



**RÉPUBLIQUE  
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**FRENCH NATIONAL  
REPORT FOR THE 10<sup>TH</sup>  
REVIEW MEETING  
IN 2026**

**Convention on Nuclear Safety**

**France – August 2025**





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## Foreword

France signed the Convention on Nuclear Safety (CNS) on 20 September 1994, the date on which it was opened for signature during the IAEA General Conference. The Convention was ratified by France one year later, on 11 September 1995, and entered into force on 24 October 1996.

This report is the tenth French report presented for review, in compliance with the provisions of Article 5 of the Convention, before the Review Meeting for the tenth cycle, which is to be held at the International Atomic Energy Agency (IAEA) from 13 to 24 April 2026. It has been updated and structured in accordance with the guidelines for the national reports required by the Convention, focusing on the provisions implemented by France in order to meet each of the obligations of the Convention. It more particularly includes boxes to clarify the concrete application of these provisions, boxes that are indicated by .

This report consists of 3 parts:

- introductory Part A, which presents the context of France's nuclear power program, nuclear safety policy and energy policy;
- part B, which summarises the report. It notably includes a summary of the major achievements of the period April 2023 to July 2025, an overview of the questions issued during the combined review meeting for the eighth and ninth cycles France was asked to develop, the future main activities for the coming three years and the steps taken to meet the obligations of the Vienna Declaration;
- part C, in which the numbering of the chapters corresponds to that of Article 6 to 19 of the Convention. It presents the provisions demonstrating that France meets the obligations of the Convention, Article by Article, each of which is covered by a separate chapter, at the beginning of which the corresponding text of the Article of the Convention is recalled in grey.

This report was produced by ASNR, the French Authority for Nuclear Safety and Radiation Protection, acting as coordinator, with contributions from the nuclear reactor licensees, Électricité de France (EDF), the French Alternative Energies and Atomic Energy Commission (CEA), the Laue Langevin institute (ILL) and ITER Organization, following consultation with the other parties concerned (government authorities).

France's presentation to the Convention's Review Meeting for the tenth cycle will be based on this report, supplemented by information about any pertinent developments that may have occurred in the meantime.

## A. INTRODUCTION

### 1. The nuclear programme

The first resolution by the French government concerning nuclear energy was to create a public research organisation in 1945, the French Atomic Energy Commission, which was renamed the French Alternative Energies and Atomic Energy Commission (CEA) on 10 March 2010.

The first French experimental nuclear reactor Zoé went critical in December 1948, thus paving the way for the construction of other research reactors, followed by reactors designed to generate electricity.

The French civil nuclear programme started during the third five-year plan (1957-1961), with the construction of reactors operating with natural uranium, referred to as gas-cooled reactors (GCR). This technology was then abandoned and replaced by light water reactors, through an interministerial resolution in 1969. These GCR reactors are currently being decommissioned.

In 1974, following the oil crisis of 1973, France initiated a vast programme to have EDF build nuclear power plants, based on the pressurised light water reactor (PWR) technology and model standardisation around a license provided by Westinghouse, with up to 5 plant units being built every year in the 1980s. This programme led to the construction of 58 pressurised water reactors distributed over 19 sites and generating about 75% of the electricity produced in France. Two of these reactors, located at the Fessenheim site, were permanently shut down in 2020.

A new type of reactor was launched in 2005, the EPR (European Pressurised Reactor), developed by Areva, with a design based on that of the existing French N4 type and German Konvoi reactors. It thus benefited from proven technologies and operating experience feedback from these predecessors. Significant safety changes were however introduced in relation to the existing reactors, in order to reinforce accident prevention, protect the facility more effectively against internal and external hazards and mitigate the possible consequences of an accident with core melt, with regard to the high level safety goals defined. Construction of the EPR reactor in France began in December 2007 at Flamanville (Manche *département*<sup>1</sup>). This reactor was officially commissioned following authorisation issued by the Nuclear Safety Authority on 7 May 2024.

Based on feedback from the design, construction and operation of the first EPR reactors worldwide, the EPR design was optimised to create the EPR2 model. On 28 June 2023, EDF submitted licence applications to build the first pair of EPR2 reactors at the Penly site in Normandy. Following a decree in June 2024 granting environmental authorisation, EDF has begun preparatory work for construction. The decree authorising the creation of the basic nuclear installation is currently under review.

France also developed a fast neutron reactor series, currently being decommissioned:

- in 1967, the Rapsodie (24 MWth) prototype was commissioned at the Cadarache research centre (Bouches-du-Rhône *département*) and shut down in 1983;
- in 1973, the Phénix reactor (250 MWe) in Marcoule (Gard *département*) produced electricity until being shutdown in 2010, and constituted part of the design study for the “generation IV” reactors;
- in 1977, construction of the 1200 MWe Superphénix fast breeder reactor began on the Creys-Malville site. It was commissioned in 1985 and shut down in 1998.

