providing ASN internal rules for the sound conduct of each of missions;
- internal and external audits concerning implementation of the measures contained in ASN's quality management system;
- performance indicators for measuring the effectiveness of ASN's actions;
- listening to the stakeholders (public, elected officials, associations, media, trade unions, industry);
- annual reviews of the management system with the aim of continuous improvement of its operation.

8.1.3 ASN's technical support bodies

ASN benefits from the expertise of technical support organisations in preparing its resolutions. The main organisation is IRSN (www.irsn.fr). For several years, ASN has been making efforts to diversify its experts.

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

IRSN was created by Act 2001-398 of 9th May 2001 and by Decree 2002-254 of 22nd February 2002 as an independent public establishment within the framework of the national reform of the control of nuclear safety and radiation protection with a view to pooling public appraisal and research resources in these fields.

IRSN runs and implements research programmes with a view to consolidating national public expert capability around the most advanced scientific knowledge at the international level and to contribute to the development of scientific knowledge concerning nuclear and radiological risks. It is tasked with technical support of the public authorities with competence for safety, radiation protection and security, not only in the civil sphere, but also for national defence purposes. According to its above-mentioned creation decree, it also performs certain public interest duties outside the research field, more specifically with regard to monitoring of the environment and of persons 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, as well as contributing to information of the public about the risks associated with ionising radiation.

In accordance with the ISO 9001 certification it received in 2007, IRSN is developing its own quality policy based on a continuous-improvement approach in order to enhance the quality of its skills. In accordance with this approach, the opinion of ASN and of all organisations benefiting from IRSN's technical support is taken into account. Periodic meetings are also held to enable ASN and IRSN to discuss past, present and future expert appraisal work.

The Government consults ASN on the share of the State's subsidy to IRSN for its technical support mission for ASN. A five-year agreement signed by ASN and IRSN determines the technical support procedures, involving some 420 staff. It is described every year in a protocol which fine-tunes priorities according to the nuclear safety and radiation protection issues.

8.1.3.2 Advisory Committees of experts

In preparing its decisions, ASN relies on the Advisory Committees' opinions and recommendations.

Seven Advisory Committees (GPE) have been constituted to assist the ASN Director General. The Advisory Committees are consulted by ASN on the nuclear safety and radiation protection of installations and activities relating to their field of competence, that is 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 each of the subjects covered, the Advisory Committees study reports prepared by IRSN or other duly mandated expert, by an ad hoc working group created for the occasion or by one of the ASN entities. They issue an opinion together with recommendations.

The Advisory Committees comprise experts appointed for their competence. They can come from varied backgrounds, such as universities, associations, or can be licensees concerned by the subjects addressed. Every Advisory Committee may call upon any person recognised for his or her particular skills. It may also conduct a hearing of the licensee's representatives. The participation of foreign experts can bring new approaches to problems and benefit more widely from international experience.

With the constant concern of improving the transparency of nuclear safety and radiation protection, ASN publishes the documents relating to Advisory Committee meetings, especially its opinions and the position adopted by ASN. The programming and results of the work of the Advisory Committees are closely monitored by the management at ASN and IRSN. Discussion and coordination meetings are held three times a year to contribute to continuous improvement of the technical quality and consistency of Advisory Committee opinions, which remain key elements for ASN.

8.2 Other actors involved in nuclear safety and radiation protection

8.2.1 The Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST)

Created by in July 1983, the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) is a parliamentary delegation whose mission is to inform Parliament about the impact of scientific and technological choices, particularly with a view to ensuring that decisions are taken with the full knowledge of the facts. The OPECST is assisted by a Scientific Council consisting of 24 members from various scientific and technical disciplines.

The members of the OPECST duty is to examine the organisation of safety and radiation protection, both within the Administration and on operators' premises, to compare its characteristics with those of other countries and to check that authorities have sufficient resources to perform their mission. They also played an important role in the drafting of the TSN Act. The Office's reports are drafted before voting of the law in order to prepare the legislative decision, or afterwards for follow-up of implementation of the text passed.

Hearings are open to the press and have become a well-established tradition at the OPECST. They allow all interested parties to express their views, to put across their arguments and to debate publicly any given topic under the guidance of the OPECST Rapporteur.

In 2011, in the wake of the Fukushima Daiichi accident, a Parliamentary delegation submitted a report on "nuclear safety, where the industry stands, today and tomorrow".

It is before the OPECST that ASN tables every year its report on the status of nuclear safety and radiation protection in France.

8.2.2 Nuclear safety and radiation protection mission (MSNR)

The Nuclear Safety and Radiation Protection Mission (*Mission de sûreté nucléaire et de radioprotection* – MSNR) is the ministerial service placed under the authority of the Minister of Ecology and Sustainable Development, the Minister of Industry and the Minister of Health, in order to deal on their behalves with the issues pertaining to the government's jurisdiction in the field of nuclear safety and radiation protection. Hence, the MSNR:

- drafts general regulations, in connection with ASN;
- leads individual administrative procedures pertaining to the ministers' jurisdiction;
- provides secretariat services to the High Committee for Transparency and Information on Nuclear Security (see § 8.2.3.1).

8.2.3 Advisory bodies

8.2.3.1 The High Committee for Transparency and Information on Nuclear Security (HCTISN)

In matters of nuclear safety and radiation protection, the *TSN Act* provided for the creation of a High Committee for Transparency and Information on Nuclear Security (*Haut Comité pour la transparence et l'information sur la sécurité nucléaire*), as an information, consultation and debate structure on the hazards induced by nuclear activities and their impact on human health, the environment and nuclear safety.

The High Committee is empowered to issue opinions on any issue within its jurisdiction, as well as on all associated controls and information. It may also address any topic relating to access to information regarding nuclear security and to propose any step aiming at ensuring or at improving transparency in nuclear matters.

The Ministers in charge of nuclear safety, the presidents of the competent committees of the National Assembly and of the Senate, the President of the OPECST, the presidents of the CLIs or INB operators may also call upon the advice of the High Committee on any information issue relating to nuclear safety and its regulation.

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.

8.2.3.2 The High Council for Prevention of Technological Risks (CSPRT)

The High Council for Prevention of Technological Risks (CSPRT) advise the Ministers in charge of Installations Classified on Environment Protection grounds (ICPE), nuclear safety and industrial security.

The High Council gives its opinion when demanded by the law or the regulation, notably on draft decrees provided by Article 28 Part III of the TSN Act. Its opinions are, when required, included to the projects submitted to ASN. ASN considers that obtaining the opinion of the CSPRT is one means of achieving greater consistency in the requirements applicable to the ICPEs and BNIs.

It analyses, among others, draft regulations or all questions related to BNIs submitted by the ministers in charge of these topics or ASN.

8.2.4 The Local Information Committees (CLI)

The TSN Act of 13th June 2006, now codified in books I and V of the Environment Code, has formally defined the status of the BNI local information committees (CLI). These Committees, set up by the President of the *Conseil général* and comprising elected officials, associations, trade unions, qualified personalities and representatives from the economic world, have a general duty to monitor, inform and discuss nuclear safety, radiation protection and the impact of nuclear activities on man and the environment with regard to the facilities that concern them.

As regard texts involving individual measures for BNIs (such as creation authorisation decree or final shut down and decommissioning), they are now subject to a hearing of the operator and the CLI by ASN, as enacted by ASN's resolution on 13 April 2010.

9. Article 9: Responsibility of a licence holder

Each Contracting Party shall ensure that prime 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.

9.1 Prime responsibility for the safety of a BNI

The French system of organisation and specific regulations for nuclear safety is based on the prime responsibility of the licensee. This principle of licensee prime responsibility is defined by the Environment Code.

The BNI order also deals with the licensee's integrated management system and requires that this latter define and implement a management system enabling it to ensure that the requirements concerning protection of the interests of the BNI regime are systematically taken into account for all decisions concerning its facility.

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

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

9.2 Transparency and public information by the licensees

9.2.1 Measures taken by EDF

As a responsible industrial firm and being aware of the particular nature of the nuclear power generating activity, EDF has always, since the beginning of operation of the NPPs, sought to inform the public about the operation of the facilities, technical events and activities concerning this form of energy in general and all safety aspects in particular.

EDF's policy aims to ensure that dialogue and transparency result from clear and accurate information about events and their potential impacts. This policy of dialogue and transparency is also adopted with respect to the staff and its representatives, the subcontractors, the regulatory bodies, the local communities, especially the CLIs, and all other nuclear safety stakeholders.

For example, these transparency and communication actions take a variety of forms: annual report, CLI meetings and thematic visits, meetings with elected officials, press releases, monthly newsletters, public information centre, website (www.edf.com), toll-free telephone number, and answering public queries about the safety and radiation protection measures taken.

The TSN Act in particular requires each site to publish an annual report describing the steps taken concerning nuclear safety and radiation protection, nuclear safety and radiation protection incidents and accidents, the nature and results of measurements of radioactive and non-radioactive environmental discharges, the nature and quantity of radioactive waste stored on the facility site. This report is made public and transmitted to the CLI of each site.

9.2.2 Measures taken by CEA

A CLI (see § 8.2.4) is in place for each CEA centre. CEA keeps the committees regularly informed of research activities, of the changing regulatory situation of the facilities and of any events concerning nuclear safety and radiation protection.

The follow-up to the Fukushima Daiichi accident, in particular the stress tests, was the subject of special presentations by CEA and was widely discussed within the CLIs.

The CEA general management takes part in the annual meeting of all French CLIs for the EDF, AREVA and CEA facilities.

CEA takes part in the work of the HCTISN, from which a delegation visited the Cadarache centre in October 2012. Two days were devoted to discussions focusing on:

- CEA's industrial policy concerning the use of contractors,
- the working procedures for these contractors in the facilities, in compliance with the nuclear safety baseline requirements,
- the stress tests.

9.2.3 Measures taken by ILL

The ILL participates in a large number of actions to promote transparency and public information, more specifically:

- participation in the CLI meetings;
- participation in the regional industrial risks information programmes;
- updating its website (www.ill.eu) with information concerning the TSN Act, reactor safety, environmental monitoring, security, inspections, emergency exercises and incidents. The follow-up to the Fukushima Daiichi accident was the subject of detailed presentations. Question-and-answer sections were included;
- participation in technical and scientific forums;
- public meetings in the communes, with the involvement of local companies.

E – GENERAL CONSIDERATION 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

To guarantee and improve the quality and effectiveness of its actions, ASN implements an organisation which is described in Chapter 8.

In accordance with the duties entrusted to it, ASN from the outset asked the BNI licensees to adopt an organisation ensuring that absolute priority is given to nuclear safety.

The importance given to safety is underlined in the TSN Act and its implementing texts, such as the BNI order. These texts define the principles and objectives that every BNI licensee must consider when drafting its safety policy. Its incorporation into the integrated management system and its implementation at all stages in the design, construction, operation and decommissioning of the facilities contribute to its continuous improvement.

Historically, this safety management system is based on the development of a nuclear safety culture. Safety management must be integrated into the company's general management system in order to guarantee protection of the interests mentioned by the Environment Code, while giving priority to the prevention of accidents and the mitigation of their consequences.

In order to put into context and explain certain requirements of the BNI order, ASN will be publishing a resolution and a guide to safety policy and management in the BNIs (Guide n°15).

The Environment Code also requires all BNI licensee's to produce an annual report more specifically presenting the nuclear safety and radiation protection measures taken. This report is made public and transmitted to the CLI and to the HCTISN.

10.2 Measures taken for nuclear power reactors

The responsibility as nuclear licensee within EDF SA is assumed at four main levels: the President and CEO, the Senior Executive Vice-President for the Generation and Engineering (DPI) Division, the Director of the Nuclear Generation Division (DPN), who is the officer responsible for the operation of all French NPPs, and every NPP manager (see the EDF SA organisation chart in Appendix 3). In the particular case of a BNI undergoing dismantling on an isolated site, the function of representative of the nuclear licensee, EDF SA, is taken over by the Director of the Nuclear Engineering Division who reports to the Senior Executive Vice-President for DPI.

Given the importance of all EDF's nuclear activities and its responsibilities and involvement in the reactor operations in France, but also in Great Britain and the United States, the EDF Group adopted a Nuclear Safety Policy in 2012, which applies to all its activities within each Group company operating nuclear facilities (design and construction of new projects, operation of existing reactors, maintenance, waste management, dismantling, engineering). This policy, which is inspired by international guidelines and safety requirements (IAEA SF-1 and GRS-3, INSAG 4 for the safety culture, INSAG 13 for safety management, INSAG 18 for change management), aims to reaffirm the priority given to safety within the Group and to help each manager clearly demonstrate this, with the involvement of industrial partners. In the current context, this reflects the fact that the safety culture is an absolute requirement that must encourage all players within the EDF Group to take greater and better account of the human and organisational aspects to enhance operational reliability and take account of the lessons learned from past events which affected safety, in order to reinforce the safety management system within the Group. The responsibility for implementing this policy in each professional sector and each company lies with the corresponding managerial line.

An independent safety assessment is carried out on each site, on each company and on the Group. In the field of safety, the NPP safety and quality delegation, the nuclear inspectorate at the DPN, the general nuclear safety and radiation protection inspectorate are these independent entities, reporting to the site director, the DPN director, the DPI director and the CEO of the EDF Group respectively.

Thus, on the basis of the system built up gradually since the beginnings of the nuclear fleet, EDF has in the past three years aimed to further reinforce the safety culture of each party, by promoting the following main attitudes.

Priority for safety is the role of each manager

The Group's new safety policy, published in 2012, reaffirms the priority given to safety with a view to the sustainable use of nuclear energy, with a clear principle of responsibility and oversight at all levels of the company, a strong commitment to competence, safety attitudes and culture, a permanent search for progress, openness to international best practices, preparedness for emergency situations, and transparency and dialogue. This policy is disseminated to each member of staff and to each contractor and subcontractor.

With the same aim, a new version of the 2004 safety management guide takes account of progress in this field, more specifically the creation of an integrated management system on the sites and the deployment of the human performance project (intervention reliability enhancement practices, field visits by the managers, analysis of field visits).

The new version of the safety management guide presents the history of the safety management system (which is particularly important when handing over to the new generation of staff), the key principles of safety management and, finally, the questions that the various management levels must ask themselves.

In addition to the document itself, deployment of the guide is also important. It began with training of the "incoming" managers and will continue in 2013 with local implementation by each site management team.

Incentives to develop a questioning and prudent attitude, where there is room for legitimate doubt

To help develop safety culture in the field, for each member of staff or contractor during an intervention, EDF carried out a human performance project, with one part concerning the assimilation of intervention reliability enhancement practices: pre-job, stop and think, self-check, cross-check, secure communication, debriefing. The various practices are designed to reduce the occurrence of human errors, with some, such as the stop and think phase, being there to give legitimacy to any interruption of the intervention in the event of doubt as to the actual conditions in which the work is being carried out, thus helping to control the risks.

An attitude encouraging feedback about problems and difficulties

Being in touch with realities in the field, understanding and encouraging feedback of problems and difficulties were the core driving forces behind the development of two other aspects of the human performance project. Firstly, going out into the field is an opportunity to positively reinforce the expected attitudes but also to identify deviations and discuss difficulties. Analysis loops are then set up for rapid resolution of problems, but also to identify trends and early-warning signs. This is supported by the experience feedback project currently being deployed.

A decision-making process designed to guarantee the priority given to safety

EDF has continued to reinforce the decision-making process in order to guarantee the priority given to safety. Since the early 2000s, implementation of the OSRDE (observatories for safety, radiation protection, availability and the environment) has been promoted, in order to identify the conditions in which decisions are taken. In addition, work has been done in recent years, based on the INPO "effective decision-making" document, so that conditions favourable to good decision-making are systematically set up.

Check and verification

A check and verification system is in place within every entity. Checks must be implemented first of all by the relevant operational line, which has responsibility. In addition, verification actions are ensured by independent bodies.

All the units are also audited at various levels:

- by the DPI's auditing entity, which periodically carries out:
  - audits concerning implementation of the internal monitoring policy within the units,
  - assessments of the unit's resources, be they technical, organisational or human.
- by the nuclear inspectorate, the DPN's auditing entity. These assessments, carried out every four years, consist in evaluating the level of safety, radiation protection and environment, by comparing the actual performance of the organisations and the baseline requirements established by the DPN management, and then in issuing recommendations to the entire hierarchical line in order to further improve safety.
- by IAEA, through OSART missions, with a special nuclear inspection preparatory audit carried out between 18 months and two years in advance (1 OSART mission per year for the DPN),
- by the World Association of Nuclear Operators (WANO) by means of peer reviews. These reviews consist of a plant assessment programme, covering technical and managerial aspects, performed by foreign licensee peers. They are also an opportunity for productive discussions between the assessment team and the operators of the plant inspected. Since 2012, the frequency of the peer reviews has been gradually increased and will reach one every 4 years on each plant in 2015. In 2013, the sites of Blayais, Civaux and Paluel will host WANO review missions. Moreover, 49 EDF peers took part in peer reviews in 2010, organised by the 4 WANO centres, as compared with 54 in 2011, 57 in 2012, with 60 being scheduled for 2013.

All of these assessment means, the scope and detail of which have been expanded, help the DPN management define its priorities for permanent reinforcement of safety, for inter-comparisons between the plants, for reinforcing the management of safety and for improving the overall performance of the NPPs in service. They are also a good opportunity for engineers and managers to take part in the WANO and IAEA assessments abroad and observe good practices there. This is why the EDF Group encourages these assessments and is looking to increase the number of managers who take part in them.

10.3 Measures taken for research reactors

10.3.1 CEA reactors

The measures to ensure safety taken by CEA take into account the considerable variety of its installations, resulting from the broad range of research programmes CEA carries out, and the way those programs develop over time. The consequence is a diverse range of potential risks. Since 2006, CEA has adopted a safety policy which is implemented through a three-year plan. This approach has led to contracts which, within the units and at various hierarchical levels, formally define precise safety and radiation protection targets and the associated means. CEA thus also committed to a self-assessment approach based on a certain number of indicators for monitoring safety and the correct working of the organisation.

Nuclear safety is the priority of CEA. The level of safety it achieves is based on meeting 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 clearly assigned to him or her (refer to the organisation chart in Appendix 3);
- a safety culture that is taught, maintained and developed;
- staff that are professional, skilled and capable of teamwork.

At a central level, the Chairman determines the broad safety outlines and defines measures designed on the one hand to implement the legislative, regulatory and specific provisions applicable and, on the other, CEA's nuclear safety organisation. The Chairman also makes strategic decisions.

With regard to nuclear safety, radiation protection and transport operations, the Chairman is assisted by the nuclear safety protection division. This division, which is part of the "risk management" centre, defines CEA's safety policy, which is based on constant progress.

The nuclear energy director, assisted by the quality and environment division, implements and monitors application of the CEA safety policy in all the installations.

Existing doctrine is given in the CEA nuclear safety manual. It comprises:

- circulars that are General Management Directives;
- recommendations which aim to define CEA doctrine.

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

The check function is carried out by entities independent of those forming part of the management hierarchy. The check function reviews the efficiency and adequacy of the actions taken, and of the internal technical controls. General nuclear safety support units provide the installations with assistance in the centres.

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 scheduled inspections (about 10 every year) and reactive inspections after significant events. The IGN Director may decide on the inspectorate's intervention on relevant topics.

CEA has reinforced the organisational and radiation protection arrangements in the operations performed by outside contractors.

CEA is also continuing to reinforce certain areas for progress, including:

- the organisation of the technical support provided to the installations in certain areas of expertise, such as earthquakes, civil engineering, criticality and human factors;
- organisational arrangements concerning management of contractors.

10.3.2 The ILL high-flux reactor (RHF)

Nuclear safety has always been and remains the priority at ILL. The level of safety reached by ILL is based on the following organisation:

- a radiation protection unit reporting directly to the Institute's Director;
- a reactor division, the head of which, with authority delegated by the director, is responsible for the operation and safety of the reactor and its auxiliaries, as well as for operational quality assurance.

Some of these activities, as listed, are said to be “quality monitored” (AQS) and must be the subject of a special procedure. AQS in principle undergo two-level checks, as stipulated in the BNI order:

- o first level check: this is primarily technical, to guarantee that the AQS results objective is obtained. This is normally carried out within the functional group responsible for conducting the AQS;
- o second level check: in the reactor division, additional checks, which can be spot checks, concerning the two-fold AQS technical and management aspects. These checks are carried out by the quality assurance level set up in the reactor division.

10.4 ASN analysis and oversight

10.4.1 ASN

ASN's actions are based on its quality management system, built around internal and external audits.

With a view to ensuring continuous progress, ASN welcomed an IRRS (Integrated Regulatory Review Service) mission in 2006. This “full scope” mission covered all nuclear safety and radiation protection fields.

In 2009, an IRRS follow-up mission was organised. On this occasion, the international experts considered that ASN had satisfactorily answered 90% of the recommendations and suggestions made in 2006. In numerous fields such as inspection, preparedness for emergency situations, public information or the international role of ASN, they again considered that ASN’s actions position it among the best international practices. They also identified a few areas for improvement, notably in terms of skills management.

ASN took advantage of the conclusions of this mission to reinforce the conformity of its practices and its organisation with the best international standards. The next IRRS mission will be received in 2014. So that the scope of this mission can be considered to be complete (mission known as “full scope”), the peer review must concern all of the following facilities and activities: nuclear power reactors, research reactors, fuel cycle facilities, waste management facilities, decommissioning, radioactive sources. France may request that the review also cover optional fields, in particular the following: transport, medical exposure, occupational radiation protection, environment, interfaces with security. The final scope of the IRRS review must be confirmed in 2014 during the preparatory meeting with IAEA and the IRRS mission pilot.

ASN frequently takes part in the auditor teams for missions performed abroad at other nuclear safety regulators.

10.4.2 The licensee

ASN’s regulation of the safety policy and management system (at local and national level) of the BNI licensees is carried out every year at several levels:

- o verify that the commitments made by the licensee are met, in particular when they lead to concrete measures being taken in the facilities concerned;
- o within the framework of the reviews of generic subjects with major implications, examine the organisations put into place by the licensee and how they function, including from the managerial angle;
- o analyse the methods for assessing licensee safety management, the means of leveraging improvements that they identify and the gains achieved by the organisational modifications implemented.

In addition to the inspections, ASN regulation is based on the assessments conducted at its request by IRSN and the GPR. For example, the GPR will be asked in 2013 for its opinion on the management of safety and radiation protection during reactor outages.

ASN publishes its opinion and its analysis of safety management policy in the annual reports on the state of nuclear safety and radiation protection in France. These opinions appear in all the following chapters of this report, especially in § 12 and 13.

NPP licensees

ASN considers that the safety policy of the EDF Group, approved by its CEO in 2012, is satisfactory. Initiatives were taken as of 2012 to deploy this policy on the sites.

ASN observes that EDF has gradually built up a management system incorporating safety, based on principles such as quality management, continuous improvement, experience feedback management, rigorous intervention practices, consideration of organisational and human factors, complementarity of controls and individual commitment. These principles were applied in arrangements which today constitute the foundations of the EDF safety management system. Nonetheless, despite a proactive commitment to “priority for safety” at all EDF management levels, simultaneously taking account of all requirements and objectives (safety, radiation protection, environmental protection, availability, labour organisation, costs, etc.) can in certain situations lead to losing sight of the safety requirements, potentially affecting the decisions that need to be taken. In this respect, ASN considers that the “observatories for safety, radiation protection, availability and environment” (OSRDE), which is capable of analysing how safety is taken into account in the decision-making process, in the face of other demands such as facilities availability, needs to be better used to create an effective organisational experience feedback tool.

ASN sees the presence of an internal safety check body, independent of the operational side and structured at several levels, as a strong point. This independent channel benefits from significant resources as well as clear support from the management of the NPPs. However, problems with filling certain safety engineer positions and a trend towards these positions being occupied mainly by young safety engineers from the operations sections, have been observed. This trend could lead to the independent safety function experiencing problems in the complete performance of its duties with respect to the operations side.

ASN also identifies a considerable number of projects being initiated by EDF at the same time. When taken individually, each of these projects would seem to be correctly incorporating safety-related considerations or aiming to remedy the shortcomings identified by EDF. However, the combined effect of initiating all of these projects, at the same time as a large-scale programme of skills renewal at EDF, could make the situation a complex one. EDF must remain vigilant in ensuring that this combination of projects does not lead to destabilisation of certain professional sectors, which is the opposite of the defined objective, and that it remains compatible with the workload on the professional sectors.

Research reactor licensees

For CEA, although ASN considers that safety management is satisfactory on the whole, it wants to see progress in the monitoring of outside contractors. A large-scale inspection operation revealed organizational shortcomings in some facilities, and insufficient CEA involvement in the decommissioning of these BNIs, this latter aspect being confirmed by other inspections. CEA must be attentive to maintaining the skills necessary to ensure the required quality and safety of subcontracted activities.

For the ILL, its declaration that nuclear safety has always been and remains the priority at ILL takes the following tangible form;

- at an organisational level, by the existence of a radiation protection unit (radiation protection and environmental monitoring department) reporting directly to the Institute’s director;
- at an operational level, by the definition of “monitored quality” activities which are in principle subject to a two-level control process.

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 Financial resources

11.1.1 ASN requests

The TSN Act requires that, when creating a BNI subject to authorisation, "the authorisation takes account of the technical and financial capacities of the licensee". These capacities must enable it to carry out its project while protecting the interests mentioned, "in particular to cover the costs of decommissioning of the installation and rehabilitation, monitoring and maintenance of its site or, for radioactive waste disposal facilities, to cover the costs of final shutdown, upkeep and surveillance".

The BNI order requires that the licensee have adequate resources - specifically financial resources – for defining, implementing, maintaining, evaluating and improving an integrated management system. It also requires that the licensee have adequate resources to implement the policy for public health and safety and protection of nature and the environment.

In addition, the 28th June 2006 Act creates an arrangement for ring-fencing funds to meet the costs of decommissioning nuclear facilities and managing radioactive waste.

The legal arrangement aims to secure the funding for nuclear costs, in compliance with the "polluter-pays" principle. It is therefore up to the nuclear licensees to cover the cost of this funding, by creating a portfolio of specific assets able to cover the anticipated costs. This is done under the direct control of the State, which analyses the licensees' situation and can prescribe the measures necessary if the identified resources are felt to be insufficient or inadequate. In any case, the nuclear licensees remain responsible for adequate financing of their long-term costs.

The legal arrangements require that the licensees make a prudent assessment of the cost of decommissioning their facilities or, for radioactive waste disposal facilities, their final shutdown, upkeep and surveillance costs. They also evaluate the cost of managing their spent fuel and their radioactive waste. They thus submit three-yearly reports and annual updates.

11.1.2 Measures taken for nuclear power reactors

With a net installed power of 139.5 GWe worldwide as at 31st December 2012 (128.5 GWe in Europe) for global production of 642.6 TWh, the EDF Group has the world's largest NPP fleet.

In 2012, the Group achieved consolidated sales of 72.7 billion euros, a gross operating surplus of 16.1 billion euros and a net income of 4.2 billion euros.

In France, the net production of electricity by EDF in 2012 was 454.3 TWh, of which 404.9 TWh was from nuclear sources (63.13 GWe), 34.5 TWh hydraulic (20 GWe) and 14.9 TWh fossil (14.7 GWe), out of a total of 541.4 TWh from all the producers taken together.

With regard to nuclear power production in France, operational investments for nuclear maintenance amounted to nearly 3.1 billion euros in 2012. The Group will be increasing its investments in the nuclear fleet between now and 2015, in order to reinforce safety and allow efficient operation of the fleet while increasing production. Particular emphasis will thus be placed on maintenance, with the ramp-up of the programme to replace major components such as turbine-generators, transformers and steam generators (3.4 to 3.6 billion euros between now and 2015) which aims to enable the operating life of the plants to be extended beyond 40 years in optimum conditions of safety and operation. In 2011, this for instance led to the signing of contracts for refurbishment of the I&C systems for the 1300 MWe reactors and orders for 44 steam generators. This is the purpose of the Generation 2020 “Grand Carénage” (major overhaul) programme planned for the NPPs in operation. Finally, the Group will take account of the lessons learned from the Fukushima Daiichi accident, as stipulated by ASN, and intends to invest a total of about 10 billion euros in order to meet the ASN requirements.

Furthermore, to secure financing of its long-term nuclear commitments, EDF has in the past few years set up a portfolio of assets exclusively devoted to meeting provisions linked to dismantling of the NPPs and the back-end fuel cycle facilities. As at 31st December 2012, its market value is 17. 6 billion euros, to be compared with provisions of 20.1 billion. This gap in provisions will be filled by June 2016, deadline for the dedicated portfolio of assets to cover the whole long-term nuclear commitments pursuant to the 28th June 2006 Act.

EDF considers that all of the above shows that adequate financial resources are available to ensure the safety of each nuclear facility throughout its lifetime.

11.1.3 Measures taken for research reactors

11.1.3.1 CEA reactors

Together with radiation protection, more than 25 million euros are spent on the safety of CEA’s research reactors. This evaluation does not include the works to be performed within the context of the stress tests and which are currently being quantified.

11.1.3.2 The ILL high-flux reactor (RHF)

The ILL is the world leader in neutron research. Its annual budget is about €80M, 20% of which is devoted to investments, both for major maintenance work, upgrades or new work on the reactor, and for continuous modernisation of the scientific instruments.

11.1.4 ASN analysis and oversight

11.1.4.1 Nuclear power reactors

EDF underwent a number of changes in 2000 and 2004, with changes to both the domestic market and its statutes. In late 2005, the company was partially privatised, with the State retaining an 86% holding and the legislative framework stipulating that it must hold at least 70% of the capital and voting rights.

In its dialogue with ASN, the licensee reaffirms that cost control remains a concern, particularly the economic feasibility and the justification of certain requests or certain schedules and the handling of very urgent issues during reactor outages.

With regard to the financing of decommissioning and the management of radioactive waste, ASN and the Ministry for Ecology, Sustainable Development and Energy (MEDDE) carried out a check in 2010 with the licensees on how they produced their three-yearly reports and annual updates.

In 2010, the licensees submitted their third three-yearly reports. Generally speaking, the robustness of the assessments produced needs to be more clearly substantiated and the uncertainties surrounding decommissioning and waste management operations, with a potential impact on the costs, must be clarified. ASN and the MEDDE also identified the need to verify the tools used by the licensees to assess the decommissioning costs and defined an audit programme that should be conducted over the 2011-2013 period.

11.1.4.2 Research reactors

Research facilities are frequently operated by major public research organisations. Their resources are thus sensitive to the context of the State Budget. If the funding source, represented by the State, provides certain guarantees, it also sometimes leads to unavoidable decisions that may compromise the future of certain research installations. The renovations and upgrades of current safety requirements, following periodic safety reviews, often entail extensive work and remain difficult. These operations can thus take several years. ASN ensures that budgetary constraints have no impact on safety and radiation protection for the operation of research facilities. In 2006, for instance, it asked CEA, the main research facilities licensee, to implement an approach designed to ensure efficient monitoring of all major projects (major commitments to safety and radiation protection), through an effective control tool that was transparent to ASN, especially with regard to the decision-making process. This tool must thus allow improved management of complex programmes with major nuclear safety and radiation protection implications, and protect these projects, which are few in number, from any budgetary threats.

ASN considers that the "major commitments" initiative implemented by CEA over the last 4 years must be continued and regularly expanded to include new "major commitments". Any extension to the deadline must therefore firstly be duly justified, and secondly be discussed beforehand with ASN. Generally speaking, ASN will remain vigilant in ensuring compliance with the commitments made by CEA, both for its facilities in service and those being decommissioned. Were this to prove necessary, ASN could issue instructions, as was the case in 2012 for storage removal operations in the MASURCA facility.

11.2 Human resources

11.2.1 ASN requests

It is up to the licensee of a BNI to have sufficient, appropriate and qualified human resources. The regulatory requirements are given in the TSN Act and the BNI order, more generally concerning the resources that must be at the disposal of a BNI licensee.

In addition, the BNI order states that "the activities important for protection, their technical check, the verifications and assessments are carried out by persons with the necessary skills and qualifications". The licensee must therefore adopt appropriate training procedures in order to maintain and develop the skills and qualifications of its own personnel or those of outside contractors.

What ASN expects in terms of human resources management and skills in particular is clarified by the ASN regulatory resolution on safety policy and management in BNIs, and the associated ASN guide (see Chapter 10).

11.2.2 Measures taken for nuclear power reactors

At the end of 2012, the workforce of the EDF nuclear operation division (DPN), responsible for operating the nuclear reactors, stood at about 21,000, distributed among the 19 NPPs in operation and the 2 national engineering units. Engineers and managers represented 35% of the workforce (7,400 staff), supervisors 62% (13,100 staff) and operatives 3% (700 staff).

To these 21,000 staff must be added EDF's human resources devoted to design, to new constructions, to engineering of the NPPs in service and support functions, and to dismantling of nuclear reactors:

- about 4,500 engineers and technicians from the nuclear engineering division (DIN) split 75% management and 25% supervisors;
- nearly 170 engineers and technicians from the nuclear fuel division (DCN);
- more than 600 engineers and technicians from EDF's research and development division (EDF R&D).

For the development of a safety culture, the accountability policy implemented within the company means that a vast majority of the personnel devotes a significant percentage of their time and activities to nuclear safety and radiation protection.

If one considers only those personnel whose role and duties are exclusively concerned with nuclear safety, then more than 450 staff are involved.

About 950 people are devoted to security and radiation protection activities.

Since 2006, EDF has been devoting considerable efforts to guaranteeing the skill levels and the careers of the staff, by adopting a forward-looking jobs and skills management approach, based on uniform principles for all the NPPs, built up gradually from actual feedback from the field. These aspects are the subject of monitoring, oversight and specific check.

The staffing levels are currently rising, to deal with the skills renewal process currently under way and with the projects for the NPPs in service and to reinforce skills with regard to severe accident management (for example with the creation of the FARN – the nuclear rapid intervention force). Large numbers of staff have been hired in recent years: in 5 years, nearly 5,500 new staff have joined the DPN (25% of the workforce). Additional training work positions are today provided for 2700 staff (nearly 13% of the workforce).

The volume of training has also risen significantly over the past 5 years: it has doubled, rising from 1.2 million hours in 2007 to 2.7 million in 2012. The initial training curricula have been added to and adapted to this new context, with the creation of "Nuclear common knowledge academies", along with programmes that have been revised for each specific professional sector. Reactive training programmes are also deployed on the sites, based on experience feedback from other international licensees.

Similarly, with regard to engineering, the nuclear engineering division (DIN) has since 2006 been running a "key nuclear engineering skills development plan" (PDCC), involving the units of the DIN and other divisions of the DPI and R&D. This approach aims to develop the skills of the engineering sectors and, through a cross-cutting and forward-looking approach, helps the other units prepare their choices for future management of jobs and skills.

New entrants at the DIN follow a 5-week training course on the common knowledge of the "design" engineer (operation, safety and quality culture, security and radiation protection, etc.).

11.2.3 Measures taken for research reactors

11.2.3.1 CEA reactors

A safety engineer is on duty in each facility. This engineer is familiar with the facility and has experience of analysing and handling safety issues. The facility also has criticality expertise.

In accordance with the requirements of the BNI order and the "human resources" chapter of standard ISO 9001-version 2000, the skills of the persons assigned to positions that are important for the safety of a BNI must be guaranteed.

The principles adopted for the qualification and certification procedure are:

- the separation of qualification and certification responsibilities;
- assessment of qualification by a manager who, if so deemed necessary, may call in specialists;
- assessment of qualification, notably by validating the skills acquired during professional experience rather than solely by training;
- giving consideration to the diversity of the means of skills acquisition (initial and continuous professional training, professional experience, self-training, tutoring);
- the traceability of the qualification and certification decisions;

Prior to taking up their duties, the facility heads follow specific training covering the following aspects: management of staff and operations, nuclear safety at CEA, the operational legal responsibilities of the licensee, radiation protection and waste management.

Furthermore, the safety issues are supervised and coordinated by the following various contributors:

- the nuclear safety unit within each centre;
- the nuclear protection and safety department.

For certain technical matters, experts can be called on from one or more of the centres of expertise created by CEA and run by the DPSN.

The human resources needed for this work requires from 10 to 20 engineers on each site.

11.2.3.2 The ILL high-flux reactor (RHF)

In order to meet safety requirements, the ILL has since 2008 employed a second safety engineer, who also reports directly to the head of the reactor division.

For surveillance of the facility and radiological monitoring of the personnel; the radiation protection unit comprises 9 staff under the authority of a radiation protection engineer.

For environmental surveillance, the ILL set up a new laboratory in 2010, employing 7 technicians under the responsibility of an engineer. This task was previously the responsibility of CEA Grenoble, prior to the transfer of its equipment to the ILL. CEA trained the personnel during the course of the year preceding this activity transfer to ILL.

In order to carry out the post-Fukushima actions, the ILL set up a project structure which utilises both the services of the ILL and personnel from outside contractors. An additional safety engineer was hired for the duration of this project, covering the period 2012-2016.

11.2.4 ASN analysis and oversight

ASN regulation of human resources is based on inspections and assessments conducted with the support of IRSN and the Advisory committees, covering the subjects of human and organisational factors (see Chapter 12) and safety management (see chapter 10). Human resources are also checked during BNI construction and decommissioning inspections.

For the nuclear power reactors, the organisation in place on the sites for skills management is well-documented and coherent. Inadequacies on certain sites are however still being found during the inspections, concerning the forward planning of jobs and skills management (GPEC) so as to be able to prepare for renewal of skills. Failure to anticipate large scale departures from certain disciplines was therefore observed on a few sites. The relative balance observable hitherto could be jeopardised by a significant transition between generations and the high levels of work required as a result of the stress tests. The success of the large-scale skills renewal programme underway at EDF entails on the one hand an unprecedented effort in terms of personnel recruitment in most sectors, but also considerable investment in training.

Generally speaking, the training programmes are run satisfactorily and the deployment of the professional sector academies is identified as being a strong point for the training of new arrivals on the sites. Deviations are however still found during inspections or following significant events, in particular in the fields of transport of radioactive materials, radiation protection and environmental protection.

During the targeted inspections performed in 2011 as part of the Fukushima Daiichi accident experience feedback process, ASN in particular checked personnel training for severe accident management. These inspections confirmed that the training and qualification of the personnel in the facilities was on the whole satisfactory, even though a few deviations were observed on the documentation or monitoring of the training on some sites.

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 requests

ASN is counting on integration of organisational and human factors (OHF) that is compatible with the safety issues identified by the licensee, in the following fields of activity:

- engineering activities, during the design of a new facility or the modification of an existing one;
- the activities carried out for operation of existing NPPs, throughout their service life;
- the compilation of experience feedback concerning reactor design, construction and operation.

Social, organisational and human factors received particular attention during the stress tests performed in France.

12.2 Measures taken for nuclear power reactors

INSAG 18 identifies and characterises the safety risks linked to the changes initiated in the nuclear industry for the purposes of optimisation and profitability.

Since 2006, EDF has been employing a two-fold approach in its major projects and more generally for technical, documentary and organisational modifications with significant implications:

- an approach taking account of socio-organisational and human aspects (SOH approach) aims to incorporate the necessary methods into the engineering processes, so that the licensee can have at its disposal modifications that are suited to its activities, that it can easily assimilate and that are acceptable in terms of impacts on the professional sectors;
- on the basis of the human and organisational impacts identified, an approach inspired by INSAG 18 is carried out to characterise the potential safety consequences of these impacts.

Several projects, concerning maintenance, information, running of unit outages, post-Fukushima actions or the Grand Carénage overhaul programme, benefit from this approach.

The organisation set up by EDF also makes provision for a “human factors consultant” (CFH) position per pair of reactors. The duties of the CFH chiefly concern operating experience feedback and training of the EDF or contractor staff in practices to increase the reliability of human interventions.

12.3 Measures taken for research reactors

12.3.1 CEA reactors

The perceived weight of human factor components in events and incidents justifies the specific approach adopted by CEA and the creation of a dedicated organisation.

The following persons meet one day each year to discuss external and CEA internal practices:

- specialists in the safety support units of the CEA centres;
- contacts in the facilities, more specifically in each research reactor;
- correspondents in the monitoring units reporting to each centre director.

Actions are focused on several areas:

- the performance of “organisational and human factors” (OHF) studies in several facilities, following the emergence of identified problems or incidents;
- the performance of systematic OHF interventions during the periodic safety reviews, more specifically concerning the operation phases and the handling of fuel and experimental devices.

In addition to an awareness raising kit distributed in January 2011, steps were taken to incorporate OHF into documents enabling them to be harmonised for CEA as a whole.

Targeted training courses were set up on the subject of incorporating OHF into activities with safety implications and a significant OHF component.

With regard to R&D, CEA took part in the European MMOTION (Man-Machine Organisation Through Innovative Orientations For Nuclear) project and developed cooperation with the Institute for Energy in Halden (Norway) on the topic of operations and MTO (Man Technology Organisation).

Exchanges are held outside CEA:

- within the IMdR (risk management institute), on the topics “Experience Feedback” and “Organisation”;
- with EDF/CIDEN and the IAEA, on the topic of OHF in post-operational clean-out/decommissioning.

Nine publications were presented at conferences or in specialised or general reviews.

12.3.2 The ILL high-flux reactor (RHF)

The steps taken by the RHF in the field of OHF broadly follow those of CEA. The two institutions are regularly in contact on this subject.

12.4 ASN analysis and oversight

12.4.1 Organisational and human factors in nuclear power reactor operations

ASN regulates the steps taken by the licensee to improve the integration of organisational and human factors (OHF) into all phases of the lifecycle of an NPP.

The approach adopted by the licensee is notably based on methods which require resources and specific skills, as well as a particular organisation. ASN regulates compliance with the associated requirements, particularly in the design and implementation of modifications to the facilities. In 2012, the ASN inspectors gave a favourable opinion on the appointment of an OHF correspondent and the creation of an OHF committee in the EDF engineering centres. ASN however considers that greater participation by the OHF consultants in the skills management systems implemented by the sites could improve how the needs of the participants and the organisations are taken into account.

In the facilities, ASN inspections look at the conditions in which this activity is carried out and the means placed at its disposal, both of which can have an impact on the safety of the facilities and the security of the workers.

Within this framework, the EDF jobs, skills, training and qualifications management systems are regulated. ASN considers that the organisation and the specific actions to improve how OHF are integrated into operational activities differ from one site to another, which means that on some of them, their assimilation of the OHF approach could be improved.

With regard to safety management more broadly, ASN observes that there is now greater presence of EDF managers in the field, mainly to disseminate and implement managerial policies and requirements. ASN considers that this presence however still does not contribute enough to a better understanding of the realities in the field on the part of the site’s management.

Finally, ASN regulation also relies on the assessments conducted at its request by IRSN and the GPR, jointly with safety management. For example, the GPR is asked for its opinion on the management of safety and radiation protection during reactor outages.

12.4.2 Organisational and human factors in research reactor operations

The organisation put into place at CEA in recent years has helped make the responsibilities and duties of the units more comprehensible, specifically with regard to continuity of the specified plan of action, independence of the check function and identification of a facilities assistance function.

More particularly with respect to integration of human factors, CEA set up an expertise centre, with a workforce distributed among the head office departments and the operational units. It provides support and assistance for the operational units and contributes to the drafting of internal directives. Although ASN considers this initiative to be satisfactory, it does feel that the actions taken need to be added to and better structured in order to create a real strategy for taking organisational and human factors into account in the safety policy.

ASN nonetheless observed with satisfaction the integration of organisational and human factors into the design process for the JHR.

In 2011, ASN adopted a position with regard to the file concerning safety and radiation protection management at CEA, which had been assessed by the Advisory Committees of experts in 2010.

This assessment shows that CEA has made considerable progress since the last review on the same subject (1999), more specifically with regard to the integration of human and organisational factors and the incorporation of safety and radiation protection into the projects. ASN duly noted the improvement actions in progress concerning skills management and the management of safety and radiation protection in contracted work (creation of an acceptance committee for the contractors working on radioactive post-operational clean-out and a centralised supplier evaluation database).

12.4.3 Work done on organisational and human factors within the framework of the stress tests

Following the assessments conducted during the stress tests, three priorities were identified:

- the renewal of the licensees' workforce and skills,
- the organisation of subcontracting, which is a major and difficult issue,
- research into these subjects, for which programmes must be initiated.

ASN has set up a pluralistic working group on these subjects called the CoFSOH (Social, organisational and human factors steering committee). In addition to ASN, this committee includes representatives of institutions, environmental protection associations, personalities chosen for their scientific, technical, economic, legal or social, or information and communication expertise, persons in charge of nuclear activities, nuclear industry professional federations and representative employees' unions.

This committee held three plenary sessions in 2012.

The organisation of the follow-up to the work of the CoFSOH, through working groups, has been discussed.

The major work themes identified at the present stage are:

- use of subcontracting in normal operating situations: organisation and conditions of intervention;
- the use of subcontracting: legal aspects (sharing of liability in situations of particularly intensive subcontracting, as well as how to reconcile safety constraints with the requirements of labour legislation);
- management of emergency situations;
- assessment of organisational structures and material or organisational changes;
- the relationship between "managed security" and "regulated security";
- skills management.

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

The BNI order contains provisions to be implemented by a BNI licensee to define, obtain and maintain the quality of its facility and the conditions necessary to ensure operating safety.

The licensee must also implement an integrated management system specifying the provisions applied in terms of organisation and resources of all types (see Chapter 10), and must maintain it, assess it and improve its effectiveness.

This order requires that the licensee define quality requirements for each activity concerned, utilise appropriate skills and methods in order to achieve them and, finally, guarantee quality by checking satisfactory compliance with these requirements.

It also requires that:

- detected deviations and incidents be dealt with strictly and that preventive measures be taken;
- suitable documents provide evidence of the results obtained;
- the licensee supervises its contractors and checks that the organisation implemented to guarantee quality does indeed operate satisfactorily.

13.2 Measures taken for nuclear power reactors

Quality assurance policy and programme for nuclear power reactors

It is up to EDF to guarantee design, construction and operation of its NPP fleet that is safe and efficient, both technically and economically. The quality management policy, which primarily focuses on activities important for safety, contributes to this.

There are three resulting objectives:

- to consolidate acquired knowledge and experience, and improve results where required, as part of a continuous improvement process;
- to bring the quality system personnel on-board by involving them in its implementation and improvement;
- to have a quality system in place that is compliant with French regulatory requirements, international quality recommendations, and best practices and methods as confirmed by operating experience feedback (see § 19.7). As part of this approach, indicators are used to monitor trends and define preventive measures.

Developing the quality system on the basis of acquired knowledge

The need to guarantee safety has led EDF to develop a quality system based on personnel skills, work organisation and formally documented methods. Acquired experience leads to changes to the quality system on the following points, the overview of activities, prior consideration before each step in the process, the need to apply the requirements of the quality system to activities that are important for safety and the involvement of each stakeholder in obtaining quality.

Adjusting the quality assurance requirements to the importance of the activities

Each activity is the subject of a preliminary analysis. This analysis concerns the difficulties inherent in the activity and the consequences resulting from possible failures at each step in performance.

The quality characteristics essential for the activity are thus highlighted, in particular the quality level required. The result is appropriate quality assurance provisions. Through a questioning attitude, risk assessments and improvement proposals, a responsible player can contribute to improving these provisions.

Appropriate organisation and resources

Achieving the required quality objectives means that the activities must be clearly allocated and that the duties, responsibilities and coordination between players is defined at all levels of the company.

Relations with contractors

To ensure the quality of its services, EDF first of all ensures that its contractors are capable of performing the services in good conditions. It then monitors the activities entrusted to its contractors. This monitoring does not relieve the contractor of its contractual responsibilities, notably those concerning the implementation of the technical and quality assurance requirements. Contracts between the ordering customer and its contractors clearly define the responsibilities of each party, the applicable requirements and the commitments in terms of quality and results.

Furthermore, in order to strengthen the quality of the partnership with the contractors, an improvement programme is put into place. This in particular concerns the quality of interventions, contracts which accord more importance to the "best bidder" and the facilitation of the intervention conditions in the field.

The stipulation of a subcontracting system with a maximum of three tiers, including the contract holder, must apply to any contract, in compliance with EDF's undertakings for new calls for bids and for currently ongoing contracts.

The social specifications were examined by the performance working group of the nuclear sector strategic committee set up by the Government in January 2012. The social specifications comprises rules common to all players in the sector, designed to guarantee know-how, skills, training and qualification, as well as the adoption of nuclear safety, radiation protection, occupational risk prevention and quality of life at work as fundamental, essential criteria.
These social specifications and the proposals for regulatory changes were sent to the Prime Minister, the Minister for Industrial Renewal and the Minister for Ecology on 20th July 2012. It was also presented to the Steering Committee for Social Organisational and Human Factors, chaired by ASN, on 9th November 2012.
Implementation of these social specifications in the contracts will begin in financial year 2013.

Guaranteeing quality by means of appropriate checks

The quality of an activity depends first and foremost on those performing it. Check processes can guarantee this quality.

As necessary, these processes comprise:
- self-assessment;
- checks by another qualified person capable of providing a critical vision;
- verifications, with the necessary distance and independence, to ensure correct implementation of the quality requirements.

All of the above contribute to defence in depth.

Certification of quality through traceability

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.

13.3 Measures taken for research reactors

13.3.1 CEA reactors

The quality management system is defined by each operational sector. Research reactors are covered by the nuclear energy sector's nuclear energy division (DEN).

The DEN has held ISO 9001 certification since 2005 for all its activities. It implements an integrated management system for quality, health/security/safety and the environment (QSE).

The DEN's Quality Security Environment Manual (MQSE) outlines the organisational structures of CEA and of the DEN sector.

This documented system is based on the following principles:

- the DEN Director formulates the general policy of the sector and the associated objectives;
- each process pilot translates this policy into measurable targets;
- an annual review per process;
- an annual management review to analyse the working of the processes and the QSE system at the DEN.

At each hierarchical level, "process" managers interpret CEA policy and ensure consultation, coordination and oversight of implementation within the unit.

In the event of complete subcontracting of a facility, CEA retains its responsibilities as licensee and user company and appoints a Facility Contract Manager (RCI) and set up an appropriate safety and security organisation. When the nature of the contracted work so warrants, CEA ensures that it retains overall control of the associated knowledge and know-how.

Regular audits are conducted in the 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 progress achieved and define new areas for progress;
- to assess the ability of the suppliers and contractors to meet CEA's quality requirements.

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

13.3.2 The ILL high-flux reactor (RHF)

The Reactor Division is responsible for operating the reactor and its auxiliaries. Given the particular importance of these operational activities in terms of safety, and in accordance with the provisions of the BNI order, a quality assurance organisation is put into place in order to guarantee that the level of quality required is obtained and maintained and to provide the necessary evidence.