<sup>1</sup> Administrative region headed by the Prefect

The project called ASTRID (Advanced Sodium Technological Reactor for Industrial Demonstration) a 600 MWe sodium-cooled fast breeder reactor prototype was initiated in 2010, but abandoned in 2019.

Other small modular reactor projects using different technologies (light water reactors, sodium- or lead-cooled fast neutron reactors, molten salt reactors) are currently under development.

## 2. Nuclear safety policy

In France, nuclear safety policy is built around the following principles:

- the prime responsibility of the licensee of a nuclear facility,
- the independence of the authority responsible for oversight and regulation and its transparency with regard to the public,
- continuous improvement of nuclear safety.

Implementation of this policy led to:

- the merging of the two organisations in charge of regulatory oversight of nuclear safety and radiation protection: this was done with the 2002 creation of the General Directorate for Nuclear Safety and Radiation Protection (DGSNR), the precursor of ASN;
- the independence of the regulation and oversight authority from the Government and the bodies promoting nuclear energy: this was achieved with the 2006 creation of ASN as an independent administrative authority;
- the creation of a specific and integrated oversight regime for basic nuclear installations (BNI) aligning BNI environmental protection with the provisions in force for installations classified for protection of the environment (ICPE): this was done with the “Transparency and Nuclear Safety” (TSN) Act in 2006;
- separation, until the end of 2024, of the regulatory oversight entrusted to ASN in the civil field and the expert technical analysis entrusted primarily to the Institute for Radiation Protection and Nuclear Safety (IRSN);
- information and transparency with regard to the public: this led notably to the creation of the Local Information Committees (CLI) and the High Committee for Transparency and Information on Nuclear Safety (HCTISN);
- regular peer reviews of regulation and oversight practices: this began in 2006 with the hosting of the first IRRS “full-scope” mission, then carried out in accordance with Directive 2014/85/71/Euratom amending Directive 2009/71;
- the creation of ASNR on 1 January 2025, merging ASN and most of the IRSN, as part of the revival of nuclear power in France and in order to maintain excellence in safety and radiation protection control in this context of heavy workload. ASNR is an independent administrative authority. The law specifies that ASNR must put in place provisions to ensure the distinction between, on the one hand, expertise activities and, on the other hand, preparation or decision-making activities.

## 3. Energy policy

In order to deal with the major climatic and energy challenges it will have to face in the coming decades, France has defined ambitious medium and long-term national energy transition objectives. These are implemented through the Energy Transition for Green Growth Act published in 2015, supplemented by the

Energy Climate Act, adopted in 2019, with the main aims of closing the coal-fired power plants, reducing greenhouse gas emissions and achieving carbon neutrality by 2050.

Two additional documents formally set out French energy and climate strategy. They were adopted by Decree in April 2020 following a public inquiry:

- the multi-year energy programme (MEP) implements France's energy policy objectives in the operational roadmaps for all sources of energy;
- the national low carbon strategy (SNBC) defines a roadmap concerning the coordination of policy to attenuate climate change in France, by providing guidelines for its transition in all activity sectors.

In November 2021 and February 2022, the President of the Republic announced the start of a new construction programme of nuclear reactors, in addition to the continued large-scale development of renewable energy sources, to guarantee France's energy independence and achieve carbon neutrality by 2050.

In 2024, MEP No. 3 (covering the periods 2025-2030 and 2031-2035) was put out for consultation. It sets more ambitious targets than the previous one for carbon-free energy production and, with regard to the revival of the nuclear industry, sets the following objectives:

- removal of the target for closing nuclear reactors before the end of their life cycle and continued operation of existing nuclear power plants, taking into account international best practices, to enable them to operate after 50 or 60 years of operation, in compliance with all applicable nuclear safety requirements;
- commitment to the programme of work, led by EDF, aimed at increasing the available power (uprating) and annual production of existing reactors, for example through the optimisation or replacement of certain parts, in compliance with all applicable nuclear safety requirements;
- confirmation of the programme to build six EPR2 nuclear reactors, led by EDF, with a view to a final investment resolution by EDF's Board of Directors for launch no later than 2026;
- continuation of the study of a possible second phase of at least 13 GWe, corresponding to the capacity of eight EPR2 reactors in their current design;
- support for the Nuward project, led by EDF, to develop a small modular reactor model;
- support for disruptive innovation through the France 2030 plan, with the aim of launching at least one prototype of an innovative small nuclear reactor by 2030;
- confirmation of France's strategy for the treatment and recovery of spent nuclear fuel and, with this in mind, continuation of work to renew the industrial facilities that enable its implementation, with a view to a resolution being taken by the end of 2026, while ensuring that measures are taken to ensure that existing infrastructure remains adequate for needs up to 2035 and beyond.