Six guiding principles underpinned the creation of this organisation:

- Principle I: The licensee defines the scope of the quality organisation, by identifying the safety-related activities and equipment and then defining the requirements for each of them. These activities and this equipment are referred to as being of "monitored quality" (MQA and MQE);
- Principle II: Persons qualified to carry out a monitored-quality activity are designated by the Head of Operation. These persons are referred to as "accredited";
- Principle III: All monitored-quality activities are performed following written documentation prepared in advance, and this performance is written up in reports. These documents are referred to as "monitored quality". In this respect, they are subject to either a technical inspection or an internal check, and either management or external checks;
- Principle IV: Monitored-quality documentation is updated and kept for a defined time depending on the document's importance;

- Principle V: The results of a monitored-quality activity are verified both technically (quality check) and as regards management (quality monitoring). The verification is written up in a report;
- Principle VI: The “performance” and “verification” functions are separate and assigned to different persons. The quality-monitoring function is independent of the operational functions;
- Principle VII: A minimum of two supplier audits are programmed each year.

13.4 ASN analysis and oversight

13.4.1 Quality assurance in the construction and operation of nuclear power reactors

13.4.1.1 General oversight of quality in construction and operation

During its inspections on sites under construction or already in operation, regardless of the field to be checked, ASN verifies that the quality assurance principles are respected. 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.

ASN considers that the quality management system put into place by EDF on the whole meets the requirements of the BNI order. Through its inspections, ASN notes that the principles of the EDF integrated management system are applied on the sites. The steps taken are in particular able to identify deviations from the defined requirements applicable to equipment and to organisations. They could however be improved with regard to making greater use of operating experience feedback on some sites and stricter control of deadlines for completion of remediation work.

13.4.1.2 Quality aspects related to the use of contractors

The maintenance of French reactors is to a large extent subcontracted by EDF to outside contractors. The decision to implement this industrial policy lies with the licensee.

The role of ASN is to verify that EDF assumes its responsibility for the safety of its facilities by implementing a quality approach and in particular by monitoring the condition in which this subcontracting takes place.

A system of prior contractor qualification was put into place by EDF. It is based on an evaluation of the technical know-how and quality organisation of the subcontractor companies and is formally written up in the "progress and sustainable development charter" signed by EDF and its main contractors.

13.4.1.3 Contractor selection and monitoring

In the NPPs, ASN conducts inspections on the implementation of and compliance with the EDF baseline contractor monitoring requirements. With regard to regulation of the construction of the Flamanville 3 reactor, ASN also conducts inspections on this subject within the various engineering departments responsible for the design studies.

More generally, it conducts a number of inspections every year at the suppliers of the reactors in service.

In principle, the contractor qualification and assessment system is satisfactory and meets the regulatory requirements. In reality, EDF’s assessment of its policy for industrial maintenance and use of contractors could be improved and ASN ensures that this aspect is given full consideration in the approaches mentioned in § 11.2.

13.4.2 Quality assurance in the operation of research reactors

The quality requirements specified in the BNI order apply without restriction to research reactors.

Within this context and primarily by means of inspections, ASN checks licensee application of the quality assurance principles during the operation and maintenance of its reactors. In recent years, ASN has observed an improvement in the contractual documentation of the safety requirements applicable to outside contractors.

ASN pays particular attention to the check and management, by the reactor licensee, of the activities carried out by the common technical services in a CEA centre, to ensure that this check is carried out with the same degree of stringency as for outside contractors. ASN notes that this is the subject of a formal internal contract between the units of the centres, thus contributing to improved visibility of the distribution of responsibilities and to clarification of each party’s tasks.

Exceptional maintenance or renovation operations are the subject of particularly close monitoring by ASN, which adapts its inspection programme to ensure the performance quality of these operations.

In addition, the structure put into place within the CEA centres, as referred to in Chapter 11, has contributed to improving operational quality in research reactors. The centres have set up structured management systems and assimilation and adoption efforts by the various stakeholders have been observed. However, ASN considers that such efforts must be continued, 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 checks on behalf of centre managers, was reviewed and reinforced with a view to improving the detection of weak points and selecting objectives such as to correct them. Coordination between the various action, support and check levels, whether local or national, must continue to progress in order to make the actions more consistent and more 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.

14.1 Safety assessment before the construction and commissioning of a BNI

14.1.1 ASN requests

14.1.1.1 Regulatory framework

The TSN Act provides for a creation authorisation procedure, which may be followed by other authorisations during the operation of a BNI, from its commissioning to its final shutdown and decommissioning, including any changes made to the facility. These aspects are detailed in § 7.2.

The safety options are presented in the authorisation application file.

The preliminary safety analysis report (PSAR), incorporated into the authorisation application file, informs ASN of and substantiates the measures taken at each step in the life of the facility to comply with the regulations and guarantee safety. It contains all information able to verify that all risks (whether or not nuclear) and all possible hazards (internal or external) have indeed been taken into account and that in the event of an accident, the personnel, the population and the environment are adequately protected by the means put into place. This report takes account of the specific characteristics of the site and its environment (meteorology, geology, hydrology, industrial environment, etc.).

Commissioning corresponds to the first use of radioactive materials in the facility or the first utilisation of a particle beam. In preparation for commissioning, the licensee sends ASN a file comprising the updated safety analysis report for the facility “as-built”, the general operating rules (RGE), a waste management study, the on-site emergency plan and the decommissioning plan. These aspects are reviewed by ASN with the support of IRSN and the Advisory Committees of experts.

14.1.1.2 Stress tests

The stress tests (see §14.2.1.6), carried out following the accident which occurred in the Fukushima Daiichi NPP, were extended to include facilities under construction (EPR and JHR).

ITER was also included within the scope of the stress tests, according to specifications identical to those for reactors in operation.

14.1.2 Measures taken for nuclear power reactors

With regard to the Flamanville 3 EPR reactor, following the granting of the creation authorisation decree, dated 10th April 2007, the next major regulatory step in the project schedule is the commissioning authorisation, corresponding to the first loading of nuclear fuel into the reactor.

To obtain this, EDF submitted the working versions of the commissioning application file ahead of time, between October 2010 and October 2011. ASN reviewed the data and in the summer of 2011 notified what needed to be included for the commissioning application.

The Advisory Committee for reactors (GPR) will hold meetings between now and the commissioning application on the subjects of Safety Classification, Probabilistic Safety Assessments, the EPR Human Machine Interface and the fuel building.

The characteristics of Flamanville reactor 3 were reviewed within the more general framework of the stress tests. In September 2011, EDF sent ASN its report on the EPR.

14.1.3 Measures taken for research reactors

The JHR, which is part of the first batch of 5 facilities, including 4 CEA reactors, underwent the stress tests process. The reactor is currently under construction and the results of this assessment indicated no need for any changes to the civil engineering.

14.1.4 ASN analysis and oversight

14.1.4.1 Detailed design review of the Flamanville 3 reactor

Without waiting for transmission of the complete commissioning application file, ASN and IRSN jointly initiated an advance review of the following, to prepare for examination of the commissioning application file:

- technical baseline requirements necessary for the safety demonstration and for finalising the reactor's detailed design;
- the detailed design of certain systems important for safety presented in the safety analysis report;
- certain elements of the commissioning application file or used to assist with determining the contents of the file.

The details of this review as well as the monitoring of the construction of the EPR Flamanville 3 reactor are presented in Chapter 18.

14.1.4.2 Stress tests

Nuclear power reactors

Following the stress tests, EDF proposed a number of measures to reinforce the robustness of the Flamanville 3 EPR reactor. ASN estimates that these propositions are relevant and considers that they should be implemented.

Following the stress tests (see § 14.2.1.6), ASN issued resolutions requiring the adoption of particular measures for the Flamanville 3 EPR reactor under construction:

- ECS 1: Defining the structures and components of the "hardened safety core", including the emergency management premises. Defining the requirements applicable to this hardened safety core. Hardened safety core based on diversified structures and components.
- ECS 6: Reinforcement of protection against flooding
- ECS 13: Study of the implementation of automatic shutdown in the event of an earthquake
- ECS 14 I: Integration of industrial risks in extreme situations.
- ECS 14 II: Coordination with neighbouring industrial operators in the event of an emergency
- ECS 15: Heat sink design review
- ECS 16: Emergency water supply resources
- ECS 17: Reinforcement of the facilities to manage long-term situations of total loss of heat sink or total loss of electrical power supplies.
- ECS 18: Ultimate backup diesel generator sets
- ECS 20: Reinforcement of pool condition instrumentation
- ECS 23: Placing a fuel assembly in safe position during handling;
- ECS 24: Thermohydraulic development of a pool accident

- ECS 30: Designing the emergency premises to withstand earthquakes and flooding
- ECS 31: Modifications to ensure facility management further to releases
- ECS 32: Multiple plant unit emergency organisation
- ECS 34: Updating of agreements with hospitals
- ECS 36: FARN (Nuclear rapid intervention force)

Research reactors

The ASN opinions and requirements following the stress tests on the research reactors under construction are presented in § 6.3.2.

14.1.4.3 The ATMEA1 reactor

The ATMEA company, a joint-venture created by the French company AREVA and the Japanese firm Mitsubishi Heavy Industries (MHI), asked ASN, in accordance with authorisation procedures (see § 7.2.1), to conduct a review of the safety options for a new pressurised-water reactor called ATMEA1. According to ATMEA, this medium-power reactor (1,100 MWe) is intended primarily for export. ASN responded favourably to the ATMEA request and signed an agreement clarifying this review process. The purpose of this review of the safety options, performed with the support of IRSN, is to assess whether the ATMEA1 safety options are in conformity with French regulations. The review began in the summer of 2010 and continued in 2011 with consultation of the Advisory Committees for reactors (GPR) and for nuclear pressure equipment.

ASN made public the conclusions of this review in early 2012. It considered that the safety options for the ATMEA 1 reactor are on the whole satisfactory and in conformity with the French requirements. Nonetheless, a few measures to ensure compliance with French practice could lead to changes to the design or construction if such reactor would be actually built in France. At the detailed design stage, the ATMEA company will be particularly vigilant with regard to optimising worker exposure to ionising radiation, to the provisions necessary for the “virtual elimination” of certain accidents or to the preclusion of rupture of certain pipes and, of course, with regard to the continued efforts to learn the lessons from the Fukushima Daiichi accident. This safety options review will also enable ASN, as necessary, to assist the safety regulators of any countries in which this reactor would be built.

14.2 Safety assessment and verification during operation

14.2.1 ASN requests

ASN asks the licensee to set up an integrated safety management system able to maintain and continuously improve safety, notably during operation of the nuclear facilities.

14.2.1.1 Correcting anomalies

Deviations are detected in the NPPs through the proactive attitude of the licensee and through the systematic checks requested by ASN. The periodic safety reviews and the deviation searches continuously performed by the licensee play an important role in maintaining an acceptable level of safety.

Systematic checks are performed by the licensee every ten years on the occasion of the periodic safety reviews (see § 6.3.1.1 and § 14.2.1.3). The licensee then compares the actual condition of the facilities with the applicable safety requirements and lists any deviations.

“Continuous” checks are also performed by the licensee as part of the periodic test and preventive maintenance programmes carried out on the equipment and systems (see § 19.3).

ASN requires that deviations with an impact on safety be corrected within a time-frame compatible with their degree of severity. ASN thus examines the remediation procedures and deadlines proposed by EDF.

14.2.1.2 Examining events and operating experience feedback

ASN requires that the licensees notify it of any significant events (see § 19.6 and § 6.2). These events are the subject of a more detailed analysis.

Integrating experience feedback and processing of significant events are also subjects of particularly close attention during ASN inspections.

Finally, the Advisory Committees periodically review national and international experience feedback from the facilities in operation.

14.2.1.3 Periodic safety reviews

In addition to these procedures made necessary by changes to the facilities or to their operating modes, the Environment Code requires that the licensee carry out periodic safety reviews every 10 years.

The periodic safety review is an opportunity to conduct a detailed, in-depth examination of the condition of the facilities, to check that they are in conformity with the applicable baseline safety requirements. Its aim is also to improve the level of safety in the facilities. The requirements applicable to the existing facilities are therefore compared with those to be met by the most recent installations, and the improvements which could reasonably be implemented are proposed by the licensee. The conclusions of these reviews are submitted to ASN, which may issue new demands to reinforce the safety requirements.

After consulting the Advisory Committees when necessary, depending on the facility concerned, ASN rules on the list of topics chosen for safety reassessments, during the phase referred to as the periodic safety review orientation. Following these reassessments, a batch of modifications to improve safety is defined. They will be deployed during the power or research reactor ten-yearly outage.

The conclusions of the nuclear power reactor reviews are presented in § 6.3.1.1.

With regard to the research reactors, these facilities are of an older design and their equipment is ageing. They have also undergone modifications during the course of their operation, sometimes without an overall safety review being conducted. As of 2002, ASN had informed the licensees that it considered that a safety review of the old facilities was required every 10 years. This provision is now written into the TSN act (now codified in books I and V of the Environment Code by order 2012-6 of 5th January 2012).

The periodic safety reviews on the CEA facilities have been scheduled according to a calendar approved by ASN. All of the facilities should undergo a first review no later than 2017.

14.2.1.4 Ageing phenomena

The periodic safety review is also an opportunity for an in-depth examination of the effects of ageing on the equipment. For the reactors going through their third ten-yearly outage, an ageing analysis must therefore be performed for all degradation mechanisms that could affect the components important for safety and the components that are not classified but which could have an impact on the operation of the components important for safety. Control of ageing must be demonstrated, relying on operating experience feedback, the maintenance provisions and the possibility of either repairing or replacing the components. On the occasion of the third ten-yearly outage of each reactor, this analysis leads to the production of a file clearing the reactor for continued operation.

Furthermore, with a view to continued reactor operations beyond 40 years (see § 6.4.1.4), ageing management and equipment obsolescence become key issues. EDF's proposals concerning the study programme to be launched were therefore submitted to the GPR at its meeting of 19th January 2012. Following this session, EDF undertook to carry out extensive studies in order to obtain a clearer understanding of ageing phenomena.

14.2.1.5 Modifications made to equipment and operating rules

In accordance with the principle of continuous improvement of reactor safety levels, but also to improve the industrial performance of its production tool, the licensees periodically made modifications to the equipment and the operating rules. These modifications are for instance the result of processing of deviations, periodic safety reviews or the integration of operating experience feedback.

The BNI procedures decree led to clarification of the requirements concerning the implementation of changes by the licensees and their review by ASN. In 2012, the equipment modification notifications received by ASN mainly concerned improvements to the safety level of the reactors and the correction of deviations.

14.2.1.6 Stress tests

The Prime Minister tasked ASN with carrying out a study of the safety of the civil nuclear facilities in the light of the Fukushima Daiichi accident.

This study was conducted following the specifications produced at a European level, with two extensions: on the one hand, the study conducted in France concerns all nuclear facilities, including research and fuel processing facilities[17] ; on the other, the specifications were supplemented by points concerning the use of subcontractors, which was also assessed.

According to the specifications, the stress tests consisted of a targeted re-assessment of the safety margins of the nuclear installations in the light of the events that occurred at Fukushima Daiichi NPP, namely extreme natural phenomena (earthquake, flooding) and combinations thereof, that placed intense demands on the safety functions of the installations and led to a severe accident.

The assessment first of all concerns the effects of these natural phenomena. It then looks at the case of a loss of one or more systems important for safety involved at Fukushima Daiichi NPP (electrical power supplies and cooling systems), regardless of the probability or of the cause of the loss of these functions. Finally, it looks at the organisation and the management of the severe accidents that could result from these events.

Three main aspects were included in this assessment:

- the measures integrated into the installation design basis and the conformity of the installation with the applicable design requirements;
- the robustness of the facility beyond its design basis; the licensee must notably identify situations leading to a sudden deterioration of the accident sequences ("cliff-edge effect") and present measures for preventing them;
- any possibly modification liable to improve the facility's safety level.

In these extreme situations, the approach presupposes successive loss of the lines of defence by applying a deterministic approach, independently of the probability of this loss. For a given facility, the assessment concerns on the one hand the facility's behaviour in response to extreme situations and, on the other, the effectiveness of the prevention and mitigation measures, recording any potential weak

[17] The 150 French nuclear facilities have been divided into three groups of descending order of priority for the stress tests: 80 priority facilities, including all the NPPs, were examined in 2011. A second batch of facilities is examined in 2012. The third batch will be examined on the occasion of their periodic safety reviews.

point and any "cliff-edge effect" for each of the extreme situations. The aim is to assess the robustness of the defence in depth approach and the pertinence of the accident management measures, and to identify the possible means of improving safety, both technical and organisational.

The scope of the stress tests covers the following situations:

- initiating events that can be envisaged on the site: earthquake, flooding, other extreme natural phenomena;
- induced losses of safety systems: loss of all electrical power supplies, loss of heat sinks, including the ultimate heat sink, combination of the two losses;
- severe accident management;
- conditions of recourse to subcontractors.

For each technical field, the licensee checked the design of the facility and assessed the available margins by identifying the level beyond which the severe accident becomes inevitable ("cliff-edge effect") and the level which the facility could withstand without jeopardising containment integrity.

Given that the stress tests approach in 2011 concerned a large number of facilities and that these facilities are operated by a small number of licensees, ASN introduced an intermediate step into the assessment process, asking the licensees to present the methodology they had adopted by 1st June 2011. These methodologies were on the whole considered to be satisfactory by ASN, subject to compliance with a number of particular ASN requests[18].

The reports submitted by the licensees on 15th September 2011[19] were analysed by IRSN, with the results presented to the GPR and the GPU. Following these presentations, the Advisory Committees formulated about ten recommendations, that ASN incorporated into its stress tests report[20].

On 26th June 2012, ASN adopted 32 resolutions[21], each one setting some thirty complementary requirements relating to the EDF nuclear power plants, to the AREVA facilities and to certain CEA reactors.

These resolutions oblige the licensees to conduct a considerable amount of work, involving significant investments in human resources and skills. This work has been started by some licensees and will take place over several years. For the more complex measures, whose completion dates lie further in the future, the resolutions stipulate interim measures. The details of the ASN requirements issued following these stress tests are given in § 6.3.1.3 and in § 19.4.4 for the nuclear power reactors.

The results of the work done during the stress tests are detailed in the French report for the second extraordinary CNS meeting.

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[18] Link to the ASN position statement on the methodologies adopted by the licensees for the stress tests http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-resolutions

[19] Link to the EDF reports (only in French): http://www.asn.fr/index.php/Les-actions-de-l-ASN/Le-controle/Evaluations-complementaires-de-surete/Rapports-EDF

Link to the CEA reports (only in French): http://www.asn.fr/index.php/Les-actions-de-l-ASN/Le-controle/Evaluations-complementaires-de-surete/Rapports-CEA

Link to the Areva reports (only in French): http://www.asn.fr/index.php/Les-actions-de-l-ASN/Le-controle/Evaluations-complementaires-de-surete/Rapports-AREVA

[20] Link to the ASN report on the stress tests: http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-report

[21] Link to the ASN resolutions: http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-resolutions

More specifically, for research facilities and other facilities regulated by ASN, which are of widely different types, ASN defined priorities for submission of the stress test reports concerning the nuclear facilities other than power reactors.

Three categories of facilities and of priorities were thus defined:

1. the four CEA research reactors, with the highest priority, assessed in 2011 following the same schedule as the power reactors: these are CEA's Osiris, Phénix and Masurca reactors, plus the Jules Horowitz Reactor (JHR);
2. three facilities considered to be of lower priority and dealt with in 2012: 2 other CEA research reactors (Cabri and Orphée), plus ITER;
3. for the other research reactors, experience feedback will be taken into account according to the ongoing or future requests, particularly within the framework of the periodic safety reviews.

For CEA's four top-priority experimental reactors – Osiris, Phénix, Masurca and the Jules Horowitz reactor (JHR) – as well as for the RHF, ASN issued additional requirements in its resolutions of 26th June 2012 for CEA and 10th July 2012 for ILL, in the light of the conclusions of the stress tests.

In 2013, ASN issued a position statement on the "hardened safety core" of the facilities for which the stress tests were examined in 2011 (priority 1 reactors). It also issued an opinion on the stress test reports transmitted in September 2012 (priority 2).

Finally, it also drafted resolutions concerning all the facilities which have not yet undergone the stress tests (priority 3). These resolutions in particular specify the deadlines for transmission of the stress test reports.

The ASN opinions and requirements for research reactors are presented in § 6.3.2.

14.2.2 Measures taken for nuclear power reactors

Periodic safety review

The safety review of the reactors, carried out by means of periodic safety reviews or reviews of certain thematic subjects, leads in a certain number of cases to nuclear reactor modifications. In most cases, these modifications are made in batches, each batch being implemented on all the reactors of the plant series concerned, with an initial reactor, referred to as the "first off", playing the role of prototype. This grouping of modifications allows greater consistency and industrialisation by facilitating scheduling, documentation updates and operator training.

These batches are generally implemented during the ten-yearly outages (VD) in order to minimise the impact of the work on reactor availability. The results of these programmes, covering the period 2007-2012, are presented in §6.3.1.1.

Description of the baseline safety requirements

Following each ten-yearly outage, the baseline safety requirements for each plant series change in order to take account of the safety improvements made.

EDF conformity check

The conformity of the facilities with the safety requirements is a major aspect of the exercise of the responsibility of a nuclear licensee, at several levels.

At the design stage, the designer defines a reference facility (plant series) meeting these requirements and ensures construction according to predetermined rules able to verify the conformity of the facilities up to industrial commissioning.

During operation, the licensee ensures that the conformity of the facilities with the safety requirements is maintained by means of permanent or periodic surveillance processes.

During the periodic safety review, EDF identifies the points requiring:

- additional analysis, with regard to the safety case of the reference facility;
- specific checks to be carried out on the actual reactors, in addition to the surveillance measures that already exist.

The conformity check programme consists of a range of specific checks or targeted actions concerning topics relating to the requirements and, in certain fields, enabling a baseline for the state of the installations to be established. Implementation of this programme is a means of identifying deviations for which processing is important in safety terms, to adopt a position on the conformity of the reactors, but also to help identify lessons of use in strengthening the conformity of the facilities, with the aim of prolonging their service life. Any conformity deviations observed during this review are corrected no later than the ten-yearly outages for the reactors concerned.

Ageing phenomena

EDF has implemented a strategy based on three lines of defence: designed-in ageing prevention, surveillance and anticipation of ageing phenomena, and the repair, modification or indeed replacement of equipment liable to be affected.

14.2.3 Measures taken for research reactors

14.2.3.1 CEA reactors

All of the research reactors operated by CEA have now undergone a periodic safety review. This first review phase began in 2002 and ended in 2010 with the Eole and Minerve facilities.

The stress test reports for the 5 CEA facilities, including the Osiris, JHR, Masurca and Phénix reactors, were transmitted to ASN by CEA on 15th September 2011. They were reviewed at a joint meeting of the Advisory Committees in November 2011.

In 2012, CEA conducted stress tests on nine other facilities, including the Cabri, Orphée and Rapsodie reactors, as well as on the general resources of the Cadarache and Marcoule centres.

The reports were sent to ASN on 15th September 2012 and will be reviewed in early April 2013 by a joint meeting of the Advisory Committees.

14.2.3.2 The ILL high-flux reactor (RHF)

Following the first periodic safety review held in 2002, the RHF set up a special project organisation, the "*Refit Management Committee"* which, together with the reactor division, carried out work between 2002 and 2006 on the seismic resistance of the buildings, fire detection and the seismic qualification of certain equipment.

In 2007, a meeting of the Advisory Committee confirmed that the undertakings made had been satisfactorily met. The next periodic safety review is scheduled for 2017.

Between 2009 and 2011, the RHF also strengthened its defence in depth, by adding a new backup system to prevent and mitigate the consequences of a core melt accident.

Between 2012 and 2016, the ILL will continue to reinforce its defence in depth, with the performance of work defined following the post-Fukushima stress tests, thus creating a "hardened safety core" of emergency equipment. More particularly:

- a seismic depressurisation system to prevent any direct leaks and thus any unfiltered releases,
- a groundwater system to guarantee the long-term water inventory,
- an emergency command post will enable the facility to be monitored and the backup systems to be controlled, even after rupture of all the dams located upstream and after an earthquake far larger than the design-basis earthquake.

14.2.4 ASN analysis and oversight

14.2.4.1 Nuclear power reactors

14.2.4.1.1 Next periodic safety reviews

Following the stress tests, ASN asked EDF to include an assessment of the seismic robustness of the facilities beyond the design baseline. This assessment will aim on the one hand to periodically analyse the risks of a beyond baseline cliff-edge effect, on the basis of updated data and, on the other, to identify the works, structures and equipment necessary for safe shutdown of the reactor and requiring further reinforcement.

The methods for assessing seismic robustness beyond the design baseline that will be implemented during the forthcoming periodic safety reviews and how they are to be applied per unit, site or plant series were transmitted to ASN in late 2012.

14.2.4.1.2 Assessment and verification of nuclear power reactor safety for the period 2010-2012

Every year, ASN gives a general assessment of the performance of the EDF head office departments and NPPs in terms of safety, radiation protection, environment and labour inspection.

This assessment is itself based on the result of regulations carried out by ASN during the course of the year, in particular by means of inspections, oversight reactor outages and analysing the processing of significant events by EDF, as well as on the inspectors' familiarity with the sites they control.

ASN considered the years 2011 and 2012 to be satisfactory for EDF in terms of nuclear safety.

The overall assessment of each site represents ASN's viewpoint for the years 2011 and 2012. These data help guide ASN's regulation works for the subsequent years.

Belleville-sur-Loire

In 2011 and 2012, ASN considered that the performance of the Belleville-sur-Loire site was on the whole in line with ASN's general assessment of EDF concerning the safety of the installations.

In 2011, ASN noted progress which must be maintained in 2012 concerning operation of the facilities and the rigorousness of interventions. In 2012, ASN noted that the site was able to identify and implement corrective measures concerning certain operational deviations. However, the site needed to initiate progress in management of the periodic tests.

Blayais

Regarding nuclear safety, ASN considers that the site's performance in 2012 stands out positively with respect to its assessment of EDF as a whole. It was in line with the average performance in 2011.

In 2012, ASN considered that the site needed to be more rigorous in the preparation, performance and check of operating and maintenance activities. Consequently, the application of reliability enhancement practices needed to be improved.

In 2012, ASN noted that the maintenance operations during reactor outages were generally performed well, but considered that the site needed to improve the quality check of the activities carried out. The deployment of a new computer system on the site caused several organisational difficulties.

Bugey

In 2011 and 2012, ASN considered that the performance of the Bugey site was on the whole in line with ASN's general assessment of EDF.

In 2011, as in 2010, the quality of site operations showed signs of weakness. In particular, significant improvements were needed with respect to lock-out, circuit configuration and compliance with technical operating specifications. The site had to deal with a significant programme of reactor outages, in particular comprising the third ten-yearly outages for reactors 4 and 5, which lasted 5 and 6 months respectively. The restart of reactor 5 was disrupted by a number of operational incidents related to system configuration deviations.

During the first half of 2012, progress was achieved in compliance with the technical operating specifications. However, the site was unable to build on this progress in the second half of 2012. The site also shows recurring signs of weakness in the preparation for and performance of periodic tests or certain maintenance activities.

Finally, on 10th July 2012, ASN considered that reactor 2 of the Bugey NPP was fit for operation beyond its third periodic safety review.

Cattenom

Whereas in 2011, ASN had considered that the performance of the Cattenom NPP was on the whole in line with its general assessment of EDF performance, it considered that in 2012 the site’s performance was on the whole in line with its general assessment of EDF performance but that its radiation protection performance fell short.

In 2012, ASN nevertheless considered that the site needed to improve its management of risks and work preparation, particularly with regard to communication between the various entities involved.

In November 2011, the IAEA carried out an operational safety review (OSART mission) of the Cattenom NPP, the second on the site after that of 1994, which confirmed ASN's opinion of the site.

Chinon

In 2011 and 2012, ASN considered that the performance of the site fell short of ASN's general assessment of EDF. The lack of stringency in the performance of operations and in application of the baseline requirements and operating procedures is a point that could be improved. A proactive action plan was implemented by the site's management. Through its regular regulations, supplemented by the in-depth inspection carried out in October 2012 on operational stringency, ASN does see improvements, even if no significant turnaround was observed. With regard to radiation protection, ASN observes a significant improvement since late 2011.

Chooz

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance.

In 2011, the site stood out positively with regard to compliance with the regulations on pressure equipment, especially concerning the main primary and secondary systems. This level was maintained in 2012. However, the site must remain attentive to fuel assembly deformation phenomena.

The site in particular needs to make progress in its work preparation and in the quality of the risk assessments drawn up prior to the work, and must pay particular attention to the maintenance of the equipment contributing to protection of the environment.

Finally, ASN considers that the site has regressed in terms of operational stringency and notes a rise in line connection errors in the facilities and errors in the planning of periodic tests.

Civaux

Whereas in 2011 ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance, it fell significantly short in 2012.

In 2011, ASN noted that the site needed to make progress in preparing for and improving the reliability of interventions and identified recurring conformity deviations on the seismic qualified equipment. In

2012, ASN considered that the site needed to demonstrate greater rigour in preparing for and carrying out operation and maintenance and that the monitoring of these activities needed to be improved.

Cruas-Meysse

Whereas in 2011 ASN considered that the performance of the Cruas-Meysse site was on the whole in line with ASN's general assessment of EDF, its performance in 2012 was considered on the whole to be falling short. In 2012, ASN particularly noted a lack of proficiency in maintenance and operation during the reactor outage phases, resulting in significant extensions to the initial outage schedule.

ASN moreover observed that the restart of reactor 4 was marked by the notification of seven significant safety events, three of which were rated at INES level 1, highlighting shortcomings in the line connection and system configuration activities. Considering that EDF needed to significantly improve its results in this field, ASN issued a resolution on 10th July 2012, instructing the Cruas-Meysse site to reinforce the technical checks and the performance of audits concerning line connection and system configuration operations.

Finally, ASN considers that in general the management of skills on the Cruas-Meysse site needs to be significantly improved in order to guarantee that qualifying training, in particular the conversion courses, is carried out in accordance with the baseline requirements in force on the site.

Dampierre-en-Burly

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance.

In 2011, efforts to improve operational stringency needed to be continued and quality deviations in the preparation for and performance of maintenance operations had also been detected.

In 2012, progress was observed in operational and maintenance activities, despite a particularly dense programme of reactor outages. However, the management of the material resources required during the incident or accident operating phases needs to be significantly improved.

Fessenheim

Whereas in 2011, ASN considered the site's performance to be satisfactory and in line with ASN's general assessment of EDF performance, its nuclear safety performance stood out positively in 2012, while radiation protection performance fell short.

ASN noted progress in the maintenance of the facilities and the monitoring of outside contractors in 2011, which was a particularly busy year, notably with the third ten-yearly outage of reactor 2 and a concomitant shutdown of reactor 1. The licensee took into account experience feedback from the previous outages.

In addition, a considerable amount of equipment was replaced in order to improve the condition of the facilities.

In 2012, the site stood out positively with regard to preventive maintenance during the outages (for example, replacement of the steam generators for reactor 2), and demonstrated considerable reactivity in incorporating regulatory requirements. Completion of the works associated with the continuation of reactor 1 operations, within the deadlines set by ASN, enables the level of safety of the installation to be improved.

Flamanville

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance.

In 2011, the site needed to continue its efforts in the organisation and safety culture fields and also needed to make progress in managing reactor outages, in terms of reactivity and anticipation concerning the technical issues with safety implications.

In 2012, the site continued its efforts to catch up on longstanding and substantial delays in carrying out certain maintenance operations. However, the site needs to make progress in the preparation, performance and check of maintenance activities. The site must also reinforce its reliability enhancement practices when carrying out interventions in the facilities.

Golfech

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance and that its radiation protection performance stood out positively.

The operating teams performed satisfactory surveillance of the facilities, but ASN identified a lack of rigour in the preparation, performance and second-level check of operational activities and in the monitoring of maintenance activities performed by outside contractors. Furthermore, inclusion of the seismic risk and the management of emergency situations need to be improved, along with monitoring of outside contractors during maintenance work, in view of the late detection of several deviations.

Gravelines

In 2011 and 2012, ASN considered that the performance of the Gravelines site was on the whole in line with ASN's general assessment of EDF performance.

However, the site must improve its operational rigour, the analysis of significant safety events and the quality of maintenance operations which have been the cause of a rise in the number of significant safety events. The licensee will also need to address the conformity deviations of certain equipment items that could be affected in the event of an earthquake.

In 2012, EDF continued the programme of the third ten-yearly outages for the Gravelines NPP. ASN examined the results of the inspections of reactor 1 which had suffered a crack in a reactor bottom-mounted instrumentation penetration. ASN authorised restart of this reactor, provided that compensatory measures were taken, with mandatory repair at the next outage. ASN also analysed the results of the checks carried out on reactor 3, for which the steam generators were replaced during the ten-yearly outage.

In 2011 and 2012, ASN noted the positive development in the way EDF takes industrial risks into account in the site environment. These efforts must be continued, in particular with regard to the methane tanker terminal which is under construction close to the site.

An OSART mission was conducted on the Gravelines suite by a team of 14 IAEA experts in November 2012. This is the first IAEA assessment in France since the Fukushima Daiichi accident and this mission examined numerous topics related to nuclear safety, radiation protection, fire protection and management of emergency situations.

Nogent-sur-Seine

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance.

The site is no longer making progress in terms of stringency of operations. 2011 was marked by errors in reading the facility operating rules and failures in the management of equipment lock-outs. Furthermore, the dissemination of experience feedback among the operating teams needs to be improved. 2012 was marked by errors in line connection and by insufficient oversight during steam generator control operations. This second point clearly highlights the fallibility of the human resources available in the control room.

In addition, the site's maintenance performance, more specifically with regard to contractor monitoring, fell short of the general assessment of the EDF fleet.

Paluel

In 2012, ASN considered that the site's nuclear safety performance fell short of the general assessment, unlike in 2011.

In 2011 and 2012, several significant events notified by the site, the vast majority of which took place during reactor restart following a maintenance outage, revealed shortcomings in safety culture, in work preparation and in the check and monitoring of maintenance activities.

In 2012, the management of three reactor outages was problematical, involving numerous technical difficulties with equipment important for safety, entailing lengthy repairs. The site must therefore make progress in this field with a view to the next ten-yearly outages.

Penly

In 2011 and 2012, ASN considered that the performance of the Penly site stood out positively with respect to ASN's general assessment of EDF.

The site is on the whole maintaining the dynamism of previous years. However, the site will need to reinforce its organisational measures concerning contractor monitoring during reactor outages, particularly with regard to the resources allocated in the field.

In the last quarter of 2011, reactor 1 underwent its second ten-yearly outage.

Saint-Alban

After three years in which it fell short of ASN's general assessment of EDF performance, ASN considered that the site's performance in 2012 was generally in line with its assessment of EDF performance.

ASN in particular notes that the site has improved the deployment of its independent safety organisation and reinforced the robustness of the analyses it produces. In addition, in 2012, the Director of the Saint-Alban site and the Director of the EDF nuclear production division defined the organisational measures they intended to deploy in order to respond to ASN's findings following the in-depth inspection carried out in September 2011. Thus, in the light of the inspections performed in 2012, ASN notes that although they remain fragile, the site's nuclear safety results are on the whole improving, as the fundamental actions initiated by EDF begin to bear fruit. However this improvement must be sustained over the long term.

Saint-Laurent-des-Eaux

In 2011 and 2012, ASN considered that the performance of the site was on the whole in line with ASN's general assessment of EDF performance.

In 2012, significant progress was made by the site on most of the weak points identified in previous years, such as problems with technical checks and with preparation and coordination of work. Nonetheless, particular attention must be given to the management of operating documents.

Tricastin

In 2012, ASN considered that the site's performance was on the whole in line with its general assessment of EDF performance, whereas it had stood out positively in 2011. This performance needs to be significantly improved with regard to periodic testing, post-maintenance equipment qualification and, to a lesser extent, line connection and systems configuration. The site will also need to fully assume its responsibility as licensee with regard to the files it submits to ASN.

In 2011, ASN also instructed the site to improve its protection against the flooding risk by carrying out work on the Donzère – Mondragon hydraulic structure. In June 2012, EDF submitted a file applying for authorisation to carry out this work.

14.2.4.2 Research reactors

14.2.4.2.1 Periodic safety reviews of research reactors

The main problem identified is linked to the fact that each research reactor is a special case, for which ASN must adapt its regulation, while ensuring that safety practices and rules are applied. In this respect, the last few years have seen the development of a more generic approach to the safety of these facilities, inspired by the rules applicable to power reactors, and more particularly the method of safety analysis by "postulated initiating events" and safety classification of the associated equipment. This has led to significant progress in terms of safety. This approach is now used for the periodic safety reviews of the existing facilities as well as for the design of new reactors.

14.2.4.2.2 Stress tests

For the facilities considered to be high priority, the stress test reports were submitted on 15th September 2011 by CEA and the ILL. At the request of ASN, these reports were analysed by IRSN and were presented to the Advisory Committees in November 2011. Following this analysis, the Advisory Committees issued about ten recommendations.

14.3 Application of probabilistic risk assessment methods

14.3.1 ASN requests

14.3.1.1 Nuclear power reactors

The safety case for these facilities is primarily based on a deterministic approach, whereby the licensee guarantees the facility’s ability to withstand reference accidents. This approach is supplemented by probabilistic safety assessments (PSA) based on a systematic investigation of the accident scenarios to evaluate the probability of them leading to unacceptable consequences. They enable an overview of safety to be obtained, incorporating both equipment strength and operator behaviour.

The PSAs help estimate whether the measures adopted by the licensee are satisfactory. They can be used to rank safety problems relative to the design or operation of reactors and are a tool for dialogue between licensees and the administration.

The PSAs are developed and implemented in conformity with the 2002-01 basic safety rule concerning the development and utilisation of probabilistic safety assessments. The rule covers the following aspects:

- French PSA doctrine;
- Scope of PSA coverage;
- Acceptable methods for performance of level 1 PSAs – internal hazards;
- Acceptable PSA applications.

The acceptable applications stipulated by this basic safety rule concern periodic safety reviews, probabilistic assessment of events, planned new facilities, determining the importance of safety systems and technical operating specifications.

For existing reactors, the practice is to perform a PSA for each series of similar reactors and to update it at each periodic safety review. ASN asked EDF to develop each PSA in conformity with this basic safety rule.

For future reactors (such as the EPR), the PSAs are developed at the same time as the design is fine-tuned, in order to highlight situations comprising multiple failures, for which steps must be taken to reduce their frequency or mitigate their consequences.

14.3.1.2 Research reactors

Pursuant to Article 3.3 of Part I of the BNI order, whereby the nuclear safety case shall also include probabilistic assessments of accidents and their consequences, unless the licensee demonstrates that this is irrelevant, ASN will request that the licensees of research reactors produce probabilistic safety assessments.

14.3.2 Measures taken for nuclear power reactors

The PSAs are useful in ranking and defining the steps to be taken in the light of the potential risk and participate in optimising the design and the operation of the plant units.

The PSAs are used during the periodic safety reviews to assess the frequency of core melt and how this has developed by comparison with the assessment made following the previous review, incorporating an analysis of the changes to the system characteristics and operating practices. The overall probabilistic core melt frequency target is thus consistent with the recommendations of INSAG 12.

In addition, the PSAs also contribute to two activities carried out during a review:

- definition of the complementary field;
- the Cost – Benefit – Safety approach.

Two types of PSAs are produced for nuclear power reactors:

- Level 1 PSAs which identify the sequences leading to core melt and determine their frequency,
- Level 2 PSAs which assess the nature, importance and frequency of releases outside the containment.

Table 5: PSAs currently available and the main categories of initiating events considered for each French reactor plant series

Plant series	Events considered for the level 1 and 2 PSAs
900 MWe reactors (CP0-CPY)	Failures within the reactor (PSA 1 and 2) Fire (PSA 1) Earthquake (Tricastin)
1300 MWe reactors (P4-P'4)	Failures within the reactor (PSA 1 and 2) For the safety review associated with the 3rd ten-yearly outage, the following shall also be considered: o the events associated with the spent fuel pool (PSA 1 and 2); o on-site fire and flooding (PSA 1); In addition, studies are carried out to verify the possibility of extending PSA 1 to include earthquake, extreme climatic hazards and external flooding.
1500 MWe reactors (N4)	Failures within the reactor (PSA 1) A level-2 PSA and a fire PSA (levels 1 and 2) will be carried out for the next periodic safety review.
1650 MWe reactors (EPR) under construction	With a view to the commissioning authorisation application, the level-1 PSA will be revised and the level-2 PSA will be established. They shall take into account: o the events within the reactor; o the events associated with the spent fuel pool; o earthquake; o internal fire and explosion (initiating events approach); o on-site flooding

Probabilistic assessment of events in the NPPs in service

The main goals of the probabilistic assessment of events are to rank the events according to the probability of core melt and the assessment of the pertinence of the corrective actions.

These main objectives are supplemented by two others, which are to enhance the licensee’s safety culture and improve the PSAs.

This exercise has been carried out by the licensee on an annual basis since 1994.

PSA contribution to the technical operating specifications

The PSAs help shed light on how to respond better to unavailability of an equipment item required by the technical operating specifications and how to rank the requirements in the light of the importance for safety of the postulated unavailabilities.

They can be used to assess the increased core melt frequency for all reactor states, in the light of the unavailability(ies) concerned, and during transients between states.

They can also be used to support the licensee when requesting authorisation to perform a particular intervention and/or for operation in a reactor state that is not in conformity with the technical operating specifications, in order to justify that that resulting increased core melt frequency is limited, taking account of any mitigating measures it intends to implement.

14.3.3 Measures taken for research reactors

14.3.3.1 CEA reactors

With regard to research reactors, the specificity of each one makes it hard to carry out PSAs, which are not therefore performed for these facilities, but ASN will request probabilistic safety analyses.

14.3.3.2 The ILL high-flux reactor (RHF)

In the light of the forthcoming periodic safety review scheduled for 2017 and more specifically the revision of its safety report, the ILL proposed a methodology for conducting the safety assessments, based on a deterministic approach, but also on PSAs.

14.3.4 ASN analysis and oversight

ASN’s assessment of the changes made by EDF to the level 1 PSAs during the periodic safety reviews is on the whole positive. ASN notes the interest of the hazard PSAs, notably those concerning fire and internal flooding.

The “earthquake” PSA exercise carried out for the Saint-Alban NPP comprises the steps essential to its production. However, additional analyses are necessary, notably for the seismic hazard and for definition of the various equipment and structure failure modes and the fragility curves taking account of these various modes.

ASN considers that the methods and hypotheses adopted for the “internal events” PSA on the whole comply with the recommendations of basic safety rule (RFS) n° 2002-01. However, ASN observed that the reliability data for some equipment had been produced from old experience feedback, even though the PSAs must take account of changes to system characteristics, such as the equipment reliability data. ASN considers that the PSAs must use reliability data that are representative of the most recent operating experience feedback.

The “spent fuel pool” PSA does not currently cover all scenarios liable to lead to a loss of cooling or rapid emptying. The licensee must complete its assessment in order to allow a final ruling to be made on the modifications to be carried out for the VD3 1300 periodic safety review.

ASN considers that the “fire” PSA represents a significant contribution to risk assessment. It considers that the approach adopted by EDF is appropriate but that certain hypotheses and data must be further improved in order to rule on the modifications to be selected.

ASN considers that the “internal flooding” PSA is state of the art and represents significant progress in the PSA utilisation approach. ASN more specifically considers that this assessment highlighted the preponderance of scenarios which could lead to core melt following rupture of a fire extinguishing system in the electrical building.

The assessment concerning the feasibility and benefits of performing PSAs for extreme climatic conditions and external flooding, highlighted the difficulties in estimating the probability of hazards linked to natural phenomena. However, ASN considers that complete PSAs, partial probabilistic assessments or margin assessments must be carried out for these hazards for the next periodic safety reviews.

15. Article 15 : Radiation protection

Each Contracting Party shall take the appropriate steps to ensure that in all normal operational states the radiation exposure of 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 has been extensively modified in recent years. The legislative system is now relatively complete and the publication of the application documents is well advanced, even if not as yet complete.

The European Commission has started work on merging into a single text several Euratom directives, including those concerning basic radiation protection standards, protection of patients against medical exposure and the regulation of high-level sources. This proposal is currently being examined at a European level and its publication is planned for 2013.

15.1.1 The Public Health Code and the general principles of radiation protection

Chapter III dealing with ionising radiation of Title III of Book III of the legislative part of the Public Health Code defines all “nuclear activities”, that is, all activities 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 defines 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 (ICRP) 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 set up and chaired by ASN, with a view to regulating the application of its radiation-protection provisions. The code also defines a system of administrative or criminal penalties.

15.1.1.1 The justification principle

"A nuclear activity or 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 the individuals are likely to be subjected”.

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

15.1.1.2 The optimisation principle

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

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

15.1.1.3 The limitation principle

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

The exposure of the general public or workers as a result of nuclear activities is subject to strict limits (see § 15.1.2.1 and § 15.1.3.1). If these limits are exceeded, this situation is considered to be unacceptable and can lead to administrative or criminal penalties.

15.1.2 General protection of the population

In addition to the particular radiation protection measures taken for the individual authorisations concerning nuclear activities, for the benefit of the general public and the workers, several more general measures incorporated into the Public Health Code help protect the public against the dangers of ionising radiation as a result of nuclear activities.

15.1.2.1 Dose limits for the general public

The effective annual dose limit received by a member of the public as a result of nuclear activities is set at 1 mSv; the equivalent dose limits for the crystalline lens of the eye and for the skin are set at 15 mSv/year and 50 mSv/year respectively (average value for any 1 cm^2 area of skin). The method of calculating effective and equivalent doses, and the methods used to estimate the dose impact on a population, are defined by the order of 1st September 2003.

15.1.2.2 Radiological monitoring of the environment

15.1.2.2.1 The objectives of environmental monitoring

The objectives of environmental monitoring are to:

- contribute to the knowledge of the radiological and radio-ecological state of the environment of the installation, and its evolution;
- to contribute to estimating the impact of the facility on health and the environment;
- to detect any abnormal increase in radioactivity as early as possible;
- to ensure that the facility is not malfunctioning;
- to contribute to public information.

15.1.2.2.2 The French national network of environmental radioactivity measurements (RNM)

The French national network of environmental radioactivity measurements (RNM) was created by the Public Health Code and its aim is to provide the public with the results of environmental radioactivity monitoring and information concerning the health impact of nuclear activities nationwide in France.

ASN’s 29th April 2008 resolution describes the working of the RNM and defines the laboratory approval procedures. ASN thus determines the RNM guidelines and issues approval of the laboratories taking the measurements. In this respect, it chairs the RNM steering committee and the measurement laboratories accreditation commission. This network is managed by IRSN.

The non-regulatory measurements taken by accredited laboratories can also be made available to the public. An average of 15,000 measurements are thus added every month and more than 750,000 measurement results have been transmitted since 2009.

15.1.2.2.3 ASN duties concerning regulatory radiation protection monitoring

The Environment Code gives ASN the task of *"organising a permanent watch regarding radiation protection across the country"*, of which radiological and environmental monitoring form an integral part.

In this capacity, ASN issues technical regulatory resolutions, either of a general scope, if they apply to all BNI operators, or of a more individual scope, if they regulate a specific installation. ASN thus sets the minimum prescriptions for monitoring radioactivity in the environment with a view to ensuring subsequent compliance with these prescriptions.

ASN also plays a major role in public information notably by ensuring that environmental information is available to the public.

Lastly, ASN helps the Ministry of Health to develop technical provisions applicable to health monitoring of the radiological quality of waters intended for human consumption and for the accreditation of laboratories performing these health monitoring.

15.1.2.2.4 Other monitoring players

General radioactivity monitoring nationwide is the responsibility of IRSN.

IRSN monitors the environment by means of measurement and sampling networks for monitoring the air, surface water and groundwater, the human food chain, along with terrestrial continental monitoring.

Two approaches are used for this:

- continuous on-site monitoring by self-contained systems (remote monitoring networks) with real-time transmission of results, including:
  - the Teleray network based on 163 measurement detectors. The on-going refurbishment plan provides for an increase in the network to about 450 detectors by 2015,
  - the Hydroteleray network (monitoring of the major rivers)
- laboratory processing and measurement of samples taken in various compartments of the environment in the vicinity of or at a distance from installations likely to discharge radionuclides (sampling networks, such as OPERA[22] in particular).

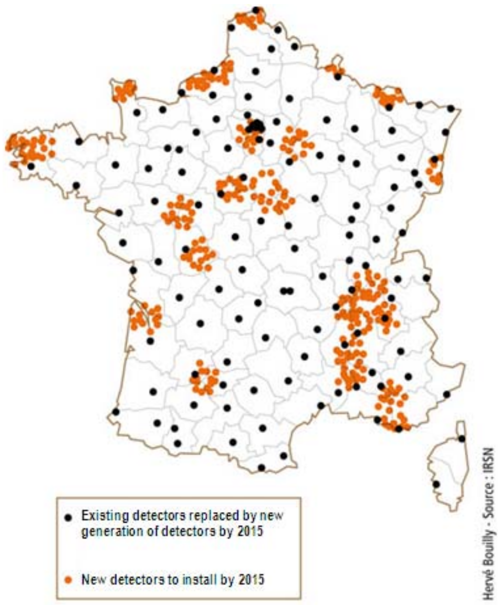

Figure 3: Teleray network in 2015 (source IRSN)

15.1.2.2.5 Radioactive waste and effluent

Management of waste and effluents from BNIs and ICPEs is subject to the provisions of the particular regulatory regimes concerning these facilities.

Although directive 96/29 Euratom so allows, French regulations do not include the notion of a discharge threshold, neither for effluents, nor for solid waste. However, for the effluents from BNIs, discharge licenses set limits not to be exceeded, the discharge conditions and the environmental monitoring procedures.

[22] http://www.irsn.fr/en/research/scientific-tools/experimental-facilities-means/Opera/Pages/Opera-network.aspx

In practice, the discharge of waste and effluents is monitored on a case by case basis when the activities producing them are subject to authorisation (as is the case with BNIs and ICPEs) or can be the subject of requirements when these activities simply require notification.

BNI discharges

A process of reduction of BNI discharges at source aims to reduce their quantity. The optimisation efforts initiated by the Authorities and implemented by the licensees lead to, for "equivalent operation", constantly, sometimes significantly, reduced discharges. Setting discharge limit values should encourage the licensees to maintain their optimisation and their discharge control efforts.

ASN defines the BNI discharge requirements, while those which more specifically set BNI environmental discharge limits must be approved by the Minister responsible for nuclear safety. Since 1st July 2012, any BNI modification project that could cause a significant increase in its water intakes or effluent discharges to the environment is now made available to the public for examination.

15.1.2.3 Protection of persons in a radiological emergency situation

The steps taken to protect persons in an accident or radiological emergency situation are detailed in § 16.

15.1.2.4 Reference and intervention levels

Intervention levels were updated in 2009 by an ASN resolution[23]. This resolution 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 the event of an emergency and the corresponding intervention levels are the following:

- sheltering, if the forecast effective dose exceeds 10 mSv ;
- evacuation, if the forecast effective dose exceeds 50 mSv;
- administration of stable iodine tablets, if the forecast dose to the thyroid is liable to exceed 50 mSv.