## B. SUMMARY

### 4. Summary

#### 4.1. Major achievements since the combined Review Meeting for the eighth and ninth cycles

##### 4.1.1. ASNR creation

In the context of the revival of nuclear power in France, the French Parliament adopted, on the government's proposal, Law No. 2024-450 of 21 May 2024 on the organisation of nuclear safety and radiation protection governance to meet the challenge of reviving the nuclear industry.

This law led to the merger of ASN and IRSN on 1 January 2025, giving rise to the Nuclear Safety and Radiation Protection Authority (ASNR). The impact assessment of the draft law specifies the objectives and requirements related to the creation of ASNR, which constitutes a major organisational change and aims to address the following issues:

- improving the efficiency of nuclear safety and radiation protection procedures,
- the Authority's independence from nuclear operators and the Government,
- enhanced transparency towards the public,
- the attractiveness to ensure that the authority responsible for safety and radiation protection control can rely on top-level skills and expertise.

ASNR thus created is responsible, on behalf of the State, for regulating civil nuclear activities in France and fulfils missions relating to review and assessment, research, training and public information.

As an independent administrative authority, ASNR is headed by a board of five commissioners who define the Authority's general policy on nuclear safety and radiation protection in all its missions: research, expertise, regulation and oversight. It is responsible for providing recommendations to the authorities on measures to protect the population in emergency situations. It contributes to the development of a culture of radiation protection among citizens. It also fulfils a role in its areas of competence in terms of information and dialogue with stakeholders and the public.

ASNR thus combines the functions of regulator of nuclear installations and activities with those of TSO, with the associated missions of providing review and assessment in nuclear safety and radiation protection, and is a major player in the field of research. At the international level, ASNR continues all the activities that existed at ASN and IRSN (relations with other authorities, participation in WENRA, ETSON, participation in the activities of the IAEA, the OECD/NEA, research projects within the European framework, etc.).

See Article 8 (§ 8.1).

##### 4.1.2. Commissioning of Flamanville EPR

In 2015, EDF submitted an application for the authorisation for Flamanville EPR commissioning, along with a file that has been updated several times.

On 7 May 2024, ASN authorised the commissioning of the reactor. This authorisation enabled EDF to load the nuclear fuel into the reactor core and to carry out start-up tests and then operate the reactor. The core was loaded between 8 and 15 May 2024.

On Monday 2 September 2024, the Nuclear Safety Authority gave EDF the go-ahead to proceed with the divergence operations. The plant teams carried out the necessary activities for the first nuclear reaction in the core. The first divergence took place on 3 September at 3.54 p.m.

The Flamanville EPR was connected to the national grid for the first time on 21 December 2024.

The reactor was ramped up in successive stages: the start-up operations include a large number of tests carried out at different power levels to verify the performance and behaviour of the systems.

Various events occurred during the start-up of the EPR, which were addressed by corrective actions taken by the operator.

See Article 19 (§ 19.1.2 and Focus 21).

#### **4.1.3. Fourth periodic safety review of 1300 MWe reactors: a resolution for safety involving citizens**

##### ***ASNR resolution on the continued operation of 1300 MWe reactors beyond 40 years***

On 1 July 2025, ASNR issued its position on the continued operation of 1300 MWe reactors beyond 40 years. This position concludes the generic phase of their fourth periodic safety review, for which ambitious objectives were set in line with the safety objectives set for third-generation reactors, in particular the EPR. As such, EDF is extending the safety case to the prevention and mitigation of serious accidents, including in extreme situations beyond the design basis, and is implementing major modifications.

In its position, ASNR emphasised the extent of the studies carried out by EDF during the generic phase. These studies led EDF to identify numerous modifications to the facilities that will improve safety. ASNR's requirements provide a framework for the implementation of the most significant safety modifications. Implementation of the modifications will begin during the fourth ten-yearly outage inspection of reactor N°1 at Paluel nuclear power plant in early 2026.

##### ***Citizens involved in the ASNR's resolution***

Since 2019, the public has been involved in the preparation of ASNR's resolution on the continued operation of 1300 MWe reactors after their fourth periodic safety review. The actions taken are aimed at informing, facilitating understanding of safety issues, explaining ASNR's requirements for the periodic safety review, and gathering the expectations and opinions of stakeholders. Various phases of consultation have taken place:

- consultation in 2019 on the guidelines adopted for the review, organised with IRSN and the Anccli;
- technical dialogues between 2022 and 2023, which involved CLI, associations and non-institutional experts in preparation for the national consultation and facilitated access to IRSN expertise. Around 250 questions were raised, particularly on confinement provided by the containment structures and on external hazards, especially in light of climate change;
- national consultation organised in 2024 near 1300 MWe reactor sites, which mobilised local stakeholders through meetings and thematic workshops. The public expressed their views on topics such as the ageing of facilities, the effects of climate change, and a comparison of the safety level of 1300 MWe reactors with the Flamanville EPR;
- the official online public consultation in 2025 to gather opinions on the ASNR's draft resolution, accompanied by an explanatory document to make the nature and implications of the resolution easier to understand and to ensure that everyone's input is taken into account in the resolution.