The reference exposure levels for persons intervening in a radiological emergency situation are also defined; two groups of intervention personnel are thus defined:

- the first group includes all members of staff forming special technical or medical intervention teams, which have been constituted in advance to deal with a radiological emergency;
- 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.

15.1.2.5 Protecting the population in the event of long-term exposure

Some sites are contaminated with radioactive materials due to a past or obsolete nuclear activity, or an industrial activity calling upon the use of raw materials containing non-negligible quantities of natural radioelements. The majority of these sites are listed in the inventory issued and periodically updated by ANDRA, the French national agency for radioactive waste management and can be consulted on its website www.andra.fr.

A new guide on the management of potentially polluted sites, drafted under the coordination of ASN and the Ministry of the Environment, was published in December 2011 and describes how to deal with the various situations that could be encountered when rehabilitating sites (potentially) contaminated by radioactive substances.

[23] ASN resolution of 18th August 2009.

15.1.3 Protection of workers

The Labour Code contains specific provisions for the protection of workers, whether or not salaried, exposed to ionising radiation. It transposes into French law the Euratom 96/29 and Euratom 90/641 directives concerning the protection of external workers liable to be exposed to ionising radiation during their work in limited access areas.

The link between the Public Health Code and the Labour Code is clearly established: the rules concerning worker protection were the subject of a specific decree, the provisions of which are included in the Labour Code.

For all workers (salaried or otherwise) liable to be exposed during their professional activity, the Labour Code also sets provisions more specifically concerning:

- worker dose limits;
- the technical rules for outfitting of working premises;
- the training and dosimetric and medical follow-up of workers;
- abnormal working situations (exceptional exposure);
- the functional organisation of radiation protection within the establishment (in particular the department with competence for radiation protection).

15.1.3.1 Dose limits for workers

Limits are set for the exposure levels induced for workers by nuclear activities. Worker dose limits have been reduced to 20 mSv over 12 consecutive months, except for specific waivers being granted to account for exceptional exposure or emergency professional exposure. In addition to this dose limit, referred to as the "effective dose" there are the following specific dose limits, known as the "equivalent dose" for individual organs or tissues:

- 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,
- 150 mSv for the crystalline lens of the eye;

There is also a dose limit for pregnant women, or more specifically for the unborn child (1 mSv for the period between the declaration of pregnancy and the actual birth).

The Labour Code prohibits the employment of temporary contract staff for the performance of work in areas where the hourly dose rate is liable to exceed 2 mSv.

If a temporary contract worker is exposed to ionising radiation and if at the end of his or her contract, this exposure exceeds the annual limit as calculated by comparison with the duration of the contract, the employer must propose an extension of the contract for a time such that the exposure observed at expiry of the extension is no higher than the annual limit value calculated by comparison with the total duration of the contract.

EDF also applies these requirements to staff under contract for the duration of the worksite, provided that their seniority within the company is less than six months.

15.1.3.2 Zoning

The regulations[24] set stipulations for definition of monitored, controlled and specifically regulated areas (particular controlled areas) and also defines health, safety and upkeep rules which must be applied in these areas.

[24] Order of 15th May 2006.

The definition of regulated areas takes account of the effective dose for external exposure and, as applicable, the internal exposure of the whole body, the equivalent doses for external exposure of the extremities and, as applicable, the dose rates for the whole body. The regulations set reference values.

15.1.3.3 Person Competent in Radiation protection (PCR)

The duties of the person competent in radiation protection (PCR) have been extended to include the delimiting of ionising radiation work areas and the study of exposed workstations and of measures to reduce exposure (optimisation). In order to fulfil his missions, the PCR has access to all data on passive and operational doses.

The regulations[25] identify three different activity sectors:

- o the "medical" sector groups nuclear and radiological activities in preventive and curative medicine;
- o the "BNI-ICPE" sector encompasses not only establishments consisting of one or more BNIs, but also those that include an ICPE subject to licensing;
- o the "industry and research" sector grouping all nuclear activities (Labour Code).

Training comprises a theoretical module and a practical module specific to each sector. The instructor must be certified by an organisation accredited by the French Accreditation Committee (COFRAC).

It is possible to call on the services of a PCR who is not on the payroll (said to be external) of the company carrying out the nuclear activity (for nuclear activities subject to notification).

15.1.3.4 Dosimetry monitoring of workers[26]

The procedures for certifying organisations in charge of worker dosimetry and those for the medical follow-up of workers and the transmission of individual dosimetry data, are defined by the regulations[27]. ASN examines the certification applications.

The external exposure monitoring system for persons working in facilities in which ionising radiation is used has been in place for several decades. It is based primarily on the mandatory wearing of passive dosimeters for workers liable to be exposed and enables compliance with the regulatory limits applicable to workers to be checked.

The data recorded indicate the total exposure dose over a given period. They are collated in the SISERI system managed by IRSN and are published annually.

At the national level, the SISERI system consolidates the following data:

- o passive external dosimetry, the results of which are supplied by the dosimetry organisations;
- o operational external dosimetry, the results of which are sent in by the PCRs;
- o monitoring of internal exposure, the results of which are supplied by the medical biology laboratories or the occupational health services, and the internal doses calculated by the occupational physicians;
- o aircrew dosimetry, the results of which are forwarded by the airlines;
- o monitoring of exposure to radon or to natural radioactivity, the results of which are supplied by the approved organisations.

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[25] Order of 26th October 2005 concerning PCR training and instructor certification.

[26] Information taken from the summary "Radiation protection of workers – Occupational exposure to ionising radiation in France: summary 2011" published by IRSN. Reference PRP-HOM/2012-007.

[27] Orders of 6th December 2003 amended and of 30th December 2004.

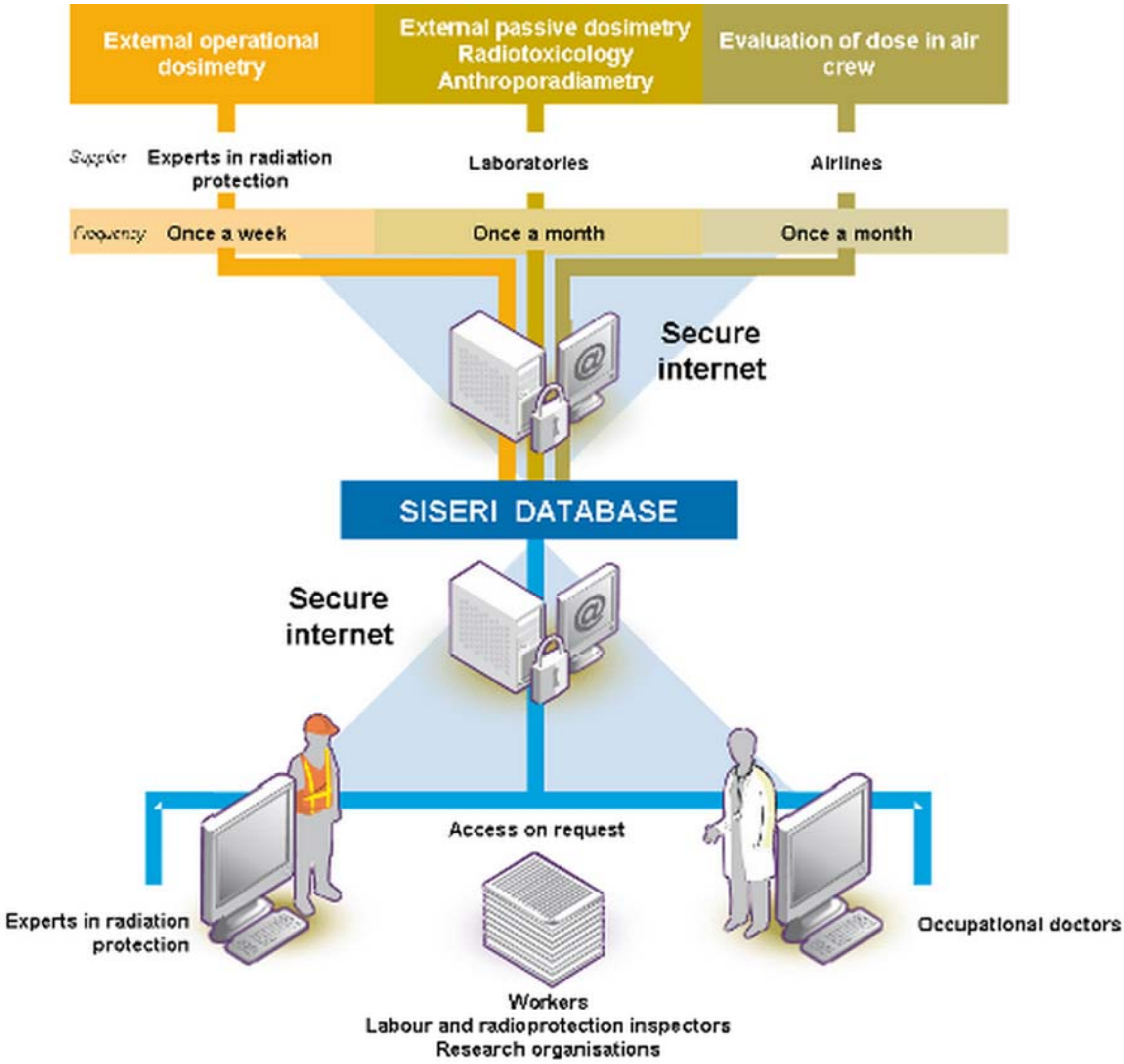

Figure 4: Working of the SISERI system (source IRSN)

If one of the limit values is exceeded, the occupational physician and the employer are immediately informed. The occupational physician notifies the employee concerned.

15.1.3.5 Radiation protection checks

The radiation protection checks can be entrusted to IRSN, to the department with competence for radiation protection or to approved organisations[28]. The nature and frequency of the radiation protection technical checks are defined by the regulations[29].

The technical checks concern sources and devices emitting ionising radiation, the environment, measuring instruments and protection and alarm devices, source management and any waste and effluents produced.

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[28] The list of approved organisations is available on the www.asn.fr website.

[29] Order of 26th October 2005 amended by the order approving the ASN resolution of 4th February 2010.

15.2 Measures taken 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. The majority of doses received can be attributed to external irradiation, which EDF is endeavouring to reduce in various ways.

In order to optimise and further reduce the doses received by exposed individuals, EDF launched its ALARA 1 policy in 1992, which was given fresh impetus in 2000. Considerable gains were then obtained, with the collective dose per year and per reactor falling from 2.4 man.Sv in 1992 to 0.67 man.Sv/ unit in 2012.

With regard to the individual dose, the doses of the most heavily exposed workers were significantly reduced in 2012. At the end of 2012, no workers (EDF and contractor personnel) had an annual dose between 16 and 20 mSv (as against 2 at the end of 2011). There were 3 workers with an annual dose of > 14 mSv (as against 20 at the end of 2011) and there are 263 workers with an annual dose of > 10 mSv (as against 424 at the end of 2011).

This dose optimisation approach is based on three fundamentals:

Reduced contamination of systems

Contamination of primary systems is the origin of exposure. Steps are therefore being taken to optimise the operation of systems and the facility outages (periods during which the main maintenance work is carried out) by modifying the chemical conditions or optimising the purification of the primary system water.

Foreign experience feedback shows that the controlled injection of zinc into the primary system reduces the contamination of the systems. To date, 14 reactors use this system, which should eventually demonstrate its effectiveness.

In addition, as in any NPP fleet, there are differences between the dosimetry results from the sites. The national engineering department has therefore since 2003 proposed helping the sites with understanding and treating the radiological pollution of their systems.

The success of the decontamination operations carried out in 2004 on the systems of Chinon reactor 2, with national level support, validated the method. Since then, Flamanville 1 was cleaned up in 2006, Gravelines 3 in 2007, Bugey 2 in 2008 and Blayais 4 in 2009, Gravelines 2 in 2010, Civaux 1 in 2011, Bugey 3 and Cruas 4 in 2012.

Preparation for interventions and dose optimisation

The process, common to all nuclear sites (EDF and contractor staff) is as follows:

- perform a forecast dosimetry evaluation for each operation (collective and individual dose),
- rank these operations according to the dosimetric implications,
- carry out an optimisation analysis of these operation according to the potential dosimetry. For work with the highest potential dosimetry, the operation is studied phase by phase, post by post, to determine the most appropriate protection, tooling and intervention methods,
- set a collective and individual dosimetry target for each operation as a result of this optimisation analysis,
- carry out real-time measurement of the changing collective and individual dosimetry of these operations, analyse and process any deviations,

- carry out experience feedback work, with analysis of deviations and good practices to be used for the benefit of future operations.

The measured dose received by workers on certain sites with potentially high dosimetry can now be retransmitted to a supervisor in real-time via a system of teledosimeters. This supervisor advises the worker and checks that any changes in the dose received are in compliance with the forecasts. A centralised supervisor experiment was carried out on three sites. The decision to extend it to all the sites was taken in 2012. Deployment to all NPPs should take place between 2016 and 2018.

Use and dissemination of experience feedback

To limit the doses received by the workers, EDF set up alert thresholds in the application for managing operational doses common to all EDF nuclear sites. These thresholds are set at 14 mSv for the pre-alert and 18 mSv for the alert. If these values are reached, special consultation procedures involving workers, doctors and radiation protection specialists are triggered. They lead to an assessment and detailed optimisation of subsequent doses, as well as enhanced follow-up to prevent regulatory limits from being exceeded.

The jobs subject to the highest exposure are given specific follow-up which is bearing fruit, as the individual doses are falling significantly.

Activities involving a significant risk of exposure to radiation are subject to a specific process

These specific activities comprise means of access to prohibited areas (dose rate higher than 100 mSv/h), to a lesser extent access to limited stay areas (dose rate higher than 2 mSv/h), and gamma radiography operations. If not managed, these activities could lead to occasional irradiation in excess of the forecast or greater than a regulatory limit. Specific organisations were formally defined and documented so that all the sites implement them in the same way. These organisations are periodically assessed by teams from the Nuclear Inspectorate, which is independent of the NPPs and which assesses all the sites. These sites are then classified according to a rating system which is monitored particularly closely by the Nuclear Operation Division. Any significant event concerning gamma radiography operations and the means of access to the prohibited areas is particularly closely monitored by the centralised engineering service and is the subject of a presentation by the site itself to the risk prevention committee dealing with radiation protection. This committee is chaired by the Deputy director of the Nuclear Operation Division.

15.2.2 Radiation protection of the public

15.2.2.1 Effluent discharges

For several years now, EDF has maintained efforts to reduce and control discharges.

15.2.2.2 Environmental monitoring

Radio-ecological monitoring is carried out every year on all nuclear sites in operation. This monitoring has been performed on the entire fleet since 1992 and gives an overview of the impact of the facilities in terms of both space and time.

The sites also produce ten-yearly summaries comparable to the “benchmark” baseline situation determined when the first reactor is commissioned on a site. Analysis of the results of radio-ecological monitoring and the ten-yearly summaries confirm that the 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 Measures taken for research reactors

15.3.1 CEA reactors

Dedicated teams monitor the facilities, the CEA personnel and, outside normal working hours, provide an on-call duty service.

Radiological monitoring of the personnel is performed on each site by specialised teams in charge of allocating and checking the passive dosimeters of the CEA staff. All of the values recorded are forwarded to IRSN. Every employee intervening within a controlled area is also equipped with an individual dosimeter to ensure continuous and real-time tracking of any doses received.

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.

On the basis of the principle of equivalence, CEA clarified the steps taken to organise the radiation protection of operations entrusted to outside contractors. For these operations with a risk of exposure to ionising radiation, the outside contractor has a PCR, in compliance with the regulations. Moreover, during the operations in the facilities, the radiation protection of the contractor's staff is guaranteed by a certified radiation protection technician, provided by and acting under the responsibility of the contractor company.

The effectiveness of the system put into place is clearly shown by the dose history of facility personnel and outside contractor personnel over the past three years (2010, 2011 and 2012): no CEA employee was exposed to an annual dose in excess of 5 mSv (reference dosimetry), with the annual collective dosimetry over this period remaining below 0.6 man.Sv, for the CEA staff and for the staff of outside contractors. The mean individual dose does not exceed 0.11 mSv for both CEA staff and those of outside contractors (operational dosimetry).

The environmental monitoring programme is drawn up and performed on each site by the departments with competence for radiation protection, under ASN regulation.

For all the CEA research reactors, gaseous and liquid discharges remain low and in any case below the discharge licence limits.

15.3.2 The ILL high-flux reactor (RHF)

The radiation protection department providing ILL and personnel monitoring comprises 9 persons. Outside normal working hours, an on-call duty service is provided on the ILL site

The effectiveness of the overall radiation-protection system in place is demonstrated by the dose history of BNI personnel, researchers and staff from outside contractors: over the last three years (2010, 2011 and 2012), no staff member was exposed to any annual dose exceeding 5 mSv and the total dose (personnel, researchers and contractors) during that period amounted to 0.2 man.Sv, thus corresponding to a low total annual average dose of 0.07 man.Sv, with the average individual dose not exceeding 0.2 mSv. The total average dose remains below 0.03 mSv for the 2,400 people wearing a dosimeter.

For the years 2010, 2011 and 2012, gaseous discharges stood at about 20 to 30% of the authorised carbon 14 limits, about 10 to 20% of the tritium and rare gases authorised limits and a few per cent for the other radionuclide categories.

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

15.4 ASN analysis and oversight

15.4.1 Exposure of workers

15.4.1.1 ASN regulation

One of ASN's duties is to check compliance with the regulations relative to protection of workers liable to be exposed to ionising radiation in BNIs. ASN focuses on all workers active on the sites, both in-house and external contractor staff, for the entire operating cycle of the facility.

This regulation takes two main forms:

- performance of inspections:
  - specific radiation protection inspections, scheduled one to two times per year and per site;
  - during reactor outages in the nuclear power plants;
  - following ionising radiation exposure incidents;
  - in the head office departments in charge of radiation protection doctrine.
- examination of files concerning the radiation protection of workers, which can cover:
  - significant radiation protection events notified by the licensee;
  - design, maintenance or modification files with national implications, produced under the responsibility of the licensee;
  - documents produced by the licensee concerning application of the regulations.

15.4.1.2 Nuclear power plants

Every year, ASN presents EDF with its assessment of the radiation protection situation on the sites. This summary is a means of comparing ASN's analysis with that of the licensee and of identifying possible areas for progress.

Periodic meetings are also held to check the progress of technical or organisational projects being considered or actually being deployed.

In the light of ASN's various findings during these inspections and analyses of significant events, it considers that the radiation protection organisation defined and implemented by the NPPs is on the whole satisfactory. The collective dose per reactor and the individual dose in particular fell slightly in 2012. This reduction is partly linked to a smaller volume of maintenance work than in 2011.

However, ASN considers that the average situation in the NPPs could be improved on a small number of points and that areas for improvement identified in recent years still need to be addressed.

ASN observes that the collective doses have reached a plateau of about 0.65 man.Sv per reactor, depending on the volume of maintenance work.

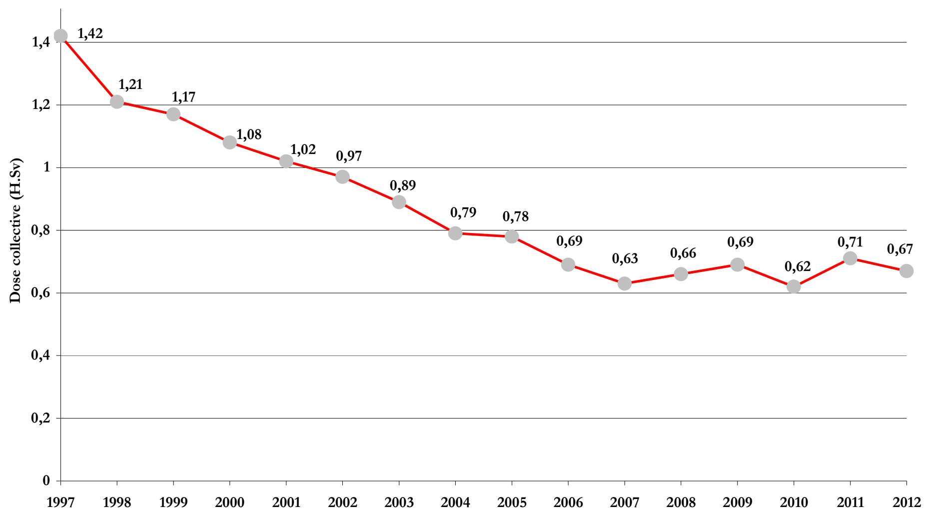

Figure 5: Mean collective dose per reactor (EDF data)

In preparation for the project to renovate the major components of the NPPs, ASN considers that in its future reactor outage campaigns, EDF must increase its efforts to limit the expected rise in collective doses.

ASN also notes in 2012 that, even though significant progress had been made in recent years, there has been an increase in the number of events concerning industrial radiography operations, in particular the quality of the clear marking out of the operations area.

Finally, EDF must improve the quality and integration of risk assessments, of contamination management in controlled areas, of monitoring the application of radiation protection rules, the management of mobile radiation protection devices and the dissemination of lessons learned and best practices, so that they reach the workers.

15.4.1.3 Research reactors

At CEA, the organisation of radiation protection is dependent on application of the fundamental principles of radiation protection:

- justification of practices;
- optimisation of exposure levels;
- limitation of individual exposure.

As well as by:

- application of the principle of equity: for equivalent work, the distribution of individual doses must be equitable in order to minimise dosimetry disparities between the workers.
- application of the principle of equivalence: the radiological protection measures and the level of personnel monitoring are the same for all exposed workers (CEA and outside contractors).

The following table gives the external passive dosimetry results for staff subject to dosimetric monitoring.

Table 6: External passive dosimetry summary for the period 2009-2011

	2009	2010	2011
Number of staff subject to dosimetric monitoring	7100	7021	6888
Dosimeters showing a dose < detection threshold	87 %	85%	87%

15.4.2 Exposure of the population and the environment

15.4.2.1 Monitoring of discharges in environment from NPPs

The monitoring of discharges and the environment around nuclear reactors is the responsibility of the licensee. The discharge authorisations stipulate minimum monitoring that have to be made by the licensee, in particular concerning effluents and environmental monitoring.

The results of regulatory measurements must be recorded in registers that are forwarded to ASN every month for monitoring purposes. They are also transmitted to the RNM. (See § 15.1.2.2.2)

The results of nationwide radiological monitoring are published annually by IRSN. They are drawn up on the basis of IRSN's measurements and are published on the RNM website.

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

Finally, ASN also carries out unannounced inspections. Since 2000, ASN carries out from 10 to 20 inspections with sampling per year (20 in 2012).

The nature of the environmental monitoring around the NPPs is presented in Appendix 4.

With regard to the environment, despite the positive moves observed in previous years and a satisfactory organisation on most of the sites, ASN in 2012 still observes numerous deviations by all the sites and considers that there is room for performance improvements in this field.

In the near future, ASN will continue its work with the licensee to optimise discharges, in accordance with the measures decided on following the meeting of the Advisory Committee for reactors in 2009 concerning the management of radioactive and chemical effluents associated with the NPPs in operation.

In 2011, ASN completed its review of the effluent discharge and water intake files for the Dampierre and Civaux NPPs.

In 2012, ASN continued to examine the files concerning the discharge of effluents and intake of water by the NPPs at Cruas-Meysse, Belleville-sur-Loire, Cattenom and Bugey.

ASN also initiated a review of the files for Saint-Alban-Saint-Maurice, Saint-Laurent-des-Eaux and Fessenheim. ASN will ensure that discharge limits are set for these sites according to the best available techniques and taking account of experience feedback from the NPPs in operation.

15.4.2.2 Research reactors

The water intake and discharge licenses for CEA Fontenay-aux-Roses are regulated by ministerial decrees dating from 1988. The obsolescence of these texts, which do not take account of changes to the status of the existing BNIs and to their activities and thus the resulting modifications to the discharges, led ASN to ask CEA to submit a water intake and discharge requirements modification file which was submitted in early 2013. This file is currently under review.

With regard to the Marcoule site, the liquid discharges from the civil BNIs are currently being treated by the secret basic nuclear installations (INBS). In 2012, CEA was authorised to continue to discharge liquid and gaseous effluents and to intake and consume water for the operation of the Marcoule INBS.

Discharges and water intake by the CEA Cadarache facility have not been modified recently.

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 for emergencies

The organisation of the public authorities in the event of an incident or accident is determined by a series of legal texts relating to nuclear safety, radiation protection, public order and civil protection, as well as the emergency plans.

The Act of 13th August 2004 relative to the modernisation of the civil protection defines new orientations. It provides in particular for an updated inventory of risks, an overhaul of operational planning, the performance of exercises involving the population, informing and training the population, an operational watch and a warning system. Several decrees implementing this Act were adopted in 2005, including in particular:

- Decree 2005-1158 of 13th September 2005 concerning off-site emergency plans (PPI in French);
- Decree 2005-1157 of 13th September 2005 relative to the ORSEC plan (general plan organising the emergency services if a disaster is declared by the State at departmental, defence zone, or *maritime Prefecture* level);
- Decree 2005-1156 of 13th September 2005 relative to the local safeguard plan.

The TSN Act stipulates that ASN assists the Government on all matters within its competence and defines the tasks of ASN. These tasks are detailed in § 16.2.

The scope of nuclear emergencies and more generally radiological emergency situations is detailed in the ministerial directives mentioned below. The organisation of the public authorities and the licensee is presented in the diagram below. It is designed to respond to the case of an accident in an EDF reactor. A similar organisation is set up for other nuclear operators or for an accident involving radioactive material transport.

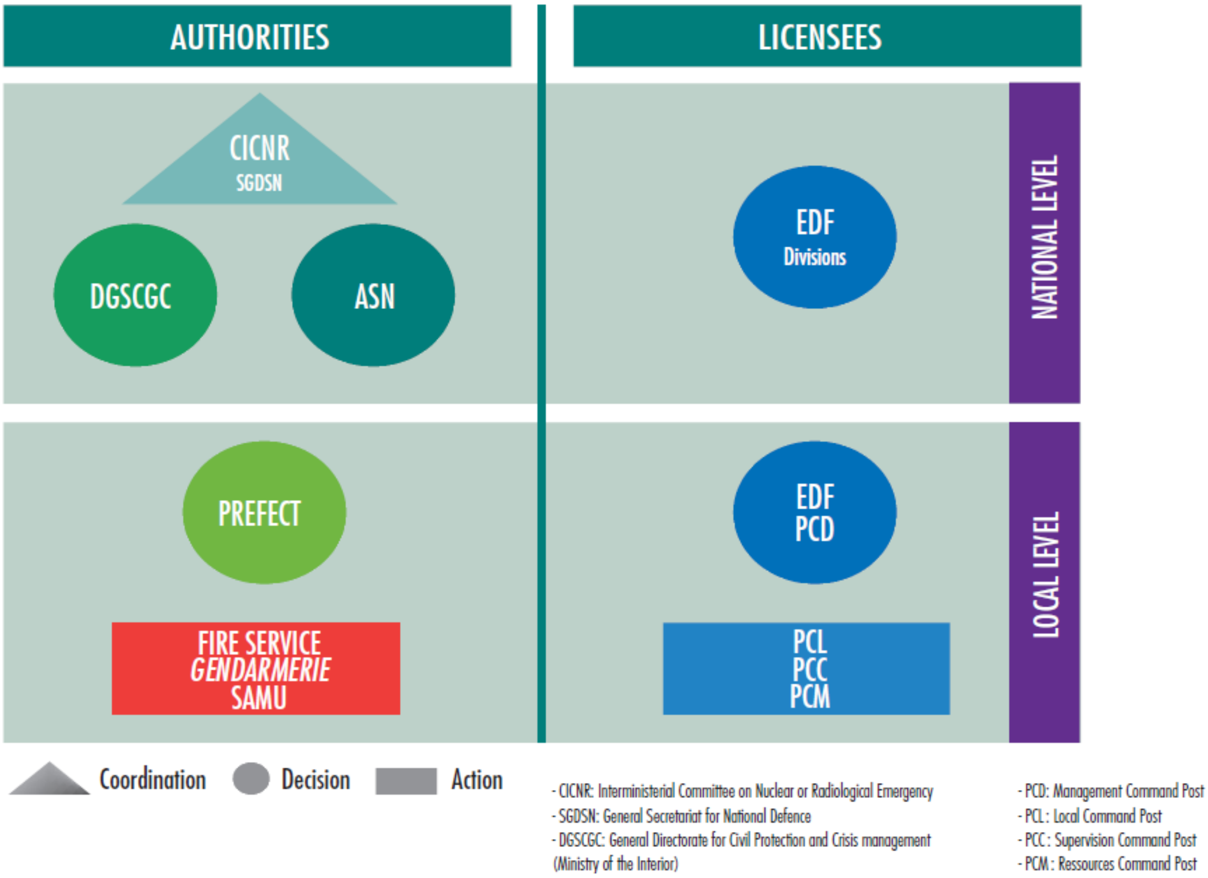

Figure 6: Emergency response organisation in an accident situation affecting a nuclear reactor operated by EDF

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 14th 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 event of a nuclear accident or radiological emergency.

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

Exercises are performed regularly, both to train the emergency teams and to test the means and organisational measures in order to identify and correct any malfunctions.

16.1.1 Local organisation

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

- The licensee of the affected nuclear facilities, who must implement the on-site emergency plan (PUI in French) which it is obliged to prepare;
- The Prefect of the *département* in which the facility is situated is responsible for deciding on the necessary measures to protect the population and the property threatened by the accident. The Prefect acts within the framework of the off-site emergency plan (PPI) prepared specifically by the Prefect for the vicinity of the installation in question.

The content and objectives of these emergency plans are detailed in section §16.1.3.1.

16.1.2 National organisation

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

The main entities involved are:

- The Ministry for the Interior, in which the General Directorate for Civil Security and Emergency Management (DGSCGC) is in charge of the Operating Centre for Interministerial Emergency Management (COGIC) and is assisted by the Nuclear Risk Management Aid Committee (MARN), which ensures in particular that the Prefect is provided with suitable material and human resources to protect the public and property;
- Ministry of Health: it ensures the protection of individuals against the effects of ionising radiation;
- The Ministry in charge of nuclear safety: the Minister in charge of Ecology takes part in national communication in the event of an incident or accident affecting a nuclear installation under its responsibility or occurring during the transport of radioactive materials;
- The Ministry of Foreign Affairs: is the national alert point with regard to the Convention on early notification of a nuclear accident, the Convention on assistance in the event of a nuclear accident or radiological emergency and the Council of the European Communities decision of 14th December 1987. The Ministry is in charge of, without prejudice to responsibilities of ASN and the Ministry of Interior, informing, where appropriate, member states and international organisations concerned. As and where necesseray, with the support of ASN and IRSN, the Ministry also informs the French embassy abroad and the foreign embassy in France on the provisions taken to protect the population.
- The Prime Minister, who can set up an emergency management unit and is assisted by the SGDSN (General Secretariat for Defence and National Security), which is responsible for ensuring the interministerial consistency of the planned measures in the event of an accident and for the planning and assessment of exercises. An Interministerial Crisis Committee (CIC) thus met many times when the Fukushima Daiichi accident occurred in Japan.
- Météo France: is tasked with assisting the public authorities by providing appropriate weather forecasts in the event of an actual or potential accidental release of hazardous materials into the atmosphere;
- ASN: is involved in the management of radiological emergency situations. It assists the government regarding all issues within its competence and informs the public about the safety of the facility causing the emergency situation. ASN's organisation relies notably on its regional divisions and on IRSN, its technical support organisation.

16.1.3 The emergency plans

16.1.3.1 The general principle

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

The purpose of the on-site emergency plan (PUI) is to restore the plant to a safe condition and mitigate the consequences of the accident. It describes the organisation and the means to be deployed on the site. It also includes the provisions for rapidly informing the public authorities. The PUI is activated by the licensee on the basis of 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) is to protect populations in the short term in the event of potential danger and provide the licensee with outside emergency response resources. It defines the duties of the various services concerned, the ways of broadcasting the alert and the material and human resources. The PPI is activated if measures to protect the population are found to be necessary.

16.1.3.2 Technical bases and countermeasures for emergency plans

The emergency plans must be prepared so as to bring an effective response to the accidents that could occur at BNIs This implies defining a technical basis, i.e. the adoption of one or more accident scenarios and identifying the most penalising characteristics of the possible consequences in order to determine the nature and extent of the resources to plan for. The approach relies primarily on a conservative theoretical approach leading to an estimation of the source terms, then calculating their dispersal in the environment, and finally assessing their radiological impact.

On the basis of the response levels updated in 2009 by ASN resolution 2009-DC-0153 of 18th August 2009 (see details of the sheltering measures, administering of stable iodine tablets and evacuation in § 15.1.2.4), it is then possible to define in the PPI the population protection measures which appear justified to limit the direct impact of the release.

To give an example, the accident scenario envisaged for a PWR could lead to a decision, taken within 12 to 24 hours, to shelter the population and administer stable iodine within a 10 km radius, and to evacuate the population within a 5 km radius.

It should be noted that the off-site emergency plans only provide for the emergency measures during the first hours of the accident. They do not prejudge the steps that could be taken in the longer term and over longer distances, in the framework of other civil protection or post-accident measures (see §16.5.3).

16.2 ASN's role and organisation

In accident situations, with the support of IRSN, ASN must ensure four tasks:

- check and ensure the validity of the measures taken by the licensee;
- advise the Prefect;
- help disseminate the information;
- act as competent Authority in the framework of the international agreements.

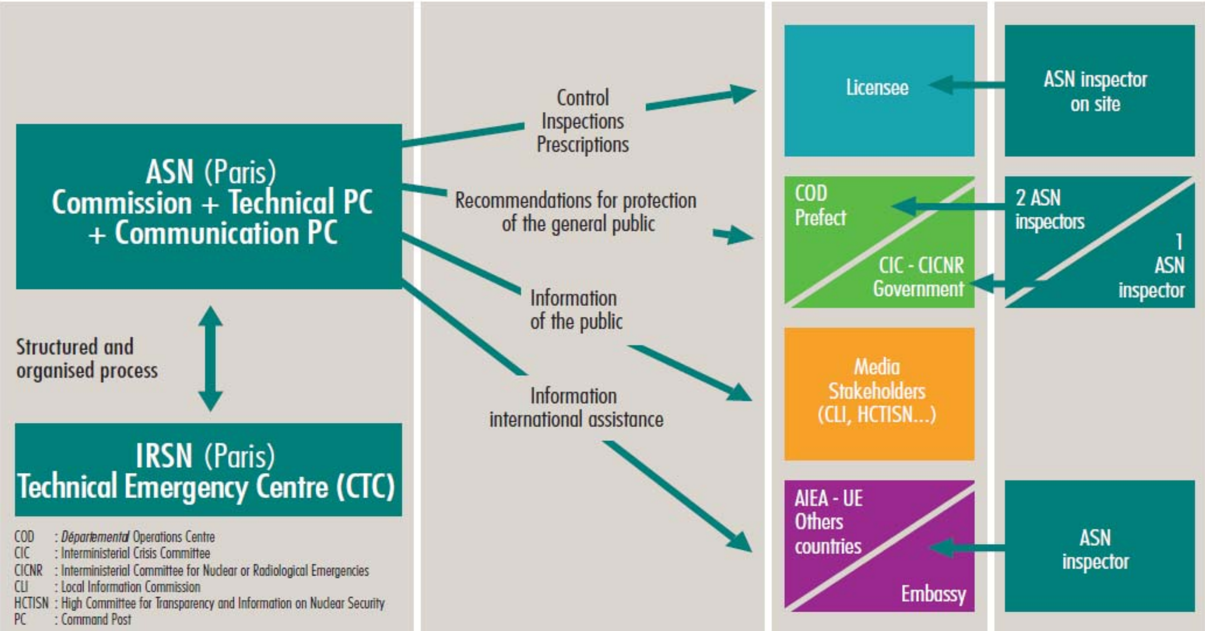

Figure 7: The role of ASN in a nuclear emergency situation

16.2.1 Oversight of the measures taken by the licensee

In this particular context, ASN must check that the licensee is fully exercising its responsibilities to control the accident, mitigate its consequences and inform the public authorities rapidly and regularly, without replacing the licensee in implementing the technical measures to cope with the accident. In particular, when several strategies are available to the licensee to control the accident, some of which could have substantial environmental consequences, ASN must check the conditions under which the licensee makes its choice.

16.2.2 Advising the Prefect

The Prefect's decision on the population protection measures to take depends on the effective or foreseeable consequences of the accident around the site. It is up to ASN to inform the prefect of its position on this subject, on the basis of the analysis performed by IRSN. This analysis focuses on both the diagnosis of the situation (understanding the situation of the affected facility) and the prognosis (evaluation of the possible short-term developments, especially radioactive releases). This advice also concerns the steps to be taken to protect the health of the public.

16.2.3 Dissemination of information

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

- ASN contributes to the **informing of the media and the general public**; it is important that this be done in close collaboration with the other entities that are required to communicate;
- **institutional information**: ASN keeps the Ministers concerned informed, along with the SGDSN which is responsible for informing the President of the Republic and the Prime Minister;
- **informing the foreign nuclear safety bodies**: without prejudice to application of the international conventions signed by France, ASN informs the foreign safety authorities.

16.2.4 Function of competent authority under the international conventions

ASN acts as competent authority with regard to international conventions signed by France (see § 16.1). In this capacity, it collects and summarises information in order to provide the notifications and information stipulated by these conventions with regard to the informing of third countries in the event of a radiological emergency situation. This information is communicated to international organisations (IAEA and European Union).

16.2.5 Organisation with regard to nuclear safety

16.2.5.1 The different action centres

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

16.2.5.1.1 At national level

ASN has an emergency centre in its offices in Montrouge, which is organised around:

- the ASN Commission, which may be brought to take decisions and issue requirements to the licensee in an emergency situation;
- a technical command post, which is in constant contact with ASN's technical support organisation - IRSN, and with the ASN Commission which takes the most important decisions. This echelon is directed by the ASN Director-General or his/her representative. Its role is to adopt positions to advise the Prefect who directs the emergency response operations, but not to make a technical analysis of the ongoing accident;

- a communication command post supported by an information unit situated near ASN's strategic management command post (PCD). The Chairman of ASN or his/her representative fulfils the function of spokesman, separately from that of head of the PCD.

ASN is supported by an analysis team located at IRSN's emergency technical centre (CTC). It must work in close collaboration with the licensee's technical teams in order to reach converging views on analysis of the accident situation and to predict its development and consequences. ASN and IRSN, its technical support organisation, have signed agreements with the main licensees covering the setting up of the emergency organisation. These agreements designate the entities in charge in the event of an emergency and define their respective roles and modes of communication.

16.2.5.1.2 At local level

The local organisation is as follows:

- a local team at the Prefect's office, consisting mainly of staff from ASN's regional divisions, whose role is to assist the Prefect in making his/her decisions and communication actions by providing explanations to help understand the technical aspects involved, in close collaboration with ASN's PCD;
- a local team at the affected site, also consisting of representatives from ASN's regional divisions (inspectors) who forward the positions adopted at the national level and check the decisions taken by the licensee. The local team also collects any information useful for the inquiry that will follow the accident.

Furthermore, experience feedback from the Fukushima Daiichi accident leads ASN to envisage sending one of its representatives to assist the French embassy in the country of the accident.

The following two diagrams show the relations between the public authorities, the Government and ASN, the licensees and the technical experts in a radiological emergency situation. These relations are organised around three circles of appraisal, decision and communication, within which regular audio-conferences are held.

The diagram below presents the exchanges leading to decisions and orientations concerning the safety of the facility and the protection of the general public (decision circle and appraisal circle).

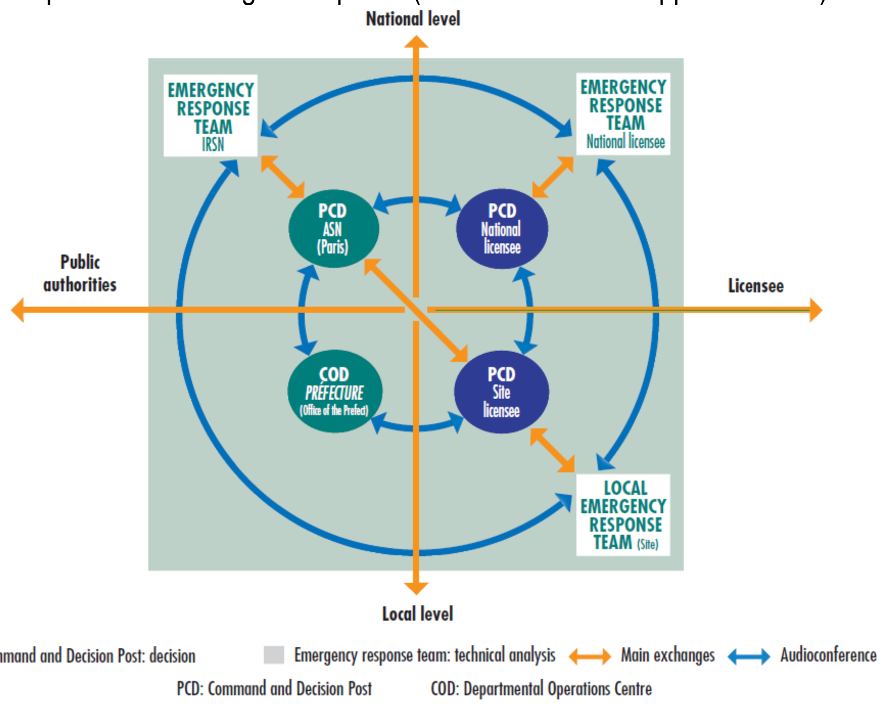

Figure 8: Planned safety response

An organisation with the same structure is set up between the communication units and the PCD spokespersons to allow the necessary consultation ensuring consistency of the information issued to the public and the media (communication circle):

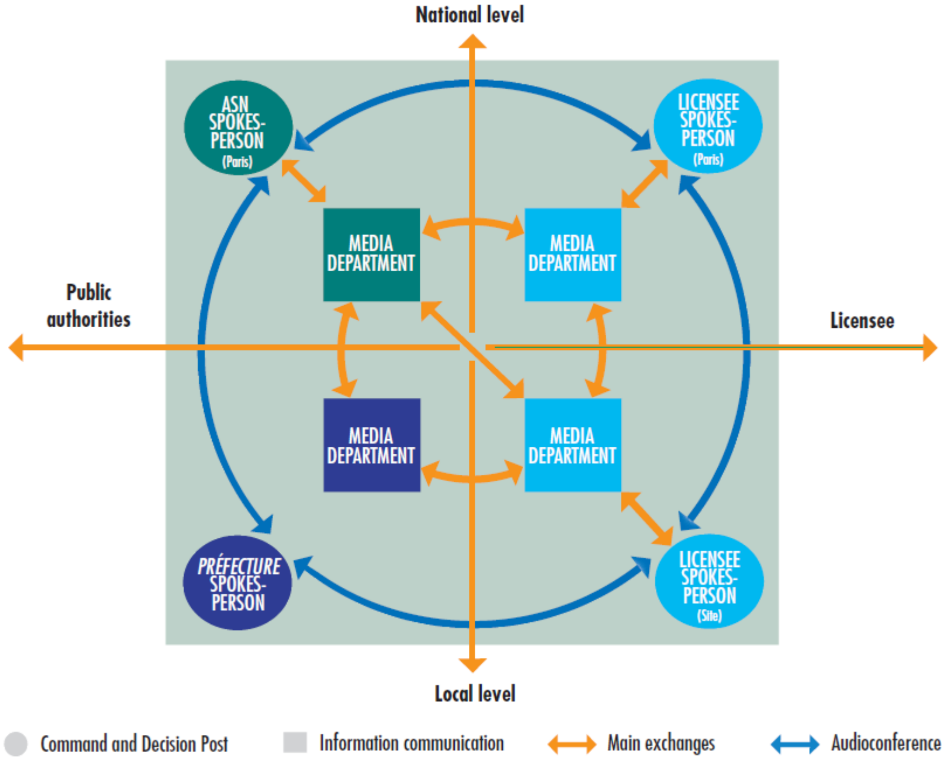

Figure 9: Planned communication response

For the year 2013, further to the experience feedback from Fukushima Daiichi accident and in order to train its spokespersons, IRSN will also be involved in the planned communication organisation.

16.2.5.2 ASN emergency response centre

To successfully fulfil its duties, ASN has its own emergency centre, equipped with communication and computerised tools for:

- rapidly alerting the ASN staff;
- alerting or informing the IAEA, the European Commission and the other countries;
- exchanging information under reliable conditions with its many contacts.

Since 2009, the emergency response centre has been deployed in real emergency situations on several occasions, the details of which are given in the following table:

Table 7: Deployment of the ASN emergency response centre in real situations

Date	Site	Alert	Event
24th January 2009	Blayais NPP	General	Flood risk due to very strong winds on the Gironde River
9th February 2009	Blayais NPP	General	Flood risk due to weather forecast
5th July 2009	CEA Cadarache centre	General then restricted	Forest fire near the site perimeter fence
1st December 2009	Cruas NPP	General	Shutdown of the reactor No. 4 following loss of cooling system due to the clogging of the water intake by a mass of plant debris
27th December 2009	Fessenheim NPP	General	Reduction of the water flow in cooling systems due to gradual clogging of heat exchangers

27th February 2010	Blayais NPP	General	Flood risk due to weather forecast
11th March 2011	Fukushima Daiichi	/	Deployment on ASN's initiative in order to monitor the development of the situation and provide regular information updates.
12th September 2011	Centraco plant	General	Explosion of a melting furnace
16th December 2011	Blayais NPP	General	Triggering of the on-site safety/flooding emergency plan
5th April 2012	Penly NPP	/	Deployment on ASN's initiative in order to monitor the development of a leak at the primary seal of a reactor coolant pump set.

The ASN alert system (radiomessaging or telephone) allows the rapid mobilisation of ASN staff, the IRSN duty engineer and staff from the DGSCGC, the SGDSN and Météo France.

The emergency centre is connected not only to the public telephone network but also to several independent restricted-access networks that provide direct or specific secured lines to the main nuclear sites. ASN's PCD also has a videoconference system that is used chiefly to communicate with IRSN's CTC. In addition, the PCD uses computing equipment specially adapted to its role, particularly for exchanging information with the European Commission and the member States (ECURIE - European Community Urgent Radiological Information Exchange System, and USIE - Unified System for Information Exchange on Incidents and Emergencies).

Since 2005, the PCD has had access to the dose rate values permanently measured by the probes in IRSN's Teleray network.

On the occasion of ASN's relocation to new premises in 2013, the emergency response centre was modernised, taking into account ASN's internal experience feedback on its organisation during the Fukushima Daiichi accident (see § 16.5.4).

16.2.6 ASN's role in the preparation of emergency plans

16.2.6.1 Approval and regulation of on-site emergency plans (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 that the licensee must submit to ASN at least six months before the use of radioactive materials in a BNI. In this context, the PUI is analysed by IRSN and the relevant advisory committee of experts issues an opinion on it.

ASN ensures proper implementation of the on-site emergency plans in particular through inspections and exercises.

16.2.6.2 Participation in off-site emergency plan (PPI) preparation

ASN assists the Prefect in the preparation of the PPIs by providing the basic technical elements derived from the IRSN analysis, taking into account the most recent available data on severe accidents and the dispersion of radioactive or chemical materials and ensuring consistency between the PPIs and the PUIs in this respect.

The intervention levels are defined on the basis of the most recent international recommendations, and since 2003 they are subject to regulatory requirements (see § 15.1.2.4).

16.3 Role and organisation of the reactor licensees

16.3.1 Role and organisation of EDF

16.3.1.1 Organisation

The emergency response organisation adopted by EDF as the nuclear operator fully meets the objective of covering situations presenting a significant risk for the safety of the facilities, and which can lead to releases of radioactive substances into the environment.

Outside this area, there are also many situations at an installation that require a rapid response.

Consequently, the following areas are covered by the emergency organisation:

- safety and radiological emergency situations triggering the PUI;
- the other situations covered, for which an appropriate internal organisation must be set up in advance in order to prevent the development of an emergency and to provide a suitable response, by bringing together the necessary and appropriate resources for the situation, such as:
    - situations requiring triggering of a conventional PUI: this organisation is deployed in the event of accidents in which persons are injured and/or in case of fire. In such cases, the first actions are dependent on the teams from the 24-hour duty services. The external emergency services are always called before this PUI is implemented;
    - certain external hazard situations resulting from weather conditions or human factors are also taken into account and in such cases the analysis of the organisation (local or national) set up to cope with these events is predetermined (scaled to manage an event affecting several reactors or even several sites).

EDF deployed in 2012, as planned, its revamped baseline emergency requirements: streamlined and standardised PUI (taking into account in particular the organisation and management of multi-unit accidents), and Support and Mobilisation Plans whose end-purpose is to ensure the structured deployment of all or part of the emergency teams in anticipation of a foreseeable hazard.

These revamped baseline requirements constitute a robust support for the changes in emergency organisation that will result from the Fukushima Daiichi accident experience feedback, with a first deployment deadline planned for late 2014.

The emergency organisation adopted by EDF since the start of operation of its NPP fleet to cope with such situations is based on human and material resources that can be mobilised 24 hours a day and 7 days a week, if an NPP calls the national emergency situation director.

The emergency organisation deployed following triggering comprises a national level and a local level. This organisation is structured in teams (or command posts - PC) covering the four broad areas for crisis necessary for emergency management (appraisal, decision, action and communication).

EDF's emergency structure and the missions of the different units are described below:

At local level

The unit manager or his/her representative is responsible for managing the emergency response. The emergency response manager directs the local strategic management command post (PCD) and ensures the implementation of the PUI.

Restoring the situation is primarily the responsibility of the operating team in charge of the affected reactor, which constitutes the local command post (PCL), under the responsibility of the shift operations supervisor in charge of the operating manoeuvres in accordance with the procedures in force.

The local PCD is assisted by two appraisal teams:

- the local emergency response team (ELC), more specifically in charge of the analyses of the state of the facility and predicting developments;
- the controls command post (PCC), responsible for assessing the consequences of the accident on the population and the environment.

All the technical information concerning the installation is sent to the local emergency response team (ELC), while the technical information concerning environmental monitoring is available at the PCC.

Environmental monitoring in accident situations is based largely on the monitoring resources used during normal operation (namely a network of radiation detectors and laboratory vehicles equipped with measuring and sampling equipment).

Meteorological data are provided by the weather station situated on or near the site.

In accordance with the specific agreement between EDF, ASN and IRSN, these two teams – ELC and PCC – inform the national technical teams (EDF and IRSN) and keep the local PCD regularly informed of events that could change the emergency management strategy.

The local PCD is also assisted by a resources command post (PCM), whose mission is to ensure all logistic actions on the site for managing the emergency. Its actions also cover the following areas:

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

At national level

The national strategic management command post (PCD-N) is directed by the head of the DPN (EDF's nuclear operations division); Working in permanent contact with the local PCD, it coordinates the actions taken by EDF’s emergency-response structure as a whole, advises the NPP management concerned by the event and provides information to the EDF Executive Board, to the national public authorities and to other NPPs.