See Article 6 (§ 6.3).

#### **4.1.4. Perspectives for the operation of nuclear power reactors beyond 60 years**

The law stipulates that ASNR must issue a statement every ten years, following the periodic safety review of reactors, on the conditions for their continued operation with regard to nuclear safety and environmental protection. However, this ten-year process does not provide for nuclear safety issues to be sufficiently anticipated and integrated into energy policy. ASN therefore considered that the perspectives for the continued safe operation of EDF's existing reactors should be anticipated well in advance.

In 2023, ASN therefore requested that EDF identify the factors limiting the operation of the reactors and establish a strategic roadmap and action plan to gain visibility on the possibilities for continuing to safely operate reactors beyond 60 years. In this regard, EDF, IRSN and ASN identified in 2023 the technical issues that need to be analysed in detail, or even require research and development efforts, in order to consider continuing operation beyond 60 years. Based in particular on reviews conducted with international experts, EDF has analysed each technical issue and identified the work to be carried out in the coming years.

#### **4.1.5. Programmes and actions by the nuclear industry to address resource and skills challenges**

France has implemented measures to identify and quantify human resource requirements and skills shortages in the nuclear industry, and concrete solutions to address these issues by steering the industry's skills action plan, with a view to ensuring that training provision matches identified needs.

Set up and led by GIFEN<sup>2</sup>, the MATCH programme aims to provide the sector with a structured, dynamic and collaborative tool to forecast its skills and industrial resource needs and to guide the actions required to match the needs. It takes into account the current situation of the sector and projects already launched in France and internationally, such as the major overhaul, the preparation of the EPR2 programme, the CIGEO project, the extension of the enrichment plant, etc.

The MATCH programme has identified the nuclear industry's needs for the next 10 years, covering human and industrial resource issues in 20 operational segments such as engineering, civil engineering, testing and inspection, piping and welding, and in approximately 80 significant professions. The programme has also enabled action plans to be drawn up to prepare for the future of the sector. Its first results show that around 10,000 people will need to be recruited per year in the sector between now and 2033, mainly by suppliers.

The University of Nuclear Professions (UMN), created in April 2021 on the initiative of the French nuclear industry and other stakeholders, with the support of the State, is tasked with developing a collective approach at both national and local level to bring together stakeholders from the nuclear industry, education and employment. It is steering the nuclear industry's skills action plan developed to meet the recruitment needs identified by the MATCH programme. The skills action plan has been structured around seven levers and 30 actions: it includes measures to enhance the sector's attractiveness, broaden sourcing, adapt initial education provision, promote work-based learning and strengthen companies' integration capacities.

<sup>2</sup> The Groupement des industriels français de l'énergie nucléaire (GIFEN), created in 2018, is the national trade association for the nuclear industry. GIFEN provides a structure and governance tailored to carrying out the actions necessary for the collective efficiency and mobilisation of the nuclear industry. With more than 400 members, including companies and professional organisations, it brings together all players in the nuclear industry.

#### 4.1.6. Development of dedicated supply chain inspections

Control of the supply chain is a major challenge for the safety of nuclear facilities, both those in operation and those in the planning stage. Operators, suppliers and subcontractors: the quality of materials that are important for the safety of facilities is everyone's business and everyone's responsibility.

ASNR has stepped up its inspection programme of the supply chain for equipment that is important for the safety of nuclear power plants. As part of these inspections, ASNR examines compliance with regulatory requirements relating to important activities for manufacturing operations, the ability of suppliers to manufacture equipment that meets safety requirements, and the fraud risk prevention. During these inspections, ASNR also checks EDF's monitoring of its suppliers and their subcontractors. Inspections are also carried out within EDF's engineering departments to ensure that contractors involved in design studies are monitored.

In addition, ASNR conducts awareness-raising initiatives among suppliers, in particular through the publication of a specific educational guide for suppliers in the nuclear sector. This guide sets out the pillars of a robust supply chain for equipment that plays an essential role in preventing, detecting or limiting the consequences of an accident at a nuclear facility. The aim is to make the regulatory objectives and requirements for the design and manufacture of equipment for nuclear facilities easier to understand.

In addition, targeted inspections focusing on the risks of counterfeiting, fraudulent substitution and falsification of documents (CFSI) have been put in place:

- in central units to assess how fraud risk prevention is integrated into procurement and supply chain policies in the sector and to monitor the handling of proven cases;
- at nuclear sites, incorporating in-depth evidence gathering element into the activities carried out;
- at suppliers, in order to address the risk of fraud in the subcontracting chain with the aim of raising awareness of fraud risks.

Finally, ASNR shares its experience on CFSI cases and the inspection methods, in particular during bilateral meetings with its foreign counterparts and within international working groups.

See Article 13 (§ 13.4.3 and Focus 12 and 13).