The PCD-N is in contact with the Executive Board of the EDF group which can also mobilise its emergency management unit. It is also in contact with the experts of the national emergency technical team (ETC-N).

The ETC-N has two main missions:

- providing technical support to the PCD-N which consists in giving an analysis of the situation and a prediction of how it will evolve. In continuous contact with the local emergency response team and the IRSN emergency response team, it compares its results to supplement the PCD-N's information;
- providing on-site technical assistance in collaboration with the ELC and the PCC. The ETC-N issues opinions and recommendations for the management of the installation and in respect of environmental aspects.

The telecommunications resources available to those involved are an essential aspect of the organisation. Installation status parameters are relayed to the emergency response teams by automatic means and by telecommunication means. The information exchanged between the various command posts (PCs) is supported by a telephone network dedicated to EDF and the emergency situations, thereby guaranteeing that the networks do not become saturated.

The response to an emergency situation requires appropriate mobilisation, ranging from customised mobilisation to automatic mobilisation both locally and nationally.

In the NPP, 24h/24 and 365 days per year, the emergency organisation must be operational within 1 hour and mobilise 70 people.

At the national level, the National Emergency Organisation must be operational in its Paris premises within two hours, mobilising 50 people and alerting 300 others.

In addition to the premises used by the emergency teams, the sites have assembly stations (LR) in which the personnel assembles if the PUI is triggered, and a fallback centre, located off the site and not under the prevailing winds, to accommodate the persons present on the site at the time of the accident in order to protect and inform them. Application of the procedures by the operators in the control room remains possible in the event of an external hazard (earthquake, flooding), as the control room is robust to the design-basis hazards. The emergency management centre will be replaced by a local emergency management centre protecting firstly the emergency response protagonists and their equipment against the hazards targeted by the stress tests, and secondly the persons involved if there is a problem of radioactivity on the site.

In the event of total loss of the electrical power supply, the required actions in the facilities will have to be rendered secure, particularly if building lighting is lost. Specific intervention means are currently being acquired by the sites.

The procedures put in place for the management of severe accidents, the training and the exercises form part of the Severe Accident Management Guidelines (SAMG) and baseline requirements of the PUI of the sites.

The skills and capabilities of the persons and organisations involved are maintained by training and by performing periodic exercises. To this end, exercises are performed regularly. The internal PUI exercises held by EDF cover all the domains, including design accidents, fuel building (BK) incidents and severe accidents.

Experience feedback from actual emergency situations and all the exercises is used to improve emergency preparedness and the emergency response organisation, as well as the necessary coordination between the public authorities and the licensee.

EDF continues its analysis of the sizing of the operating teams for application of the current severe accident management procedures, particularly for events affecting several reactors, postulating in particular the impossibility of the on-call response teams getting to the site during the first 24 hours following an unpredictable large-scale hazard affecting the entire site. Further to these analyses, the sizing of the operating teams in conformity with the current baseline requirements will have to be adapted to the implementation of the hardened safety core equipment.

16.3.1.2 Setting up of the Nuclear Rapid Intervention Force (FARN)

As envisaged in 2011, EDF has made improvements in its emergency organisation, particularly with the creation of a Nuclear Rapid Intervention Force ("FARN" from its French acronym) and the first deployment of its material and human resources. The FARN is a national EDF entity, devoted to the licensee, integrating EDF's emergency organisation, which is capable of rapidly providing material and human aid to a site in difficulty, following the decision of the national emergency director (PCD-N).

Thus, once fully deployed, the FARN will be able to:

- intervene within 24 hours, without interruption and to take over from the operating teams that will have carried out the emergency measures for the site concerned and whose access infrastructures may be partially destroyed;
- work autonomously for several days on a partially destroyed site (non-seismic-design tertiary buildings, for example), whose environment could be radioactive, and - on some sites - possibly affected by chemical pollution;
- deploy heavy-duty protection or intervention means within a few days;

- ensure a permanent link with company management, site management and teams, and the local authorities in order to manage and coordinate the interventions;
- prepare for continuation of the intervention beyond the first days of autonomy in the event of a long-duration emergency.

Today, the first FARN teams are "projectable" in accordance with the requirements of ASN.

The context and environment hypotheses associated with this deployment phase are:
- the PUI is activated on the affected site,
- the level of the hazard does not exceed the current baseline requirement,
- the FARN intervenes on a single reactor only,
- the site access points may be unusable,
- the buildings and equipment, particularly tertiary, that cannot withstand the hazards, may be damaged.

16.3.2 Role and organisation of the CEA

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 plays a role at local and national level.

The site affected by the emergency (local level):
- manages the response inside the establishment;
- ensures communication with the local media for the site affected by the emergency, in collaboration with the prefecture;
- is responsible for relations with the prefecture and with IRSN emergency technical centre.

The CEA's administration (central level):
- directs the CEA's response at national level;
- is responsible for communication with the national media;
- is responsible for relations with the public authorities at national level.

To fulfil their role, the local and national levels are assisted respectively by a local strategic management command post (PCD-L) and an emergency coordination centre (CCC).
- the PCD-L is under the responsibility of the director of the centre or his/her representative. 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 CCC is under the responsibility of the general administrator of the centre or his/her representative. It comprises a decision-making unit, a central emergency technical 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.

It is the responsibility for the director of the site or his/her representative to assess the seriousness of the event, based on predetermined criteria for triggering the PUI and determining its level.

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 General Administrator or his/her representative may decide to activate the CCC.

As indicated in paragraph 14.2.3.1, stress tests have also been carried out on the general emergency response resources for the Marcoule and Cadarache centres further to the Fukushima Daiichi accident.

The Marcoule centre has an emergency management centre whose functions are preserved, including in the event of the seismic hazard considered for the "hardened safety core". The Cadarache centre will be equipped with a new building housing the local command post (PCL).

For the two centres, complementary measures are envisaged with regard to:

- fire-fighting water reserves,
- fuel reserves,
- means of preventing the flood risk,

The stress test report for the Saclay centre must be submitted to ASN in June 2013.

With regard to Organisational and Human Factors, the content of the training courses and the operational documentation will be adapted to consolidate the preparation for and training in emergency management situations further to the stress tests.

16.4 Emergency exercises

16.4.1 National nuclear 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. To this end, exercises are performed regularly, both to train the emergency teams and to test the means and organisational measures in order to identify any malfunctions. In addition to the exercises organised by licensees to test their own internal organisation, a national emergency-response exercise held on average every three years on each site that includes a BNI seems to be a fair compromise between the training of personnel and the time needed to make organisational changes. The number of national exercises held since 1981 is shown in the graph below.

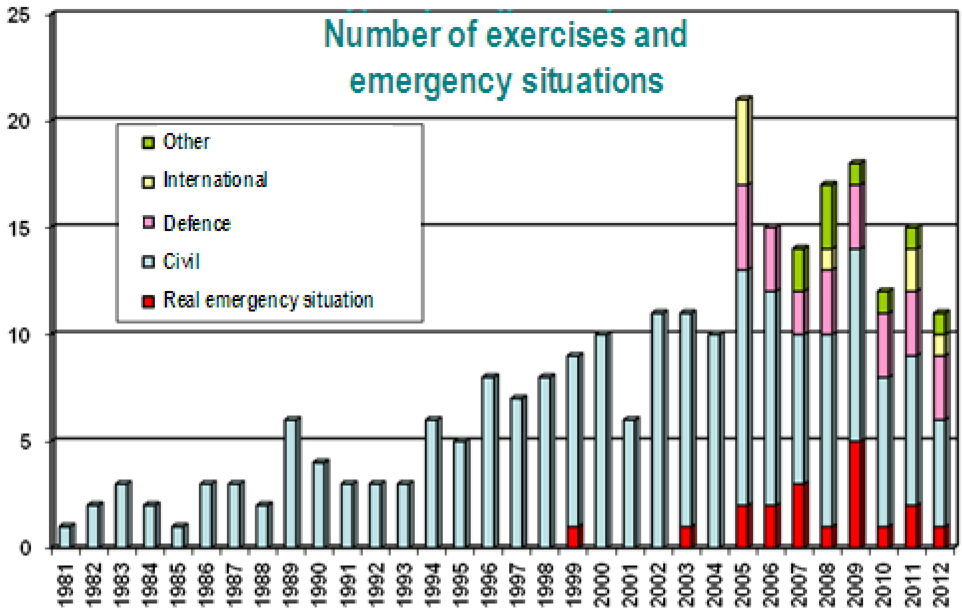

Figure 10: Number of exercises and emergency situations

The national exercises are large in both number and scale. They enable the ASN staff and the national stakeholders to build up a wealth of knowledge and experience in the management of emergency situations. The exercises also provide the opportunity to train the field participants, some 300 people per exercise.

For example, ASN prepared a programme of national nuclear emergency exercises for 2012, announced to the Prefects in a circular dated 20th December 2011 which provided for two different types of exercise:

- one type 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;
- the other type targeting “civil protection” involving actual and large-scale application of population protection measures as specified in the off-site emergency plans (PPIs), based on a scenario built around the role-play conditions chosen for the population.

In addition, this programme included the case of a natural event affecting several nuclear installations on the same site simultaneously. Thus on 17th January 2012, an exercise including a safety aspect was organised on the CEA Cadarache site. The initiating event for this exercise was external to the site and took into account the actual weather conditions. The main objectives of the nuclear part of the exercise were to:

- test the control of the consequences of the event by the licensee and the public authorities;
- test the *inter-département* coordination of the public authorities;
- test the liaising with the mayors of the communes concerned;
- test the concomitant management of a seismic emergency and a nuclear emergency;
- test the implementation of the local safeguard plans (PCS);
- test the capability of the Cadarache centre to manage an event simultaneously affecting the BNIs and BNIS's (secret BNIs under the supervision of the ASND (Defence Nuclear Safety Authority)) at the Cadarache centre;
- implement the post-seismic phase of the event.

The exercise was rich in lessons for all the stakeholders and placed the emergency-response organisation in an unusual situation, based strongly on the events at Fukushima Daiichi NPP. It led us to give a reminder of the need - given the diversity of the players involved - to ensure clear governance by the State services to ensure good coordination and greater effectiveness in the actions carried out.

In the majority of these exercises, media pressure is simulated by journalists on the main protagonists to test their communication abilities. The table below describes, as an example, the main characteristics of the national exercises conducted in 2012 and concerning reactors.

Table 8: Main characteristics of the national exercises carried out in 2012

Nuclear site	Date of exercise	Main focus of the exercise	Objectives
CEA Cadarache	17th January 2012	Civil protection Nuclear safety	Management of a nuclear event caused by an earthquake
Saint Alban NPP	31st January 2012	Civil protection	Emergency management during the first hours of the event, including the real-time deployment of the emergency command posts (PC)
Flamanville NPP	28th June 2012	Civil protection	Real-time deployment of a mobile PC and implementation of the first post-accident actions
Blayais NPP	20th November 2012	Nuclear safety	Ability of the services to cope with a major event on this site and mobilisation of site protection
Dampierre NPP	18th December 2012	Civil protection	Inter-zone coordination of the health chain and transfer of the personnel from the Dampierre site to the Belleville sur Loire site

Evaluation debriefings are organised immediately after each exercise in each emergency command post. One month after each exercise, ASN organises experience feedback meetings at which, along with the other players in the emergency exercises, it endeavours to identify the good and bad practices brought to light during these exercises in order to improve the organisation as a whole.

16.4.2 International exercises and cooperation

ASN maintains international relations in order to exchange the good practices observed during foreign exercises. Thus, during the course of 2011 and 2012, ASN:

- participated as an observer in many exercises organised by foreign safety authorities;
- participated in the organisation and holding of the three-nation exercise simulating an accident on the Cattenom NPP site and involving Luxembourg, Germany and France. France will coordinate the 3rd phase of this exercise in 2013, the first two phases carried out in 2011 and 2012 having been coordinated by Germany and Luxembourg respectively;
- received foreign delegations attending exercises organised by France as observers.

ASN is a member of the IAEA's National Competent Authorities Co-ordination Group (NCACG) and notably participated 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 April 2012 ASN was re-elected and now represents the Competent Authorities not only of Western Europe but also of the Eastern Europe region.

In addition, with regard to international assistance, ASN has set up data bank listing all the technical and human resources available in the event of an accident or radiological emergency and, since August 2008, it is one of the competent authorities having registered the French means of international assistance with the Response Assistance Network (RANET). ASN is involved in defining the strategy for international assistance needs and resources, and in the development of RANET. On this account, in April 2012 ASN took part in the meeting of the competent Authorities concerning the conventions on early notification and on international assistance.

At the European level, ASN is a participant in the "Emergencies" working group reporting to the HERCA (Heads of European Radiological Protection Competent Authorities) Association. It also acts as secretary. This group was tasked with proposing harmonised European measures to protect the general public, on the one hand in the event of an accident in Europe and, on the other, in the event of a more remote accident, in the light of the lessons learned from the Fukushima accident.

Within WENRA (Western European Nuclear Regulators' Association), ASN coordinates the "Mutual assistance" working group tasked with proposing mutual assistance actions between European safety regulators with a view to ensuring coordinated, rational and efficient accident management. It also acts as secretary.

A working group common to the "Emergencies" and "Mutual assistance" groups is moreover studying the possibility of combining European expertise in the event of an accident, converging towards a shared risk assessment, in order to lead eventually to more closely harmonised recommendations and resolutions between the countries.

Maintaining and strengthening bilateral relations with neighbouring countries is one of ASN's major priorities. Experience feedback from the Fukushima Daiichi accident and the steps taken since then in each country, were at the heart of the debate. Agreements exist with all the nuclear safety authorities of the neighbouring countries.

16.4.3 Lessons learned from the exercises

The emergency exercise scenarios generally involve simulated releases of radioactivity outside the installation in which the accident occurs. This enables the entire national emergency response organisation, and the local emergency response services in particular, to practice dealing with the risks and consequences of radioactive contamination of the population, habitats, the food chain and the environment.

Experience feedback from the exercises showed that the measurement results took a long time to reach the experts and decision-makers. 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 interministerial directive of 29th November 2005. This directive is now being implemented in the emergency plans, integrating local measurement programmes that are tailored to the individual installations. For the past two years, IRSN has been testing a system giving a geographical representation of the results of environmental radioactivity measurements. This tool, called CRITER, gives a rapid summary display of all the environmental radiological measurements taken, giving decision-makers a clear view of any radiological impact.

Experience feedback from the exercises also highlights actions or procedures that need to be improved. All the stakeholders integrate these elements and actively seek appropriate solutions. To this end, ASN brings all the stakeholders together twice a year to review best practices and identify avenues for improvement.

Taking advantage of these lines of improvement, the public authorities have decided to preventively distribute iodine tablets in a radius of 10 km around the NPPs, to avoid people having to distribute tablets during the release phase following an accident and risk exposure to radiation; Furthermore, to take account of fast-developing accidents (radioactive releases in less than six hours), which do not leave a sufficient response time, they have decided to integrated a reflex phase in the off-site emergency plan in which the population concerned are warned by a network of sirens supplemented by a cell (telephone) broadcast system. The exercises have demonstrated the importance of reducing population warning times. Delegation of power from the Prefect to the nuclear site licensee now enables the populations to be warned more rapidly.

Experience has also shown that it is necessary to optimise the frequency of the “decisional” audio-conferences between the emergency response technical teams, the command posts and the communication units set up in the framework of the national emergency-response structure.

Lastly, the Fukushima Daiichi accident has shown that in the event of a severe nuclear accident in France, the French Government would be directly involved. It is therefore important that the emergency exercises closely involve the licensee managers and the public authorities at a high level. These exercises must also be able to test the interface between the ORSEC and PPI arrangements and ensure that the skill levels of the emergency response players are maintained. ASN will ensure that these exercises have an educational dimension by widely involving the populations concerned in their preparation.

16.5 Developments in nuclear emergency management

As is the case in other areas of nuclear safety, the emergency-response organisation must evolve in the light of the experience acquired. The main sources of experience in France are the exercises and notable events in France and abroad, as well as exchanges with foreign countries. The main changes thus made to the national emergency organisation are described below.

16.5.1 Population protection measures

The population protection measures must be adapted to the phase considered, namely threat, emergency or post-accident phase. The population protection measures take into account the magnitude and speed of development of the event.

The measures that can be implemented during the emergency phase are described in the contingency plan, PPI for a BNI. 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 severe accident, a number of preventive measures can be considered by the prefect in order to protect the population:

- instructing the population to take shelter and wait for instructions;
- instructing the population to take stable iodine tablets (see § 16.5.2);
- evacuation of the population.

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 permissible levels have been set on foodstuffs for this purpose. The prefect must inform the population regularly on the development of the situation and its consequences.

Lastly, if radioactive substances are actually released into the environment, the CODIRPA doctrine (see § 16.5.3) defines the first actions decided upon to prepare for management of the post-accident phase: They are based on the definition of area zoning to be implemented on exiting the emergency phase and including:

- a population protection zone (ZPP) within which action is required to reduce both the exposure of the populations to ambient radioactivity and the consumption of contaminated food to a level that is as low as reasonably achievable (ALARA);
- a heightened territorial surveillance zone (ZST), which is larger and more concerned with economic management, within which specific surveillance of foodstuffs and agricultural produce will be implemented;
- if necessary, an evacuation zone is created within the population protection zone, defined according to the ambient radioactivity (external exposure). The residents must be evacuated for a length of time that will vary according to the level of exposure in their living environment.

16.5.2 Stable iodine tablets

The guideline intervention level for taking iodine tablets in France was reduced from 100 mSv effective dose to the thyroid to 50 mSv in 2009, following the development of a "new iodine doctrine" oriented towards the most sensitive populations and better harmonised with those of the neighbouring countries.

The last preventive distribution campaign for iodine tablets dates back to 2009 and concerned the populations located within the zone covered by the PPIs around nuclear power plants. During this campaign, 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 inhabitants were asked to go and collect their iodine tables from the pharmacy. In a second phase, an additional distribution was carried out by directly mailing the box of tablets to the households that had not picked them up. Lastly, boxes of tablets are kept permanently in stock in each pharmacy in the area.

The aim of this method is to better manage tablet distribution since it keeps track of exactly who has received a box of tablets The final coverage rate thus approaches 100%. Outside the area covered by the PPI, stocks of tablets are constituted to cover the rest of the country. Each Prefect organises the procedures for distribution to the population in his/her *département*, relying in particular on the mayors for this. This system is described in a circular dated 11th July 2011. The Ministry for Health thus ordered the manufacture of 110 million 65 mg tablets, which have been shipped to the regional platforms.

16.5.3 Managing the post-accident consequences

The "post-accident" phase concerns the longer-term management of the consequences of a lasting contamination of the environment by radioactive substances following a nuclear accident. It concerns dealing with varied consequences (economic, health, social), in the short term or even the long term, with a view to restoring an acceptable situation.

Pursuant to the Interministerial Directive of 7th April 2005, and in association with the ministerial departments involved, ASN was tasked with establishing the framework, and defining, preparing and implementing the necessary provisions in response to post-accident situations following a nuclear accident. In order to draw up the corresponding aspects of doctrine, ASN in June 2005 created the steering committee for managing the post-accident phase of a nuclear accident or radiological emergency situation (CODIRPA).

In order to carry out its work, the CODIRPA set up various thematic working groups as of 2005, involving a total of several hundred experts from a range of backgrounds (local information committees, associations, elected officials, health agencies, appraisal organisations, authorities, etc.). It was able to put its doctrine to the test on the ground and during national exercises.

In November 2012, ASN sent the Prime Minister elements of the doctrine drafted by the CODIRPA, covering the emergency exit, transition and long-term phases, accompanied by an opinion from the ASN Commission. These elements, which constitute a first and important step in the preparation of post-accident management, were then published on the ASN website and issued to the ministries concerned.

In late 2012, the CODIRPA, chaired by ASN, decided to continue its work, primarily driven by the need to take account of the lessons learned from the post-accident management implemented in Japan in the wake of the Fukushima Daiichi accident, but also to ensure support for the preparatory work to be organised in the regions. Some questions are also still on hold, pending the outcome of the first phase of the CODIRPA's work and the thought that has so far been given to intermediate scale accidents must be extended to include the management of severe accidents.

In this context, three areas for focus were proposed:

- test and supplement the elements of doctrine with respect to the different accident situations;
- assist with the regional implementation of the post-accident management findings;
- take into consideration and share international work carried out on the post-accident theme.

Post-accident management of a nuclear accident is a complex subject involving numerous aspects and players. The ongoing thought being given to this subject must continue to benefit from the support of a pluralistic structure based on the current participants of the CODIRPA, plus other stakeholders involved in the preparation of post-accident management.

The new duties will focus on keeping a watching brief and on supporting and analysing the various post-accident preparation processes, with the aim of periodically proposing updates to the doctrine.

16.5.4 Recent news: integration of experience feedback from Fukushima Daiichi accident

16.5.4.1 Plan of action to integrate experience feedback on ASN's internal organisation during the Fukushima Daiichi accident

In order to get maximum benefit from the lessons learned in its management of the Fukushima Daiichi accident, ASN organised a general assessment involving all the its personnel. The areas chosen for the functional assessment of the ASN emergency centre focused in particular on the material and logistic resources, its missions, its internal functioning, its deployment and ASN's relations with its various external contacts.

The assessment report sets out the strong points and lines for improvement. It resulted in an improvement action plan implemented as of 2012 and concerning the following points in particular:

- development of an aid for organising shift reliefs in the event of a lasting emergency,
- implementation of a service continuity plan,
- setting up of a system to better inform the ASN staff in emergency situations,
- setting up additional training courses for the potential heads of Strategic Management Command Posts (PCDs),
- updating of the documentary baseline held at the emergency centre,
- setting up post-accident management training courses, etc.

Some of these lines for improvement will be applied in the deployment of the new emergency response centre (see 16.2.5.2).

16.5.4.2 “Fukushima” steering committee

A steering committee (called COPIL “Fukushima”) was set up in early April 2011 to coordinate ASN's action relating to the experience feedback from the Fukushima Daiichi accident.

This decision-making authority comprises representatives of various departments of ASN, IRSN, and ASND (defence nuclear safety authority). The committee is chaired by the ASN Director-General.

The COPIL Fukushima monitors the actions undertaken since 2011 following the accident:

- respond to the referral from the Prime Minister and the demand of the European Council to perform stress tests;
- track the targeted inspection campaigns organised further to the Fukushima Daiichi accident on the themes of the loss of cooling resources, loss of electrical power supplies, earthquakes, flooding and lastly operational management for incidents / accidents & on-site emergency plan (PUI);
- issue requirements for the licensees;
- reflect upon the impact of Fukushima Daiichi accident on the regulatory texts currently being prepared;
- associate the stakeholders with the process as a whole.

The COPIL steering committee meets regularly to decide on the strategy to adopt, the communication concerning ASN actions, the organisation of meetings of the Advisory Committees of Experts, the involvement of the stakeholders, etc.

F - SAFETY OF INSTALLATIONS

17. Article 17: Siting

Each Contracting Party shall take the appropriate steps to ensure that the appropriate procedures are established and implemented with a view to:

i) evaluating all relevant site-related factors likely to affect the safety of a nuclear installation during its projected lifetime;

ii) evaluating the likely safety impact of a proposed nuclear installation on individuals, society and the environment;

iii) re-evaluating as necessary all relevant factors mentioned in sub-paragraphs (i) and (ii) so as to ensure the continued safety acceptability of the nuclear installation,

iv) consulting Contracting Parties in the vicinity of a proposed nuclear installation, insofar as they are likely to be affected by that installation, and providing the necessary information to such Contracting Parties on request so that they can evaluate and make their own assessment of the likely safety impact of the nuclear installation on their own territory.

17.1 ASN requests

17.1.1 Evaluation of relevant site-related factors

Section 7.2 specifies the different authorisation procedures in effect for the creation, commissioning, modification, shutdown and decommissioning of a BNI.

Well before applying for a BNI creation authorisation, the prospective licensee must inform the administration of the site(s) on which it plans building the installation. ASN analyses the safety-related characteristics of the sites: seismicity, hydrogeology, industrial environment, cold water sources, etc. The characterisation of the risks associated with the site and the design of the installations with respect to these risks form the subject of basic safety rules (RFS – see Appendix 2.3).

The safety options, which include the accident and hazard situations considered in the design and the methods of dealing with them must then be presented in the preliminary safety report.

The stress tests carried out further to the Fukushima Daiichi accident concerned all the French nuclear installations (see § 14.2.1.6). The assessment focuses firstly on the characterisation of the natural phenomena and their impacts on the safety of the installations. The case of multiple accidents was also studied.

17.1.2 Evaluation of the impact of a BNI on the local population and the environment

As indicated in § 7.2.2, the BNI creation authorisation application is accompanied by a file comprising a number of items, including the impact study and the risk control study.

17.1.3 Reassessment of the relevant factors

The external hazards are reassessed in the periodic safety reviews conducted every 10 years. The ASN resolution relative to the BNI periodic safety reviews will specify that at each review the licensee will reassess the intensity of the external hazards considered in the nuclear safety demonstration of the installation, along with their frequency of occurrence in the light of any new knowledge.

The external hazards, particularly earthquakes and flooding, were the subject of a targeted review as part of the stress tests (see § 14.2.1.6).

17.1.4 Consultation of neighbouring countries

In application of the regulations, authorisation to create a BNI cannot be granted until the European Commission, including the neighbouring countries in particular, has been consulted (see § 7.2.5).

ASN associated the civil society in the stress tests and the corresponding targeted inspections. Foreign experts were thus able to participate in inspections and meetings of the Advisory Committees of Experts.

17.1.5 Public consultation

In application of articles L. 121-1 and following of the Environment Code, the creation of a BNI is subject to the public debate procedure when it involves a new nuclear power production site. The public debate focuses on the appropriateness, the objectives and the characteristics of the project. Furthermore, as indicated in § 7.2.3, the BNI creation and decommissioning authorisations are issued following a public inquiry.

A public debate was held in 2010 before taking the decision to build an EPR nuclear reactor at Penly. Smaller-scale projects can also give rise to a "local consultation" approach. This was the case for example in 2005 with the Jules Horowitz research reactor project on the CEA Cadarache site.

With regard to the stress tests and the targeted inspection campaigns, ASN involved the local information committees (CLI - see § 8.2.4) in the inspections and members of the HCTISN (French High Committee for Transparency and Information on Nuclear Security - see § 8.2.3.1) in the meetings of the Advisory Committees of Experts.

17.2 Measures taken for nuclear power reactors

The safety analysis reports feature a "Site and Environment" chapter that covers the following themes: industrial environment and communication routes, population, meteorology, geology, hydrogeology, radiological situation, natural environment and rural economy.

By examining these themes, the relevant site-related factors that could affect the safety of the installation can be identified and the impact of the installation on safety, individuals, society and the environment can be assessed.

These themes take account of the requirements of the basic safety rules (RFS) concerned, namely site geology (RFS 1.3.c), seismic conditions (RFS I.2.c5 and RFS 2001-01), flood risks of external origin (RFS 1.2.e), climatic risks and risks relating to the industrial environment and communication routes (RFS 1.2.d).

These themes are analysed at each ten-year periodic safety review and the chapters of the safety report are updated accordingly.

In the framework of the stress tests, the robustness of the installations beyond the requirements of the safety report was assessed, particularly for earthquakes, external flooding and climatic hazards. The risk associated with the industrial environment was also reviewed.

17.2.1 External events – Earthquake

The deterministic approach used to define the seismic loads to be considered in the design of the installations involves determining for each site the maximum historically probable earthquake (MHPE) over an historical period of the order of 1000 years and the safe shutdown earthquake (SSE) with the addition of a further degree of intensity. The NPP is then designed so that it can be restored to and maintained in safe shutdown conditions after an earthquake corresponding to an intensity at least equivalent to that of the SSE.

An "envelope" design-basis earthquake (DBE) is taken into consideration in the standardised plant series for the design of the nuclear island. Besides this, the other structures, known as the "site structures" are specifically designed for each site. The site structures include the other buildings and facilities necessary for operation of the plant, including the heat sink and the intake channel.

The design approach for determining seismic motion to be considered for the safety of the facilities is based on basic safety rule RFS I.2.c and RFS 2001-01.

Methodology used to evaluate the design-basis earthquake during the periodic safety reviews

The ten-year periodic safety reviews provide the opportunity to perform an in-depth examination of compliance with the seismic design requirements in effect and to reassess the SSE levels in the light of the most recent data and any new knowledge.

Reinforcements may be decided, not only on the basis of a reassessment of the seismic hazard, which constitutes input data for the calculation of structures and equipment, but also on the basis of developments in paraseismic engineering (calculation methods and means).

Special measures have been taken for sites with seismic characteristics outside the envelope of the standardised plant series (due to local particularities, especially geological).

The deviations observed when performing conformity checks during the stress tests do not directly call into question safety. These deviations have been notified to ASN as significant events and are being dealt with in this context.

Identification of systems, structures and components which must remain available after an earthquake

Depending on the role items of equipment play in safety, they are placed in safety classes that comprise seismic classification requirements defined by the regulations or basic safety rules. The seismic classification requires justification either by calculation or by testing on a vibrating table or through case-by-case analysis.

EDF points out in its stress test reports that it sets seismic classification requirements in particular for the items important for safety and, on a case-by-case basis, for certain items that are not important for safety, as well as for the post-accident surveillance measures.

Items which, if they fell, could lead to the loss of a seismic-classified item important for safety, are the subject of seismic verification.

Assessment of the safety margins in the stress tests

EDF reviewed the seismic resistance margins of the structures and items important for safety, in order to determine the level of acceleration for which the installation has a very low probability of failure.

In addition, EDF carried out the seismic inspection of a sample of the equipment needed to operate the plant unit in the event of total loss of off-site and on-site power supplies, whether seismic-classified or not, for all the plant units in service. For some of these equipment items EDF has defined additional improvement measures for a hazard beyond the design-basis earthquake (DBE).

EDF concludes that the seismic capacity of the containment and of the structures and equipment which, in the event of failure, would compromise the safety functions, would enable them to withstand an earthquake with a spectrum 1.5 times greater than that of the SSE. EDF considers that this spectrum level corresponds to hazard values that are relatively to completely implausible for the sites in question.

Main operating provisions

In order, following an earthquake, to be able to rapidly take appropriate steps to bring to and maintain the power plant units in the safest shutdown state, or to continue operation, basic safety rule RFS I.3.b recommends installing seismic instrumentation for pressurised water reactors. The procedure to be followed then depends on the level of the earthquake with respect to the Half Design Response Spectrum (½ DRS):

- if the ½ DRS threshold is not exceeded, each unit can continue to operate provided that a visual inspection of the structures and equipment is carried out.
- if the ½ DRS threshold is exceeded, the units must go to the shutdown state considered for each unit to be the safest. The resumption of operation may only be initiated with the approval of ASN.

The operation of this seismic instrumentation was the subject of a series of targeted inspections by ASN in 2011.

The results of the conformity checks performed on the 19 NPPs reveal no findings that could call into question the requirements of RFS I.3b.

Apart from the Cruas and Dampierre sites, where the findings are leading to actions to determine concretely the level of earthquake having affected the sites, the main consequence of all the identified deviations is an overestimation of the earthquake intensity and therefore an early shutdown decision, which from the safety aspect is a conservative approach.

The operating teams have followed a training programme to enhance their level of preparedness for an earthquake The objective of the training course was to provide an understanding of seismic design and the existing baseline requirements, to train participants in the use of the seismic acquisition rack and application of the local instructions for taking an earthquake into account and to organise an exercise.

In response to an ASN requirement, EDF studied the advantages and drawbacks associated with the installation of a automatic reactor trip system (AAR) in the event of a seismic stress. EDF concluded that the safety benefit resulting from an earthquake-triggered AAR function justified its implementation on the reactor fleet in operation. The earthquake-triggered AAR is beneficial for emergency shutdown rod drop and clarifies the initial conditions of the plant units following an earthquake.

"Seismic interaction" procedure

The "seismic interaction" procedure aims to prevent equipment that must remain operational after an earthquake from being damaged by non-seismic classified equipment or structures.

This approach, which is implemented in the context of the ten-yearly outages, comprises a national part which can lead to modifications on a plant series, and a local part.

In response to the ASN requirement concerning the measures to take to prevent potential damage by other equipment of items which, on account of safety, must remain available following an earthquake, EDF has decided to reinforce its organisation to control hazard risks during operation.

A guide to the management of the seismic interaction hazard on the NPPs currently being drafted will define the organisational measures to implement on the sites and specify the roles and responsibilities of the protagonists and the prevention measures to implement.

Training of the seismic interaction coordinators was undertaken as a priority and will continue in 2013. Likewise, courses targeting the representatives and awareness-raising for all the personnel will be integrated in EDF's DPN (nuclear operations division) training syllabus.

Loss of off-site electrical power supplies

The PWR safety demonstration studies the simultaneous occurrence of a major earthquake and the loss of off-site power supplies, insofar as they are not designed to withstand a major earthquake.

The total loss of on-site and off-site electrical power supplies to a single plant unit on the site is taken into account in the baseline safety requirements. In the event of failure of the plant unit diesel generators (emergency power supplies) to start or connect, it is possible to connect a site ultimate backup generator or a diesel generator set belonging to a neighbouring plant unit. There is only one ultimate backup generator set per site and it is not designed to withstand an earthquake.

In the event of a common mode failure affecting all the site emergency diesel generator sets, only one of the site plant units could be backed up. In the event of an earthquake, the availability of this ultimate backup generator cannot be guaranteed.

The autonomy of the batteries powering items important for safety used in the event of loss of the electrical power supplies is currently 1 hour. Further to studies carried out by EDF, the measures necessary to guarantee 2 hours of battery autonomy will be implemented by the end of 2014.

EDF is taking the following measures in response to ASN requirements and with a view to reinforcing the electrical power supply resources:

- it is studying an additional electrical power supply means for supplying the systems and components of the hardened safety core. EDF communicated the design principles to ASN in early 2013.
- pending the installation of the ultimate backup diesel generator set, EDF plans providing a diesel generator set for each plant unit to supply the instrumentation & control necessary in the event of loss of the on-site and off-site power supplies and control room lighting. This ongoing modification is due for completion at the end of June 2013, in accordance with the ASN requirement ECS-18.

Conditions of site access following an earthquake

In the event of major disruption to roads and structures, the emergency response organisation calls on the public authorities who, in addition to triggering the off-site emergency plan (PPI) if necessary, implement special measures. These measures allow on-call personnel to be brought in.

To meet the ASN requirement to secure on-site stocks of fuel and oil and ensure that they can be replenished in all circumstances so as to guarantee at least 15 days' autonomy, EDF has set up the following organisational provisions which depend on the condition of the access routes to the site in question.

1/ Means of access to site not damaged

- <u>For oil, the situation differs according to the plant series</u>
  For the 900 MWe plant units, the volume of oil per diesel engine stored at each NPP guarantees operation of the engine for about 4.5 days (average consumption). Taking the hypothesis that one diesel engine is stopped, the operating time could reach 8 days.
  The calculated autonomies for the diesel engines of the 1300 and 1500 MWe plant series operating at the minimum prescribed level with an average consumption exceed 15 days.
- <u>For fuel</u>, compliance with the minimum volume required by the operating technical specifications guarantees an autonomy of slightly more than 72 hours. For its resupply, EDF has a contract with an oil company that provides for a minimum stock of 200 m^3 in a dedicated tank on this supplier's premises.

2/ Means of access to site damaged

The means of resupply under all circumstances to guarantee the safety of the installations are either the plant unit diesel generators or, in the end, the ultimate backup generator sets and the means specific to the FARN (Nuclear Rapid Intervention Force).

Concerning the operational readiness of the FARN, the hypotheses of extreme hazards affecting a site will be taken into consideration as from December 2014.

The FARN must bring to the site the fuel and oil reserves necessary to ensure 72 hours of autonomy for its intervention means.

In order to guarantee by end 2014 the resupply of an NPP that is potentially inaccessible by the usual means, it is necessary to identify, organise and transport if need be:

- the stocks planned for under contract in emergency situations for the emergency diesel generator sets, and the stocks of oil that can be provided by other NPPs,
- the additional stocks potentially available from the local or national distributors or other entities.

The action plans, to be detailed during 2013, should in particular:

- indicate the consumption hypotheses for the materials to be (re)supplied,
- identify the possible sources of supply ,
- study the integration of the procurement process in the emergency management plans of the public authorities,
- define and study the logistic and technical means to be put in place,
- specify the role of the FARN in the organisation.

Earthquake-induced fire risk

The buildings have sectors to prevent the propagation of a fire. These sectors have a seismic strength requirement. Fire-fighting systems are subject to seismic strength requirements and they are separated from non-seismic-classified parts by seismic-classified isolating devices.

The studies conducted by EDF in response to the ASN requirement have proven that, beyond the required level of resistance to the ½ DRS, and in view of the modifications integrated in the fire action plan and those planned in the fire risk control project, the intrinsic resistance of the fire protection equipment necessary to demonstrate safety on the 900 and 1300 MWe plant series is ensured at the SSE. EDF supplements these studies with a verification of the aspect specific to each site/plant unit by verifying the resistance to the SSE of the attaching parts, supports and anchorings of the fire-protection systems and the passive equipment which is required to remain functional. In view of the number of items of equipment and plant units concerned, the conclusions will be available at the end of 2014.

Earthquake-induced explosion risk

In the context of the ten-yearly outages, application of the SSE design requirement to the hydrogen systems and inclusion of the "seismic interaction" approach for lines carrying hydrogen situated in the nuclear island, is in progress on the 900 MWe, 1300 MWe and N4 plant series.

In response to the ASN requirement, EDF has proposed speeding up application of this requirement on the various plant series:

- CPY plant series: end of deployment in 2017 whereas the initial schedule planned for end of deployment in 2023.
- 1300 MWe: deployment between 2015 and 2019 instead of 2015 and 2023.
- CPO plant series: end of deployment is planned for 2013, while deployment on the N4 plant series ended in 2012.

Seismic level leading to non-design-basis flooding

In its stress test reports, EDF took account of the topography of each of the sites and identified the water reserves above the site which are not considered robust to the SSE. The analysis did not reveal any risk not already covered by the existing or planned protection measures.

For those sites on which the off-site flooding risk created by an earthquake exceeding the design basis for the facility cannot be ruled out, EDF proposed a study to determine if there is a real risk of the nuclear island platform being submerged. In the light of the results, EDF will determine whether or not additional protection is necessary.

17.2.2 External events – Flooding

Floods are events liable to lead to failures that can impact all the facilities on a site.

Flooding is a risk that is taken into account in the design of the facilities and reassessed during the periodic safety reviews or further to certain exceptional events, such as the partial flooding of the Blayais nuclear power plant during the storm of 27th December 1999 (see § 6.3.1.2.1).

Floods for which the facilities are designed

For the sizing of protection against flooding, the sites use basic safety rule RFS I.2.e of 12th April 1984. This text defines a method for determining the water levels to be considered when designing the facilities. This method is based on the defining of the flood safety level and provides for three different cases: sites by the sea, sites on rivers and sites on estuaries.

Measures to protect facilities from the flooding risk integrated in the design process

EDF has conducted a safety analysis for each site, drawing up a list of the systems and equipment necessary to reach and maintain a safe state.

In order to reach a conclusion on the absence of water in the premises housing the equipment to be protected in the event of flooding, EDF has adopted a two-step approach:

- comparison of the water height liable to be reached at the various possible water entry (or by-pass) points;
- indication of the material and operating measures aimed at protecting the facility against the design-basis flood level.

<u>Material provisions</u>

The material provisions concern the civil engineering, specific equipment, modifications to existing equipment, electrical equipment and instrumentation and control equipment.

To date, the work for protecting the facilities against flooding has been carried out on 12 sites (out of 19). For the remaining 7 sites, the required work has been identified and ASN has instructed EDF to carry it out before the end of 2014.

Furthermore, in order to prevent any ingress of water into a perimeter encompassing the buildings containing equipment required to guarantee reactor safety, EDF has implemented a protected volume approach on all the sites.

<u>Operating measures</u>

During the stress tests, EDF also presented the operating measures for each site aiming at protecting the facility against the design-basis flood level. They include:

- warning systems in the event of a foreseeable hazard that could lead to flooding of the site;
- agreements with organisations within or outside EDF;
- special operating rules in the event of flooding;
- local procedures.

In response to the ASN requirement concerning the organisation on the Cruas and Tricastin sites to cope with isolation in the event of flooding, the following measures have been taken:

- for the Tricastin site, the setting up and operational deployment of the necessary structures for managing site isolation situations in the event of external flooding;
- for the Cruas site, setting up in 2012 of the necessary structures for managing site isolation situations in the event of external flooding, with deployment in the first quarter of 2013.

EDF indicated in the stress test reports that loss of off-site electrical power supplies and water intakes had been taken into account.

Conformity of facilities with the current baseline safety requirements

The work to restore conformity of the protected volume and deployment of the structures and resources to maintain its effectiveness over time were carried out within the deadlines set by ASN.

At national level these measures resulted in the holding of a protected volume conformity check and updating of the protected volume management rules for the sites.

Evaluation of safety margins

During the stress tests, EDF presented for each site the margins between the flood level reached and the level of the protections provided with the current design, and decided on the additional measures to be taken where applicable.

This assessment was based on increased scenarios also taking into account the flooding induced by a beyond design-basis earthquake and the structures present on or above the platform and liable to constitute potential sources of flooding following an earthquake of intensity exceeding the SSE, if the structure is not considered robust to a beyond design-basis earthquake.

EDF thus calculated the water level resulting from these increased scenarios, highlighting the protection measures implemented on the site in the framework of protection against design hazards.

For some sites on rivers, EDF considers that the water height estimates for a number of riverside sites warrant consolidation. The approach implemented leads EDF to define increased hazards covering all the phenomena that could lead to or contribute to flooding and examine additional scenarios for certain sites.

EDF therefore envisages different solutions depending on the sites according to the identified cliff-edge effect and the increased scenario.

Furthermore, the stress test analysis shows that the requirements resulting from the complete re-evaluation of how the flood risk is taken into consideration in the nuclear power plants, completed in 2007, offer the facilities a high level of protection against the risk of flooding, on condition that the measures for satisfying these requirements are implemented as planned.

17.2.3 External events – Extreme climatic conditions

Wind

At each periodic safety review EDF checks that the buildings important for safety and the buildings housing systems or equipment important for safety are able to withstand winds with characteristics conforming to the updated Snow and Wind Rules (1999 and 1984 editions, amended in 2000) and also integrating the experience feedback from the two storms that hit France in 1999 and 2010.

EDF considers that the projectiles generated by extreme winds cannot damage the structures or civil engineering works that constitute or house systems or items that participate in a safety function.
Nonetheless, on the occasion of the latest periodic safety reviews, EDF defined baseline safety requirements concerning protection against projectiles generated by extreme winds.

EDF considers that the design of the buildings for the off-site explosion risk guarantees their robustness to extreme winds. EDF has evaluated the existing margin by comparison with this event and concludes that for all its sites, all the buildings designed for the "off-site explosion" risk are robust to extreme winds with significant margins.
For buildings not covered by the "off-site explosion" design, EDF considers that the loads associated with extreme winds are not liable to have consequences for reactor safety.

EDF has analysed the behaviour of its facilities and the possible cliff-edge effects for a wind speed value of about 200 km/h, on the basis of a statistical assessment carried out by EDF R&D. This order of wind speed is consistent with the objective of an annual frequency of occurrence of $< 10^{-4}$ for the wind values to be considered.

EDF has decided to use the tornado hazard when defining the hardened safety core.

Hail

The hail hazard had not been considered in the design of the reactors. This is because hail storms represent a relatively rare, localised and brief meteorological phenomenon. Most of the items important for safety are situated inside the buildings, which protects them from the risk of damage by hail. With regard to the robustness of the buildings themselves to the effects of hail, EDF considers that the maximum impact could be pitting of the cladding, but without penetration. No incident related to a hail storm has been observed on the reactors in service. The targets identified with respect to hail are primarily those already considered in the analyses covering wind-generated projectiles.

Lightning

The protection of facilities against lightning-related risks is in conformity with the ministerial order of 15th January 2008, abrogated and replaced by the order of 19th July 2011. In the approach adopted by EDF, the lightning prevention and protection measures must ensure that the consequences of a lightning strike on safety are encompassed by those defined in the initial design of the reactors with regard to category 2 incidents (frequency of less than 10^{-2} per reactor and per year).

In accordance with the order of 19th July 2011, an analysis of the lightning risk was carried out to demonstrate the environmental acceptability of the consequences of a lightning strike. EDF stated that further to this study, preventive measures and protection systems were defined and were implemented on 1st January 2012. The direct effects (direct impact on the building structure) and secondary effects (impact in the vicinity of the building) of the lightning strike were taken into account.

EDF considers that there is no plausible cliff-edge effect liable to be created by lightning, given the high robustness to the lightning risk and its effects of the facilities necessary for management of an accident situation and given the functional redundancy and diversity of certain systems, especially those associated with the electrical power supplies.

A "turbine hall" maintenance programme is currently being prepared to increase the robustness of the facilities.

The EPR for its part is designed in accordance with the "lightning safety baseline applicable to the EPR". Adequate steps are thus taken to ensure that the safety functions of the systems and equipment necessary to bring the plant unit to a safe condition and to prevent and mitigate radioactive releases are not unacceptably affected.

Snow

A working group with representatives from Météo France, EDF, CEMAGREF and IRSN contributed to the Flooding guide. This document also mentions other forms of precipitation such as snow. EDF considered that there was no direct correlation between snow and rain and that snow was not one of the extreme meteorological conditions linked to flooding. Nonetheless, the design of the structures in accordance with the latest revision of the Snow and Wind 65 rules available for the construction of each plant series does protect the safety-classified buildings from all snow-related cliff-edge effects.

17.3 Measures taken for research reactors

17.3.1 CEA reactors

The Safety Reports feature a dedicated "Site and Environment" chapter which covers the same themes as for nuclear power reactors.

These themes take into account the requirements of the basic safety rules concerned.

These themes are analysed at each ten-year periodic safety review and the chapters of the Safety Report are updated accordingly.

In the framework of the experience feedback (REX) following the Fukushima Daiichi accident, the robustness of the installations beyond the requirements of the Safety Report was assessed, particularly for earthquakes, external flooding and climatic hazards in relation with the hazards experienced at Fukushima Daiichi NPP. The risk associated with the industrial environment was re-analysed.

As a general rule, these assessments have shown the research reactors to display good robustness to these extreme hazards. More specifically, the susceptibility of the sites to flooding is extremely low. Research reactors, which have much lower power levels than in power reactors, are also very resistant to power supply and heat sink losses. They offer a large time allowance before intervention is necessary.

17.3.2 The ILL high-flux reactor (RHF)

The general safety presentation of the Laue Langevin Institute (ILL) describes all the external hazards that are taken into consideration in the design of the equipment items that are required according to on the operating situations. The stress tests of the ILL analyse the impact of concomitant external hazards and define the work necessary to ensure compliance with the safety perimeter even under these extreme conditions.

17.4 ASN analysis

17.4.1 Nuclear power reactors

As a general rule, the licensee has applied operating measures aiming to protect the sites against extreme meteorological conditions, including warning systems for predictable hazards and particular organisational and material prevention and protection provisions.

17.4.1.1 Change in the design basis for natural and human risks following the stress tests

For the different risks considered for each site, the licensee has highlighted the margins with respect to the design-basis risks and those going beyond the baseline requirement. It has decided, where applicable, on the additional measure to be taken. The licensee has also studied several situations which it considers representative for evaluating the cliff-edge effects.

As part of this approach, new requirements have been enacted for reactors in operation or under construction with the aim of reinforcing their robustness to such phenomena. The main requirements and demands that are a cross-cutting with respect to Articles 17, 18 and 19 of the Convention are described in chapter 6 and detailed below.

Besides this, ASN and IRSN are active members of the sub-group of WENRA that has been set up to define reference levels for natural risks. ASN will supplement its position according to the complementary reference levels defined by WENRA with regard to external hazards. These reference levels should also consider combined events, in the same way as is specified in the BNI order.

17.4.1.1.1 Earthquake

Earthquake hazard

With regard to earthquakes, the methodology currently used to determine the seismic risk in France is mainly deterministic and complies with the methodology and criteria prescribed by the IAEA.

ASN considers that the exercise conducted on the earthquake PSA (probability safety assessment) applied to the Saint-Alban NPP is worthwhile and needs to be continued and extended to the other NPPs. This PSA brings out the initiating events and equipment items that contribute predominantly to the risk of core meltdown. Additional analyses are necessary, notably for the seismic hazard evaluation and the definition of the various equipment and structure failure modes and the extent of the equipment that must be covered by fragility curves taking into account these various failure modes. EDF must also provide elements to substantiate the applicability of the American approach developed by the EPRI to the French reactors.

Indirect effects of seismic events

The indirect effects of seismic events have been examined under the periodic safety reviews and the complementary studies in the stress tests which focused on:

- the "seismic interaction" approach[30],
- loss of off-site electrical power supplies,
- conditions of access to the site following an earthquake,
- the fire, explosion and flooding risks induced by an earthquake.

The analysis of this work has led ASN to set the following requirements and formulate additional demands:

- study analysing the level of seismic robustness of the embankments and other structures protecting the facilities against flooding and presenting the consequences of the failure of these structures according to this level of robustness and the technical solutions envisaged to protect the equipment of the hardened safety core (requirement ECS-11 concerning the Tricastin and Fessenheim sites, deadline on 31st December 2013).
- implementation of the measures necessary to prevent potential damage, by other equipment, of items which the safety analysis report requires to be available following an earthquake (requirement ECS-09 concerning all the sites. The licensee shall provide ASN with an intermediate assessment of this approach before 30th June 2013 and a final assessment before 31st December 2013).
- study evaluating the resistance to a safe shutdown earthquake (SSE) of the structures and equipment contributing to nuclear safety of fire sectoring, fire detection and fixed extinguishing systems, designed to withstand half of the design basis earthquake. For items for which resistance to the SSE cannot be proven, implementation of a programme of modifications to guarantee protection of the fire safety functions in the event of an SSE (requirement ECS-12 concerning the sites of the 900 and 1300 MWe plant units, the studies were submitted on 31st December 2012 and currently being examined).
- implementation of measures to ensure resistance of the hydrogen system to the SSE and integration of the "seismic interaction" approach for lines carrying hydrogen situated in the nuclear island (ASN request Fleet-04 of 26th June 2012. Deadline of 31st December 2013).

[30] The aim of the "seismic interaction" approach is to prevent an item that must remain functional in an earthquake situation from being damaged by an item or structure that is not classified for earthquakes.

- o complementary study to analyse the behaviour of the retaining walls along the sides of the Gravelines NPP intake canal beyond the SSE, for fixed-level earthquakes used in the design of the hardened safety core (ASN request GRA-07 of 26th June 2012. Study submitted).
- o substantiation study of the raw water ponds on the Flamanville, Paluel and Penly sites for an earthquake exceeding the SSE, for fixed-level earthquakes used in the design of the hardened safety core (ASN requests FLA-08, PEN-08 and PAL-08 of 26th June 2012. Studies submitted).
- o with regard to the Tricastin, Bugey and Fessenheim sites, implement measures integrating all the factors to guarantee stopping of emptying of the channel onto the site in the event of failure of the cooling system in the ongoing studies (ASN requests TRI-13, FSH-13 and BUG-13 of 26th June 2012. Studies to be submitted before 31st December 2013).

Seismic instrumentation

The conditions of utilisation of the seismic instrumentation installed on the sites were checked by ASN during the targeted inspections carried out in 2011 (see § 6.3.1.4) and were the subject of a request in the European peer review.

Further to this, ASN:

- o set the requirements to bring the seismic instrumentation into compliance with the recommendations of basic safety rule RFS I.3.b[31] (requirement ECS-08. The studies were submitted on 31st December 2012 and are currently being analysed).
- o asked EDF to carry out a study to compare the seismic instrumentation currently used in France with that used internationally (ASN request Fleet-03 of 26th June 2012. The deadline for submission of the studies has been extended to 31st December 2013).

ASN will consider revising the basic safety rule in the light of the results of EDF's ongoing seismic instrumentation evaluation.

Other requests

- o a study of the advantages and drawbacks of implementing automatic reactor scram (AAR) in the event of seismic loading, enabling the reactor to be shut down in the safest state if the seismic level corresponding to a spectrum with half the amplitude of the design response spectrum of the site is exceeded (requirement ECS-13. Study submitted on 31st December 2012 and currently being analysed).
- o verification of the SSE resistance of the emergency situation management rooms and introduction of modifications where necessary (requirement ECS-30. The licensee has given ASN an assessment of the effective SSE resistance of the rooms along with the planned modifications. Compensatory measures have been defined to ensure the SSE resistance of the Civaux, Cruas and Flamanville sites. The deadlines for completion of the planned modifications range from 31st December 2013 to 31st December 2015).

On the basis of the in-depth experience feedback from the Fukushima Daiichi accident, ASN has planned to review the baseline safety requirements of the nuclear facilities, particularly with regard to the "earthquake" aspects.

17.4.1.1.2 Flooding

Following the flooding of the Blayais site in 1999, EDF put in place a protected volume perimeter[32] on all the sites. The conformity of this protected volume was specifically checked by ASN during the

[31] Basic safety rule RFS I.3.b 08/06/1984 relative to seismic instrumentation.

targeted inspections conducted in 2011, resulting in demands from ASN (see § 6.3.1.4). In spring 2012 the licensee submitted an overall analysis of the responses to the observations raised by ASN, which ASN judged satisfactory. ASN has set the following requirements:

- end of the work to integrate experience feedback from the Blayais flood in 1999 for the Blayais, Bugey, Cruas, Dampierre, Gravelines, Penly, Saint-Laurent-des-Eaux and Tricastin sites (requirement ECS-04. The scheduled dates of work completion are 31st December 2013 for Saint-Laurent-des-Eaux and 31st December 2014 for the other sites).
- restoring conformity of the protected volume and implementation of the appropriate organisation and resources to ensure that the effectiveness of the protected volume stipulated in the safety demonstration is maintained (requirement ECS-05. Work to restore conformity was completed on 30th June 2012).
- verification of the resistance of the emergency situation management rooms to the SSE and implementation of any modifications where necessary (requirement ECS-30. The licensee has given ASN an assessment of the effective resistance of the rooms to the SSE along with the planned modifications. The deadline for completion of the planned modifications is 31st December 2013).

In addition to the requirement on the hardened safety core (see § 6.3.1.3, requirement ECS-01), ASN has also issued a specific requirement to EDF relating to the protection of the facilities against flooding beyond the baseline requirement with the aim of increasing the robustness of these facilities in order to prevent the cliff-edge effects associated with heavy rainfall or the failure of on-site equipment due to an earthquake (requirement ESC-06). This requirement more specifically concerns the raising of the protection volume to protect against total loss of the heat sink or electrical power supplies in beyond-design-basis scenarios (increased rainfall, flooding induced by the failure of on-site equipment due to an earthquake, etc.). The planned modifications must be presented before 31st December 2013, and applied between 31st December 2014 and 31st December 2017).

In 2013 ASN published a new guide on protection against the external flood risk for nuclear facilities. It integrates the recommendations of RFS I.2.e[33] and the experience feedback from the flooding of the Blayais site in 1999. The hazards to take into consideration are defined on the basis of an in-depth assessment of knowledge in the different areas concerned, and in hydrology and meteorology in particular (11 different hazards considered). It is based on deterministic methods, incorporating increases and combinations integrated in the hazards, taking into account a "probabilistic" exceedance target of 10^{-4} per year.

17.4.1.1.3 Other natural risks

In the framework of the stress tests, the licensee also studied the margins in the event of extreme meteorological conditions such as wind, lightning, hail, and their combination, in the event of loss of the heat sink and electrical power supplies. ASN's analysis of the studies led it to set requirements and make additional demands concerning the evaluations of margins and reinforcing of the robustness of facilities beyond their current design basis:

- an overall review of the design of the heat sink in relation to hazards with an impact on the flow and quality of water and the risk of clogging of the heat sink (requirement ECS-15. The review was submitted on 30th June 2012 and is currently being analysed),

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[32] The protective volume perimeter, which encompasses the buildings housing items for guaranteeing reactor safety, has been defined by EDF so as to ensure that an influx of water that reaches the outside edge of this perimeter does not lead to flooding of premises situated inside this perimeter. Concretely, the protected volume consists of walls, ceilings, floors and structures to that close openings in these surfaces (doors, covers, etc.) that can constitute potential water ingress points in the event of flooding.

[33] Basic safety rule RFS 1.2.e. of 12/04/1982 relative to consideration of the risk of flooding of external origin.

- o complementary studies on all the sites taking into account the snow-related risks (ASN request All sites-14 of 26th June 2012. Deadline to be specified),
- o Studies on the specificities of gusting winds and the wind speeds to be considered for all the sites (ASN requests All sites-15 and All sites-16 of 26th June 2012. Studies submitted),
- o studies of the resistance of the equipment on all the sites to an extreme hailstorm (ASN request All-sites17 of 26th June 2012. The studies have been submitted and are currently being analysed),
- o studies of the definition and consideration of an extreme lightning phenomenon for the reactors in operation for the equipment necessary to manage loss of ultimate heat sink, loss of electrical power supplies and severe accident situations (ASN request Fleet-18 of 26th June 2012. The studies have been submitted and are currently being analysed).

In addition to this, in the context of the periodic safety review corresponding to the third ten-yearly outage of the 1300 MWe plant series, the baseline protection requirements of the NPPs against natural risks and risks for the heat sinks will be examined.

Lastly, ASN is going to consult the Advisory Committee of Experts on this subject, and the following points in particular:

- o experience feedback concerning external hazards,
- o assessment of the procedures to take account of the risks associated with these hazards (methods, baseline requirements, hazard levels, requirements),
- o comparison of the procedures and safety levels for the different hazards,
- o impact of the BNI order,
- o contribution of international work, notably that of WENRA,
- o consideration of climatic changes,
- o consistency in the definition of requirements,
- o general operating rules relative to hazards.

The baseline requirements associated with these hazards may be supplemented in the light of the conclusions of the review of the preceding themes.

17.4.1.1.4 Risks associated with other industrial activities

Following the stress tests, ASN issued requirement ECS-14 aiming to take into account the risk arising from activities situated near nuclear installations, in the extreme situations studied in the context of the stress tests, and in relation with the neighbouring operators responsible for these activities (deadlines for submitting studies and modification proposals ranging from 30th September 2012 to 31st December 2013. The deadlines for implementing a coordinated warning system with the neighbouring industrial operators are the same).

Based on the in-depth experience feedback from the Fukushima Daiichi accident, ASN has also planned to review the baseline safety requirements of the nuclear facilities with regard to the "risks associated with other industrial activities" aspects.

17.4.1.2 Flamanville reactor No. 3 (EPR)

The Flamanville reactor No.3 was included in the scope of the stress tests in accordance with specifications identical to those for reactors in operation. This review led to issuing of the following specific requirements[34] :

[34] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-resolutions/ASN-resolution-2012-DC-0283-of-26-June-2012

- Presentation of the measures envisaged for protecting the facility against the risk of flooding beyond the baseline requirements considered in the preliminary safety analysis report (requirement ECS-06. The measures must be submitted before 31st December 2013).
- Study of the advantages and drawbacks of installing an automatic reactor scram (AAR) system (requirement ECS-13. The study has been submitted and is currently being analysed).
- Overall review of the current design of the heat sink in relation to hazards with an impact on the flow and quality of water and the risk of clogging of the heat sink. The facility commissioning authorisation application file shall take account of the conclusions of this review (requirement ECS-15. The studies have been submitted and are currently being analysed).

Requirements ECS-14 and ECS-30 are identical.

ASN also takes part in the "siting" work of the Working group on regulation of new reactors, which is a technical group of the Committee on Nuclear Regulatory Activities (CNRA) of the Nuclear Energy Agency (NEA). ASN contributes to the activity of this working group on the basis of the examination of the Flamanville 3 projects.

17.4.2 Research reactors

Based on the conclusions of the technical review of the ITER BNI creation authorisation application file by the Advisory Committee of Experts, the conclusions of the board of inquiry, the opinion of the CLI and of the Prefect, a draft creation authorisation decree was submitted to the licensee in mid-2012 for consultation. After giving a hearing to a representative of the CLI and the licensee, ASN returned a favourable opinion on the draft decree, which was published on 10th November (decree 2012-1248 of 9th November 2012).

Alongside this, ASN has prepared a draft resolution setting the requirements for the design and construction of the facility. The civil engineering work, particularly the tokamak foundations, began in 2011.

ITER was included in the scope of the stress tests in accordance with specifications identical to those for reactors in operation. This review led to specific requirements being issued.

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 (defence 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 used 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 given to human factors and the man-machine interface.

In the framework of the reactor commissioning application reviews, ASN - with the support of IRSN - is responsible for the detailed examination of the design of new reactors. ASN also ensures regulation of the construction of the facility (see § 14).

18.1 The defence in depth concept

The safety principles and approaches have been implemented progressively in France and incorporate experience feedback from accidents.

The BNI order includes explicit regulatory requirements concerning the demonstration of safety and notably the principle of defence in depth. It also concerns the design and construction of research reactors.

18.1.1 ASN requests

The main means of preventing accidents or limiting their consequences is "defence in depth". This consists in implementing material or organisational provisions (sometimes called lines of defence) structured in consecutive and independent levels, and which are capable of preventing the development of an accident. The defence in depth principle is an integral part of the safety case. In accordance with the regulations, the implementation of this principle is based in particular on:

- the choice of an appropriate site, giving particular consideration to the natural or industrial risks weighing on the installation;
- identifying the functions necessary to demonstrate nuclear safety;
- a cautious design approach, integrating design margins and wherever necessary introducing adequate redundancy, diversification and physical separation of the items important for protection that fulfil functions necessary to demonstrate nuclear safety, to obtain a high level of reliability and guarantee the functions mentioned in the preceding paragraph;
- the quality of the design, construction, operation, final shutdown, decommissioning, maintenance and surveillance of the installations;
- preparation for the management of any incident and accident situations.

In the extreme situations analysed in the stress tests, the approach presupposes successive loss of the lines of defence by applying a deterministic approach. The aim was to assess the robustness of the defence in depth approach, the appropriateness of the accident management measures, and to identify the possible means of improving safety.

18.1.2 Measures taken for nuclear power reactors

The safety of the nuclear power reactors in operation and under construction is based on defence in depth covering five levels:

1. The first level combines specific design margins, quality assurance and inspection activities in order to prevent the occurrence of abnormal or defective operating conditions;
2. The second level consists in the implementation of protective measures to detect deviations from normal operating conditions and system-failures. This level of defence is planned to guarantee the integrity of the fuel cladding and of the primary cooling system in order to prevent accidents;
3. The third level is achieved by safeguard or protection 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;
4. The fourth level includes measures designed to preserve the integrity of the containment and to control severe accident situations;
5. The fifth level includes, in the case of a malfunction or ineffectiveness of the above-mentioned provisions, all relevant measures to protect the public in the event of significant releases.

The concept of defence in depth - Measures taken for the EPR

The safety of the EPR reactor relies on the five above-mentioned levels, implemented at the design stage, particularly with respect to severe accidents and external hazards (airplane crash).

A very high level of safety is targeted for the EPR reactor, firstly by facilitating reactor operation and maintenance, secondly by mitigating the immediate or deferred potential consequences. At the design stage, the approach for verifying design consistency with respect to the different lines of defence in depth is presented in the preliminary safety report which was submitted to the safety authority to support the application for authorisation to create a third reactor on the Flamanville site.

The implementation of the defence in depth concept during the qualification of the design and the technologies used is presented in § 18.2 and 18.3.

18.1.3 Measures taken for research reactors

The design of the CEA's Jules Horowitz Reactor (JHR) is based on the defence in depth concept which places particular emphasis on containment by defining barriers between the radioactive products and the external environment of the installation.

18.1.4 ASN analysis and oversight

18.1.4.1 Nuclear power reactors

The defence in depth concept is applied to all the nuclear installations by implementing systems that can detect or prevent certain failures of systems that guarantee the safety of the installations; these more particularly concern confinement barriers that prevent the dissemination of radioactive materials into the environment. The safety analysis must demonstrate the effectiveness of these systems in both normal operating situations and accident situations. These various systems are inspected at regular intervals.

The safety approach applied by the licensees remains satisfactory on the whole and perfectible as regards certain points identified on a case-by-case basis according to the installations concerned.

18.1.4.1.1 Stress tests

On the reactors currently in operation, the current baseline safety requirements do not require the equipment for mitigating the consequences of a severe accident and radioactive releases to take external hazards into account. The licensee must specify the hardened safety core equipment for preventing and mitigating the consequences of a severe accident. These equipment items shall be robust to hazards beyond the current hazard level considered (requirement ECS-01, see § 6.3.1.3).

The stress test analysis of robustness of the facilities in the event of loss of the electrical power supplies or the heat sink revealed, in addition to the safety enhancement measures, the need to analyse certain phenomena in more detail. This particularly concerns the long-term operating reliability of certain equipment items, notably with respect to the rise in temperature, the examination of coolant pump seal robustness, the study of how the behaviour of the fuel and the water in the spent fuel pools evolves over time in situations of loss of cooling, and the review of the changes proposed by EDF for incident operating management.

18.1.4.1.2 Flamanville-3 EPR reactor

The safety approach implemented at the design stage is based on the concept of defence in depth such as it is presented in the INSAG (International Nuclear Safety Advisory Group) documents.

This reactor was also included in the scope of the stress tests. This review led to requirements[35], including requirement ECS-01 relative to the "hardened safety core".

Since 2007 ASN has been pursuing its regulation role through the ongoing analysis of the detailed design of the future EPR reactor of Flamanville in order to prepare for its future commissioning.

18.1.4.2 Research reactors

ASN's conclusions on the general design of the JHR are presented in § 18.3.3.

18.2 Qualification of the technologies used

18.2.1 ASN requests

The BNI order stipulates the requirements of the items and activities identified as being important for protection. The qualification of these items must be proportionate to the potential consequences, aiming in particular at guaranteeing the ability of these elements to fulfil their assigned functions in the situations where they are needed. Appropriate design, construction, tests, inspection and maintenance provisions must be implemented to enable this qualification to be maintained over time.

The BNI procedures decree specifies the files in which the licensee must set out its qualification procedure.

In addition, the manufacture of nuclear pressure equipment (ESPN) is subject to an individual conformity assessment whereby the conformity of these equipment items with all the regulatory requirements and their suitability to be used is assessed with respect to the predicted operating loads.

More specifically, ASN assesses the conformity with regulatory requirements of each of the ESPN items that are most important for safety, called "Level N1 ESPN". This assessment concerns the equipment intended for the new nuclear installations (EPR) and the replacement equipment for nuclear installations in operation (replacement steam generators). ASN can be assisted in this task by organisations that it has approved.

18.2.2 Measures taken for nuclear power reactors

Equipment qualification

As a general rule, the qualification of each equipment item is defined following rules and requirements that depend on its safety classification, that is to say its importance for safety and the types of loads or stresses it must withstand:

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[35] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments/ASN-resolutions/ASN-resolution-2012-DC-0283-of-26-June-2012

- a consequence of the seismic qualification is that the stresses resulting from the earthquakes must be taken into account in the design of the equipment;
- the purpose of qualification under accident environmental conditions (temperature, pressure, humidity, irradiation) is to prove through tests or analyses that the materials are capable of fulfilling their functions under the ambient conditions and stresses to which they are assumed to be subjected.

For the electrical safety equipment, three qualification categories representing "envelope" conditions have been defined:

- category K1: equipment items installed in the containment and having to fulfil their function in accident situations;
- category K2: equipment items installed in the containment and having to fulfil their function in normal situations;
- category K3: equipment installed outside the containment.

The environmental conditions include normal, incident and accident conditions and the seismic loads, according to the equipment and qualification category.

It is important to be able to check the sustainability of these qualifications over time during operation. This is one of the important aspects taken into consideration in the conformity assessments carried out during the periodic safety reviews.

Complete initial inspection and periodic requalifications

The primary and secondary cooling systems of the PWRs are subject to a complete initial inspection and a periodic ten-yearly requalification which includes an inspection of the system, non-destructive examinations, hydrostatic testing and a functional check of the over-pressure protection accessories.

Further applications are currently being developed and qualified in order to address new requirements, in particular concerning the Flamanville-3 EPR reactor, for which the processes to be implemented during the complete pre-service inspection will be qualified by mid-2013.

Construction of the Flamanville-3 EPR reactor

<u>Quality of on-site construction and assembly operations</u>

Pursuant to Article 4 of the 1984 "Quality" Order, EDF is responsible for monitoring the quality of major activities important for safety, and in particular the activities relating to the study, on-site construction and assembly and manufacture of items important for safety.

ASN for its part continues to perform unannounced and scheduled inspections on the work site.

Two significant events concerning the construction of the Flamanville-3 EPR reactor were notified by EDF in 2012. The first concerned the detection of welding defects on the support brackets of the polar crane in the reactor building, and the second was linked to a lack of monitoring of the manufacture of the ultimate backup diesel generator engines.

<u>Manufacturing quality for the EPR</u>

The monitoring of manufacturing operations for the EPR reactor encompasses both the technical monitoring and the tracking of the manufacturing steps from the upstream review of the contractual conformity of the suppliers' technical documentation through to the inspections in factories and on the Flamanville-3 construction site.

EDF holds monthly meetings of its manufacturing monitoring teams in order to review industrial schemes, report on manufacturing progress, analyse the corresponding critical paths and examine the difficulties encountered.

These meetings have been instrumental in ensuring manufacturing "quality and lead-time" coordination and monitoring, as well as the related progress reports.

On the whole, the in-factory monitoring of the manufacture of mechanical and electrical equipment in 2011 and 2012 concerned more than 400 suppliers out of a panel of about 866 who were subject to a Flamanville-3 manufacturing monitoring plan.

18.2.3 Measures taken for research reactors

The safety analysis methodology applied for all the research reactor licensees leads to a safety classification of the components that are required to ensure a safety function and which must be qualified. This classification determines the requirement level for manufacture, operation and monitoring alike.

Furthermore, the periodic safety reviews can lead to upgrading work in various areas, including the requalification of certain equipment items.

18.2.4 ASN analysis and oversight

18.2.4.1 Assessment of nuclear pressure equipment conformity

The process for assessing the equipment conformity with the regulatory requirements is described in a specific guide of which the first version was published in March 2009. At the end of 2010, ASN started revising this guide and published a new version in September 2012 after consulting the Advisory Committee of Experts for ESPN items. This revision has let do an improvement in practices and clarified the extent of the inspections to be performed by the inspection organisations at the end of manufacture of the ESPN items.

ASN also called on the nuclear pressure equipment manufacturers to exercise vigilance with regard to demonstrating that the materials used in the equipment comply with the applicable regulatory requirements. This verification implies monitoring of the materials suppliers by the manufacturers themselves.

ASN considers that some of the practices in effect until 2012 can be improved, even if they do not compromise the regulatory conformity of the equipment currently being manufactured. The ESPN manufacturers must take all necessary steps to apply the provisions specified in the revised conformity assessment guide as rapidly as possible.

ASN however notes that all the manufacturers are taking increasing note of the new regulatory requirements. It specifically notes that certain requirements have been satisfactorily assimilated by the manufacturers.

In October 2012, ASN completed its conformity assessment of the first newly manufactured steam generators. Further to this assessment, ASN considers that AREVA has acceptably demonstrated the conformity of the equipment with the provisions of the ESPN order, thanks to the efforts made during 2012. ASN does however consider that AREVA's practices must evolve even further to fully adapt to the requirements introduced by the regulations.

18.2.4.2 Flamanville-3 EPR reactor

18.2.4.2.1 Qualification of nuclear pressure equipment

In application of the above-mentioned principles, ASN and the approved organisations regulates the manufacture of the ESPN for the Flamanville-3 reactor and other structures, systems and components on the construction site or on the manufacturers' premises. This regulation is materialised by an examination of the technical documentation of each equipment item and inspections in the shops of the manufacturer and their suppliers and subcontractors.

In addition, ASN and STUK, the Finnish nuclear regulator, are in regular contact with each other to share experience in the manufacture of the ESPN items.

During the last two years ASN has continued its assessment of the conformity of the ESPN of the EPR reactor's primary and secondary cooling systems. In addition to reviewing the technical documentation concerning the design and manufacture of ESPN, ASN and the approved organisations performed more than 820 inspections to monitor the manufacture of this equipment.

18.2.4.2.2 Qualification of other equipment items

As part of the detailed review of the Flamanville-3 reactor design (see § 18.3), several subjects linked to the qualification of other equipment items are studied:

- qualification under accident conditions which aims to verify that the equipment used in the management of incidents and accidents remains usable under deteriorated environmental conditions.
- qualification of equipment reliability, which aims at verifying that the equipment is capable of fulfilling with sufficient reliability the functions attributed to it in the safety case.

ASN has also carried out inspections concerning the organisation and coordination of the equipment qualification in accident conditions for the Flamanville-3 EPR reactor.

ASN validation of the instrumentation and control architecture

The "instrumentation & control" (I&C) of Flamanville-3 EPR reactor comprises two platforms:

- the Teleperm XS platform, specifically developed for the nuclear industry and dedicated to reactor protection functions in incident or accident situations;
- the SPPA T2000 platform, of "conventional industrial" origin, which is used for normal reactor operation and for certain reactor protection functions in incident or accident situations.

In response to the ASN request in a letter dated 9th July 2010, EDF presented alternative design measures to those initially envisaged. These new design measures consist more particularly in grouping within a "hardened safety core" system certain safety functions hitherto not installed on the Teleperm XS platform. These measures make it possible to deal with total loss of the SPPA T2000 platform combined with certain accident situations.

At the same time, together with the designers and manufacturers concerned, EDF deployed significant efforts to prove that certain safety functions could be installed on the SPPA T2000 platform.

Further to the analysis of these modifications carried out by IRSN and the opinion of the Advisory Committee for nuclear reactors (GPR) returned on 16th June 2011, ASN considers that the I&C architecture of the Flamanville-3 EPR reactor proposed by EDF is able to guarantee the safety of the systems used to manage incident or accident situations and their independence from the control systems used to run the facility in normal operating conditions. EDF can thus continue to deploy this system, for which the detailed design will be analysed by ASN prior to the commissioning authorisation.

18.2.4.3 Nuclear power reactors in operation

ASN considers that for the reactors of the fleet in operation, EDF must pay greater attention to the qualification of equipment for accident conditions, whether during preventive maintenance operations or when replacing equipment. In 2011 EDF initiated an action plan concerning control of the requirements for equipment and spare parts to be qualified for accident conditions.

18.3 Design criteria

At the preliminary design study stage for a reactor, the manufacturer can submit a safety options file containing the main characteristics and general design choices in terms of safety (see § 7.2.1).

Once the nuclear facility has been commissioned after receiving ASN's authorisation, all the modifications made by the licensee that could affect safety, public health and sanitary conditions or protection of nature and the environment are notified to ASN. The licensee must also perform periodic safety reviews taking into account any changes in techniques and regulations as well as experience feedback.

Lastly, in particular contexts the design criteria may be reviewed at specific safety reassessments.

18.3.1 ASN requests

The general technical regulations include texts of a general nature setting the technical rules in terms of nuclear safety, whether they are of a binding regulatory nature (see § 7.1.3.2) or not (see § 7.1.3.3).

ASN has developed basic safety rules (RFS in French) and ASN guides (see Appendix 2.2) on various technical subjects concerning the BNIs.

The "technical directives for the design and construction of the next generation of pressurised water reactors" adopted by ASN in 2004, define the safety approach and the general safety requirements that ASN considers acceptable to apply for the design and construction of new reactors.

Over and beyond the technical criteria, ASN is also attentive to the conditions that are favourable or prejudicial to operators and worker groups making a positive contribution to the safety of nuclear facilities. In this context, ASN expects organisational and human factors to be integrated in a way that is appropriate for the safety issues concerning safety of the facilities and worker security in the design of a new facility or the modification of an existing one (see Chapter 12).

Finally, in the particular context of the stress tests, ASN asked EDF to carry out and revise various design studies relative to the loss of the electrical power supplies and cooling systems of the reactors under construction and in operation.

18.3.2 Measures taken for nuclear power reactors

18.3.2.1 Design criteria (existing reactors and the EPR)

The safety case is based on a limited number of representative events and incident or accident scenarios to be considered at the reactor design stage, among those that could occur during its operation, as well as on the physical states of the reactor. The events initiating transients are grouped in several categories according to their estimated frequency of occurrence and their potential consequences for the environment.

These identified and classified events are used in the design of the primary and secondary cooling systems and the protection and safeguard systems used to control such situations, and consequently serve to prevent consequences that are unacceptable for the facility and its environment.

On the basis of the design of the facility and the control principles, the management of the main incident and accident operating conditions is analysed in the safety report.

Alongside the control of the simple initiating events, situations involving multiple failures that could lead to core meltdown are analysed on the basis of a probabilistic safety assessment (PSA) of the design. On account of defence in depth, additional lines of defence are put in place to prevent core meltdown situations or to mitigate their consequences.

Case of the EPR

Risk reduction and prevention of situations that can lead to core meltdown

A risk reduction category contains the combination of predominant events that can lead to core meltdown situations through multiple failures. The list of multiple failure conditions proposed in this analysis may be revised during the detailed analyses carried out when updating the PSAs.

From the technical aspect, additional safeguard systems have been designed and installed to prevent core meltdown during these sequences.

Risk reduction and control of core meltdown situations

The control of core-melt situations constitutes the second stage in risk reduction; it relies on the safety analysis of the scenarios involving core-meltdown sequences at low pressure, while the other core-meltdown scenarios are covered by specific provisions allowing the exclusion or "practical elimination" of their occurrence.

The analysis enables means for ensuring and protecting the confinement function to be defined. It also enables the instrumentation needed by the licensee and the emergency team to manage this type of situation to be defined along with the conditions of qualification of the equipment necessary to demonstrate that the safety objectives are achieved.

All analyses presented in the preliminary safety report during the design stage will be reviewed again in the safety report submitted to support the commissioning authorisation application. This safety report will take into account the detailed design and in particular the fuel management strategy, which will be defined before the installation is commissioned, along with the general operating rules.

18.3.2.2 Experience feedback from the Fukushima Daiichi accident (existing reactors and EPR)

Loss of electrical power supplies

Each reactor can isolate itself from the electricity transmission system via its step-down transformer. In addition, the reactors have on-site redundant conventional back-up sources capable of supplying the electrical panels vital for correct operation of the safety equipment (two backup diesel generator sets on the reactors of the fleet in operation and four main generator sets on the EPR reactor).

Each NPP also has an additional on-site emergency power source whose technology differs according to the plant series concerned.

Electric batteries with a power autonomy of one hour on the reactors in service and two hours on the EPR reactor ensure and guarantee continuity of the electrical supply to certain important equipment items when the generator sets are not operating.

In case of loss of the off-site electrical sources and the abovementioned on-site back-up sources, specific equipment is provided to supply certain items that are critical for managing this situation:

- on each reactor in service, one ultimate electrical power source provided by a turbine generator driven by steam from the steam generators;
- on the EPR reactor, two batteries dedicated to this situation (called "12-hour" batteries).

To summarise the situation, EDF has proposed the following measures to counter the risk of loss of the electrical power supplies to the reactors in service:

- one hazard-resistant generator set called the "ultimate back-up diesel generator" will be installed on each reactor before the end of 2018;
- initially, pending deployment of the ultimate back-up diesel generator, a fixed generator set for supplying the reactor minimum I&C and control room lighting is already installed (end of june 2013 – see § 17.2.1) in accordance with the ASN requirement ECS - 18;

- o the possibility of ensuring ultimate water make-up for certain tanks and spent fuel pool using mobile means of the FARN;

For the EPR reactor, EDF has proposed the following measures in particular:
- o extension of the autonomy: mobile means of pumping fuel from the main generator set tanks to replenish the ultimate backup diesel generator sets;
- o extension of the duration of electrical supply for essential functions by deploying supplementary fixed or mobile electrical power sources;
- o means of restarting the I&C dedicated to severe accidents.

Loss of cooling systems or heat sink

Each pumping station has two redundant and geographically separate channels.

The reactors in service are designed to have an autonomy of at least 100 hours after a heat sink loss.

If the heat sink loss affects all of a site's reactors simultaneously, the targeted autonomy is 24 hours for coastal sites and 60 hours for riverside sites in the case of an unpredictable hazard, and 72 hours in the case of a predictable hazard, in which case the tanks can be filled to maximum level as a preventive measure.

The pumping station equipment is subject to safety requirements defined in the heat sink baseline safety standard.

No nuclear power reactor apart from the Flamanville-3 EPR currently under construction has an alternate heat sink. This being said, some NPPs have a larger water reserve through their design.

In response to the ASN requirement, the licensee has carried out an overall review of the design of the heat sink of the plant units with respect to hazards having an impact on the flow and quality of water and the risk of clogging of the heat sink. The results of this design review were submitted to ASN within the set deadlines (end of June 2012). The licensee has identified the solutions it proposes to remedy the weaknesses detected by the robustness analyses.

Certain measures taken immediately using equipment present on the site enable loss of the heat sink to be compensated for temporarily until it is restored. These measures comprise:
- o implementing a control procedure that enables the thermal inertia of the primary system borated water tank to be used as a back-up heat sink;
- o maintaining of a make-up pump to ensure borated water make-up and depressurise the reactor by auxiliary spraying;
- o resupply of the auxiliary feedwater tank in order to allow long-term removal of residual power by the steam generators.

In a situation of total loss of heat sink and when the primary cooling system is closed, residual power is removed from the reactor core by the secondary system. In this case EDF identifies a cliff-edge effect related to the water depletion of the auxiliary feedwater tanks supplying the SGs. The time this would take is evaluated at "several days". EDF considers that in all cases the heat sink will have been restored before the core becomes uncovered. In situations where the primary cooling system cannot be pressurised, the residual power is removed by vaporisation of the reactor cavity water in the containment.

In the particular case of the EPR, a cliff-edge effect is associated with the auxiliary feedwater autonomy for supplying the SGs, evaluated at about 2 days. However, these can subsequently be replenished by the tanks of the fire-fighting water system, increasing the autonomy to 9 days.

In all the configurations studied by EDF, for both the reactors and the spent fuel pools, the estimated time before the feared situation occurs (nuclear fuel uncovering) is greater than the required time estimated by EDF for restoration of the heat sink. EDF has nevertheless proposed an ultimate back-up make-up means specific to each plant unit and robust to the hazards considered in the stress tests, which will draw water from the water table or large-capacity ponds using a stand-alone motor-driven pump or an electric pump backed by the ultimate back-up diesel generator. EDF has specified that this system will be installed as of 2015, jointly with deployment of the ultimate backup diesel generator on the plant units.

In response to the ASN requirement, EDF has undertaken to carry out studies (before end of 2013) on the requirements assigned to the equipment necessary for controlling total loss of heat sink situations and the proposed changes to the baseline safety requirements and the resulting reinforcements of the installations in order to cope with these situations, in particular for long-duration scenarios.

The situation of total loss of the heat sink combined with total loss of the electrical power supplies has no additional impact compared with the total loss of electrical power alone. This is because loss of the electrical power supplies causes total loss of the heat sink.

18.3.3 Measures taken for research reactors

Although the Jules Horowitz Reactor (JHR) is of a very recent design that integrates operating experience feedback from the other experimental reactors, the stress tests process has resulted in the CEA identifying possibilities for improvements that could be implemented in spite of the advanced state of construction. ASN thus considered that some of the proposals made by CEA, which are likely to make the facility more robust, should be implemented. Moreover, making these improvements at the design/construction stage favours prevention, rather than mitigation, of the consequences of possible accident situations. In this context, through ASN resolution 2012-DC-0294 of 26th June 2012, ASN has published a number of additional requirements. In September 2012, CEA proposed its “hardened safety core” for the JHR and this is currently being examined.

In order to facilitate oversight of the progress of construction of this reactor, and pursuant to the resolution setting the requirements for the design and construction of the JHR (ASN resolution 2011-DC-0226 of 27th May 2011), CEA transmits a quarterly progress report for the project. This document allows the identification of the activities or particular points which ASN considers need to be included in its spot checks during its inspections.

18.3.4 ASN analysis and oversight

18.3.4.1 Oversight of construction of the Flamanville-3 EPR reactor

The oversight of construction of the Flamanville-3 reactor comprises an examination of the detailed design, including the studies to define the data necessary for the production and inspection activities which encompass site preparation after delivery of the creation authorisation, manufacture, construction, qualification, assembly and testing of the structures, systems and components, whether on the construction site or on the manufacturers' premises.

This oversight also applies to the manufacturer of the ESPN items that will form part of the nuclear steam supply system (see § 18.2).

18.3.4.1.1 Detailed design review

At the design stage, the approach for verifying reactor design consistency with respect to the different lines of defence in depth is presented in the preliminary safety report.

The ESPN represents an important subject in nuclear power reactors. The detailed design of the nuclear pressure equipment is examined as part of their conformity assessment.

Technical review of design studies

The detailed design review is carried out by ASN with the technical support of IRSN, on the basis of a documentary review.

In 2011 and 2012, ASN and IRSN essentially finalised their examination of the design of the I&C system architecture (see § 18.2) and continued reviewing the civil engineering of the facility and the detailed design of certain systems important for the safety of the reactor, focusing on innovative systems and the systems involved in reactor protection and safeguard, or in maintaining the three safety functions. The review of the detailed design of the elements involved in optimising radiation protection and dimensioning of the radiological shielding of the reactor building has also been carried out.

Oversight of the quality of the design studies and manufacture

In addition to the technical review of the detailed design studies, ASN conducted five inspections in 2011 and six inspections in 2012 in the engineering departments responsible both for these studies and for monitoring manufacturing operations on the suppliers' premises. One of these inspections in 2011 was an in-depth inspection of the conformity of the Flamanville-3 reactor design and construction work subcontracted by EDF to AREVA.

During its inspections, ASN observed that the organisation put in place in the various EDF departments, whether for engineering or for the teams in charge of monitoring the activities performed by its contractors, was on the whole satisfactory and showed signs of improvement with respect to previous years. Numerous actions are nevertheless currently in progress at EDF and its contractors to demonstrate that the manufactured items meet the requirements set by the safety case.

Furthermore, as all the detailed design studies for the Flamanville-3 reactor have not yet been completed, EDF shall, once they are finalised, check that all elements for demonstrating reactor safety are coherent.

18.3.4.1.2 Oversight of the Flamanville-3 EPR reactor construction activities

Each year ASN performs inspections on the Flamanville-3 EPR reactor construction site, assisted by IRSN.

Table 9: Inspections performed on the Flamanville-3 EPR reactor construction site

Year	Inspections performed	Main themes
2010	37	Civil engineering of the buildings and structures, mechanical and electrical assemblies of the systems and components, worker radiation protection, environmental protection, the impact of the construction activities on reactors 1 and 2, and the monitoring of outside contractors.
2011	25	Civil engineering of the buildings and structures, mechanical and electrical assemblies of the systems and components, worker radiation protection, environmental protection, the impact of the construction activities on reactors 1 and 2, and the monitoring of outside contractors.
2012	18	Civil engineering of the buildings and structures, the mechanical and electrical assemblies of the systems and components, worker radiation protection, the organisation and management of safety within the site and within the future reactor operating team, environmental protection and the impact of the work site activities on reactors 1 and 2.

More specifically, ASN paid particular attention to the following subjects in 2012:

- installation of the prestressed concrete inner housing of the reactor building. Since 2008, ASN has been informed of a number of positioning anomalies with portions of pre-stressing ducting.

In June 2011, ASN considered that the repetitive nature of these anomalies indicated a lack of preparation, competence and safety culture among the workers concerned and shortcomings in EDF's monitoring of its subcontractors. On 23rd June 2011, ASN therefore asked EDF to suspend concreting work on the inner containment wall and to present an action plan designed to avoid any further anomaly with the positioning of the pre-stressing cable ducts. In the following days, EDF presented its action plan and in particular the steps taken to improve the competence of the teams in charge of installing the pre-stressing cable ducts and the monitoring of these teams.

On 1st July 2011, considering that the steps taken by EDF were such as to allow correct performance of the pre-stressing cable duct installation activities, ASN authorised EDF to resume concreting work on the inner containment wall. An unannounced ASN inspection was made to check implementation of the EDF action plan, its findings being that the technical and organisational measures were satisfactory.

- complex concreting activities. In July 2011, EDF informed ASN that it had discovered honeycombing in certain walls of the pools in the reactor and fuel buildings. These concrete walls thus display local concentrations of aggregate and a lack of cement, which requires repair. Beyond the processing of occasional deviations for which repairs were already scheduled, EDF – at the request of ASN – provided additional training, enhanced the preparation of the activities by including more detailed risk assessments and reinforced the inspections in order to improve the quality of complex concreting operations. ASN conducted several inspections on this theme in 2011 and in 2012, accompanied on one of them by inspectors from the Finnish nuclear regulator (STUK).

  In addition, in March 2012, EDF informed ASN of the presence of "empty spaces" behind the recesses accommodating the gates of the reactor building pools; this partial filling with concrete results from activities that took place in the summer of 2011, before the implementation of additional measures for complex concreting work. EDF detected this defect at Flamanville following experience feedback from the Olkiluoto EPR reactor construction site. The repairs initiated by EDF were the subject of an unannounced ASN inspection on 21st August 2012 and a technical meeting on the site on 13th October 2012, notably to present the results of the first repairs. ASN will remain attentive to the final construction quality - that is to say after inspection and repair – of the Flamanville-3 reactor pools;

- welding of the tank and pool liners. Since the end of 2010, work has started on assembly of the liners of certain tanks important for safety. This particularly concerns the lining of the reactor building and fuel building pools. ASN is particularly attentive to the oversight of these activities to ensure that EDF masters the manufacturing methods.

These checks and the way the detected deviations are handled show that the organisation of EDF and of the main civil engineering contractor is satisfactory. ASN in particular observes that experience feedback from the welding of this type of liner is integrated as and when difficulties are encountered. ASN will remain attentive to the oversight of these activities and to the final construction quality of these liners, for example by filling the tanks and pools with water to test them.

Manufacturing defects observed on the Flamanville-3 reactor polar crane brackets

During an inspection on 14th December 2011, ASN was informed of a number of deviations that occurred during the manufacture of the support brackets of the reactor building polar crane. EDF discovered defects in the welds of these brackets in the factory before painting, then again on the Flamanville site during complementary inspections. Whereas these defects had initially been discovered on a small number of brackets, additional inspections of other brackets revealed defects on a large number of them. EDF therefore decided to have all the polar crane support brackets remanufactured.

EDF has presented the steps taken to understand the origin of these numerous defects. In addition, all the support brackets have been replaced during the first semester 2013.

The inspections initiated due to these manufacturing defects revealed similar defects in other items of equipment intended for the Flamanville-3 reactor. EDF took steps to remedy the defected defects, returning the equipment concerned to the factory for repair when necessary.

18.3.4.1.3 Oversight of the manufacture of nuclear pressure equipment

This point is detailed in § 18.2.

18.3.4.2 The Penly-3 EPR reactor

At the end of 2010, EDF submitted to the Ministers for nuclear safety a creation authorisation application for an EPR reactor on the Penly site. These ministers asked the ASN for its opinion on the acceptability of the various elements of the dossier. ASN, with the support of IRSN, examined the dossier submitted by EDF. Their conclusion was that additional data were needed in order to carry out a detailed technical examination. These additional data requests primarily concern the preliminary safety report, the risk management study and the impact assessment. The public inquiry for this EPR nuclear reactor project was initially supposed to start in June 2011, but was postponed first until October 2011 and then, at the request of EDF, until an unspecified date in 2012. This project is at present suspended.

18.3.4.3 Stress tests

In the framework of the stress tests, a large number of design studies of reactors under construction or in operation have been carried out or revised. The conclusions of these stress tests have led ASN to set complementary requirements obliging the licensees to carry out significant works to protect against loss of the electrical power supplies and the heat sinks.

These measures are specified on the ASN website[36] and detailed in the national action plan[37] resulting from the stress tests. They include new design studies, particularly concerning:

- The defining of the structures and components of the "hardened safety core", including the emergency management premises and the defining of the requirements applicable to this hardened safety core (requirement ECS-01, see § 6.3.1.3). These files have been received and are currently being examined. A specific meeting of the Advisory Committee was held on 13th December 2012.
- The heat sink in relation to hazards with an impact on the flow and quality of water and the risk of clogging of the heat sink (requirement ECS-15, see § 17.4.1.1.3). The information has been submitted and is currently being analysed.
- Emergency water supply resources (requirement ECS-16).
  - The information relating to the emergency technical provisions have been submitted for all the sites (except Chinon and Golfech) and were examined at the Advisory Committee meeting of 13th December 2012 dedicated to the "hardened safety core" (requirement ECS-1).
  - The information concerning the systems for injecting borated water into the reactor core in the event of total loss of on-site electrical power when the primary cooling system is open has been submitted and ASN has agreed to the implementation of this modification.

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[36] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments

[37] http://www.french-nuclear-safety.fr/index.php/English-version/News-releases/2012/European-stress-tests-ASN-publishes-its-national-action-plan

- Reinforcement of the facilities to manage long-term situations of total loss of heat sink or of electrical power supplies (requirement ECS-17). The information must be submitted before 31st December 2013.
- Reinforcement of the autonomy of the batteries and of the installation of additional electrical power supply means (requirement ECS-18). The information concerning the batteries was submitted on 30th June 2012 and is currently being analysed. The studies relative to the additional electrical power supply means that meet the requirements relative to the "hardened safety core" (requirement ECS-1) are in progress.

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 on an appropriate safety analysis and a commissioning programme demonstrating that the installation, as built, is consistent with design and safety requirements;

ii) the operating limits and conditions derived from the safety analysis, tests and operating experience are defined and revised as necessary to delimit the safe operating range;

iii) operation, maintenance, inspection and testing of a nuclear installation are conducted in accordance with approved procedures;

iv) procedures are established to respond to anticipated operating incidents and to accidents;

v) the 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 notified the regulatory body in a timely manner by the holder of the corresponding licence;

vii) programmes to collect and analyse operating experience data 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 production of radioactive waste resulting from the operation of a nuclear installation is as low as possible for the process concerned, both in activity and in volume, and that conditioning and disposal are taken into consideration in any necessary treatment and storage operations for spent fuel and waste resulting directly from operation and situated on the same site as the nuclear installation.

19.1 Commissioning of a BNI

19.1.1 ASN requests

Commissioning corresponds to the first use of radioactive materials in the installation.

In application of the BNI procedures decree, the introduction of nuclear fuel into the perimeter of the installation and starting of the installation are subject to ASN authorisation. One year before the planned date of commissioning and 6 months before nuclear fuel is introduced into the BNI perimeter the licensee must send ASN a file comprising:

- the safety report,
- the general operating rules,
- a study of the installation's waste management,
- the on-site emergency plan (PUI), the decommissioning plan, and
- an update of the impact study of the installation.

After checking that the installation complies with the objectives and rules specified in the TSN Act and its implementing texts, ASN authorises the commissioning of the installation and communicates this decision to the Minister responsible for nuclear safety and to the Prefect.

Before the actual authorisation procedure is started or completed, partial commissioning may be authorised by an ASN resolution for a limited period of time in the following cases:

- the performance of specific operating tests requiring the introduction of radioactive materials into the installation;
- the introduction of nuclear fuel into the perimeter of the reactor before the first loading of fuel into this reactor.

The resolution authorising commissioning sets the deadline for the licensee to submit to ASN a start-up completion file for the installation, comprising:

- a summary report of the installation start-up tests;
- a review of acquired operating experience;
- an update of the documents constituting the commissioning application.

The BNI procedures decree also applies to the commissioning of research reactors.

19.1.2 Measures taken for nuclear power reactors

19.1.2.1 Reactor commissioning at EDF

The commissioning tests comprise:

- preliminary tests: blank tests, pump-rotation tests, cleaning of circuits, etc;
- overall tests at the different stages of progress during commissioning.

The commissioning tests follow test procedure programmes which specify, for each elementary 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 satisfied.

The test procedures accompanied by the measurement record sheets and test results are known as the test execution records.

Analysis of the results by the site personnel and the engineering centres may lead to retests. The tests are scheduled and coordinated by a group comprising the licensee and the manufacturers.

An on-site test committee meets at each important transition from one overall test phase to another. This committee comprises representatives from EDF and the manufacturers, with participation of ASN delegates. ASN authorises proceeding to the next test phase if the results presented to the committee are satisfactory.

The site manager becomes responsible for the safety of the reactor from the first loading of nuclear fuel into the core.

Preparation for operation of the Flamanville-3 EPR reactor

A unit of Flamanville-3 is conducting the preparatory work for commissioning and a large amount of training to develop personnel skills before start-up.

An independent safety organisation is in place. It oversees the quality of the activities carried out on the Unit and implements an annual programme of audits and verifications.

The site is continuing its contribution to the preparation of the general operating rules in collaboration with the designer, by checking their applicability with the help of Human Factors experts. Preparation of the operating documentation began in 2010 and is also continuing with the drafting of optimised maintenance programmes.

The process for transferring the elementary systems from the manufacturer to the future licensee is already in progress and is based on detailed verifications of conformity.

Preparation for operation will continue in 2013 and 2014, focusing on:

- the organisation of the start-up tests in collaboration with the designer;
- preparation of the emergency response organisation integrating the experience feedback from the Fukushima Daiichi accident;
- sharing experience with the other EPR licensees and integration of international operating experience feedback from the sites in the start-up phase (World Association of Nuclear Operators - WANO).

19.1.3 ASN analysis and oversight

Without waiting for transmission of the complete commissioning application file, ASN and IRSN jointly initiated an advance review of the documents already submitted to prepare for examination of the commissioning application file (see § 14.1.4.1).

In parallel with this advance technical examination, ASN also oversees the construction of the facility (see § 18.3.4.1.2).

During 2013, ASN will develop the regulatory instruments necessary for managing the preparation and inspection of the facility start-up tests and the final review of the commissioning authorisation application file. ASN will carry out these steps jointly with its counterparts also involved in such projects, particularly within the Multinational Design Evaluation Programme (MDEP).

19.2 The operating range of BNIs

Pursuant to the decree of 2nd November 2007, in view of the commissioning of a BNI, the licensee sends ASN a file containing the general operating rules (RGE) which describe the operating conditions by transforming the initial hypotheses and the conclusions of the safety studies taken from the safety report into operating rules. This collection of rules is subject to ASN approval.

19.2.1 ASN requests

The RGEs comprise several chapters, of which those most important for safety are examined by ASN. For the nuclear power plants this concerns:

- chapter III which describes the operating technical specifications (STE) that delimit the normal operating range of the reactor. The STEs also specify the actions to take if these limits are exceeded. They also define the necessary equipment according to the state of the reactor and indicate the steps to take should this equipment malfunction or be out of service.
- chapter VI which contains the operating procedures for incident and accident situations. It specifies the action to be taken in these situations to maintain or restore the fundamental safety functions and return the reactor to a safe state.
- chapter IX which defines the inspection and periodic test programmes applied to verify the availability of the equipment and systems that are important for safety. If results are unsatisfactory, the action to take is specified in the STEs.
- chapter X which defines the programme of physical tests for the reactor core to ensure monitoring of the core during restarting and operation of the reactor.

EDF may be led to modify permanently 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 exceptional circumstances EDF may have to diverge from the normal operating procedures dictated by the STEs and must report any such divergence to ASN. ASN examines the temporary modifications to the STEs and may approve them, possibly subject to the implementation of additional measures.

ASN also ensures that the temporary modifications are justified and carries out an in-depth examination each year on the basis of an assessment prepared by EDF. Hence, EDF is required to:

- re-examine periodically the soundness of the temporary changes in order to identify those that would justify a request for a permanent change to the STEs, and;
- identify any generic changes, notably those associated with the implementation of national physical changes and periodic tests.

19.2.2 Measures taken for nuclear power reactors

For each operating range, the STEs define the required operating envelope, that is to say the limits for the physical parameters and the safety functions that must be available. A system or equipment item is available if, and only if, it can be demonstrated that it is capable of performing its assigned functions with the required performance levels (start-up time, for example):

- in particular, the auxiliary equipment items required for its operation and its instrumentation and control are themselves available;
- the periodic test programmes in the general operating rules concerning these equipment items or systems are carried out in a normal manner (compliance with specified frequency, including tolerance, and procedure) and the results are satisfactory.

Unavailability can be:

- unscheduled: unexpected discovery of an operating anomaly on the equipment concerned;
- scheduled: its frequency and cause are known and predetermined (execution of a preventive maintenance programme or periodic tests);
- other: neither unscheduled nor scheduled. This is the case for example with unavailability due to the incorporation of a modification.

Any noncompliance with an STE rule (e.g. exceeding an range condition limit, unavailability of a required equipment item) constitutes an event. For each operating range, the STEs define the action to take following an event: fallback state, time taken to enter fallback state or repair time.

Fallback state is a reactor state in which the event either does not affect the safety of the reactor, or affects it to a lesser extent. Transition from the initial operating state to fallback state is made by applying normal operating procedures.

The actions for making the transition to the fallback state must always begin within the required "initiation" period, which provides the time to make a diagnosis, assess the situation, consider a repair and prepare for the transition to the fallback state. A repair time is authorized in order to attempt to make the required equipment available again.

Any waiver with respect to the STEs must be exceptional and subject to ASN approval.

19.2.3 ASN analysis and oversight

During its NPP inspections, ASN focuses on checking:

- compliance with the STEs and, if applicable, compensatory measures associated with temporary changes;
- the quality of normal operating documents, such as instructions and alarm sheets, and their consistency with the STEs;
- the training of operators in operational management of the reactor.

On the whole, EDF's periodic integration of experience feedback from the recurrent temporary modifications to the STEs since 2010 contributes significantly to the stability of the reactor operating baseline and helps facilitate its assimilation by the operators concerned.