#### 4.1.7. Establishment of a specific pre-licensing framework for small modular reactors

Several small modular reactor projects are currently under development around the world. These are reactors with a capacity of less than 300 MWe, which will mainly be manufactured in factories. They use a variety of technologies, including water reactors and advanced technologies (high-temperature gas reactors, molten salt reactors, fast neutron reactors, etc.).

In France, in March 2022, the Government launched a call for innovative nuclear reactor projects aimed at creating a new ecosystem of nuclear start-ups to complement the sector's long-standing leaders. It is in this context that around ten new companies with small modular reactor projects emerged in France in 2022 and 2023.

In order to be as well prepared as possible for any creation authorisation applications for these innovative reactor projects, ASNR has set up a specific four-phase review framework to mobilise resources commensurate with the maturity level of each project.

- Phase 1: Prospective monitoring

During an initial meeting, the project developer is invited to present:

- the main characteristics of its reactor project (technology, power, form of energy delivered, front-end and back-end of the nuclear cycle, etc.),
- the status of the reactor design and its safety case,
- the project development schedule,
- the current technical and financial capabilities of the project company, and its growth plan (fundraising and workforce growth).

Following this prospective contact, ASNRS assesses the maturity of the project as a whole in terms of the following three elements:

1. Minimum maturity of the technical project: the project developer has a complete and stable initial conceptual design for its project;
2. Ability of the project sponsor to engage in technical exchanges: the project developer has its own technical team capable of engaging in technical exchanges with ASNRS on all technical issues related to the demonstration of the safety of its reactor;
3. Minimum financial sustainability of the project developer: the company leading the project has sufficient financial guarantees to ensure its medium-term development.

If the overall maturity does not appear sufficient to initiate a preparatory review, the project leader is invited to continue development before contacting ASNRS again.

- Phase 2: Preparatory project review

When the project's maturity meets the three criteria above, a series of thematic exchange meetings is organised.

The purpose of this series of meetings is to enable ASNRS to gain an overview of the project, understand the design choices, evaluate the state of knowledge available or to be acquired, and understand the main safety orientations on which the project developer intends to rely to establish and justify its safety case.

A summary seminar may be organised to conclude this series of meetings.

This phase is merely a preparatory exchange of information for future reviews. No opinion or resolution is issued on the project at this stage by ASNRS.

- Phase 3: preliminary review of the project's structural safety options

Before finalising the detailed design of its reactor, the project proponent may then request ASNRS, pursuant to Article R. 593-14 of the Environment Code, for an official and public opinion on some of the structural elements of its project prior to initiating creation authorisation application.

For innovative reactor projects, ASNRS recommends that project developers undertake this preliminary review phase, which provides an opportunity to engage technical review and develop positions on a shared list of issues identified as critical at the end of the preliminary review phase.

- Phase 4: Examination of the creation authorisation application

Finally, once the detailed design of the reactor project is ready, a creation authorisation application may be submitted.

This phase marks a further increase in ASNR's commitment of resources because, in addition to the comprehensive technical review assessment of the project, an assessment of the characteristics of the site and an inspection programme of the applicant, who acquires de facto operator status, must also be carried out. This involves inspections of the applicant's management system and its ability to control its subcontractors.

#### **4.1.8. Joint Early Review on the NUWARD project**

In September 2023, the nuclear safety authorities of France (ASN), the Czech Republic (SÚJB) and Finland (STUK) shared the conclusions of the first phase of the Joint Early Review (JER) of Nuward's SMR in a public report.

Given the very positive results, it was agreed in a second phase (JER phase 2) not only to continue the initiative, but also to expand its composition. Three additional nuclear safety authorities have therefore joined the initiative for this second phase: the Swedish Nuclear Safety Authority (SSM), the Netherlands Authority for Safety and Nuclear Control (ANVS) and the Polish Atomic and Nuclear Safety Authority (PAA).

The objectives of phase 2 are similar to those of phase 1, namely to enable regulators to:

- familiarise themselves with the design of a SMR and identify potential challenges before the start of their respective authorisation processes,
- share their expectations, knowledge and practices on some selected topics,
- increase knowledge of regulatory practices and expectations,
- provide the designer with early feedback on the design and any associated regulatory challenges.

The six regulators are all part of the European Union and are members of WENRA. As a result, their regulatory frameworks are very similar: thus, phase 2 of the JER highlighted very few differences and contradictions between countries, most of which stem from differences in the interpretation of regulatory requirements and, consequently, the expectations of regulators.

Phase 2 of the JER also highlighted issues that would benefit from being discussed in international forums in order to develop a global perspective.

#### **4.1.9. Safety and environmental issues related to climate change**

Climate change is a major challenge for the safety of nuclear facilities and, as such, is a key issue in France's periodic safety reviews of reactors, during which Intergovernmental Panel on Climate Change (IPCC) projections are systematically taken into account.

As part of these reviews, the control of risks related to natural hazards (such as sea level rise and heat waves) and the limitation of the environmental impact of facilities, particularly in terms of thermal discharges and water intakes and consumption, are reassessed.

In this context, the IPCC projections are essential data. They provide insights into future changes, in particular, in maximum temperatures and sea level rise.

EDF has implemented a climate monitoring process that is aligned with the publication schedule of the IPCC reports. In addition to collecting data on hazards to define the climate impact reference framework, this approach includes a method for ensuring the validity of the projections used, in the event of a major climate event (an in-depth analysis is triggered when a climate event exceeds certain criteria).

Furthermore, IPCC data is also used to assess low water levels in rivers during the summer. Lower water levels and flow rates in rivers can hinder the dispersion of liquid, chemical and radiological effluents from nuclear

reactors. Finally, climate change is likely to alter aquatic ecosystems (biotopes), leading to an increased risk of proliferation of clogging organisms in heat sinks.

In addition to climate change consideration in the periodic safety review process, the EDF Group has developed a systemic and evolving approach to ensure the resilience of its power generation facilities to climate challenges. This approach, embodied in the 'ADAPT' project, encompasses all components (real estate, logistics, technical and human) that play a role in the electricity production of a nuclear facility, such as water resources at production sites (river flows, sea level, water quality, water consumption, etc.). Using specific analysis methods, the ADAPT project quantifies the consequences of climate change at each site and over different time horizons (e.g. 2050, 2070, 2100) and identifies solutions for adapting to climate change.

The EDF Group is drawing on the expertise of its R&D division's climate department to understand the multiple dimensions of climate change (e.g. scientific monitoring, retrieval of climate projections used to prepare IPCC reports, academic partnerships, etc.).

Finally, at the instigation of ASN and ONR, a discussion group between nuclear safety authorities (ASNR, ONR, ANVS, FANC and STUK) has been set up to share national approaches to climate change, whether in terms of regulatory frameworks, inspection practices or the definition of reference scenarios.

## **4.2. Main safety events since the combined eighth and ninth cycles Review Meeting**

### ***Stress corrosion cracking***

In autumn 2021, inspections revealed stress corrosion cracking on stainless steel welds in the safety injection lines of reactor N°1 at Civaux nuclear power plant (N4 plant series), between the main primary system and the first isolation device.

Stress corrosion, which is not expected in this material at these locations, is likely to lead, in the event of significant mechanical stress, to the rupture of the safety injection line systems, which are designed to ensure the fuel cooling in the event of an accident.

In view of the results of the checks carried out on this reactor, EDF has launched a comprehensive programme of checks and assessments on all of its reactors in operation. This programme, together with various analyses carried out in parallel, has identified several factors influencing the occurrence of stress corrosion, in particular the geometry of the pipes, thermomechanical stresses, the conditions under which welds were repaired during manufacture and, potentially, the oxygen content in the flow. The N4 (1450 MWe reactors) and P'4 reactors (i.e. the most recent 1300 MWe reactors) proved to be particularly sensitive.

This programme led to the development of a prioritised control and repair strategy for the entire fleet. EDF has also developed and implemented new, more effective ultrasonic testing procedures to detect and characterise defects without cutting out unaffected sections or sections with cracks that are small enough to be left in service. Finally, EDF has implemented a programme of random checks on the welds of other stainless-steel pipes in auxiliary circuits connected to the primary system of the reactors, in order to verify that these pipes are not affected by stress corrosion.

Inspections carried out in 2025 on welds at reactor N°2 at Civaux nuclear power plant in sections of the residual heat removal system which had been replaced in 2022, led to the detection of two crack indications. EDF decided to remove these welds for further analysis, to deepen its knowledge and to feed into its R&D work. Laboratory analysis showed the presence of a stress corrosion crack on one of these two welds and a thermal

fatigue crack on the other. Both cracks are of limited depth and did not compromise the integrity of the affected pipes.

Investigations are in progress to determine the reason for the presence of these defects on a repaired section. They will provide basis for decision whether the strategy for in-service monitoring of replaced pipes implemented across EDF's fleet of reactors needs to be revised, particularly with regard to defining the welds to be subject to periodic inspections, the frequency of these inspections and the types of inspections to be carried out. At this stage, the inspections carried out by EDF on the pipe sections installed since 2022 as part of the replacement of pipes sensitive to stress corrosion have only revealed these two cracks, despite several hundred inspections having been carried out.

See Article 6 (Focus 1 and Focus 2).

### 4.3. International peer reviews

France regularly hosts and participates in international peer reviews, particularly under the auspices of the IAEA or the European Commission (EC).

#### 4.3.1. Reviews coordinated by the IAEA

##### *Integrated Regulatory Review Service (IRRS)*

ASNR supports the peer review missions by encouraging their hosting in France.