Contrary to the trend observed over the last few years, ASN notes a regression in compliance with the STEs in 2012, particularly during reactor outages. The preparation and integration of changes to the STEs need to be improved, as does compliance with the actions prescribed in the waivers to the STEs. ASN has nevertheless observed positive changes in certain areas of reactor control, such as the management of administrative judgments, the number of reactor trips (AAR) and compliance with the authorised operating range.

Although a few one-off cases of deviations from the STEs are the consequences of problems with equipment, the most frequent deviations result from human failings or the operating organisation. A large proportion of these events lead to the unavailability of systems important for safety. ASN has taken note of the steps taken by EDF to correct these deviations.

19.3 Operating, maintenance, inspection and test procedures

19.3.1 ASN requests

The BNI order defines the responsibilities of nuclear installation licensees and specifies the items important for protection. The items important for protection must undergo a qualification process that is representative of the requirements they must satisfy. Maintaining this qualification over time requires the implementing of appropriate construction, tests, inspection and maintenance provisions.

The nuclear power reactors are operated in accordance with the general operating rules (see § 19.2).

Other documents remain, such as those describing the in-service inspection and maintenance operations to be carried out on the equipment.

Several maintenance methodologies have been developed by EDF and reviewed by ASN with the technical support of IRSN.

Main primary and secondary systems

The main primary and secondary systems are subject to non-destructive tests in service and requalification every 10 years.

ASN ensures that the periodic technical checks on these elements defined by the licensee are pertinent and are continuously improved.

19.3.2 Measures taken for nuclear power reactors

19.3.2.1 Inspections and tests

The purpose of the periodic tests is to verify, throughout plant unit operation with a sufficient level of confidence and insofar as the initial availability has been guaranteed:

- the availability of the safety-classified equipment and systems (see 19.2.2);
- compliance with the assumptions chosen for the operating conditions taken into account in the accident studies in the safety analysis report.

The periodic tests described in chapter IX of the general operating rules (RGE) concern the elementary systems that are classified as important for the safety of the nuclear installation. The systems important for safety form the subject of an exhaustiveness analysis note. This note aims to determine all the inspections necessary to guarantee the availability of the equipment items and their ability to fulfil their function. The periodic test rules and the associated summary tables are submitted to ASN.

Satisfactory performance of the periodic test programmes of the RGEs is one of the prerequisites for declaring that the equipment items and systems are available in accordance with the definition of availability given in the STEs. If this is not the case, the item concerned must be declared unavailable.

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 changes relating to these improvements are integrated during the multi-annual revisions of the periodic testing programmes.

19.3.2.2 Maintenance

The purpose of EDF's maintenance organisation is to ensure the operation of its equipment in accordance with requirements for safety and production performance.

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.

The policy is based on a maintenance management system for continuous improvement of performance in terms of safety, availability and operating lifetime of the installations.

The structuring of this system is based on the following eight operational objectives:

1. develop the maintenance programmes;
2. manage documentary changes;
3. maintain and monitor the equipment in order to guarantee that equipment and system maintenance and quality follow-up are carried out in compliance with the programmes;
4. resolve technical problems by reviewing and coordinating jobs and programmes, while taking budgetary arbitrations into account;
5. analyse the technical experience feedback in order to guarantee that known unwanted situations do not occur, anticipate and implement good technical practices;
6. modify the facilities (as required, after conducting studies) in order to optimise their reliability;
7. ensure the availability and required skills of workers in order to constantly guarantee that the quality and quantity of resources and means are appropriate for the maintenance activities;
8. manage the spare parts system in order to constitute and optimise the spare parts inventory;

By applying these eight objectives, EDF aims at putting in place an optimised maintenance system designed to prevent any failure of equipment considered critical, improve the reliability of the equipment and systems and thereby contribute to the constant improvement of safety and reactor availability.

Maintenance activities

Maintenance is an area where things are constantly being called into question, turning the standardisation of the nuclear fleet and experience feedback from EDF and foreign operators to good account and benefiting from the introduction of new methods over time.

This iterative approach over time has led EDF, since 2009, to gradually apply a methodology known as the "AP-913 Advanced Process" devised by the Institute of Nuclear Power Operations (INPO) and implemented in many facilities throughout the world, with the aim of achieving excellence in the operating reliability of all critical NPP components and systems.

Conducting maintenance activities

Maintenance is at the core of the nuclear operator's trade. The internal preservation of relevant skills is essential. At the same time, the use of outside contractors is just as necessary, given:

- the activity peaks resulting from reactor outages;
- the need for rare skills in specialised activities;
- as well as the mutual benefit of involving outside contractors in activities in which they bring practices and methods from other industries.

Overall, the subcontracting of activities is evolving towards multi-annual and multi-site contracts, with an adapted grid and in 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 its maintenance not only in terms of interventions and spare parts, but also of skills. A lot of work is thus carried out on equipment obsolescence and the perpetuation of industrial capabilities. Moreover, knowledge of equipment and system behaviour with regard to ageing phenomena determines the appropriateness of the maintenance activities carried out and may be particularly decisive in the choice of exceptional maintenance measures, as shown by the operations involving the change of vessel heads and steam-generators, as well as the renovation of the I&C system.

19.3.3 Measures taken for research reactors

19.3.3.1 CEA reactors

A set of procedures and instructions managed by the relevant services ensure that all the operations are carried out in compliance with the applicable rules, rules with which outside contractors must also comply.

The licensee must ensure that the contractors comply with these rules.

Experimental systems designed and operated in the facilities likewise comply with very strict safety requirements.

A technical design guide drawn up by the CEA's nuclear safety and protection division (DPSN) defines the design and construction rules and the safety analysis of experimental systems. It serves among other things to determine the safety requirement levels and the technical provisions to adopt with respect to the safety implications.

In order to check the operation of items important for safety in each facility and ensure their availability, they undergo inspections and periodic tests. Their frequency is precisely defined and can be calendar-based or event-based.

Satisfactory performance of these tests at the required frequency enables the items concerned to be declared available. The aim of systematic maintenance is to prevent failures of these items of equipment and to preserve their capability to fulfil their function with the required performance. This preventive maintenance is carried out periodically in the same way as the inspections and periodic tests, in accordance with validated procedures and accompanied by a risk analysis if the intervention could affect safety.

19.3.3.2 The ILL high-flux reactor (RHF)

The measures taken for the Laue Langevin Institute (ILL) reactor are similar to those taken for the CEA reactors.

19.3.4 ASN analysis and oversight

19.3.4.1 Nuclear power reactors

19.3.4.1.1 Operation of the reactors

Based on the results of its inspections, ASN considers in 2012 that the documents needed for operation are on the whole satisfactorily managed. In particular, the number of deviations in application of the periodic test rules is continuing to fall. However, the preparation and integration of changes to the general operating rules need to be improved.

The interfaces between operation and the maintenance or test activities are often the cause of deviations due to a lack of communication or misunderstandings. Improvements must therefore be continued in this respect.

As in 2011, improvements can still be made in the rigour of application of the baseline operating requirements and management of temporary operating instructions.

Following the efforts made by EDF since 2010, the identification, management and elimination of "exceptional equipment and means" and temporary modifications which have been present on the reactor for several years, have been improved.

However, the preparation for operational interventions remains a weak point and improvements are required in this respect.

As in 2010, ASN noted some progress in the management of equipment lock-outs, but numerous deviations persisted in this area in 2011, as well as with respect to system alignment. The rigour and oversight of these operations are insufficient.

19.3.4.1.2 Maintenance activities

In 2010, EDF informed ASN of its intention to adopt a new maintenance methodology known as AP913. The AP913 maintenance method aims to tighten equipment monitoring and initiate the corresponding repair work before the equipment actually fails. This methodology is being examined by ASN and IRSN.

ASN observes that some issues with comparable safety implications are not anticipated to the same extent. Moreover, EDF does not identify sufficiently early the equipment important for safety for which there is a risk of obsolescence or which was not designed to be replaced. The spares supply and management methods also create recurring deviations.

With regard to the implementation of the maintenance methods by the sites, ASN considers that EDF's situation can be improved and that recurrent shortcomings are observed:

- the baseline maintenance requirements are constantly changing. Delays in integration persist on all the NPPs and tend to disperse the requirements;
- the files and risk assessments to be produced prior to maintenance work are sometimes inappropriate or incomplete.
- lastly, the quality of maintenance work performance also implies having a better understanding of the human factor and closer monitoring of contractors.

ASN considers that EDF must ensure that it has adequate human and material resources.

19.3.4.1.3 Condition of equipment

The various programmes implemented by the licensee help maintain the equipment of the NPPs in generally satisfactory condition.

This being said, apart from the question of obsolescence, ASN considers that EDF must tighten its management of maintaining of equipment qualification for accident conditions. ASN notes that in 2011, EDF launched an action plan for management of the requirements regarding qualification of equipment and spare parts for accident conditions; ASN will closely monitor its effective implementation.

The first barrier

ASN considers that in 2012 the situation regarding the maintained integrity of the first barrier could be improved on certain points, in particular the cleanness of the work sites to prevent foreign objects entering the primary cooling system. The measures taken by EDF since 2008 were continued in 2012, but their implementation could be further improved.

Finally, EDF needs to continue to make progress in applying maintenance programmes for fuel handling equipment, which can be the cause of fuel assembly damage.

Pressure equipment and the second barrier

The situation of the nuclear pressure equipment is satisfactory. ASN notes the following positive points in particular:

- o functioning of the recognised inspection services is satisfactory on the whole, even if some sites must remain vigilant with respect to their staffing levels, to the updating of their documentation and to their responsiveness;
- o compliance with the requirements of the regulations, despite differences between the sites.

Weak points do however subsist, such as alignment errors which exert stresses on the nuclear pressure equipment, “pressure hammer” type dynamic transients, insufficient preparation for certain pressure tests, numerous clogging incidents, and failure to inform ASN before carrying out major maintenance interventions.

Concerning compliance with the integrity of the reactor second barrier, EDF is still in a situation that can be improved, even if it is tending to get better with the continued strategy to keep the secondary side of the steam generators clean.

The third barrier and the confinement

It is considered that the condition of confinement, in particular the third barrier and its components, can be improved. The number of events relating to confinement has increased slightly, corresponding to the overall increase in the number of significant events in 2012.

The ageing of the 900 MWe reactor containments was examined in 2005 during the review associated with their third ten-yearly outage.

The results of the ten-year tests of the reactor containments have hitherto shown leak rates in compliance with the regulatory criteria. The results of the containment test on Bugey reactor 5, which meet the criteria set by the general operating rules, are nevertheless not as satisfactory as those of the previous test 10 years ago. EDF is seeking the cause of the rise in the containment leak rate, which is probably attributable to a penetration and it will conduct an additional containment test in 5 years.

The results of the ten-year tests of the 1300 MWe and 1450 MWe reactor containments revealed an increase in the leak rates of the inner wall of some of these containments. This increase results notably from the combined effects of the deformation of the concrete and the loss of the prestressing in certain cables. Although these phenomena had been taken into consideration in the design, they were sometimes underestimated. EDF has implemented a repair programme using a resin liner in order to restore the leak-tightness of the most severely affected areas. The tests performed following the work all proved to be satisfactory.

An analysis of the issues linked to the 1300 MWe and 1450 MWe reactor confinement was carried out in 2012 and the conclusions will be examined by the Advisory Committee of Experts for Reactors (GPR) in preparation for the third ten-yearly outages of the 1300 MWe reactors. A detailed assessment of certain points resulted in the GPR meeting being scheduled for 2013.

19.3.4.2 Research reactors

Internal authorisation

The CEA has been authorised to implement an internal authorisation system (see § 7.3.2.2) since 2002. The framework of this system, which concerned some fifteen facilities, reactors, laboratories and "support" facilities, and the conditions of updating the baseline safety requirements have been covered by two ASN guides.

The experience feedback from almost 10 years of application of this system has enriched the internal authorisation criteria and increased process robustness. It has also confirmed the effectiveness of this system and did not reveal any significant or deliberate shortcomings.

In March 2009 the CEA submitted a file which was supplemented in 2009, presenting the implementation particularities specific to this licensee. The ASN resolution approving this file was taken 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 better control over time of the delivery process of some authorisations.

The 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 performance 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 acceptable safety conditions.

The 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, resulting in the drafting of a CEA technical guide in 2006. This guide specifies the safety approach to use, the requirement levels and the technical provisions to adopt with respect to the safety implications, and precisely defines the content of the safety analysis file.

In 2014, ASN plans analysing application of the approach set forth in this technical guide taking the case of an experimental system having recently undergone a periodic safety review.

19.4 Management of incidents and accidents

19.4.1 ASN requests

The operating range of the nuclear facilities is set by the general operating rules which include the operational management procedures for incident and accident situations.

To prepare for the examination of the commissioning authorisation application for the Flamanville-3 reactor, the operational management principles for incident and accident situations set out in the general operating rules will be examined in advance.

Stress Tests

The procedures necessary for the management of incidents and accidents were examined as part of the stress tests for situations going beyond the current baseline safety requirements. The warning and management procedures implemented on the sites to protect against flooding were also analysed.

19.4.2 Measures taken for nuclear power reactors

The operating parameters are monitored continuously and in the event of pre-set limits being exceeded, automatic systems trigger an alarm in the control room so that the operators can analyse the situation and take appropriate measures, in particular as required by operation technical specifications (STE). The analysis of alarms and physical variables may lead the operator to make a diagnosis that results in entry into an incident procedure.

All the nuclear sites in the EDF fleet today use the state-based approach. This method covers all "thermal-hydraulic" incidents or accidents, whether single or multiple and whether or not combined with loss of systems, loss of electrical power or human failures. Its primary goal is to prevent the risk of core meltdown.

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loss of systems, loss of electrical power or human failures. Its primary goal is to prevent the risk of core meltdown.

In the hypothetical case of core meltdown, reactor operation must take account of the new and complex phenomena that will occur as the accident develops, as well as the difficulty of diagnosing the reactor condition in a severely degraded situation. In this situation, the primary objective is to safeguard the confinement. The operating strategy in this case is contained in the Severe Accident Management Guidelines (SAMG).

The decision to apply the SAMG, which marks the abandonment of state-based approach procedures, is taken on criteria concerning the core outlet temperature and the dose rate in the containment. The Ultimate Backup Diesel Generator will be able to provide electrical back-up for the instrumentation allowing management of the severe accident situation.

In the stress tests report, EDF indicated the existing measures in response to the identified risk in a severe accident situation.

- Risk due to the production of hydrogen:
  Since the end of 2007, all the reactors in service are equipped with hydrogen passive autocatalytic recombiners (PAR). Associated operating provisions are applicable on the sites. EDF also undertook to study the hydrogen risk in the other peripheral buildings of the reactor containment. The study of the hydrogen risk in the annulus on the 1300 MWe reactors is in progress as part of the periodic safety review associated with their third ten-yearly outage.
  The Flamanville EPR has PARs and devices for monitoring the hydrogen concentration in the various containment compartments.

- Risk of slow pressurisation of the containment:
  On the reactor fleet, the time before containment is lost due to exceeding of the containment mechanical characteristics varies from one to several days depending on the assumptions adopted for the studies. EDF considers that this leaves the operator the time to take steps to avoid containment destruction while optimising control of radioactive releases. This risk is countered by a containment venting-filtration system and the associated operating procedure that preserves its long-term integrity. This system opens after 24 hours as from a minimum pressure equal to the containment design pressure. In response to the ASN requirement, EDF has started to study the possibilities of improving this venting-filtration system, including a review of the hydrogen risk and its potential consequences, and the resistance to earthquakes. The results will be submitted by the end of 2013. Thanks to the effective filtration of long-lived products, such as caesium-137 aerosols, the opening of this system mitigates the long-term radiological consequences.
  On the EPR, the CHRS (Containment Heat Removal System) controls the containment pressure. In the event of loss of the electrical power supplies, this system can be put back into service for a period of 2 days to prevent the risk of containment failure. Finally, the integrity of the containment is maintained for 3 days after the initiating event if the CHRS is not put into service. To avoid the cliff-edge effect resulting from prolonged loss of the electrical power supplies, EDF proposed adding a mobile and independent water make-up system in the reactor building via the CHRS spray nozzles. This system would be deployed within 48 hours and would extend the safe period to 5 days.

- Risk of reactor containment leak-tightness fault:
  On the reactors in service, confirmation of the isolation of the containment penetrations is required as part of the immediate actions on entry into a severe accident situation. The activity is monitored so that restoration measures can be implemented if necessary.
  On the EPR, the containment and the peripheral buildings are designed such that there is no direct leakage path from the reactor containment to the environment.

- Risk of direct containment heating:
  To avoid direct containment heating, the severe accident (SA) operating procedure on the reactors in service requires depressurisation of the primary system by opening the pressuriser relief lines immediately on entry into the SA situation. A hardware modification (integration of a bistable control accessible from the relaying room using a new independent Mobile Safety Means) to enhance the reliability of relief valve opening, decided before the Fukushima Daiichi accident and already applied on certain reactors, is planned for the next ten-yearly outages of each reactor.
  On the EPR, the primary system is depressurised by two redundant primary system discharge lines. The operator has one hour after entry into the SA situation to open these lines, which are supplied by the 12-hour batteries.
- Re-criticality risk:
  EDF has carried out reactivity studies on the fleet to analyse the risk of return to criticality for different corium configurations - compact or fragmented - in the reactor vessel or the reactor pit following the injection of water. These studies conclude that the criticality risk is zero when the corium is not fragmented in the water and excluded when the borated water is injected at the minimum boron concentration of the tank.
  As the SAMG prohibits the injection of non-borated water as long as the corium is in the reactor vessel, the re-criticality risk is excluded for such configurations. After reactor vessel rupture, the injection of clarified water could be envisaged after analysis and if recommended by the emergency response team. The re-criticality risk is ruled out in the short term but borated water make-ups must be provided in the long term
  On the Flamanville EPR, measures are taken to guarantee a dry reactor pit and a dry corium spreading area.

Added to the above-mentioned risks is the risk of basemat melt-through further to rupture of the reactor vessel containing the corium. On the reactor fleet, reflooding the corium in the vessel or injecting water into the reactor pit via the perforated vessel to keep the corium flooded limits the risk of basemat melt-through, or failing this, delays its occurrence. The SAMG defines the water injection conditions, particularly with respect to the risks of early loss of containment.

Maintaining the corium in the vessel avoids the ex-vessel corium-concrete interaction phase and thus contributes to the goal of maintaining containment integrity. Stabilisation of the situation in the vessel necessitates restoring a means of injecting borated water into the primary cooling system within a sufficiently short period of time to avoid vessel rupture. For its reactor fleet, EDF envisages different possibilities for retaining the corium in the vessel in a severe accident situation, using existing systems that are not specifically designed for managing accidents with core meltdown, and depending on their availability. Following the stress tests, EDF aims to have the reactor coolant system injection means backed-up by an Ultimate Backup Diesel Generator.

Assuming failure of the vessel, the corium pours into the reactor pit. The strategy currently in place on the fleet in operation consists in injecting water (addition of water after vessel rupture or flooding of the reactor pit prior to vessel rupture).

As the safeguard systems of the damaged plant unit were probably lost on entry into the SA, the emergency teams can implement "ultimate" alignments to flood the corium.

In a long-duration total loss of electrical power supply situation combined with the loss of water supply to the steam generators, none of the present injection means would allow flooding of the corium in the vessel and in the reactor pit. Consequently, EDF envisages, for the reactor fleet, using a generator-driven pump supplied by the Ultimate Backup Diesel, allowing injection of water into the primary cooling system. EDF specified that this will be incorporated into the hardened safety core.

For the reactor fleet there is also an ex-vessel steam explosion risk for which an international research programme is in progress to characterise the conditions of occurrence and the intensity of such phenomena. The available studies show the containment to be well able to withstand the loads resulting from a steam explosion. Its integrity would therefore probably not be compromised in this situation.

For the Flamanville EPR, the core catcher is intended to collect, cool and stabilise the corium. Prevention of basemat melt-through is thus based on a reactor pit and a core catcher that are both dry when the corium arrives, on the collection and spreading of the corium and on its passive cooling after spreading. In the longer term, the CHRS system in the reactor building enables the residual power to be removed from the corium.

For the reactor fleet, in addition to these measures to prevent basemat melt-through, examination of measures to counter the dissemination of radioactive products by the "water route", i.e. potential contamination of the groundwater in the event of a severe accident with basemat melt-through, is in progress. In late 2012 EDF submitted a study on the setting up of such "water route" countermeasures which concludes that the measures that could be envisaged display substantial uncertainties regarding their feasibility and effectiveness and would bring only minimal gains in safety. EDF considers that the modifications envisaged to further reduce the risk of core meltdown and those studied to reduce the risk of basemat melt-through taken as a whole will consolidate the residual nature of this risk. This led EDF to favour prevention of the risk of basemat melt-through, which enables the corium to be maintained in the containment and presents a tangible and measurable gain in safety.

For the particular case of the Fessenheim reactors, where the basemat thickness is the lowest in the fleet, EDF estimates that the basemat melt-through time in the worst-case scenario could be about one day. In July 2011 ASN asked EDF to reinforce the Fessenheim reactor 1 basemat before 30th June 2013 in order to significantly increase its corium resistance in the event of a severe accident. EDF submitted the file on 9th December 2011. At the end of 2012 ASN agreed to the implementation of this reinforcement, which was carried out in Spring 2013. In Spring 2013, this reinforcement has been implemented and ASN required the same reinforcement for Fessenheim reactor 2.

In response to the ASN requirement concerning the installation of redundant means for detecting vessel melt-through in the reactor pit and redundant means for detecting hydrogen in the containment, EDF has undertaken to study modifications whose application is planned for the end of 2016 for the 900 MWe and P4 series plant units and end of 2017 for the P’4 and N4 series plant units. The studies of the requirements that these means will have to satisfy and their possible inclusion in the hardened safety core are in progress, with the reply planned before the end of 2013.

Feasibility of immediate actions in the Severe Accident Management Guide (SAMG)

Assuming an event leading to simultaneous loss of all electrical power supplies and the primary cooling system means for all the reactors of a site, the feasibility of all the immediate actions provided for in the SAMG must be guaranteed for each reactor, in particular depressurisation of the primary system, with the operating and emergency response teams present on the site.

In this respect, EDF has undertaken to study the adequacy of the human and material resources for the activities involved in the deployment of the hardened safety core equipment items (including the immediate measures specified in the SAMG) and the additional equipment proposed further to the stress tests.

At the end of 2012 EDF submitted a file concerning the sizing of on-site staff levels to cope with extreme situations.

Habitability of the control room

EDF's preliminary studies on the habitability of the control room in the event of a severe accident lead to envisaging not having operators permanently present in the control rooms in the period following opening of the venting-filtration system and maintaining the supervision and monitoring of the facilities by complementary measures. Moreover, EDF plans to reinforce the electrical back-up of control room ventilation and filtration through the ultimate backup diesel generator.

On the Flamanville EPR, the atmosphere in the control room remains breathable for a period of 3 days. EDF is studying the provision by the FARN of a mobile electrical power supply source within 3 days. The technical investigation will continue as part of the Flamanville EPR commissioning process.

To reduce iodine discharges, EDF is considering installing a passive system that can guarantee the alkalinity of the water in the reactor building sumps.

<u>Spent fuel pools:</u>

At the end of June 2012, in compliance with ASN's requirement, EDF presented the modifications to be made to its facilities to reinforce prevention of the risk of accidental emptying of the fuel building pool:

- o EDF is going to redesign the siphon vacuum breaker on the cooling system delivery pipe to prevent complete and rapid siphon emptying of the pool in the event of rupture of a connected pipe. This modification is currently in progress and should be completed before the end of March 2014.
- o EDF is going to automate isolation of the cooling system intake line, which will prevent gravity draining of the pool via the intake line. The studies relating to this modification are continuing to allow on-site integration before the end of 2016, in accordance with ASN requirements.

The Bugey and Fessenheim plants entail a particular risk of spent fuel pool damage should a fuel transport container fall. In response to the ASN requirement, at the end of 2012 EDF submitted a study of the consequences of an accident involving the falling of a spent fuel transport package, integrating the extreme situations studied under the stress tests for these two sites. At Fessenheim, the integrity of the basemat is not called into question by the falling of a package. At Bugey, the analyses will be supplemented by a study of possible additional measures to prevent or mitigate the consequences of the falling of a package, to be completed for June 2013.

In response to the ASN requirement, at the end of December 2012 EDF submitted the feasibility studies for handling the case of a breach in the transfer tube. Two types of solution can be used to prevent exposure of the fuel assembly during handling. The detailed studies that will serve in particular to optimise the choice of the solution adopted according to the configuration of the premises concerned and the radiation protection constraints are in progress.
Furthermore, in order to prevent rapid loss of the water inventory in the storage compartment in hypothetical situations of leakage of the transfer tube or the transfer compartment drainage line or the compartments of the reactor building pool, closing of the door between the transfer compartment and the storage compartment will be required. In accordance with the requirement, EDF will implement - before June 30th 2013 - the material and organisational provisions to guarantee the manoeuvrability of the door, including in the case of total loss of the electrical power supplies.

In the case of the EPR, the design of the reactor and fuel buildings, which rest on a common basemat, thus limiting differential displacements, would make it possible to envisage a second containment barrier around the transfer tube such as to prevent the risk of uncovering of an assembly during handling. This topic is currently being examined as part of the Flamanville 3 detailed design review, concerning situations that are practically eliminated, as listed in the facility's creation authorisation decree.

Further to the studies conducted in 2012 to protect the fuel assemblies during handling in the reactor building, EDF favours the maintaining of a sufficient water margin above the assembly left in position after an earthquake.

At the end of 2012, in response to the ASN requirement, EDF submitted a study concerning the following 3 themes:

- o change of fuel behaviour over time in pool emptying and heat sink loss situations;
- o evaluation of the radiological atmosphere in a boiling fuel pool situation;
- o evaluation of the hydrogen concentrations resulting from radiolysis that could be reached in situations involving loss of fuel building ventilation.

The studies conclude that no complementary measures need to be implemented in the fuel building for any of these themes.

Instrumentation in the spent fuel pool necessary for accident management

For the NPPs in operation and the EPR, EDF is studying the steps to take to reinforce the robustness of the instrumentation in the spent fuel pool to ensure management of the situation and the management of water make-up in particular. By the end of 2013, EDF plans for electrical power for a two-threshold level gauge to be resupplied by the ultimate backup diesel generator set planned to be installed for all the fleet in service.

Furthermore, the national emergency response team has charts for determining the time taken for the spent fuel pools in the reactor building to boil, depending on their stored residual power, so that the site can be assisted in managing water make-up for the pools according to the boiling time.

Accessibility and habitability of the control room in case of fuel assembly degradation

If the fuel assemblies are undamaged, control room habitability remains ensured. However, an accident leading to deterioration of the fuel assemblies could lead to significant releases in the fuel building, against which it is hard or even impossible to implement effective means of mitigating the consequences.

EDF has examined the feasibility for the NPPs in operation and the EPR, of relocating the make-up system controls to areas protected from the propagation of steam. The finding of this study is that given the measures taken elsewhere to improve the robustness of the facility, by mobile or fixed equipment, there is no need to continue studying the relocating of the controls.

19.4.3 Measures taken for research reactors

19.4.3.1 CEA reactors

Outside normal operating situations, the analysis of the alarms and operating parameters measured on the installation and transmitted to the control room, can lead the operators to enter into incident or accident operating procedures.

These procedures describe the operational control applicable in such situations, the objectives being to maintain the reactor in a safe condition and to mitigate the consequences of the incident or accident.

The operational management rules applicable in incident and accident situations are described in the general operating rules.

The management of accident situations will be reinforced to take into account the extreme situations resulting from the experience feedback from the Fukushima Daiichi accident (see 16.3.2).

19.4.3.2 The ILL high-flux reactor (RHF)

General operating rule No.11 and the reactor note "Infra PUI" (On-site emergency plan infrastructure) describe the operational control applicable outside normal operating situations and the conditions of transition to the accident mode organisation.

This organisation is described in the on-site emergency plan (PUI). The criteria for triggering the PUI are indicated in it, as are the particular operating rules that must be applied according to the situation.

The stress tests will serve to supplement the safeguard, prevention and mitigation systems. These systems will be controlled automatically, but it will be possible to revert to manual control at any time. After rod drop, cooling by natural convection is sufficient, therefore it is not necessary to guarantee a heat sink. The safeguard systems essentially allow a minimum water inventory to be maintained around the fuel element and the depressurisation of the reactor containment to avoid any overpressure that could lead to a discharge at 0 metres. Lastly, an emergency management room that can withstand simultaneous extreme external hazards is planned (see § 14.2.3.2).

19.4.4 ASN analysis and oversight

The various works carried out in the framework of the stress tests took into account scenarios that had not been considered in the past. Consequently, integration of the conclusions of the stress tests and the associated requirements will lead to significant modifications in the documents relating to severe accident management.

These measures are specified on the ASN website[38] and detailed in the national action plan[39] resulting from the stress tests. They include provisions relative to severe accident management, particularly concerning:

- implementation of a hardened safety core of robust material and organisational measures (requirement ECS-01, see § 6.3.1.3).
- integration in the accident operational management procedures and the severe accident management documents, including the SAMG, of the new provisions for handling the extreme situations studied in the stress tests and affecting several reactors on the same site, for all operating states, as well as the fuel storage buildings (ASN request All sites-30 of 26th June 2012. A partial reply is expected by 30th June 2013 and the complete reply before 31st December 2015).
- development of the accident situation operational control of the reactors to adapt it to the different reactors states (EDF commitment of 15th September 2011). The elements were submitted on 31st December 2012 and require ASN approval before being implemented. ASN has already agreed to the implementation of a change in accident management in situations of total loss of electrical power supplies with a break at the reactor coolant pump seals, in order to guarantee a sufficient steam supply to drive the turbine-driven pump of the steam generator (SG) emergency feedwater system and the emergency turbine generator set by preventing the risk of excessive depressurization of the SGs.
- the defining of new emergency procedures that will integrate the new provisions identified through the stress tests. The implementation of this organisation is accompanied by specific personnel training (requirement ECS-15 in particular. The report on the human actions required for extreme situation management has been submitted. The personnel must have been trained before 30th September 2013).

2012 was marked by the implementation on 15th November 2012 of the new baseline safety requirements concerning the on-site emergency plans (PUI) for the EDF sites. ASN considers that these new baseline safety requirements improve EDF's preparedness for the management of emergency situations.

ASN has issued other requirements relative to severe accident management:

- Installation of redundant means in the reactor pit to detect vessel melt-through and redundant means in the containment to detect the presence of hydrogen. (requirement ECS-19. The

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[38] http://www.asn.fr/index.php/English-version/Complementary-safety-assessments

[39] http://www.french-nuclear-safety.fr/index.php/English-version/News-releases/2012/European-stress-tests-ASN-publishes-its-national-action-plan

deadlines for implementing these means are set at 31st December 2016 or 31st December 2017, depending on the sites);

- o Installation of reinforced instrumentation in the pool for measuring the state of the spent fuel pool (temperature and water level) and the radiological atmosphere in the fuel building hall (requirement ECS-20. The modifications have been submitted and EDF must apply transient measures before 31st December 2013);
- o Implementation of additional measures to prevent or mitigate the consequences of a fuel transport package falling in the fuel building on the Bugey and Fessenheim sites (requirement ECS-21. The specific studies are expected on 30th June 2013 and 31st December 2013);
- o Reinforcement of the measures to prevent accidental rapid draining of the fuel storage pools (requirement ECS-22. The planned modifications have been submitted and are currently being analysed). The deadlines for implementing the modifications are 31st March 2013 and 31st December 2016).
- o Study of the possible measures, in the event of total loss of electrical power supplies and accidental emptying, to ensure the safe positioning of a fuel assembly during handling in the fuel building, before the ambient conditions no longer allow access to the premises (requirement ECS-23. This study is currently being analysed and the deadline for implementing the modifications is set at 30th June 2013).
- o Study of the evolution over time of the fuel and the water present in the spent fuel pool, in situations of emptying and loss of cooling, and presentation of the planned modifications (requirement ECS-24. The study and the planned modifications have been submitted and are currently being analysed).
- o Study of conceivable changes to equipment or operating conditions to prevent uncovering of the fuel assemblies during handling, for example as the result of a break in the transfer tube between the pools of the reactor building and the fuel building or in the compartment drainage pipes (requirement ECS-25. The study has been submitted and is currently being analysed);
- o Study of the feasibility of installing a geotechnical containment or a system with the same effect for the Bugey, Fessenheim and Civaux sites, and updating of the hydrological sheets of all the sites (requirement ECS-27. The hydrological sheets and the studies for the Bugey, Fessenheim and Civaux sites have been submitted and are currently being analysed. The hydrological sheets for the other sites must be updated by 30th June 2013).
- o EPR reactor: reinforcement of the provisions for controlling the pressure in the containment (requirement ECS-28. The elements have been submitted and are currently being analysed).
- o Detailed study of the possibilities for improving the venting-filtration device, taking account of the robustness to hazards, the limitation of the risks of hydrogen combustion, the efficiency of filtration in the case of simultaneous use on two reactors, the improvement of filtration of fission products, particularly iodines and the radiological consequences of opening of the device, notably on site accessibility, and the radiological atmosphere of the emergency rooms and the control room (requirement ECS-29. Submission deadline 31st December 2013)
- o Modifications planned on its site to ensure that, in the event of release of dangerous substances or opening of the venting-filtration system, operation and monitoring of all the facilities on the site are guaranteed until a long-term safe state is reached; and the corresponding deployment schedule (requirement ECS-31. The modifications study has been submitted and is currently being analysed).
- o Reinforcing of the material and organisational measures to take account of accident situations affecting all or part of the site's facilities simultaneously (requirement ECS-32). A new on-site emergency plan (PUI) baseline has been deployed on all EDF sites since 15 November 2012. It takes into account accident situations affecting several facilities on a given site simultaneously.

Targeted inspections performed further to the Fukushima Daiichi accident.

The targeted inspections performed further to the Fukushima Daiichi accident have highlighted the following factors concerning the management of incident and accident situations:

- with regard to the earthquake theme, it is important that EDF carries out appropriate exercises so that the procedures planned in the event of an earthquake can be implemented and the staff prepared for this type of situation. The "seismic interaction" approach must also be better taken into account in the procedures and in day-to-day operation.
- with regard to the question of flooding, the organisation for managing the flood risk is satisfactory. EDF will also need to define and carry out exercises to test the equipment and teams in this type of situation.
- operational control in accident situations can be improved. The organisation set up by the sites for their on-site emergency plan (PUI) is satisfactory. EDF must nevertheless improve the management of the fallback premises.

19.5 The technical support

19.5.1 ASN requests

The regulations, and the BNI order in particular, require that the licensees establish and implement a policy for public health and safety and protection of nature and the environment. This policy defines objectives, indicates the licensee's strategy to achieve them and the resources it undertakes to assign to it.

the licensee must indicate how it organises its technical capabilities, that is to say whether they are held internally, in subsidiaries or through third parties with whom formal agreements must be made; the most fundamental capabilities must be held by the licensee or one of its subsidiaries;

The licensee must also implement an integrated management system.

Consequently, ASN expects the licensees to have appropriate expertise and technical skills to ensure operation of the facilities, maintenance of the equipment and systems and management of incidents and accidents.

19.5.2 Measures taken for nuclear power reactors

A nuclear engineering development project was initiated by EDF in 2006. It involves new modes of functioning and organisation in the NPPs and the engineering units. This project meets the unanimously stated needs to simplify the processes for making modifications to the installations and the associated documentation, and to close the gap between the designer and the licensee.

Reinforcing the links between the nuclear engineering division teams and the NPPs is a strong intention of the engineering production division in order to improve the operation of the production fleet.

The studies into ways to move towards this closer cooperation resulted in the creation of an EDF guide to operational engineering, defining new responsibilities for the NPPs and the engineering units with the designation of a pilot site for each plant series, which was put into application on 1st January 2007.

A revision of the engineering guide was issued in 2012 to draw lessons from experience feedback and to integrate into the guide the impacts associated with the TSN act and the BNI procedures decree, particularly in terms of the conditions of functioning with ASN.

19.5.3 Measures taken for research reactors

At each CEA centre, technical support units bring together the various skills required for the different activities involved in operating the facilities. These technical support units establish contracts with the outside contractors called upon by the facilities for maintenance of the equipment items. These technical support units are different from the nuclear safety support units, but their expertise is called upon wherever necessary.

19.5.4 ASN analysis and oversight

ASN carries out inspections in the head office departments of the main nuclear licensees, the workshops or design offices of the subcontractors, the construction sites, and the plants or workshops manufacturing components that are important for safety.

ASN has found that the organisational measures implemented by EDF for the quality management of the activities of the nuclear power reactor fleet in service are satisfactory. Moreover, ASN underlines the quality of the work carried out by the EDF engineering teams for the stress tests. However, the equipment modification process often results in delays in sending the modification files to the NPPs, making work preparation difficult, particularly for the reactor outages. Furthermore, the quality of the some modification files is not up to the required standard and can lead to deviations. ASN considers that steps must be taken to correct these failings, especially given the substantial amount of work planned in the complementary safety measures required further to the stress tests and the ongoing or forthcoming periodic safety reviews.

With regard to the quality management of the design and manufacturing activities in the shops of suppliers of structures, systems and components for the Flamanville-3 EPR reactor, ASN has observed during its inspections that the organisation put in place in the various EDF departments, whether for engineering or for the teams in charge of monitoring the activities of its contractors, was on the whole satisfactory and showed signs of improvement with respect to previous years.

19.6 Significant events

Operating experience feedback is one source of improvement in the areas of safety, radiation protection and the environment. The regulations, and the BNI order in particular, stipulate this principle and require the implementation by the licensee of an integrated management system that includes the provisions enabling it to identify and process the deviations and significant events (see § 7.3.3.3).

19.6.1 ASN requests

ASN requires that EDF notifies it of any significant events that occur in the NPPs. Criteria have been set for notifying the public authorities in a document named "Guide to the conditions of notification and codification of the criteria relative to significant events involving safety, radiation protection and the environment applicable to BNIs and the transport of radioactive materials". Each significant event is classified by ASN on the INES scale.

Licensees must notify all events that are significant for nuclear safety to ASN within 48 hours, with a proposed classification on the INES scale (ASN has sole responsibility for the final classification decision). ASN analyses this initial notification to verify the implementation of immediate corrective measures, to decide whether to perform an on-site inspection to analyse the event in depth and, if necessary, to prepare the communication of information to the public.

The use of the INES enables ASN to select, among all the events and incidents that occur, those that have sufficient significance to be subject to communication on its part:

- events rated level 0 only form the subject of an incident notice if they are of particular interest;
- events rated level 1 always form the subject of an incident notice published on www.asn.fr.
- events rated level 2 and higher also form the subject of a press release and are notified to the IAEA.

- international transport events concerning foreign countries are also notified to the IAEA from events rated level 1 upwards, and from level 0 upwards if they result in the loss of a radioactive source.

The notification is supplemented within two months by a report indicating the conclusions the licensee has drawn from the analysis of the events and the measures it is taking to improve safety or radiation protection. ASN checks that the licensee has suitably analysed the event, taken the appropriate measures to correct the situation and prevent it occurring again, and has circulated the lessons learned from it.

ASN has the power to initiate a technical inquiry in the event of an incident or accident concerning a nuclear activity. This inquiry, implemented for events that justify it, consists in collecting and analysing all useful information, without prejudice to the judicial inquiry, in order to determine the circumstances and the definite or possible causes of the event and, if necessary, to formulate the necessary recommendations. It is carried out by an investigation team which, in addition to ASN staff, may include duly designated outside members.

19.6.2 Measures taken for nuclear power reactors

Between 2010 and 2012, the average number of significant safety event notifications per plant unit per year was between 10.4 and 11.9 events. Over that 3-year period, the number of significant safety events classified on the INES scale varied between 0.9 /plant unit per year in 2011 and 1.55 /plant unit per year in 2012.

19.6.3 Measures taken for research reactors

Over the 3-year period, 5 significant events rated at INES level 1 were notified. Noteworthy among these were:

- the blocking of a safety rod during a rod drop-time measurement test on the Eole critical mock-up,
- storage in the Phébus reactor storeroom of a fuel rod under conditions that did not comply with the baseline safety requirements for the facility,
- automatic shutdown (reactor trip) of the ISIS reactor following a brief loss of reactor hall depressurisation,
- the presence of indications (localised stains) on the fuel assembly structures and on the fuel elements during the inspections prior to loading of the Cabri reactor.

19.6.4 ASN analysis and oversight

ASN examines all notified significant events both locally and nationally. For certain significant events considered to be more noteworthy due to their nature or their frequency of occurrence, ASN has IRSN carry out a more detailed analysis. If this analysis reveals information that warrants international dissemination, it may subsequently be published in the IAEA and NEA's International Reporting System (IRS) database.

In order to guarantee rapid dissemination of information, ASN endeavours to inform its counterparts as quickly as possible when a notable event occurs in France by using the existing multinational structures and networks.

During its NPP inspections, ASN examines the organisation and measures taken by the sites to deal with significant events. ASN analyses the way EDF deals with significant events on an annual basis, and takes this into consideration in its assessment of the overall performance of the NPPs.

In application of the rules relative to the notification of significant events in the fields of safety, radiation protection and the environment, EDF notified in 2012 712 significant events relating to safety, 114 relating to radiation protection and 93 relating to protection of the environment (events that concern neither nuclear safety nor radiation protection).

The following graph shows how the number of significant events notified by EDF and classified on the INES scale has evolved since 2007. 830 events were classified on the INES scale in 2012.

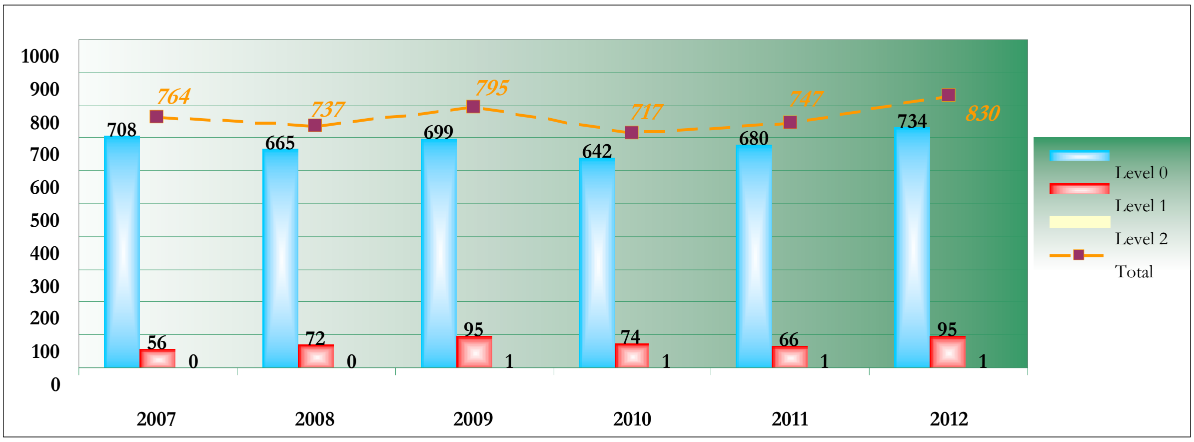

Figure 11: Evolution of the number of significant events classified on the INES scale in the EDF NPPs between 2007 and 2012

The following graph shows the evolution the number of significant events notified since 2007 by domain: events significant for safety (ESS), events significant for radiation protection (ESR) and events significant for the environment (ESE).

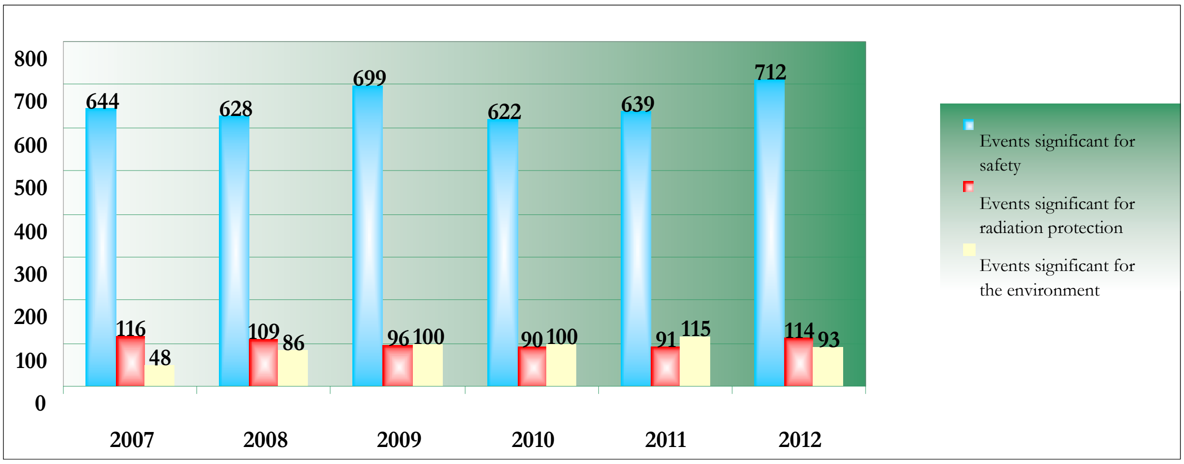

Figure 12: Evolution of the number of significant events by domain in the EDF NPPs between 2007 and 2012

The number of ESS's notified was up by about 10% on 2011, while remaining on the whole comparable with previous years. This change is chiefly due to an increase in events relating to maintenance. One ESS was rated at INES level 2 (see § 6.2, description of the significant event at the Cattenom NPP).

The number of ESS's has increased by about 20% compared with 2011. This rise is mainly due to industrial radiology operations and the non-performance of technical inspections (zoning and mobile radiation protection devices). Furthermore, as the entity responsible for radiation protection on the NPPs, EDF must ensure the protection and preservation of the radiation protection culture of both its own staff and the personnel of outside contractors.

The number of ESE's is down on last year but remains high compared with previous years: environmental protection must remain one of the core concerns of EDF.

The following graph shows the average number of significant events rated at INES level 0 and 1 per plant series for the year 2012. For the N4 plant series, the average number of significant events is slightly higher than for the other series, a difference that is mainly due to the average volume of maintenance in 2012, which is greater on these reactors than on the other plant series due to the completion of the ten-yearly outages for the N4 plant series. The increase in the number of maintenance interventions during the outage periods generally contributes to the rise in the number of deviations.

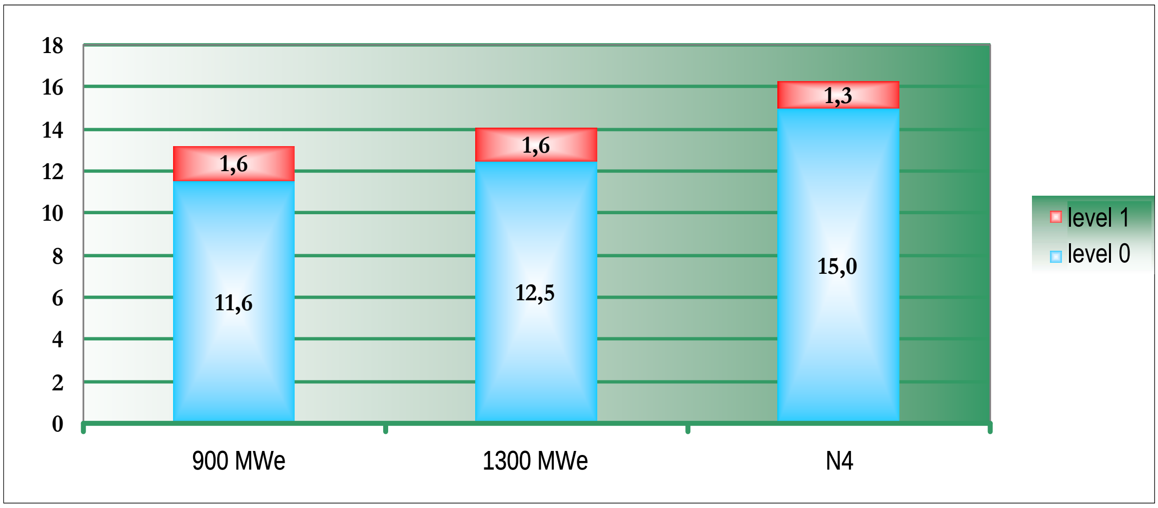

Figure 13: Mean number of significant events rated on the INES scale in EDF NPPs per type of reactor and per year for 2012

No events of INES level 2 or higher have occurred on research reactors since the 5th Review Meeting of the CNS.

19.7 Integration of experience feedback

As mentioned in §19.6, ASN places great importance on the handling of experience feedback.

The BNI order stipulates this principle and requires the licensee to implement an integrated management system that includes provisions enabling it to identify and process the deviations (difference between an observed situation and a required situation) and significant events, and to gather the experience feedback from the operation of its facility or other facilities, whether similar or not and in France or abroad, or resulting from research and development.

ASN also endeavours to disseminate experience feedback from French nuclear facilities during bilateral or multilateral discussions with its counterparts and other safety organisations. ASN and IRSN also participate in various discussion forums within the IAEA, the NEA and the European Union. For example, ASN is a member of the NEA's *Working Group on Operating Experience* (WGOE) addressing reactors in operation, and the *Working Group on the Regulation of New Reactors* which focuses more specifically on experience feedback from the construction of new reactors. ASN is also a member of the Nuclear Energy Agency's *Multinational Design Evaluation Programme* (MDEP) which evaluates the design of new reactors.

19.7.1 ASN requests

The ASN assessment, the significant event reports and the periodic assessments submitted by the licensees from the basis of the experience feedback organisation. ASN asks EDF to turn the experience feedback from significant events and reactor operation to good account. EDF must also draw the lessons from significant events that occur abroad, particularly from the reports in the IRS database of the IAEA and the NEA.

To give an example, in 2012 a primary-secondary leak occurred on a steam generator in the San Onofre NPP (USA). The reason was premature wear of certain SG tubes. ASN made sure that EDF had examined the phenomena behind this deterioration. EDF provided data showing that the causes of this damage are not encountered on the reactors operated in France.

The periodic safety reviews aim to improve the safety of the nuclear installations, particularly in the light of the experience feedback from operation of the facility or from other nuclear facilities in France and abroad, and the lessons learned from other facilities or items of equipment at risk. Integration of the licensee's experience feedback can result in modifications to equipment (and the management procedures) which are subject to review by ASN.

ASN periodically calls on the Advisory Committee for nuclear reactors (GPR) concerning the lessons learned from experience feedback for fuel and foreign reactors.

Following the Fukushima Daiichi accident, ASN considered that it was necessary to perform stress tests on the French civil nuclear facilities, with respect to the type of events which led to this accident.

19.7.2 Measures taken for nuclear power reactors

The continuous improvement in performance in the areas of safety, security, radiation protection, environmental protection and production is based on a systematic process of turning acquired experience to good account. The use of experience feedback consists in drawing the lessons from the past to improve the future. EDF's operating experience today represents 1,600 reactor-years.

In 2010 a project to reorganise operating experience feedback was initiated at EDF/DPN. Following a diagnostic phase then a trial phase, new principles are now being implemented for the local and national experience feedback loops.