Thus, after an initial plenary mission and a follow-up mission that took place in 2006 and 2009 respectively, ASN hosted another "full scope" IRRS mission in 2014, further to which the IRRS Team issued 46 recommendations and suggestions. ASN developed an action plan to take appropriate measures in response to these recommendations and suggestions. The follow-up mission took place from 1 to 9 October 2017 during which 40 recommendations have been closed or are considered to be closed "subject to implementation of the ongoing measures". The concluding report of this mission - like the previous reports - was put on line on ASN website in March 2017.

The third "full-scope" IRRS mission was initially scheduled for March 2024. However, in September 2023, France informed IAEA of its intention to postpone the mission by two to three years due to legislative work then underway concerning changes to the organisation of nuclear safety and radiation protection oversight in France. Indeed, maintaining the mission in 2024 carried the risk, if the merger of ASN and IRSN was confirmed by Parliament, of rendering certain parts of the assessment obsolete, in particular those relating to the organisation of control and the management system, as well as the action plan prepared during the self-assessment. Finally, the review of a system that is set to evolve in the short term was also likely to cause misunderstandings among IRRS Team. The third "full-scope" IRRS mission is scheduled for 2027.

ASNR also supports peer review missions by participating in IRRS missions in other countries. Between 2023 and 2025, 11 staff members from the Authority participated in 15 IRRS missions as experts, deputy Team Leaders or Team Leaders.

##### *Operational Safety Review Team (OSART)*

France regularly requests the IAEA to conduct OSART (Operational Safety Review Team) missions to perform operational safety review: on average, one OSART mission is organised in France each year. The entire French nuclear fleet has already undergone at least one OSART mission.

The following OSART missions have been carried out since the combined 8<sup>th</sup> and 9<sup>th</sup> cycles review meeting:

- in 2023 on the Penly (OSART), Paluel (Follow Up) and Belleville sites (Follow Up);
- in 2024 on the Nogent site (OSART);
- in 2025, on the Tricastin site (Follow Up).

Two OSART missions are also planned for 2025 (after this report is published): one at the Chinon site in October 2025 and the other at the Penly site (Follow-Up) in November 2025.

The implementation of the OSART review recommendations is being coordinated within EDF's improvement plans.

### 4.3.2. Reviews coordinated by EC

#### *Topical peer review (TPR)*

Council Directive 2014/87/Euratom of 8 July 2014, amending Directive 2009/71/Euratom establishing a Community framework for the nuclear safety of nuclear installations, institutes a six-yearly peer review of a technical aspect relating to the safety of nuclear facilities.

The second review, which took place mainly in 2024, focused on the protection of nuclear installations against fire risk. The conditions of this review, which focused on all nuclear installations subject to the Safety Directive, were defined by ENSREG (European Nuclear Safety Regulators Group) with the support of WENRA. The objectives of this topical review were to:

- enable the participating countries to review their fire protection provisions in order to identify strengths and weaknesses;
- undertake a European peer review to share operating experience and identify findings: common issues or challenges at EU-level, good practices, areas of good performance and areas for improvement;
- provide the participating States with an open and transparent framework to develop appropriate follow-up measures to address areas for improvement.

ASN chaired this second thematic peer review and assigned four fire risk experts to review the national reports of the 22 participating countries.

As part of this review, a self-assessment report was prepared in October 2023 by ASN, with contributions from the operators. In its report, ASN concluded that “*the level of protection of French nuclear installations against fire risk is generally satisfactory. However, the diversity of the installations and their specific constraints lead ASN to identify specific areas for vigilance that require regular monitoring*”.

For the French nuclear installations, the peer review led to the definition of seven “areas of good performance” and two “areas for improvement” concerning fuel cycle facilities. These improvement actions will be incorporated into the national action plan to be submitted to ENSREG.

### 4.3.3. Other reviews

#### *WANO review*

The safety performance of the NPPs in the French fleet is assessed by the World Association of Nuclear Operators (WANO) by means of peer reviews. These reviews are conducted jointly by WANO and the Nuclear Inspection Authority (Independent Safety Branch of EDF DPN). Their recommendations are incorporated into improvement plans.

#### 4.4. Outcome from the combined Review Meeting for the eighth and ninth cycles

At the end of the combined Review Meeting for the eighth and ninth cycles, a number of challenges were identified, firstly those specific to each Contracting Party and secondly those common to all the Contracting Parties.

##### 4.4.1. Challenges identified for France

The rapporteurs' reports indicate the challenges and suggestions for each Contracting Party, on which each country must report at the next review meeting.

At the end of the combined Review Meeting for the eighth and ninth cycles, three challenges were identified for France. The actions implemented to meet these challenges are summarised below and as well detailed in the report:

##### *Commissioning of Flamanville 3 EPR reactor* – FR-2023-01

ASN has reviewed the application for authorisation to commission Flamanville EPR reactor. In particular, ASN has verified that the facility complies with the objectives and rules set out in Articles L. 593-1 to L. 593-6-1 of the Environment Code and in the texts adopted for their implementation.