The experience feedback process comprises the following phases:

1. the phase of detection, collection of the situation (a deviation, an anomaly, a good or bad practice, etc.)

Detection is performed on the basis of all the information available: findings in the field, operating experience feedback (periodic assessments), professional feedback (professional practices, activity networks), events feedback (observed deviations, anomalies, malfunctions, events and incidents including international and outside the nuclear field but taken into consideration at national level).

The purpose of the selection process is to prioritise the subjects to be addressed according to the implications and to initiate the method of addressing them. Selection is a collegial process where each stakeholder contributes its experience, favouring the taking into account of all the components of the information and the implications. It is also a managerial process through the validation of priorities.

Selection is carried out at each level of the organisations. It helps ensure the early detection of recurrent problems or subjects with national implications because they are potentially generic or of a precursory nature.

2. the analysis phase, including the defining of corrective and preventive actions when necessary

The aim of the analysis is to define the subject to address, to specify the risks, the implications and the areas concerned, to identify the existing experience feedback and actions already engaged, and the objectives. It leads to the proposing of corrective, preventive or alternative solutions.

Supplementing the "unit" analysis performed after the event, the periodic analysis of trends uses the codification that is carried out for each finding or event. This approach allows the identification of a drift in a given event category and the defining of appropriate action to reverse the trend.

Analyses using the same methods, carried out at Fleet level (called 2nd level analyses) on events of national importance or on the grouping of events of the same type, allow the identification of generic causes and the defining of more widely-sweeping corrective actions at Fleet level.

3. the phase of implementation of the defined corrective or preventive actions, integrating the oversight of implementation and verification of their effectiveness

The actions and solutions defined by the experience feedback process can be of three different types, and contribute to:

- the reliability of the equipment (modifications for example);
- the reliability of the organisations (e.g. changes in rules and methods, or operational documentation, or change in a work process);
- the reliability of humans and acts carried out (e.g. provision of information, adapting training courses).

The phase of implementing actions also includes verifications of conformity and monitoring of effectiveness with respect to the desired objectives.

4. the phase of sharing experience feedback with the work teams

The aim of this phase is to disseminate and share the lessons learned from the analyses of information on experience feedback made available to the work teams at each level of the organisations.

Capitalising on the experience feedback information and decisions through shared and readily accessible databases and developing products based on experience feedback with the end-user in mind and made available at the right time participate in this sharing and utilisation of experience feedback.

These provisions are supplemented by the collective sharing of experience and holding activity workshops.

The experience feedback process is organised at local and national level through systems and bodies allowing:

- the entry of findings that are accessible to everyone;
- the characterisation of the findings, their weighing up and prioritising according to the implications, their codification which will allow trends to be analysed, and the assigning of selected findings to the stakeholders responsible for analysing them;
- in-depth analysis of the selected findings to propose corrective or preventive actions and the validation of the actions;
- the analysis of trends performed on the findings taken as a whole to identify the drifts to be remedied, and propose corrective actions.

The experience feedback project detailed these principles and the associated organisation (Corrective Actions Plan). At the end of 2012, 15 NPPs are involved in the deployment with varying degrees of progress. All the NPPs will be committed in 2013. The new system has been implemented at national level since the first half of 2011: it is now integrated in the operational life of the national entities DPN and DIN, notably with reinforced managerial involvement compared with the previous system, and has become the management and leadership tool for all the stakeholders.

19.7.3 Measures taken for research reactors

At the CEA, deviations and their processing are recorded in sheets for each facility. The support services can also open deviation sheets.

A CEA circular specifies that the duties of the head of a facility include analysing the anomalies and events affecting his/her facility.

Taking experience feedback into account in the centres consists notably in organising and promoting exchanges between the facilities and the centres. On this account an experience feedback leader is designated in the unit that performs the checks on behalf of the director of each centre.

At the CEA's general management level, it is the role of the DPSN to make sure that the various units consult one another, and to ensure the integration of experience feedback and the exchange of best practices. The DPSN also draws up an assessment of the significant events and defines the lines of progress. This role also leads it to identify situations that require the expertise of the competence centres.

Experience feedback is also integrated in the documents (circulars and recommendations, directives, technical data sheets) that the DPSN is responsible for producing.

The aids used are:

- the experience feedback sheets initiated by DPSN;
- the Central Experience File which contains all the notified events that have occurred since 1990;
- the significant event analysis and processing guide;
- the significant events situation assessment, established from the significant event reports (CRES);
- the IAEA international database.

19.7.4 ASN analysis and oversight

During its NPP inspections, ASN examines the organisation and measures taken by the sites to integrate experience feedback.

On 13th and 20th January 2011, the Advisory Committee for reactors (GPR) met to examine the notable findings for the period 2006-2008 concerning significant radiation protection, environment and reactor safety events, more particularly the deviations encountered on the steam generators (SG), the management of special systems and resources and temporary modifications to facilities, requalification of facilities after maintenance work and the administrative lockouts.

Following this examination, ASN considers:

- that with regard to the safety of the reactors in operation, the analyses performed and the steps taken by EDF in the light of experience feedback are satisfactory. However, the safety of the reactors in operation could be significantly improved if EDF were to pay greater attention to preparation of the interventions and enhancing the reliability of the intervention schedule.
- that with regard to radiation protection, examination of experience feedback from the operation of the nuclear reactors in service for the period 2006-2008 confirms that EDF has continued to make progress, particularly in the field of gamma radiography inspections.

On the whole, the organisation implemented by the licensee for handling experience feedback in the NPPs is satisfactory. The experience feedback is well recorded and used to good account. The sharing of information between the local and national levels of EDF is effective.

19.7.4.1 Integration of experience feedback from the Belgian reactors: detection of defects on the Doel 3 and Tihange 2 reactor vessels

During inspections carried out in July 2012 on the reactor vessel of Doel 3 (Belgium), several thousand defects were detected. These defects were revealed during ultrasound inspection of the entire heavily irradiated area of the vessel. This process was used for the first time on the Doel 3 reactor vessel and was implemented at the request of the Belgian nuclear safety regulator, AFCN.

These defects are most probably manufacturing defects. Similar checks were performed on several vessels produced by the same foundry, including those of Tihange 2 (Belgium) on which the same type of defects were observed.

ASN has also been asked to participate in the working groups between nuclear safety authorities set up by the AFCN in order to examine the analysis reports provided by the licensee for the defects observed on the vessels of the Doel 3 and Tihange 2 reactors. ASN has underlined the value of this international cooperation approach. ASN agrees with the conclusions of the Belgian nuclear safety authority (AFCN) published in January 2013, asking Electrabel to supplement the file presented in order to demonstrate the safety of the Doel 3 and Tihange 2 reactor vessels.[40]

ASN reviewed the situation of the French NPP reactors in the light of this event:

The available information concerning the manufacturing practices in force since the early 1970s in France gives no indication of the presence on the French NPP reactor vessels of manufacturing defects in numbers and of dimensions similar to those discovered on the Doel 3 reactor vessel. ASN has nonetheless asked EDF to carry out a detailed documentary review to confirm the correct performance of the manufacturing completion inspections. ASN also asked EDF to propose an inspection programme for certain vessels in order to further confirm the guarantees given.

19.7.4.2 Integration of the experience feedback from the Fukushima Daiichi accident

As a complement to the stress tests, in 2011 ASN carried out a series of targeted tightened inspections (see § 6.3.1.4) on the themes identified by experience feedback from the Fukushima Daiichi accident.

In 2012, ASN carried out follow-up inspections to check the corrective measures requested following the inspections performed in 2011 on all the NPPs.

Conclusions drawn from the peer review of the European stress tests

The stress test reports from the different European countries were subject to a peer review process which took place from January to April 21012 and comprised two successive phases: firstly a cross-cutting thematic review of all the national reports followed by a detailed review of each national report:

On 26th April 2012, the institutional group of European safety regulators ENSREG and the European Commission adopted a report on the results of the stress tests carried out on Europe's NPPs. ENSREG and the Commission praised the quality of the work done and the efforts made by all the European stakeholders to carry out this unprecedented process in the best possible conditions. They also underlined the progress that it will be possible to achieve in the field of nuclear safety, thanks to the stress tests report.

The ENSREG report gives a positive appreciation of the results of the stress tests carried out in France and notes the comprehensive nature of the assessments conducted under ASN's supervision. This report praises the wide range of improvements decided upon, which go beyond the existing safety margins of the French facilities, and the establishing of a hardened safety core in particular. This report also makes a number of recommendations that ASN has integrated in its national action plan.

Publication of the national action plan on the implementation in France of the recommendations resulting from the European stress tests carried out in 2011

[40] The documents relating to the integration of experience feedback from the Belgian reactors can be accessed through the following llink (only in French): http://www.asn.fr/index.php/S-informer/Actualites/2013/Situation-des-reacteurs-de-Doel-3-et-Tihange-2-Belgique

On 20th December, the national action plan concerning the implementation in France of the recommendations resulting from the European stress tests conducted in 2011 and, more generally, all the actions decided further to these tests, was submitted to ENSREG.

This national action plan comprises four sections:

- the first section addresses the three themes that formed the backbone of the European stress tests, namely natural hazards, loss of safety systems and severe accident management;
- the second section covers three other themes broached during the extraordinary meeting of the States who are party to the international Convention on Nuclear Safety (CNS) which was held at the IAEA in August 2012: the organisation of oversight of nuclear activities, the management of emergency and post-accident situations, and international cooperation;
- the third section reiterates the measures concerning the subcontracting of operations by the nuclear licensees: in France, the stress-test specifications were extended to cover these subjects;
- the fourth section provides tables summarising the key steps of the actions undertaken in these various areas.

This plan, like all the national action plans, has been examined by all the European safety regulators.

19.8 Management of radioactive waste and spent fuel

Directive 2011/70/Euratom of 19th July 2011 establishes a European framework for the safe and responsible management of spent fuel and radioactive waste. It applies to the management of spent fuel and the management of radioactive waste, from production to disposal, when this waste is the result of civil activities. Like the directive of 25th June 2009, it calls for each Member State to set up a coherent and appropriate national framework and sets various requirements for the States, the safety regulators and the licensees. Several of the requirements of this directive, whose transposition is to be completed before August 2013, are already in force in France, for example through the provisions of the Environment Code concerning waste, the Waste Act and the TSN Act.

National radioactive materials and waste management plan (PNGMDR)

Legislation specific to radioactive waste was established for the first time in 1991. It was modified and supplemented in 2006 by the act of 28th June 2006 for the programme relative to the sustainable management of radioactive materials and waste.

This act more particularly institutes a National Radioactive Materials and Waste Management Plan (PNGMDR) and sets a programme of research and work concerning radioactive waste for which there is no definitive means of management, along with a schedule for implementing it.

The PNGMDR presents an overall view of the management of radioactive materials and waste, with the double aim of checking that appropriate management routes exist for each category of radioactive substance in both the short and long term, and to improve mutual consistency between routes. Furthermore, the decree that establishes the requirements defines a clear road map for improving the management of radioactive materials and waste.

Radioactive waste management

The removal of waste is checked on a case-by-case basis when the activities producing the waste are subject to a licensing system (case of the BNIs).

The management of radioactive waste from the BNIs is based on a regulatory framework (in particular the BNI order) which provides for:

- the development of "waste studies" for each nuclear site which must result in the drawing up of an assessment of the waste management on a site. This waste study includes in particular the defining of "waste zoning[41]", distinguishing areas of the facility where waste is likely to have been contaminated by radioactive substances or activated by radiation, from areas were the waste cannot contain added radioactivity; it must be approved by ASN;

- the defining, for each type of radioactive waste, of appropriate and duly authorised processes based on impact studies and forming the subject of public information or a public consultation;
- the setting up of waste tracking systems to ensure the traceability of the waste.

The waste studies system should help improve the overall management of waste, particularly in terms of transparency, and help develop optimised management routes.

Spent fuel management

France has opted for a strategy of reprocessing the spent fuel resulting from the nuclear power process, a choice that is confirmed by the Act of 28th June 2006. EDF is responsible for the processing and what becomes of the spent fuel and associated waste it produces.

The management strategy for the spent fuel produced in research reactors is developed according to the characteristics of the fuel and depending on the case may involve reprocessing or direct disposal. The quantities of spent fuel planned for direct disposal are nevertheless very much smaller than the quantities of reprocessed fuel.

19.8.1 ASN requests

19.8.1.1 Radioactive waste management

The waste produced by EDF's NPPs comprises the activated waste and the waste resulting from the operation and maintenance of the NPPs. To this can be added the legacy waste and waste resulting from ongoing decommissioning operations. EDF is also the owner of high-level and intermediate-level long-lived waste resulting from spent fuel reprocessing in the AREVA La Hague plant.

For all the radioactive waste, ASN examines the baseline requirements of the licensee's waste study, in accordance with the regulations.

This baseline requirement comprises the following themes:

- an assessment of the existing situation, summarising the different wastes produced and their quantities;
- the waste management procedures and the organisation of waste transport;
- the "waste zoning";
- the state of the existing disposal solutions.

Each site sends ASN annually a detailed report of its waste production with the chosen disposal routes, an analysis of the trends compared with previous years, an assessment focusing on the observed deviations and the functioning of the site's waste management organisation and the notable events that have occurred. The future prospects are also considered.

19.8.1.2 Spent fuel management

EDF uses two types of nuclear fuel in the pressurised water reactors;

- uranium oxide (UO2) based fuels enriched with uranium-235 to a maximum of 4.5%;
- fuels consisting of a mixture of depleted uranium oxide and plutonium oxide (MOX).

Fuel management is specific to each reactor series.

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[41] "Waste zoning" divides the facilities into zones that produce nuclear (or radioactive) waste and zones that produce conventional waste. It takes acount of the design and history of operation of the facilities and is confimed by radiological checks.

After a period of about three to five years, the spent fuel is removed from the reactor to cool down in a spent fuel storage pool, first on the NPP site, then in the AREVA NC fuel reprocessing plant at La Hague.

EDF, in collaboration with the fuel cycle industry players, keeps up-to-date a file concerning the compatibility between the changes in the characteristics of new and spent fuel and the changes in the fuel cycle facilities. The review of the most recent version of this file by ASN was completed in 2010. EDF now updates this file take account of the changes in the fuel cycle facilities, notably the storage capacities of the reactor pools and of the reprocessing plants, and the management of the fuels and the products it uses in the reactors.

Lastly, the design and the resistance of the spent fuel pools situated in the NPPs and the fuel cycle facilities were examined in the framework of the stress tests performed further to the Fukushima Daiichi accident.

19.8.2 Measures taken for nuclear power reactors

The management of spent fuel and radioactive waste forms the subject of the joint convention on the Safety of spent fuel management and on the safety of radioactive waste management..

The spent fuel undergoes a reprocessing-recycling process at the AREVA La Hague plant that allows:

- the recycling of materials that can be reused.
- the conditioning of ultimate high-level long lived-waste in vitrified form in standard containers. This waste is stored on the La Hague site for cooling for a period of several decades. The waste is then intended to be disposed of in the deep geological repository that ANDRA is currently developing in the Meuse *département*.

Below is a reminder of the modes of management of the waste resulting directly from reactor operation.

Waste management on a production site comprises the following main phases: "waste zoning", waste collection, sorting, characterisation, reprocessing/conditioning, storage, shipment.

Collection is a sensitive waste management phase in the nuclear facilities. The waste is collected selectively, either directly by the process or by personnel on the sites (sorting at source). Right from the collection phase, the physical management of radioactive waste must at all levels be separate from that of conventional waste and prevent any mixing of incompatible materials.

The radioactive waste resulting from the operation of PWRs is essentially very low, low or intermediate level short-lived waste. It can be classified in two categories:

- the process waste that comes from the purification and treatment of the liquid or gaseous effluents to reduce their activity before being discharged;
- the technological waste that comes from maintenance operations. This waste can be solid or liquid.

The most radioactive waste, of intermediate level, is conditioned in concrete containers and disposed of directly at ANDRA's Aube waste repository (CSA). A part of the process waste and the technological waste is coated or immobilised in a hydraulic binder on fixed facilities: NPP nuclear auxiliaries building or effluent treatment building. For the final conditioning of the ion exchange resins, EDF uses the MERCURE process (coating in an epoxide matrix), implemented using two identical mobile machines. As far as the most recent NPPs are concerned, EDF uses - depending on the needs - a mobile machine for conditioning the sludge and favours the incineration of the evaporator concentrates.

The solid low-level waste is:

- either compacted on site in 200-litre metal drums and sent directly to ANDRA's CSA repository to be further compacted and disposed of definitively after concreting in 450-litre drums;

- o or compacted in 200-litre plastic drums and sent to the CENTRACO plant of SOCODEI for incineration. The residual ash and clinkers from incineration are conditioned in 450-litre thick metal drums and definitively disposed of at the CSA repository;
  This low-level waste processing and conditioning centre is equipped with a melting unit for metal waste, in addition to its incineration unit which also processes liquid waste. This melting unit produces 200-litre ingots which are disposed of at the CSA or CIRES repository (see below) when their specific activity so permits.

The very low level waste, which essentially comprises metal waste and rubble, is shipped to CIRES (Industrial centre for grouping, storage and disposal), a dedicated repository situated in Morvilliers, also managed by ANDRA and which entered service in 2003.

Note: recently the management of radioactive waste produced in operation has been disturbed by the administrative shutdown (for 10 months) of the CENTRACO incineration unit following the accident that occurred on the melting unit on 12th September 2011. The majority of the waste that was to be incinerated was sorted, conditioned in metal drums and shipped directly to the CSA repository. Furthermore, to avoid incinerating evaporator concentrates from the most recent NPPs, an old mobile conditioning machine (cementation in concrete containers) was put back into service.

19.8.3 Measures taken for research reactors

19.8.3.1 CEA reactors

Waste management

The majority of the waste produced by the operation of the CEA's experimental reactors is routed to the disposal facilities managed by ANDRA. The sodium wastes that will result from the post-operational clean-out and decommissioning of the Rapsodie and Phénix reactors will be treated in a facility that will be set up on the Phénix site.

Spent fuel management

All the spent fuel from the CEA experimental reactors undergoes or will undergo reprocessing. On this account the spent fuel from the Osiris and Orphée reactors is regularly transferred to the AREVA La Hague plant.

19.8.3.2 The ILL high-flux reactor (RHF)

The majority of the waste produced by the operation of the experimental reactor at the Laue Langevin Institute (ILL) is routed to the disposal facilities managed by ANDRA. The spent fuel is transferred to the AREVA La Hague plant.

19.8.4 ASN analysis and oversight

19.8.4.1 Radioactive waste management

During its NPP inspections, ASN examines the organisation and measures taken by the sites in terms of waste and spent fuel management. The inspectors review the site’s waste management organisation and various points such as the processing of deviations. They also check the operation of the waste storage and treatment areas.

EDF has developed and implemented baseline operating requirements for the buildings in which the radioactive wastes are managed, bringing a reduction in the quantities of waste stored and improved provisions with respect to the containment of the radioactive material, fire protection and radiation protection. As part of the periodic safety review of the 1300 MWe plant series, ASN has asked EDF to update the safety report for the NPPs concerned so that it contains the safety analysis approach adopted for the buildings concerned, along with the main elements of the safety case. Alongside this, ASN has asked EDF to integrate in the general operating rules (RGE), the provisions for guaranteeing compliance during normal operation with the hypotheses considered in the safety case.

Despite the positive trend already observed in previous years and progress in terms of environmental organisation on most of the sites, ASN considers that there is still room for improvement in EDF's radioactive waste management organisation. In effect, EDF does not give sufficient attention to and sufficiently anticipate the processing of facility conformity deviations, the implementation of maintenance programmes and the updating of operational documents. Furthermore, the sorting of waste and the establishing and enforcing of waste zoning remain points that ASN considers require particular attention.

Extension of the operating life of the nuclear power reactors

EDF's intention to extend the operating life time of the nuclear power reactors will lead to an increase in maintenance work. ASN considers that these maintenance operations must be sufficiently anticipated in order to take into account the volumes of waste produced and the available treatment routes.

Opinion of the Advisory Committee of experts for waste

ASN has asked EDF to present its strategy for the management of radioactive waste resulting from the operation and maintenance of its nuclear power reactors for the next ten years.

More specifically, ASN has asked EDF to present it the operating experience feedback from the last ten years and its strategy for managing the voluminous components replaced during operation of the NPPs. EDF must also present the various waste management routes available, their robustness and their redundancy, particularly in view of the planned maintenance operations.

These elements shall be submitted to the Advisory Committee of experts for waste, planned to meet in 2014.

19.8.4.2 Spent fuel management

The safety of fuel storage in the spent fuel pool has been the subject of in-depth examinations during past or ongoing periodic safety reviews, as well as in the context of the stress tests. These successive examinations have led to the defining and implementation of modifications to prevent the risk of emptying of the spent fuel pool, to improve the robustness of the water make-up means and to improve the management of accident situations (see § 19.4.2). Despite these modifications, ASN underlines that the initial design and the current state of the spent fuel pools fall significantly short of the safety principles that would be applied in a new facility. Moreover, the implementation of effective means of mitigating the consequences of prolonged exposure of spent fuel assemblies is not currently conceivable on the spent fuel pools of the EDF nuclear reactor fleet in operation. In view of these facts, ASN has asked EDF to examine options for the on-site storage of spent fuel other than the current spent fuel pools, using the safety objectives defined for the generation III reactors as a reference.

The stress tests included an in-depth examination of the consequences of a major natural hazard on the systems that can evacuate the residual power of the fuel stored in pools, on the integrity of the pools in the fuel building and the reactor building and the systems connected to them, the risks of storage rack deformation and the risks of falling loads. The conclusions of the analyses have led ASN to issue requirements, in particular to reinforce the electrical power resources, the water supply resources, the instrumentation and the measures to prevent accidental emptying of the pools.

G – INTERNATIONAL COOPERATION

20. International cooperation measures

20.1 ASN's international activities

The nuclear installations regulated by ASN represents one of the largest and most diverse fleets in the world. ASN therefore aims to ensure that its nuclear regulation and radiation protection 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 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 experience. Its main objectives are:

- 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 improving the rules and practices at European and international levels and to take an active part in work to harmonise nuclear safety and radiation protection principles and standards and in work to prepare 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;
- to participate in the international committees that produce the scientific syntheses and the recommendations stemming from them.

ASN pursues its objectives in multilateral frameworks (both European and non-European), by promoting the harmonisation of practices in the regulation of nuclear safety and radiation protection. These actions are carried out within the multilateral organisations, both formal (IAEA, OECD/NEA, MDEP, ICRP, UNSCEAR, etc.) and informal (WENRA, HERCA, etc.), but also bilaterally, by setting up exchanges with its foreign counterparts on all subjects of common interest.

The European Commission incarnates and defends the general interest of the European Union (EU). It constitutes the driving force behind its institutional system. It has set up a number of bodies in which ASN participates (such as the European Nuclear Safety Regulators Group – ENSREG).

20.2 IRSN's international activities concerning reactor safety

Within the scope of the duties assigned to it by the public authorities, IRSN (Institute for Radiation Protection and Nuclear Safety) develops international relations with regard to research and expertise in the areas of nuclear installation safety, radioactive material transport safety, human and environmental protection, safety and regulation of sensitive nuclear materials and organisation and training for emergency management.

IRSN's international activities have three main objectives:

- increase the scientific and technical knowledge required for better risk assessment and improved risk control;
- contribute to the establishing of international consensus both on technical questions and on the drafting of guides, recommendations and standards;
- take part in the implementation of projects aimed at reinforcing radiation protection, nuclear safety and security abroad.

These activities are conducted within the framework of bilateral and multilateral collaborations, work performed under the auspices of such international organisations as the IAEA, the OECD Nuclear Energy Agency (NEA), the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR), the International Commission on Radiation Protection (ICRP) and the European Commission, but also as part of services or cooperation projects developed by the IAEA, the European Commission or the European Bank for Reconstruction and Development. Some of these activities are carried out to support ASN in international collaborations.

20.3 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; the development of nuclear projects internationally enables EDF to turn increased mutual experience feedback to good account and to develop synergies within the Group, particularly with regard to safety;
- the international institutions (WANO, FROG, WOG, EPRI, WNA, INPO, etc.) promote dialogue and exchanges between nuclear licensees. EDF makes extensive use of these institutions with the aim of improving the safety and operating reliability of nuclear power plants on a global scale;
- consultancy and service activities in the form of contracts;
- The preparation of the reactors of the future and technological watch. EDF's activity is exercised essentially through its participation in the European Utility Requirements (EUR) organisation, the Cooperation on Reactor Design Evaluation and Licensing (CORDEL) group and the World Nuclear Association (WNA).

20.4 CEA's international activities concerning reactor safety

The CEA participates in international collaborations in nuclear areas, particularly that relating to the safety of nuclear power reactors.

Research into safety focuses chiefly on the following main objectives:

- the Organisational and Human Factors aspects in operation (see § 12.3.1);
- the use of passive systems for returning to a safe state from an accident situation;
- the reduction in the probability of core meltdown;
- mitigation of the off-site consequences of a severe accident situation, notably by reinforcing containment.

The CEA contributes to the IAEA’s work on research reactors and has established regular exchanges with foreign counterparts, based on operational experience and lessons learned from incidents. In the area of fast-neutron reactors, it maintains close contact with Russia, India and Japan.

With regard to the 4th generation reactors, in the collaborative framework of the Forum, the CEA contributes to studies on fuel and the safety of the gas-cooled fast-neutron experimental reactor project (ALLEGRO).

With regard to radiation protection, the CEA participates in various research activities as well as the activities of UNSCEAR.

20.5 French participation in the Nuclear Safety and Security Group (NSSG) of the G8

ASN provides its technical support to the French authorities within the Nuclear Safety and Security Group of the G8 countries (G8/NSSG). Since the accident at the Fukushima Daiichi NPP, this group has essentially worked on coordinating the actions of the seven member States and of the European Commission to support the preparation then implementation of the IAEA's Action Plan on Nuclear Safety.

Working in close collaboration with its G8 partners, France played an active role in the work of the 2nd extraordinary meeting of States Party to the Convention on Nuclear Safety held from 27th to 31st August 2012, and in the development of its conclusions.

APPENDIX 1 – LIST AND LOCATION OF NUCLEAR REACTORS IN FRANCE

1.1. Location of the nuclear reactors

The 58 nuclear power reactors and the 11 research reactors in operation in the administrative sense as at 31st July 2013 are distributed over the French territory as shown in the map below. In addition to this, one nuclear power reactor and one research reactor are currently under construction.

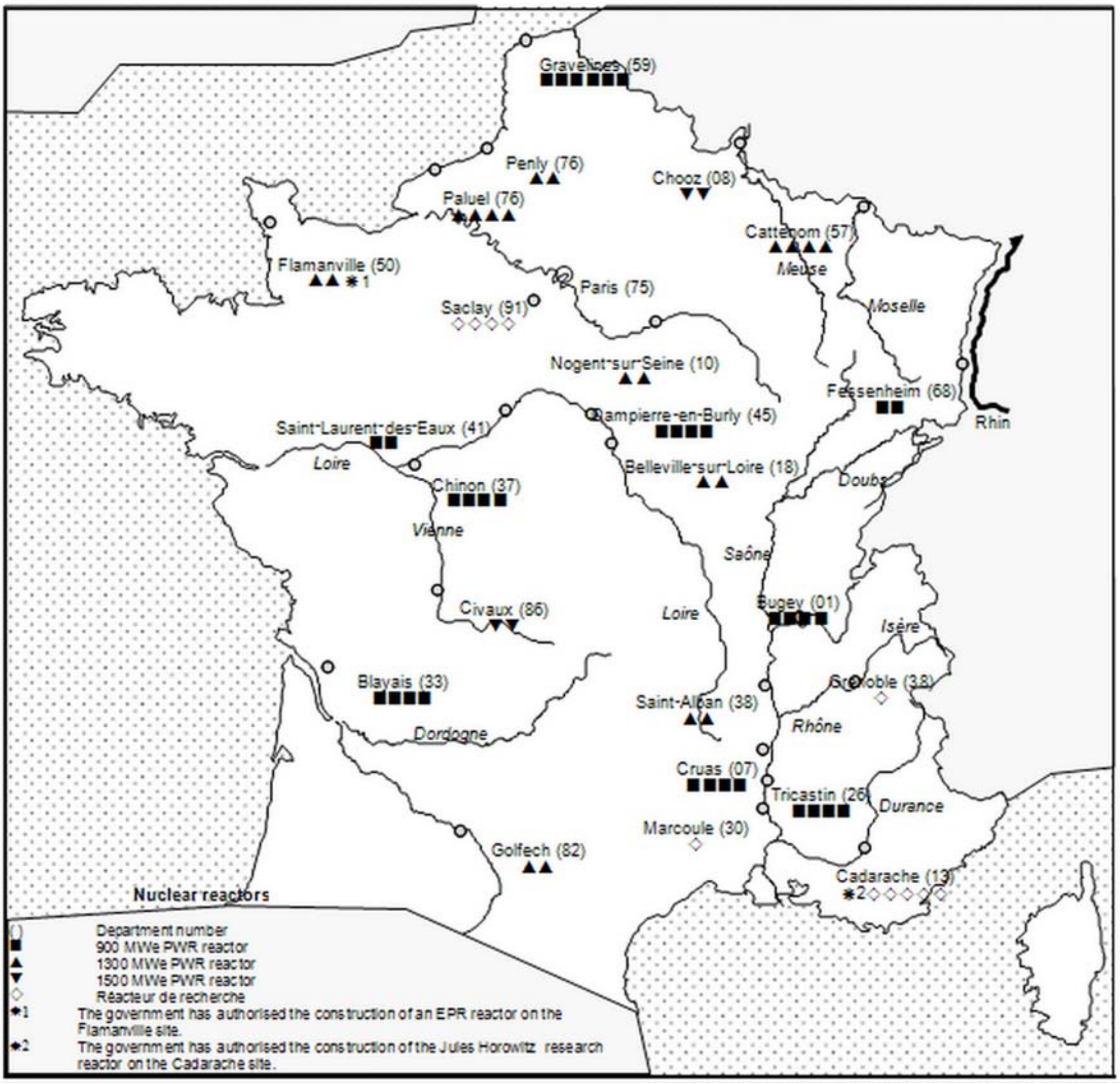


Figure 14: Map of France situating the nuclear reactors in operation and under construction

The total installed electrical power is of the order of 64,000 MWe.

The 58 pressurised water nuclear power reactors situated on 19 sites are operated by EDF.

The prototype fast-neutron nuclear power reactor PHENIX (shut down) and 9 other research reactors are operated by the CEA. The high-flux research reactor (RHF) is operated by the Laue-Langevin Institute (ILL).

1.2. List of nuclear power reactors

Table 10: Nuclear power reactors in operation and under construction

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Author-ised on:	Official Journal (O.J.) 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.J. 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.J. 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.J. 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.J. of 18.12.85 and decree of 29.11.04 O.J. 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.J. 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.J. 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.J. 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	
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.J. 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.J. of 18.12.85 and decree of 29.11.04 O.J. 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.J. of 02.12.04

APPENDIX 1 – List and location of nuclear reactors in France

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Author-ised on:	Official Journal (O.J.) of:	OBSERVATIONS
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.J. of 18.12.85 Modification Decree of 02.11.07 O.J. 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	
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.J. 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.J. 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.J. 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.J. 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.J. 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.J. of 23.10.93 and 11.06.99 O.J. 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	
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.J. of 23.10.93 and of 11.06.99 O.J. of 18.06.99

APPENDIX 1 – List and location of nuclear reactors in France

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Author-ised on:	Official Journal (O.J.) of:	OBSERVATIONS
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.J. 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.J. 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 research nuclear reactors

Table 11: Research reactors in operation, in the administrative sense, and under construction

BNI no.	NAME AND LOCATION OF THE INSTALLATION	OPERATOR	Type of installation	Declared on:	Author-ised on:	Official Journal (O.J.)	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.J. 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.J. 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.J. 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 REACTOR – JHR (Cadarache) 13115 Saint-Paul-lez Durance Cedex	CEA	Reactor 100 MW		12.10.09	14.10.09	Decree 2009-1219 O.J. of 14.10.09

APPENDIX 2 – MAIN LEGISLATIVE AND REGULATORY TEXTS

2.1. Codes, acts and regulations

- Environment Code.
  - Book I – Part II – Chapter V (Articles L. 125-10 to L.125-40)
  - Book V – Part IV – Chapter II (Articles L. 542-1 to L.542-14)
  - Book V – Part IX (Articles L. 591-1 to L.59-7-46)
- Public Health Code: 1st Section – Book II – Part III – Chapter III (Articles L 1333-1 and following and articles corresponding to the regulatory section of this Code) relative to the general protection of individuals against the hazards of ionising radiation.
- Labour Code: Articles 4451-1 and following and R.4451-1 and following relative to the protection of workers against the hazards of ionising radiation.
- Defence Code: Articles D. 1333-68 and 69 relative to the Interministerial Committee for Nuclear or Radiological Emergencies.
- Act 2006-686 of 13th June 2006 relative to Transparency and Security in the Nuclear Field (Articles 19 and 21).
- Planning Act 2006-739 of 28th June 2006 relative to the Sustainable Management of Radioactive Materials and Waste (Articles 3 and 4).
- Decree 2007-830 of 11th May 2007 relative to the Nomenclature of Basic Nuclear Installations.
- Decree 2007-831 of 11th May 2007 setting the Appointment and Certification Procedures for Nuclear Safety Inspectors;
- Decree 2007-1557 of 2nd November 2007 relative to Basic Nuclear Installations and the Control, with Regard to Nuclear Safety, of the Transport of Radioactive Substances (decree concerning the procedures).
- Decree 2007-1572 of 6th November 2007 relative to Technical Inquiries into Accidents or Incidents Concerning a Nuclear Activity;
- Decree 2007-1582 of 7th November 2007 relative to the Protection of Workers against the Hazards of Ionising Radiation and Modifying the Public Health Code.
- Decree 2008-251 of 12th March 2008 relative to Local Information Committees for Basic Nuclear Installations.
- Decree 2010-277 of 16th March 2010 relative to the High Committee for Transparency and Information on Nuclear Security.
- Order of 7 February 2012 setting the general rules concerning basic nuclear installations (in force on 1st July 2013).
- Ministerial Order of 10th August 1984 relative to the quality of design, construction and operation of BNIs (repealed on 1st July 2013).
- Interministerial Order of 10th November 1999 relative to the monitoring of operation of the main primary system and the main secondary systems of pressurized water nuclear reactors.
- Order of 26th November 1999 setting the general technical requirements relative to the limits and conditions of BNI water intakes and discharges subject to authorisation (repealed on 1st July 2013).
- Ministerial Order of 31st December 1999, setting the general technical regulations intended to prevent and mitigate off-site detrimental effects and risks resulting from BNI operations (repealed on 1st July 2013).
- Ministerial order of 12th December 2005 relative to nuclear pressure equipment.

2.2. ASN regulatory resolutions

Table 12: List of ASN regulatory resolutions as at end of June 2013

Theme	Reference	Consultations
Texts relative to the procedures		
Periodic safety review		From 25/04 to 26/05/2013 (1st consultation on 18/03/10 by post and via the Internet from 18/04/10 tol 15/7/2010; WENRA on 26/03/10 (by e-mail)
Treatment of equipment modifications		On 18/03/10 by post and via the Internet from 18/04/10 to 15/7/2010; WENRA on 26/03/10 (by e-mail)
Safety report (content),		On 21/04/11 by post and via the Internet from 30/04/11 to 31/07/2011)
Content of the general operating rules (RGE)		On 22/06/10 by post and via the Internet from 06/07/10 to 30/09/2010 WENRA on 06/07/10 by e-mail
Internal authorisations	ASN resolution 2008-DC-0106 of 11th July 2008 Approval: order of 26/09/2008 (Official Journal of French Republic of 11/10/2006)	-

Decommissioning plan (content)		*
Public consultation procedures		Public consultation: from 12/03/2013 to 13/04/2013 CSPRT (Higher Council for the Prevention of Technological Risks): 28/05/2013
Diverse provisions concerning the procedures		*
Audition of licensees and CLIs	ASN resolution 2010-DC-0179 of 13th April 2013	-
Technical texts		
Organisation and management system		
Protection of interests policy		On 03/08/10 by post and via the Internet from 10/08/10 to 15/11/10) WENRA on 10/08/2010 by e-mail
Control of accident risks and harmful effects (excluding waste)		
BNI operation resolution		On 22/06/10 by post and via the Internet from 06/07/10 to 30/09/2010) WENRA on 06/07/10 by e-mail
Refuelling shutdown of PWRs		On 30/03/10 by post and via the Internet from 18/04/10 to 15/7/2010; WENRA on 09/04/10 (by e-mail)
Design and operation of waste repositories		*
Control of fire risks		From 26/12/12 to 28/02/13

Criticality		*
Control of detrimental effects and impact on the environment		From 15/03/13 to 16/04/13 CSPRT: 03/07/2013 (1st consultation on 12/07/10 by post and via the Internet from 19/07/10 to 15/10/10)
Waste management and disposal		
Content of the BNI waste studies		On 28/05/10 by post and on via the Internet from 26/05/10 to 31/08/10; WENRA on 16/10/10 by e-mail
Conditions of approval of waste conditioning		On 26/07/10 by post and via the Internet from 20/09/10 to 05/12/10)
Design and operation of on-site waste storage facilities		*
Management of emergency situations		
Management of emergency situations		On 21/05/10 by post and via the Internet from 26/05/10 to 31/08/10) WENRA on 10/06/10 by e-mail
Informing of the authorities and the public		
Notification of incidents		
Nuclear Pressure Equipment (NPE)		
Spare parts for the main primary system (MPS) and main secondary system (MSS)	ASN resolution 2012-DC-0236 of 3rd May 2012 Approval: order of 22/06/2012 (Official Journal of French Republic of 04/07/2012)	On 01/10/10 by post and via the Internet from 11/10/10 to 31/12/2010) CCAP 04/10/2011
Regulations applicable to NPE		*

After a first series of consultations in 2010 and 2011, the draft resolutions were revised in the light of the observations made and of the order of 7th February 2012 *setting the general rules relative to basic nuclear installations.* The new versions of draft resolutions have been or will be subject to consultation in 2013-2014 before they are adopted.

2.3. Basic safety rules and guides

As indicated in § 7.1.3.3, as part of the on-going restructuring of the general technical regulations, the basic safety rules (RFS) are being modified and transformed into guides.

There are at present about forty basic safety rules and other technical rules published by ASN which can be consulted on its website.

2.3.1 Rules relative to PWRs

RFS 2002-1	Basic safety rule 2002-1 on the development and the utilisation of probabilistic safety assessments for PWRs (26th December 2002).
RFS-I.2.a.	Integration of risks related to aircraft crashes (5th August 1980).
RFS-I.2.b.	Integration of risks of projectile release following fragmentation of the turbogenerators (5th August 1980).
RFS-I.2.d.	Integration of risks related to the industrial environment and communication routes (7th May 1982).
RFS-I.3.a.	Use of the single failure criterion in safety analyses (5th August 1980).
RFS-I.3.b.	Seismic instrumentation (8th June 1984)
RFS-I.3.c.	Geological and geotechnical site studies; determination of soil characteristics and study of soil behaviour (1st August 1985).
RFS-II.2.2.a.	Design of containment spray systems (5th August 1980); revision 1 (31st December 1985).
RFS-II.3.8.	Construction and operation of the main secondary system (8th June 1990).
RFS-II.4.1.a	Software for safety-classified electrical equipment (15th May 2000).
RFS-IV.I.a.	Classification of mechanical equipment, electrical systems, structures and civil engineering works (21st 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 (21st 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 (31st July 1985).
RFS-V.I.a.	Determination of the activity released outside the fuel to be considered in accident safety studies (18th January 1982).
RFS-V.I.b.	Means of meteorological measurements (10th June 1982).
RFS-V.2.b.	General rules applicable to civil engineering works (ref.: RCC-G code), (30th July 1981).
RFS-V.2.c.	General rules applicable to the production of mechanical equipment (ref.: RCC-M code), (8th April 1981); revision 1 (12th June 1986).
RFS-V.2.d.	General rules applicable to the production of electrical equipment (ref.: RCC-E code), (28th December 1982); revision 1 (23rd September 1986).

RFS-V.2.e. General rules applicable to the production of fuel assemblies (ref.: RCC-C code), (28th December 1982); revision 1 (25th October 1985); revision 2 (14th December 1990).

RFS-V.2.f General rules relative to fire protection (ref.: RCC-I code), (28th December 1982).

RFS-V.2.g. Seismic calculations for civil engineering works (31st December 1985).

RFS-V.2.h. General rules applicable to the construction of civil engineering works (ref.: RCC-G code), (4th June 1986).

RFS-V.2.j. General rules relative to fire protection (ref.: RCC-I code), (20th 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 plant units" (ref.: RCC-P code).

2.3.2 Rules relative to the other BNIs

RFS-I.1.a. Integration of risks related to aircraft crashes (7th October 1992).

RFS-I.1.b. Integration of risks related to the industrial environment and communication routes (7th 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 (8th November 1982 – revision of 19th June 1984).

RFS-I.2.b. Basic design of ionisers (18th May 1992).

RFS-I.3.c. Criticality risk (18th October 1984).

RFS-I.4.a. Fire protection (28th February 1985).

RFS-II.2. Design and operation of ventilation systems in BNIs other than nuclear reactors (20th 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 (24th September 1982).

RFS-III.2.b. Special provisions applicable to the production, monitoring, processing, packaging and storage of high-level waste packaged in the form of glass and resulting from reprocessing of fuel irradiated in PWRs (12th 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 (5th 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 (1st February 1985).

RFS-III.2.e. Prerequisites for the approval of packages of encapsulated solid waste intended for surface disposal (31st October 1986 – revision of 29th May 1995).

2.3.3 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 – 16th May 2001).

RULE SIN C-12308/86 (RR1)

Cleaning systems equipping nuclear research reactor ventilation systems (4th August 1986).

RULE SIN A-4212/83

Relative to meteorological measurement means (12th August 1983).

RULE SIN C-12670/9-1 (RR2)

Protection against fire risk in nuclear research reactors (1st July 1991).

2.3.4 Guides

ASN Guides (in force in june 2013)

ASN Guide 2/01 (26th May 2006) dedicated to consideration of seismic risk in conception of BNIs civil engineering works, except for long-term storage of radioactive waste.

General safety orientation guide for siting of long-life low-level activity waste storage facility (May 2008).

N°1 Safety guide on the final disposal of radioactive waste in a deep geological formation (8th February 2008).

N°2 Transport of radioactive materials in airports (15th February 2006).

N°3 Recommendations for the preparation of annual reports on public information concerning BNIs (20th October 2010).

N°4 Self-assessment of risks by external-beam radiotherapy patients (15th January 2009).

N°5 Management of security and quality in radiotherapy care (10th April 2009)

N°6 Final shutdown, decommissioning and delicensing of French BNIs (18th June 2010).

N°7 Shipment approval requests and certification applications for package design or the road transport of radioactive materials for civilian uses (28th February 2013).

N°8 Conformity assessment of nuclear pressure equipment (4th September 2012).

N°10 Involvement of local information committees (CLIs) in the framework of the third ten-yearly outages of 900-MWe reactors (1st June 2010).

N°11 Notification procedures and the codification of criteria relating to significant events in the field of radiation protection not related to BNIs and to the transport of radioactive materials (7th October 2009).

N°12 Notification procedures and 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 (21st October 2005).

N°13 BNIs protection against external flooding (8th January 2013).

N°14 Acceptable complete clean-out methodlogies in BNIs in France (21st June 2010).

N°16 Event significant for patient radiation protection in radiotherapy: notification and classifcation on the ASN-SFRO scale (1st October 2010).

N°18 the elimination of effluents and of waste contaminated with radionuclides in BNIs in accordance with Public Health Code (26th January 2012).

N° 19 Implementation of the 12th December 2005 order related to nuclear pressure equipment (21st February 2013).

Draft ASN Guides (in June 2013)

Table 13: List of draft ASN Guides

Title	Consultation
Decommissioning	
Procedures for public consultation	
Perimeter	from 18/04/13 to 19/05/2013
Interest protection policy (for example safety management policy)	from 03/08/10 by mail or via internet from 10/08/10 to 15/11/10 WENRA the 10/08/2010 by mail
PWR design	
PWR fuel	
Shut down for refuelling PWR	
Crtiticality	
Content of waste studies	
Approval methods for waste packaging	
Design and operation of internal waste storage	
Emergency preparedness	
Incident notification	

APPENDIX 3 – ORGANISATION OF NUCLEAR REACTOR OPERATORS

3.1. EDF's organisation

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.

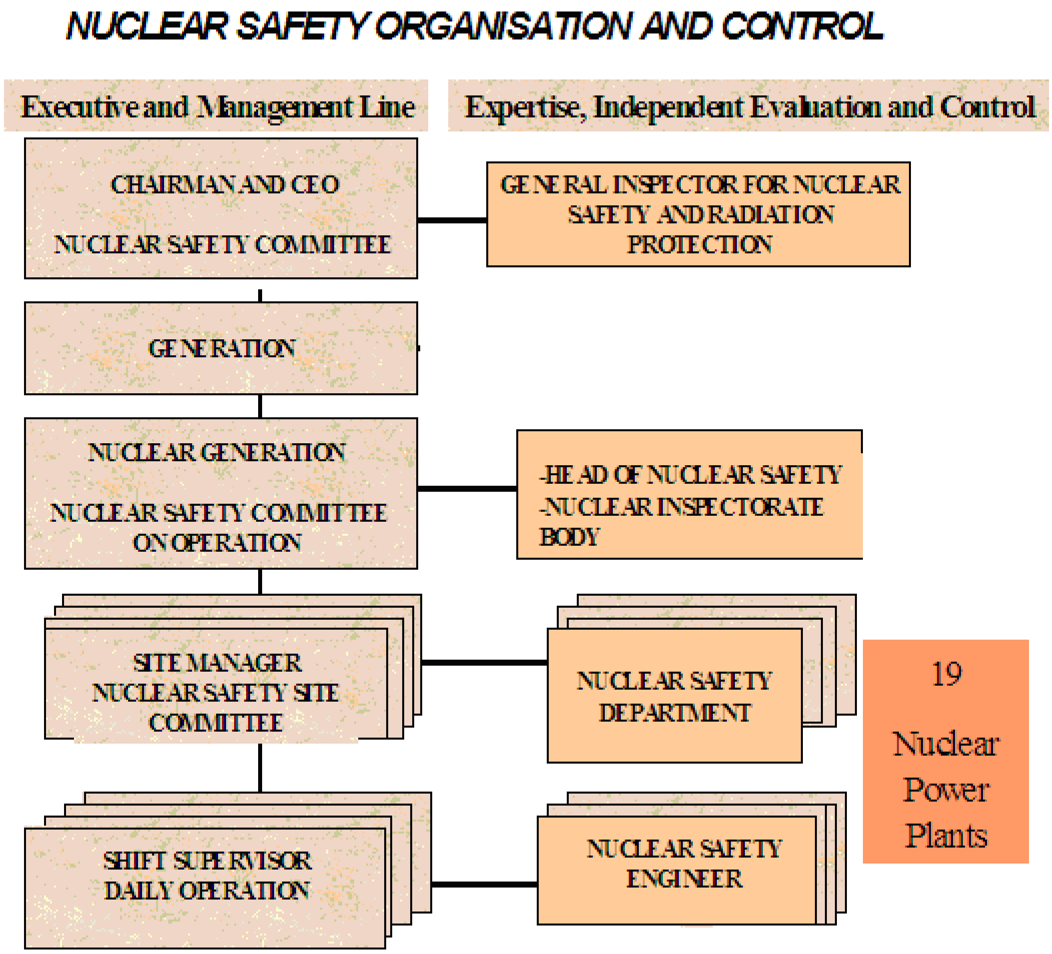


Figure 15: Organisation of nuclear safety and oversight at EDF

Regarding facilities operated by subsidiaries of the EDF S.A. Group, responsibility for nuclear safety and radiation protection lies with the licensee named in the plant authorisation decree (or the equivalent in other countries).

Nuclear safety and radiation protection concern all personnel working or present in a BNI for any reason. However, where personnel from external companies are concerned, the provisions detailed below in no way limit the responsibilities of managers of the companies concerned, or relieve the latter of such responsibilities.

3.1.1 The Chairman and Chief Executive Officer

Under the powers delegated to him by the Board of Directors, the Chairman & CEO has all the powers required for EDF S.A. to exercise its role as a nuclear licensee. In particular, he determines strategies regarding nuclear safety. He sets the general organisational principles that allow EDF S.A. to exercise its responsibilities as nuclear licensee, with the support of the Senior Executive Vice-President for 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 chief point of contact with ASN. 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 Executive Vice-President, Generation & Engineering to represent him in this task.

The Inspector General for Nuclear Safety and Radiation Protection ensures that nuclear safety and radiation protection concerns have been properly taken into account for the company's nuclear installations, and reports to the Chairman & CEO in this respect.

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 ensure compliance with nuclear safety and radiation protection rules, and allow EDF S.A. to exercise its responsibilities as nuclear licensee. In this respect, the Senior Executive Vice-President, Generation & Engineering makes the main 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 nuclear licensee, for all installations in operation.

In the case of a BNI undergoing dismantling at an isolated site with no BNI in operation, and by decision of the Senior Executive Vice-President, Generation & Engineering, EDF S.A. as nuclear licensee is represented by the Director of the Nuclear Engineering Division.

The Director of the Nuclear Power Operations Division (or the Director of the Nuclear Engineering Division in the case in point) takes all of the measures required for EDF S.A. to exercise its role as 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 ensure compliance with nuclear safety and radiation protection rules, and allow EDF S.A. to exercise its responsibilities as 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 3 Directors of the Nuclear Engineering Division (new nuclear, industrial and technical engineering, engineering of the in-service fleet and dismantling) are also in charge of developing, in consultation with the Director of the Nuclear Power Operations Division, the reference system for installation design. The Director of New Nuclear Engineering is responsible for this aspect being taken into account in the construction of the facilities. With regard to the fleet in service, the evolution of the reference system for the design of installations is the responsibility of the Director of In-Service Fleet Engineering and Dismantling, in consultancy with the Director of the Nuclear Power Operations Division. This Director of the Nuclear Power Operations Division 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 In-Service Fleet Engineering and Dismantling is also in charge of implementation of the dismantling programme approved by the Senior Executive Vice-President, Generation &

Engineering of the EDF Group with regard to the strategy, technical and industrial options, budget, general planning, etc. The 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 licensee EDF S.A. for the installations undergoing dismantling, save exceptions.

In the exercise of their missions, the Directors of the Nuclear Engineering Division organise the supporting tasks provided by the study and engineering units of their division to the Nuclear Power Operations Division.

Each of the Division Directors determines the specific measures to be implemented in their field, as well as the policy and strategy in terms of nuclear safety and radiation protection. He delegates to each of the unit managers concerned the powers required to exercise the role of representative of EDF S.A. as nuclear licensee. He sets objectives, and distributes resources among the units. He ensures that unit managers have at all times the authority, skills and resources required to achieve their objectives, either at their respective units, or in the form of collective resources available to them within or outside the Division. In particular, assisted by one or more members of staff, the Director of the Nuclear Power Operations Division ensures that the unit managers accomplish their duties, on the basis of information received from them and the oversight exercised in respect of the overall performance of the units and compliance with nuclear safety and radiation protection requirements. The Director of the Nuclear Power Operations Division is the chief 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 BNIs for which he 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 representative of EDF S.A. as the nuclear licensee for the BNIs under his responsibility, and assisted in this by one or more members of staff, the Director of the Nuclear Engineering Division concerned ensures that the unit managers accomplish their duties, on the basis of information received from them and the oversight exercised in respect of the nuclear safety and radiation protection requirements. He is the chief point of contact for the competent regulatory authorities in the area of nuclear safety and radiation protection for these BNIs.

3.1.4 Unit Manager

As the representative of EDF S.A. the nuclear licensee in respect of the facilities for which responsibility is delegated to him by the Director of his Division (NPP, nuclear facility undergoing dismantling), and under the latter's authority, the Unit Manager takes all measures necessary to exercise 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 ensure compliance with nuclear safety and radiation protection rules and allow the effective exercise of the responsibilities of EDF S.A. as the nuclear licensee. This responsibility may only be delegated to the person he has designated to substitute for him in the event of absence or incapacitation. Where he is representing EDF S.A. the nuclear licensee for installations undergoing dismantling, he applies the decisions of the Nuclear Engineering Division, and checks compliance with nuclear safety and radiation protection provisions. The reciprocal obligations of the NPP manager and manager of the site undergoing dismantling are specified in a joint protocol.

The unit manager enacts internal measures to facilitate compliance with nuclear safety and radiation protection requirements. He has compliance with these requirements verified through appropriate internal checking. He reports the information relating to nuclear safety and radiation protection to the Director of the division. He is the chief point of contact for the national and local competent regulatory authorities in the area of nuclear safety and radiation protection for the issues specific to the installations under his responsibility.

3.2. Organisation of the CEA

The CEA is a public research organisation established in 1945. In 2001, it set up an operational organisation based on the establishment of 4 "sectors" corresponding to its main areas of activity as illustrated on the organisation chart below: nuclear energy sector, technological research sector, fundamental research sector and defence sector. Four other functional sectors, including the "risk control sector", complete the organisation. Each operational sector is provided with resources (general management, objectives departments, internal functional resources) that it uses to develop, plan and control all its activities.

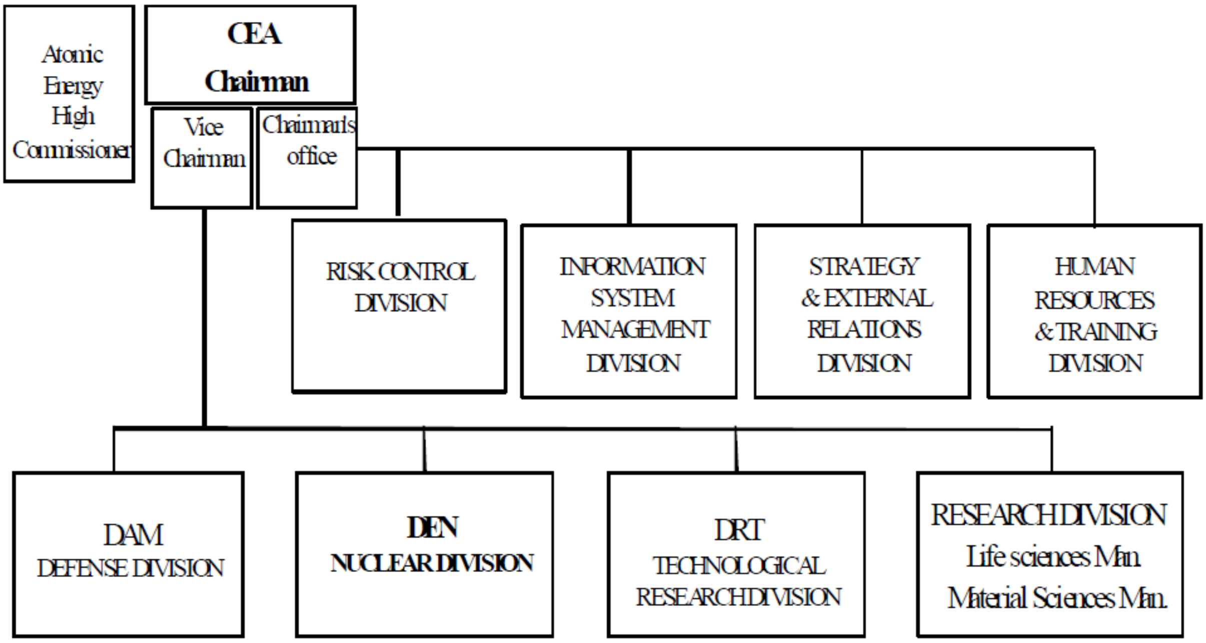


Figure 16: General Organisation of the CEA

Nuclear reactors, which are the subject of this report, are grouped in the nuclear energy sector (Nuclear Energy Directorate) with regard to civil nuclear applications.

On 10th March 2010 the CEA became the French Alternative Energies and Atomic Energy Commission

The Security, Quality and Nuclear Safety Department, if a functional department with the Nuclear Energy Directorate, which is organised as shown below:

APPENDIX 3 – Organisation of nuclear reactor operators

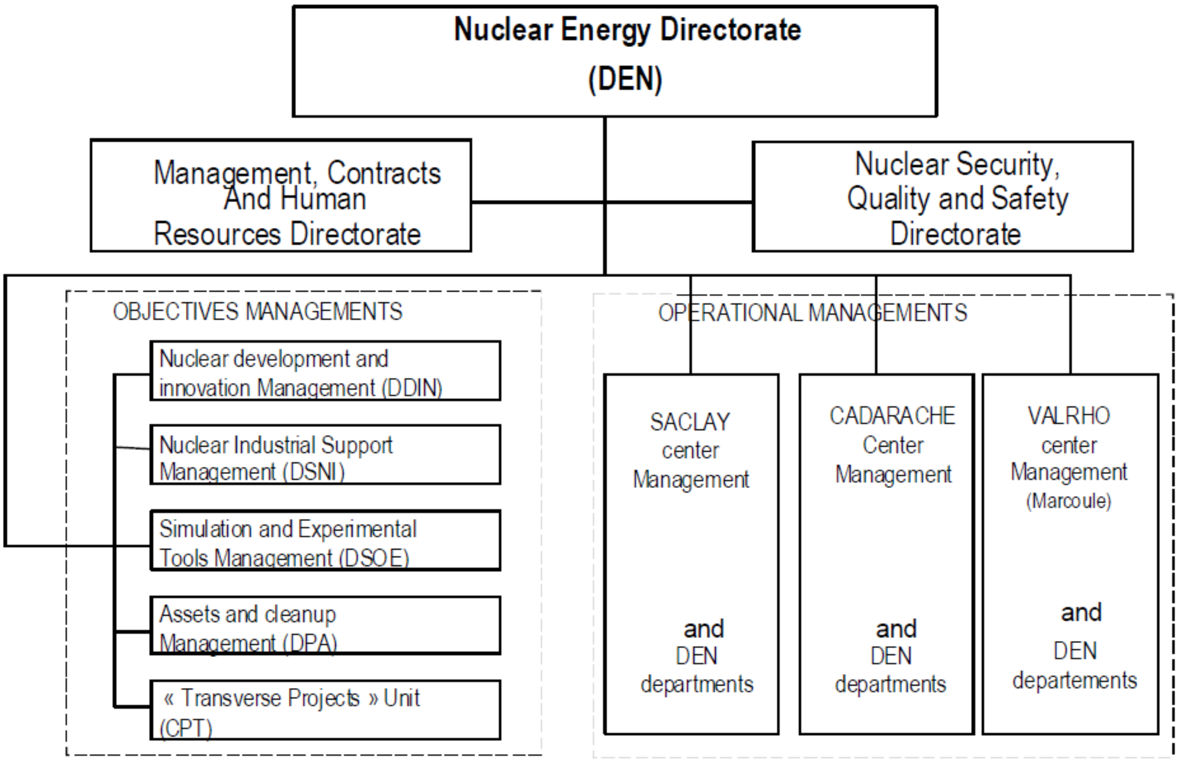


Figure 17: Organisation of Nuclear Energy Directorate (DEN) of the CEA

3.3. Organisation of the ILL

The Laue-Langevin Institute (ILL) was founded in January 1967 by Germany, France and the United Kingdom, 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 groups together includes all the 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 operating the reactor, its facilities and auxiliary equipment.

The Radiation Protection and Environmental Monitoring Service, which also includes conventional security, reports directly to the Director of the ILL.

With regard to the management of the BNI and the other facilities specified in the safety report, the Director delegates his responsibilities as licensee to the Head of the Reactor Division. The Head of the Reactor Division is Deputy Director with regard to the safety and management of the BNI and the other facilities specified in the safety report. In this capacity he is responsible for the final decision concerning the safety of the operating conditions of the reactor, the instruments and the experimental devices.

APPENDIX 4 – ENVIRONMENTAL MONITORING

4.1. Monitoring of NPP discharges (based on the most recent authorisations issued by ASN)

4.1.1 Regulatory monitoring of NPP liquid discharges

Table 14: Regulatory monitoring of NPP liquid discharges

ORIGIN AND TYPE	REGULATORY SAMPLINGS AND CHECKS TO BE CARRIED OUT BY THE LICENSEE
T Tanks Process effluents, Service effluents, Steam generator blowdowns	Sampling from each 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 end of month, taking of a pooled monthly average sample ▪ analyses : ^{63}Ni ▪ analyses of chemicals according to site configuration
EX Tanks (Turbine hall effluents)	Sampling from each tank after mixing: ▪ pre-discharge analyses: β_G, ^3H At end of month, taking of a pooled monthly average sample ▪ analyses: pH, αG, βG, γG, ^3H, γ spectrometry
Wastewater, stormwater	Spot water sampling – analyses: β_G, potassium, ^3H Sampling of the deposits in the drainage systems at least once a year ▪ analyses: γ spectrometry

Activity α_G, β_G, γ_G = activity α, β, γ globale

4.1.2 Regulatory monitoring of NPP gaseous discharges

Table 15: Regulatory monitoring of NPP gaseous discharges

ORIGIN AND TYPE	REGULATORY SAMPLINGS AND CHECKS TO BE CARRIED OUT BY THE LICENSEE
Continuous measurement with recording of β_G activity in each stack	
CONTINUOUS DISCHARGES (ventilation)	Instantaneous weekly gas samples – analyses: γ spectrometry (rare gases) Continuous sampling of tritium and weekly analyses (currently being set up) Continuous sampling of gaseous halogens – weekly analyses: γ_G, γ spectrometry Continuous sampling of aerosols – weekly analyses: α_G, β_G, γ spectrometry Continuous sampling of ^{14}C – quarterly analyses (currently being set up)
PLANNED DISCHARGES (draining of tanks, air from reactor buildings, etc.)	Pre-discharge analyses: ▪ gas – analyses: γ spectrometry (rare gases), ^3H ▪ gaseous halogens – analyses: γ_G, γ spectrometry ▪ aerosols – analyses: α_G, β_G, γ spectrometry

4.2. Nature of environmental monitoring around the NPPs

Table 16: Nature of environmental monitoring around NPPs

Monitored medium of 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 tritium (^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 of prevailing wind (monthly collector) with measurements of β_G and ^3H on monthly pool
Outlet of liquid discharges	▪ Upstream river sampling at mid-discharge for each 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_G = beta global

4.3. Monitoring exposure of the population and the environment (examples)

The French national network of environmental radioactivity measurements (RNM)

The French Public Health Code provides for the creation of a national network of environmental radioactivity measurements (RNM) with a dual aim:

- ensuring information transparency by making the environmental monitoring results available to the public along with information on the radiological impact of nuclear activities in France,
- guaranteeing the quality of the environmental radioactivity measurements by instituting a system of laboratory approvals delivered by ASN resolution.

On 2nd February 2010 the RNM launched a website presenting the results of environmental radioactivity monitoring and information on the impact of the nuclear industry on health in France. In order to guarantee measurement quality, only the measurements made by an approved laboratory or by IRSN can be communicated to the RNM.

The website provides information on radioactivity, on the RNM, and access to a database that groups all the radioactivity measurements made on the French national territory (i.e. nearly 600,000 measurements).

The RNM is accessible on www.mesure-radioactivite.fr.

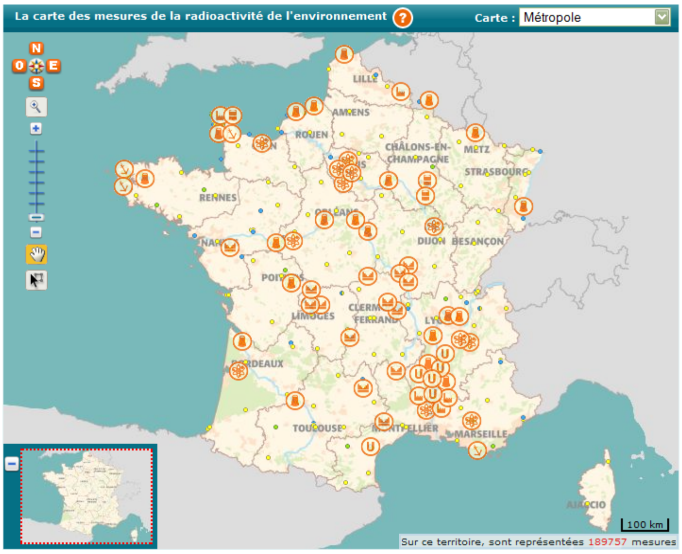


Figure 18: Location of the Teleray network measurement stations (source: IRSN)

The Teleray network, which initially comprised 163 Geiger Müller probes, has been managed by IRSN since 1991. The probes are placed on the majority of the prefectures and near BNIs. A renovation plan for the Teleray network has been in underway since 2009, and by 2015 the network will comprises about 450 probes,

This renovation plan includes a change of instruments (proportional counters), data transmission system, supervision system and an increase in the number of measurement stations. Deployment is concentrated in an area of 10 to 30 km around BNIs, and some fifteen probes are being added. This redeployment should be completed in 2014.

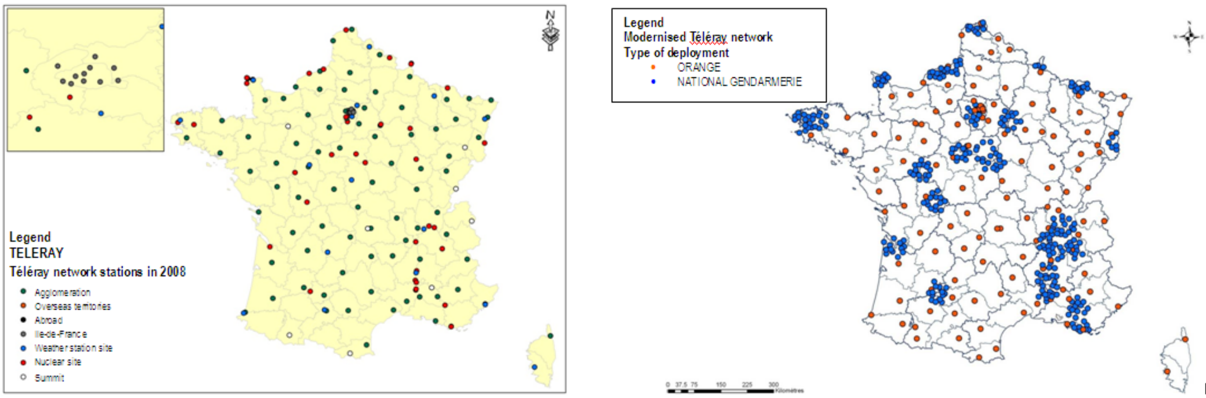
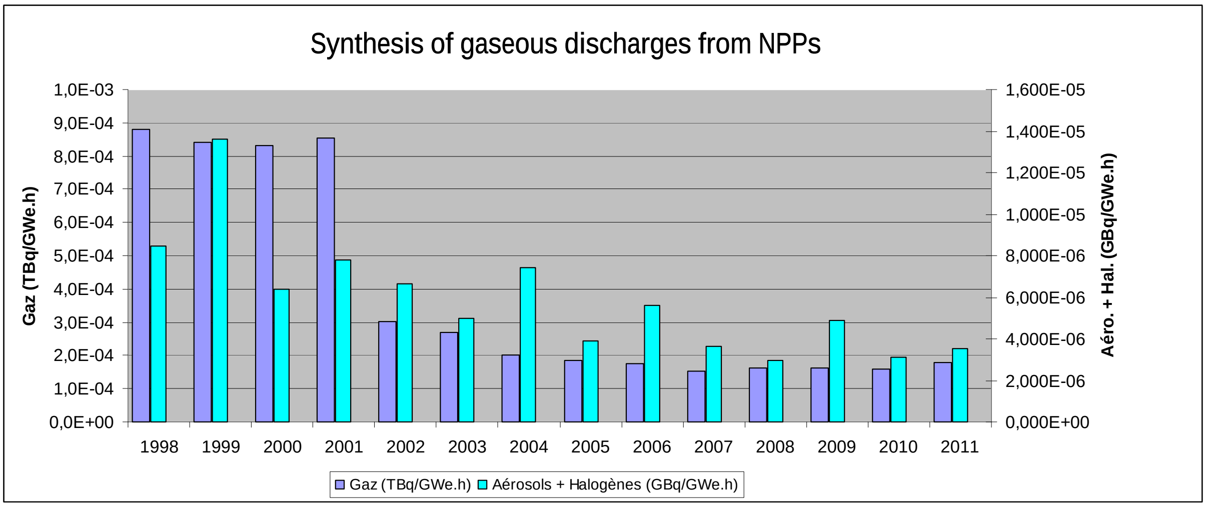


Figure 19: Teleray network before and after redeployment

4.4. Synthesis of discharges from NPPs (1998 – 2011)



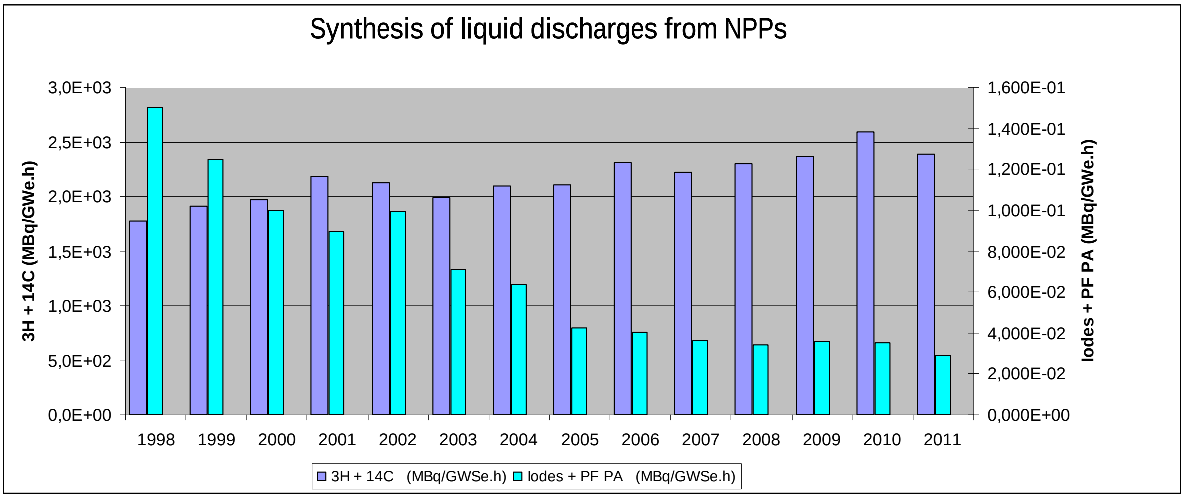


Figure 20: Synthesis of discharges from NPPs (1998 – 2011)

PF: other fission products
PA: other activation products

APPENDIX 5 – OSART MISSIONS

France is a regular host to OSART missions

The in-depth analysis of the operational safety of NPPs is carried out through OSART (Operational Safety Review Team) missions. Each mission, which lasts 3 weeks on average, concerns a nuclear power plant and is supplemented by a follow-up mission which takes place 18 months after the review mission.

France has hosted OSART missions and the associated follow-up missions since 1985. Once the OSART mission reviewing the Chooz plant has been completed in 2013, the entire French NPP fleet will have been reviewed. Thus, with regard to these missions, France will have applied the recommendation of the IAEA's action on nuclear safety decided after the Fukushima accident: *"Member States to be strongly encouraged to voluntary host IAEA peer reviews, including follow-up reviews, on a regular basis"*.

France moreover regularly sends experts to participate in the teams conducting audits abroad.

The following table lists the OSART missions carried out in France.

Table 17: List of OSART missions carried out in France

	NPP	Mission dates	Follow-up mission dates
25	Chooz	17th June – 4th July 2013	-
24	Gravelines	12th - 29th November 2012	-
23	Cattenom	14th November – 1st December 2011	2013
22	Saint-Alban	20th September – 6th October 2010	19th - 23rd March 2012
21	Fessenheim	23rd March – 8th April 2009	7th -11th February 2011
20	Cruas	24th November - 11th December 2008	13th - 17th December 2010
19	Chinon	27th November – 14th December 2007	7th - 11th December 2009
18	Saint Laurent	25th November – 14th December 2006	6th - 10th October 2008
17	Blayais	2nd - 18th May2005	6th - 10th November 2006
16	Penly	29th November - 15th December 2004	2nd - 5th May 2006
15	Civaux	12th - 28th May 2003	6th - 10th December 2004
14	Nogent	20th January – 6th February 2003	15th - 19th November 2004
13	Tricastin	14th - 31st January 2002	17th - 25th November 2003
12	Belleville	9th - 26th October 2000	13th - 17th May 2002
11	Bugey	8th - 25th March 1999	5th - 9th June 2000

APPENDIX 5 – OSART Missions

10	Golfech	26th October - 12th November 1998	6th - 10th March 2000
9	Paluel	12th - 30th January 1998	21st - 25th June 1999
8	Dampierre	11th - 29th November 1996	15th - 19th June 1998
7	Flamanville	30th January - 16th February 1995	3rd - 7th June 1996
6	Cattenom	14th - 31st March 1994	12th - 16th June 1995
5	Gravelines	15th March - 2nd April 1993	7th - 10th November 1994
4	Fessenheim	9th - 27th March 1992	-
3	Blayais	13th - 31st January 1992	-
2	Saint Alban	20th October - 10th November 1988	-
1	Tricastin	4th - 29th October 1985	-

The conclusions of the last OSART missions

Saint-Alban (follow-up mission from 19th-23rd March 2012):

It was noted that the NPP management and personnel had drawn benefit from the OSART mission and that corrective action plans had been implemented further to the recommendations of the 2010 mission. Out of the 20 subjects identified in 2010, 10 had been settled, 9 displayed satisfactory progress and 1 had not yet progressed sufficiently.

Cattenom (mission from 14th November to 1st December 2011)

The OSART team underlined that the NPP management was working on improving the operational safety of the facility. It highlighted the site's performance in various areas while at the same time identifying several possible lines for improvement.

The reports for all these missions are made public and available on the ASN website: http://www.asn.fr/index.php/English-version/Professional-events/OSART-Mission-conducted-in-France

The next missions

The next OSART mission will be at the Chooz NPP in Summer 2013. Later on it is planned to review the Flamanville reactors in operation (plant units 1 and 2) and have a "Corporate OSART" mission review EDF S.A.

APPENDIX 6 – ACTIONS TAKEN BY FRANCE IN SUPPORT OF THE IAEA ACTION PLAN ON NUCLEAR SAFETY

Table 18: Actions taken by France in support of the IAEA action plan on nuclear safety

<table>
<tr><th colspan="5">Action 1: Safety assessments in the light of the accident at TEPCO's Fukushima Daiichi Nuclear Power Station</th></tr>
<tr><th rowspan="2">IAEA Action Plan on Nuclear Safety</th><th colspan="4">Actions taken by France</th></tr>
<tr><th colspan="2">National actions</th><th colspan="2">Bilateral and international actions</th></tr>
<tr>
<td>Member States to promptly undertake a national assessment of the design of plants against site specific extreme natural hazards and to implement the necessary actions in a timely manner.</td>
<td>➢ Organization of targeted inspection campaigns by the French nuclear safety authority (ASN – Autorité de sûreté nucléaire)
38 campaigns have been conducted to check the compliance of the organization and equipment of operators with regards to the existing safety reference framework, in areas related to Fukushima Daiichi accident (loss of power supply, loss of cooling capacity, etc.).

➢ Complementary safety assessments
At the request of the Prime Minister, in March 2011 the ASN requested that operators conduct stress tests, to check the resistance of their nuclear facilities to extreme natural threats. The specifications of these stress tests were developed in line with those of European stress tests, and not only concerned power reactors but also research facilities and fuel cycle plants; a total of 79 nuclear facilities were given priority status. The reports by operators within this context were subject to an in-depth analysis by the IRSN (Institut de Radioprotection et de Sûreté Nucléaire - French Institute for Radiological Protection and Nuclear Safety). This extensive analysis work, conducted within a very short period of time (four months) by operators, then for two months by the IRSN and ASN, resulted in the ASN submitting a report to the French Prime Minister on January 3, 2012. This work mobilized around a hundred experts for the period in question. On the basis of this analysis, the ASN prescribed, in 2012, that nuclear operators implement several measures to strengthen safety in the face of extreme natural situations (see below: operator actions).

The same exercise was planned in 2012 in France for an additional 22 facilities of secondary priority (e.g.: ITER, facilities undergoing dismantling, etc.). For the remaining nuclear facilities – around 35 low-priority facilities – feedback from the Fukushima Daiichi accident will be taken into account as part of planned safety reviews which might be anticipated.</td>
<td>- completed

- completed

- in progress</td>
<td>➢ Implementation of stress tests
Decided on by the European Council of March 24-25, 2011, for all European power reactors, stress tests were conducted between June 2011 and April 2012, in compliance with strict specifications drawn up by the ENSREG (European Nuclear Safety Regulators Group), on the basis of proposals by the WENRA (Western European Nuclear Regulators Association). The recommendations issued by ENSREG following these stress tests are currently being implemented by the Member States, as part of European-level and national action plans.

A national action plan has been published by ASN on 20th December 2012 to sum up the implementation by France of the recommendations following the stress tests conducted in 2011 and, more generally, all the actions decided following these evaluations.</td>
<td>- completed

- completed</td>
</tr>
</table>

	➢ **Actions by operators** o In addition to checking the compliance of facilities and the existence of safety margins with regard to threats taken into account in the design basis, an additional level of defence in depth has been defined and proposed for safety facilities, so that under all circumstances the availability functions essential to the safety of the facility can be maintained, for a sufficient period of time, under any extreme environmental conditions. This additional level of defence requires the strengthening and/or installation of equipment essential to the management of extreme situations, able to withstand large earthquake or floods in excess of the existing design basis. This minimum essential equipment would therefore constitute a "hardened safety core", and would have to be extremely robust, available under all circumstances, so as to be able to prevent a serious accident or restrict its consequences. The stress tests are just the first step in a long feedback process following the Fukushima accident. In France, they will lead to a strengthening of the capacity of facilities to maintain their fundamental safety functions in the face of markedly more severe threats than those taken into consideration in their design. o The creation of a French nuclear rapid response team (FARN – *Force d'Action Rapide Nucléaire*), able to respond to a situation on any EDF site within 24 hours. This team should be able to intervene on one reactor of a site before the end of 2012. It shall be able to intervene on all the reactors of a site at the same time before the end of 2014 (on a site with four units), and by the end of 2015 (for a site with six units). o AREVA is currently creating an AREVA National Response Force (ANRF), comprising resources and equipment dedicated to on-site response interventions. o Strengthening of on-site communications resources for extreme situations (strengthening of the self-sufficiency of communications resources, satellite communications). o Strengthening of the shared resources made available by EDF, AREVA and the CEA, and currently restricted to automated robotic equipment for operation in highly radioactive conditions. o Creation of an action plan to study and address the risks related to the nearby industrial environment in the event of extreme situations.	- in progress - in progress - in progress - in progress - in progress - in progress		

Action 2: Peer reviews				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
The IAEA Secretariat to strengthen existing IAEA peer reviews by incorporating lessons learned and by ensuring that these reviews appropriately address regulatory effectiveness, operational safety, design safety, and emergency preparedness and response; Member States to provide experts for peer review missions.			➢ Participation of French experts in IAEA peer reviews. On average, experts from the ASN take part in four IRRS missions a year. ➢ New permanent resources (CFE AREVA) made available to the Agency to directly help it complete IRRSs and design reviews for new reactor models submitted to the Agency by Member States.	- regular - regular
The IAEA Secretariat, in order to enhance transparency, to provide summary information on where and when IAEA peer reviews have taken place, and to make publicly available in a timely manner the results of such reviews with the consent of the State concerned.	The ASN publishes reports on IRSS (International Regulatory Review Service) and OSART (Operational Safety Review Team) missions conducted in France on its website.	- regular	➢ Agreement given by France for information on IAEA peer review missions already conducted or planned in France to feature on the website for the Action Plan on Safety (message from the Governor of March 28, 2012). ➢ Agreement in principle given by France for the IAEA to publish the results of certain types of peer review missions conducted in France (message from the Governor of May 16, 2012).	- completed - completed
Member States to be strongly encouraged to voluntarily host IAEA peer reviews, including follow-up reviews, on a regular basis; the IAEA Secretariat to respond in a timely manner to requests for such reviews.	➢ One OSART mission hosted in France each year. ➢ IRRS mission hosted in 2006, with a follow-up mission in 2009, and the next mission planned for 2014. ➢ 24 OSART missions hosted since 1985. ➢ After the Chooz mission in 2013, all French nuclear power reactors will have been subject to an OSART mission. ➢ EDF will host a « Corporate OSART » mission in 2014	- regular		
The IAEA Secretariat to assess, and enhance as necessary, the effectiveness of the IAEA peer reviews.				

Action 3: Emergency preparedness and response				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States to conduct a prompt national review and thereafter regular reviews on their emergency preparedness and response arrangements and capabilities, with the IAEA Secretariat providing support and assistance through Emergency Preparedness Review (EPREV) missions, as requested.	➢ Public authorities o ASN action plan to improve its crisis organization by integrating feedback from the mobilization carried out during the Fukushima Daiichi accident. o Modification of the IRSN crisis organization, integrating feedback from the mobilization carried out during the Fukushima Daiichi accident. o Creation of guidelines for post-accident management by the Steering Committee for the management of the post-accidental phase of a Nuclear Accident or a Radiological Emergency of the ASN (CODIRPA): publication of guides in the first half of 2012. At the request of the ASN, the Nuclear Energy Agency of the OECD (Committee on Radiation Protection and Public Health - CRPPH), conducted an international peer review to improve, prior to its validation, the guide drafted by the CODIRPA describing French policy in terms of the management of the post-accident phase of a nuclear or radiological accident situation. o Integration into the planning of nuclear and radiological emergency exercises of the feedback from Fukushima (simulation of accidents with an impact on several facilities at the same time – inter-ministerial circular of December 20, 2011). ➢ Operators o Standardization and streamlining of EDF emergency plans currently under assessment by the ASN. o Integration of a specific emergency plan for climactic and related risks to safety. This plan applies to several facilities. Its implementation is planned for the end of 2012. o Creation of a French nuclear rapid response team (FARN – *Force d'Action Rapide Nucléaire*) by EDF and the ANRF (AREVA National Response Force) by AREVA (see Action 1).	- in progress		

The IAEA Secretariat, Member States and relevant international organizations to review and strengthen the international emergency preparedness and response framework, taking into account recommendations given in the final report of the International Action Plan for Strengthening the International Preparedness and Response System for Nuclear and Radiological Emergencies, and encouraging greater involvement of the relevant international organizations in the Joint Radiation Emergency Management Plan of the International Organizations. The IAEA Secretariat, Member States and relevant international organizations to strengthen the assistance mechanisms to ensure that necessary assistance is made available promptly. Consideration to be given to enhancing and fully utilizing the IAEA Response and Assistance Network (RANET), including expanding its rapid response capabilities. Member States to consider, on a voluntary basis, establishing national rapid response teams that could also be made available internationally through RANET.			➢ Planned IAEA-IRSN cooperation to support the strengthening of the technical capacities of the IAEA and establish an operational working relationship between the two, based on the sharing of data and expertise. This technical cooperation program, planned as a multi-year initiative (2012-2015) will be based on a first stage dedicated to the development of the technical capacity of the IEC, followed by a set of actions taken on a periodic basis to maintain and strengthen this capacity. ➢ French proposals on the creation, under the aegis of the IAEA, of an International Rapid Response Mechanism for Nuclear and Radiological Emergencies, and a network of several national or regional nuclear crisis management training centres. ➢ Declaration by French and British authorities (February 17, 2012) to act together to strengthen their own capacity and develop bilateral coordination in terms of the organization and management of emergency situations. Launch of works to this end in summer 2012.	- in progress - in progress - in progress
The IAEA Secretariat, in case of a nuclear emergency and with the consent of the State concerned, to conduct timely fact-finding missions and to make the results publicly available.				

Action 4: National regulatory bodies				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States to conduct a prompt national review and thereafter regular reviews of their regulatory bodies, including an assessment of their effective independence, adequacy of human and financial resources and the need for appropriate technical and scientific support, to fulfil their responsibilities	Increased staff numbers and budget for the ASN and IRSN, to adequately meet the requirements for the missions of these organizations.	- completed		
The IAEA Secretariat to enhance the Integrated Regulatory Review Service (IRRS) for peer review of regulatory effectiveness through a more comprehensive assessment of national regulations against IAEA Safety Standards.				
Each Member State with nuclear power plants to voluntarily host, on a regular basis, an IAEA IRRS mission to assess its national regulatory framework. In addition, a follow-up mission to be conducted within three years of the main IRRS mission.	➢ IRRS mission hosted in 2006, with a follow-up mission in 2009, and the next mission planned for 2014 (see Action 2). ➢ In compliance with Directive 2009/71/Euratom on nuclear safety, this international peer review must take place in France at least every ten years (see Action 2).	- regular		

Action 5: Operator's organisations				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States to ensure improvement, as necessary, of management systems, safety culture, human resources management, and scientific and technical capacity in operating organizations; the IAEA Secretariat to provide assistance to Member States upon request.	➢ France has extended post Fukushima complementary safety assessments and the resulting provisions to organizational, social and human factors, as part of a continuous improvement approach with regard to safety (see Action 1). ➢ February 8, 2012: adoption of decree setting out the general rules for basic nuclear installations on safety policy, safety management system, human resources, sub-contracting, etc.). ➢ Strengthening of crisis organization and related resources (FARN mobile resources, strengthened crisis buildings, etc.) by operators.	- completed - completed - in progress	Widening of the scope of action of WANO (World Association of Nuclear Operators), to improve the level of protection and mitigation amongst nuclear operators worldwide: external threats, management of serious accidents, emergency preparedness for crisis situations, etc.	- completed
Each Member State with nuclear power plants to voluntarily host at least one IAEA Operational Safety Review Team (OSART) mission during the coming three years, with the initial focus on older nuclear power plants. Thereafter, OSART missions to be voluntarily hosted on a regular basis.	➢ One OSART mission hosted each year in France (see Action 2) ➢ After the Chooz mission in 2013, all French nuclear power reactors will have been subject to an OSART mission. aura fait l'objet d'une OSART ➢ EDF will host a « Corporate OSART » mission in 2014.	- regular		
The IAEA Secretariat to strengthen cooperation with WANO by amending their Memorandum of Understanding to enhance information exchange on operating experience and on other relevant safety and engineering areas and, in consultation with other relevant stakeholders, to explore mechanisms to enhance communication and interaction among operating organizations.				

Action 6: IAEA Safety Standards				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
The Commission on Safety Standards and the IAEA Secretariat to review, and revise as necessary using the existing process in a more efficient manner, the relevant IAEA Safety Standards in a prioritised sequence.			France contributes to the drafting of IAEA Safety Standards: o French experts take part in the meetings of the Commission on Safety Standards (CSS), as well as those of the four technical committees. o The Chairman of the ASN chaired the CSS from 2006 to 2011. o Making resources (CFE AREVA, CFE EDF) available to the Agency to help it update its safety standards, including, as far as necessary, the lessons learned from the Fukushima Daiichi accident.	- regular
Member States to utilize as broadly and effectively as possible the IAEA Safety Standards in an open, timely and transparent manner. The IAEA Secretariat to continue providing support and assistance in the implementation of IAEA Safety Standards.	The French regulatory framework has been developed in accordance with IAEA Safety Standards.			

Action 7: International legal framework				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
States parties to explore mechanisms to enhance the effective implementation of the Convention on Nuclear Safety, the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, the Convention on the Early Notification of a Nuclear Accident and the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, and to consider proposals made to amend the Convention on Nuclear Safety and the Convention on the Early Notification of a Nuclear Accident.			➢ Active participation to the extraordinary meeting of the Convention on Nuclear Safety (CNS) in August 2012 in particular through the submission of proposals for changes to the guidelines controlling the CNS mechanism with a view to strengthening the effectiveness of the process put in place by the CNS. ➢ The ASN takes part in the "Transparency and effectiveness" Working Group of the CNS, and the joint CNS/JC WG to ensure consistency between the two conventions (WG initiated by France).	- completed - in progress
Member States to be encouraged to join and effectively implement these Conventions.	➢ France has adhered to the following conventions: o the Convention on Nuclear Safety (France applies the CNS to research reactors on a voluntary basis) o the Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management o the Convention on Early Notification of a Nuclear Accident o the Convention on Assistance in the Case of Nuclear Accident or Radiological Emergency	1995 2000 1989 1989	Active participation by France in the meetings of the contracting parties for the assessment of the application of these conventions	

Member States to work towards establishing a global nuclear liability regime that addresses the concerns of all States that might be affected by a nuclear accident with a view to providing appropriate compensation for nuclear damage. The IAEA International Expert Group on Nuclear Liability (INLEX) to recommend actions to facilitate achievement of such a global regime. Member States to give due consideration to the possibility of joining the international nuclear liability instruments as a step toward achieving such a global regime.	➢ Adherence of France to the Paris and Brussels Conventions ➢ Two draft laws were submitted to the French Senate in Spring 2012: these draft laws respectively plan: o the ratification of the Joint Protocol relating to the Application of the Vienna Convention and the Paris Convention. o the expected inclusion in French legislation of the increase of compensation ceilings for nuclear operators set out by the amending protocols of 2004. ➢ The ratification process for the 2004 protocols amending the conventions of Paris and Brussels has been completed. The instrument of ratification will be simultaneously deposited by all EU Member States party to the Paris and Brussels conventions.	- effective - in progress - in progress	➢ Participation of a French expert in the IAEA's INLEX group ➢ Participation of France in the OECD Nuclear Energy Agency's Nuclear Law Committee ➢ Sharing thoughts with USA to establish a worldwide civil liability for nuclear.	- permanent - permanent - in progress s
Action 8: Member States planning to embark on a nuclear power programme				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States to create an appropriate nuclear infrastructure based on IAEA Safety Standards and other relevant guidance, and the IAEA Secretariat to provide assistance as may be requested.			➢ France provides assistance to States wishing to launch a nuclear power program, either as part of IAEA activities or as part of bilateral cooperation (organization of training and workshops for the IAEA, actions by the AFNI *[Agence France Nucléaire International* – France International Nuclear Agency], in particular to develop skills as part of partnerships made with the International Institute of Nuclear Energy [I2EN]; CFE IRSN within the IAEA Safety Action Group [2012-2014], etc.) ➢ The ASN responds to requests for assistance, as part of bilateral action initiatives or through European instruments (EU Instruments for Nuclear Safety Cooperation), and international instruments	- regular - regular

IAEA Action Plan on Nuclear Safety	Actions taken by France – National actions		Actions taken by France – Bilateral and international actions	
			(IAEA Regulatory Cooperation Forum). This cooperation aims to enable the countries concerned to implement a suitable regulatory framework, a competent and independent safety authority, and deploy a culture of safety and transparency essential to a national nuclear safety and radiation protection inspection system.	
Action 9: Capacity Building				
Member States with nuclear power programmes and those planning to embark on such a programme to strengthen, develop, maintain and implement their capacity building programs, including education, training and exercises at the national, regional and international levels; to continuously ensure sufficient and competent human resources necessary to assume their responsibility for safe, responsible and sustainable use of nuclear technologies; the IAEA Secretariat to assist as requested. Such programmes to cover all the nuclear safety related areas, including safe operation, emergency preparedness and response and regulatory effectiveness and to build upon existing capacity building infrastructures.	➢ Scope of stress tests conducted by the ASN extended to the areas of sub-contracting and taking into account organizational and human factors. ➢ Creation of the I2EN (International Institute of Nuclear Energy). ➢ February 8, 2012: adoption of decree setting out the general rules for basic nuclear installations on safety policy, safety management system, human resources, sub-contracting, etc.). ➢ Operator action: implementation of the FARN and training of crisis teams in the use of mobile resources, extension of the scope of exercises to extreme situations affecting several sections at once.	- completed - completed - completed - in progress	➢ France has developed active cooperation with the Agency and as part of bilateral cooperation initiatives (see Action 8). ➢ The ASN cooperates with its counterparts at their request (see Action 8). ➢ The IRSN and its European partners have created a European Nuclear Safety Training and Tutoring Institute (ENSTTI), which provides training to safety professionals in Europe and worldwide. ➢ Under the aegis of the IAEA, the TSO (Technical Safety Organisations) Forum has been created to promote the sharing of information, experiences, lessons and safety cultures, and to standardize nuclear safety practices according to the highest safety standards.	- regular - regular - completed - completed
Member States with nuclear power programmes and those planning to embark on such a programme, to incorporate lessons learned from the accident into their nuclear power programme infrastructure; the IAEA Secretariat to assist as requested.	France extended post-Fukushima stress tests and the resulting provisions to organizational, social and human factors, as part of a continuous improvement approach with regard to safety (see Actions 1 and 5).	- completed		

Action 10: Protection of people and the environment from ionizing radiation				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States, the IAEA Secretariat and other relevant stakeholders to facilitate the use of available information, expertise and techniques for monitoring, decontamination and remediation both on and off nuclear sites and the IAEA Secretariat to consider strategies and programmes to improve knowledge and strengthen capabilities in these areas.			➢ Studies at the Fukushima Daiichi site o participation in environmental measurement campaigns around Fukushima Daiichi (IRSN-JAEA) o projects (IRSN-JAEA: TOFU, FreeBird) ➢ Generic studies o sharing of information on the management of post-accident situations (IRSN-JAEA) o Doctrine and tools on post-accident management developed as part of the CODIRPA (coordinated by the ASN).	- completed
Member States, the IAEA Secretariat and other relevant stakeholders to facilitate the use of available information, expertise and techniques regarding the removal of damaged nuclear fuel and the management and disposal of radioactive waste resulting from a nuclear emergency.				
Member States, the IAEA Secretariat and other relevant stakeholders to share information regarding the assessment of radiation doses and any associated impacts on people and the environment.			Treating people exposed to radiation in the specialized services of French hospitals: The IRSN and Percy Hospital are currently in discussions with the IAEA and certain South American countries with a view to developing an international technical cooperation project.	- completed

Action 11: Communication and information dissemination				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Member States, with the assistance of the IAEA Secretariat, to strengthen the emergency notification system, and reporting and information sharing arrangements and capabilities.	Continuous improvement of the emergency notification system (see Actions 1 and 3).	- regular		
Member States, with the assistance of the IAEA Secretariat, to enhance the transparency and effectiveness of communication among operators, regulators and various international organizations, and strengthen the IAEA's coordinating role in this regard, underlining that the freest possible flow and wide dissemination of safety related technical and technological information enhances nuclear safety.	➢ The Environment Code stipulates general provisions with regard to public information (public consultation are mandatory for draft regulatory text, public inquiry, availability for the public of environment information). ➢ French law on nuclear safety and transparency of June 13, 2006, which stipulates in particular the possibility for the public to get access to all information related to nuclear safety and setting up of local information commission near each BNI.	- completed - completed		
The IAEA Secretariat to provide Member States, international organizations and the general public with timely, clear, factually correct, objective and easily understandable information during a nuclear emergency on its potential consequences, including analysis of available information and prognosis of possible scenarios based on evidence, scientific knowledge and the capabilities of Member States.			Following consultation at national level, France will make proposals to the Secretariat to better define the IAEA's role in the event of a nuclear crisis. The aim is to promote consultation in the international community, in particular within the context of the Emergency Preparedness and Response Expert Group (EPREG).	- in progress
The IAEA Secretariat to organize international experts meetings to analyse all relevant technical aspects and learn the lessons from the Fukushima Daiichi nuclear power station accident.				

The IAEA Secretariat to facilitate and to continue sharing with Member States a fully transparent assessment of the accident at TEPCO's Fukushima Daiichi Nuclear Power Station, in cooperation with Japan.				
The IAEA Secretariat and Member States, in consultation with the OECD/NEA and the IAEA International Nuclear and Radiological Event Scale (INES) Advisory Committee to review the application of the INES scale as a communication tool.				
Action 12: Research and development				
IAEA Action Plan on Nuclear Safety	Actions taken by France			
	National actions		Bilateral and international actions	
Relevant stakeholders, with assistance provided by the IAEA Secretariat as appropriate, to conduct necessary research and development in nuclear safety, technology and engineering, including that related to existing and new design-specific aspects.	➢ The IRSN pursues research activities in a range of areas (environmental and human radiation protection and safety, development of codes, creation of databases, etc.). ➢ Call for projects by the national agency for research as part of the new “nuclear safety research" action within the “nuclear” program of the French *investissements d’avenir* (investments for the future) initiative. ➢ The CEA, EDF and AREVA cooperate within a joint research institute, coordinating work on second and third-generation reactors and their fuel.			
Relevant stakeholders and the IAEA Secretariat to utilize the results of research and development and to share them, as appropriate, to the benefit of all Member States.			➢ CFE IRSN mentioned in actions 8 and 9. ➢ Creation of the TSO Forum to promote the sharing of information, experiences, lessons and safety cultures and to standardize nuclear safety practices according to the highest safety standards. ➢ Participation of French institutes in the IAEA Coordinated Research Projects (CRP).	- in progress

APPENDIX 7 – BIBLIOGRAPHY

7.1. Documents

/1/ Convention on Nuclear Safety (CNS), September 1994.

/2/ Guidelines regarding National Reports under the Convention on Nuclear Safety, IAEA - INFCIRC/572/Rev.4, January 2013.

/3/ Convention on Nuclear Safety – Fifth National Report on the Implementation by France of its Obligations under the Convention, July 2010.

/4/ Convention on Nuclear Safety – National Report for the Second Extraordinary Meeting, August 2012.

/5/ ASN Annual Report 2010, April 2010.

/6/ ASN Annual Report 2011, April 2011.

/7/ ASN Annual Report 2012, April 2012.

/8/ EDF – The Inspector General's Report on Nuclear Safety and Radiation Protection, 2010.

/9/ EDF – The Inspector General's Report on Nuclear Safety and Radiation Protection, 2011.

/10/ EDF – The Inspector General's Report on Nuclear Safety and Radiation Protection, 2012.

7.2. Websites

The abovementioned documents, or at least the essential of their content, as well as other relevant information concerning the subject of this report are available on the Internet. The following sites can be consulted in particular:

- Légifrance : www.legifrance.fr
- ASN : www.asn.fr
- IRSN : www.irsn.fr
- SFRO : www.sfro.org
- CEA : www.cea.fr
- EDF : www.edf.fr
- Flamanville-3 EPR information site: 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
- AIEA : www.iaea.org

APPENDIX 8 – LIST OF ABBREVIATIONS

Table 19: List of Abbreviations

½ DRS	Half Design Response Spectrum
AAR	Reactor trip
ALARA	As Low As Reasonably Achievable
ASN	Autorité de Sûreté Nucléaire (French nuclear safety authority)
BK	Fuel Building
BNI	Basic Nuclear Installation
CEA	French Alternative Energies and Atomic Energy Commission
CLI	Local Information Committee
CMS	Flood safety level
CODIRPA	Steering committee for managing the post-accident phase of a nuclear accident or a radiological emergency situation
CORDEL	Cooperation on Reactor Design Evaluation and Licensing
CSPRT	Higher council for the prevention of technological risks
DAC	Creation Authorisation Decree
DBE	Design-Basis Earthquake
EDF	Electricité De France
ENSREG	European Nuclear Safety Regulators Group
EPR	initially European Pressurized Reactor, rebaptised Evolutionary Power Reactor
EPRI	Electric Power Research Institute
ESE	Events Significant for the Environment
ESR	Events Significant for Radiation protection
ESS	Events Significant for Safety
ETC	Emergency Technical Centre
EUR	European Utility Requirements
FARN	Nuclear rapid intervention force
FROG	Framatome Owners Group
GPE	Advisory Committee of Experts
GPR	Advisory Committee for Reactors
HCTISN	High Committee for Transparency and Information on Nuclear Security
HERCA	Heads of European Radiological Protection Competent Authorities
IAEA	International Atomic Energy Agency
ICPE	Installation Classified on Environmental Protection grounds
ICRP	International Commission of Radiation Protection
ILL	Laue–Langevin Institute
INPO	Institute of Nuclear Power Operators
IPS	Important for Safety
IRRS	Integrated Regulatory Review Service
IRSN	French Institute for Radiation Protection and Nuclear Safety
ITER	International Thermonuclear Experimental Reactor
JHR	Jules Horowitz Reactor
MDEP	Multinational Design Evaluation Programme
MPS	Main Primary System
MSS	Main Secondary System

APPENDIX 8 – List of abbreviations

NEA	Nuclear Energy Agency
NPE	Nuclear Pressure Equipment
NPP	Nuclear Power Plant
OEF	Operating Experience feedback
OHF	Organisational and Human Factors
OPECST	Parliamentary Office for the Evaluation of Scientific and Technical Choices
OSART	Operational Safety Review Team
OSRDE	Safety, Radiation Protection, Availability, Environment Observatory
PCD	Strategic management command post
PCR	Person Competent in Radiation protection
PNGMDR	National radioactive materials and waste management plan
PPI	Off-site emergency plan
PSA	Probabilistic Safety Analysis
PUI	On-site emergency plan
PV	Report
PWR	Pressurised Water Reactor
RDS	Safety report
RFS	Basic safety rules
RGE	General operating rules
RGV	Replacement of the steam generators
RHF	High flux reactor
RNM	French national network of environmental radioactivity measurements
RPS	Preliminary Safety Report
SA	Severe Accident
SAMG	Severe Accident Management Guidelines
SG	Steam Generator
SSE	Safe Shutdown Earthquake
STE	Operating Technical Specifications
UNSCEAR	United Nations Scientific Commission on Effects of Atomic Radiation
VD	ten-yearly outage
WANO	World Association of Nuclear Operators
WENRA	Western European Nuclear Regulators' Association
WNA	World Nuclear Association
WOG	Westignhouse Owners Group