ASN's review focused on the design, safety case, impact assessment, general operating rules and on-site emergency plan. This review was carried out with IRSN support.

The ASN's review also took into account the results of tests carried out at the site and feedback from EPR reactors commissioned abroad. To this end, ASN maintained regular contact with the Finnish and Chinese nuclear safety authorities in order to benefit from their experience in the construction, start-up tests, preparation for operation and operation of EPR reactors.

In addition, ASN conducted inspection of the construction of Flamanville EPR reactor. As part of this, ASN has carried out inspections of construction activities, including site preparation after the construction licence was granted, manufacturing, construction, qualification, assembly and testing of structures, systems and components, both on site and at the manufacturers' premises. Since 2022, ASN's inspection program has mainly focused on the completion of the installation, the performance of tests and the preparation of the operator. ASN has thus carried out around 600 inspections related to the EPR project since the start of construction in 2007.

Prior to the commissioning of Flamanville EPR reactor, France asked IAEA to carry out OSART missions. ASN analysed the conclusions of these missions in order to guide its inspection in preparation for its decision on the commissioning of the reactor.

Following its review, ASN authorised the commissioning of Flamanville EPR reactor by decision of 7 May 2024. This authorisation enabled EDF to load nuclear fuel into the reactor and carry out start-up tests and then operate the reactor. ASN published its [review report](#) when it issued the authorisation for the reactor to be commissioned in May 2024.

On 2 September 2024, the Nuclear Safety Authority gave EDF the go-ahead to proceed with the divergence operations on Flamanville EPR reactor. The plant teams carried out the necessary activities for the first nuclear reaction in the reactor, and the first divergence took place on 3 September at 3:54 p.m.

See Article 19 (§ 19.1.2 and Focus 21).

**ASN position on generic phase of the 4th PSR of the 1300 MWe reactors – FR-2023-02**

The ASNR resolution of 1 July 2025 on the continued operation of 1300 MWe reactors beyond 40 years concludes the generic phase of their fourth periodic safety review.

Ambitious objectives, identical to those of the fourth safety review of 900 MWe reactors, have been adopted for this periodic review, and ASNR emphasises the extent of the studies carried out by EDF during the generic phase. These studies have led EDF to identify numerous modifications to the facilities that will improve safety.

The resolution defines the common requirements for all 1300 MWe reactors that EDF must meet in order to consider continuing their operation beyond 40 years. The ASNR's requirements govern the implementation of the most significant modifications and the completion of additional studies to ensure that the objectives set are achieved. This implementation will begin with the fourth ten-year inspection of reactor N°1 at Paluel nuclear power plant in early 2026.

ASNR considers that the measures planned by EDF, supplemented by the responses to the ASNR's requirements, will enable the objectives of the review to be achieved and bring the safety level of the 1300 MWe reactors closer to that of the most recent (third generation) reactors, in particular by:

- verifying, over a wide area, the reactors' compliance with their safety reference framework,
- improving the consideration of hazards (earthquakes, floods, explosions, fires, etc.). The reactors will also be able to withstand more severe hazards than those considered to date,
- by limiting the radiological consequences of accidents without core meltdown. This will significantly reduce the occurrence of situations requiring the implementation of measures to protect the population (sheltering, evacuation, iodine intake),
- improving the provisions for managing accident situations in fuel pool,
- reducing the risk of accidents involving core meltdown and, should such an accident occur, the consequences of such an accident. The safety modifications will thus significantly reduce releases into the environment during this type of accident,
- identifying improvements that will enable each site to reduce the impact of normal operation on the environment.

As for the 900 MWe reactors, ASNR required EDF to report annually on the actions taken to comply with the requirements and deadlines, as well as on its industrial capacity and that of the nuclear industry to carry out the modifications to the facilities on schedule. ASNR requests that this information be made public.

The ASNR's resolution was preceded by a public consultation phase on the conditions for continuing to operate 1300 MWe reactors after 40 years. This public consultation was conducted under the auspices of the High Committee for Transparency and Information on Nuclear Safety (HCTISN) and with the support of guarantors from the National Commission for Public Debate (CNDP).

**Assessment of the authorisation to build an EPR2 – FR-2023-03**

EDF has launched a programme to build EPR2 reactors in France.

The EPR2 model is a new pressurised water reactor that aims to incorporate feedback from the design, construction and commissioning of EPR reactors, as well as feedback from the operation of existing reactors. Like EPR reactors, it aims to meet the general safety objectives for third-generation reactors. In addition, it is designed to incorporate all the lessons learned from the accident at the Fukushima nuclear power plant. This is reflected in particular in a reinforced design to withstand external natural hazards and in an enhanced

autonomy of the installation and the site in the event of an accident (with or without core meltdown) before the intervention of off-site resources.

A first pair of reactors is planned for the Penly site in Seine-Maritime. In this context, a public debate was held from 27 October 2022 to 27 February 2023. Following this debate, EDF submitted a creation authorisation application for a BNI to the Minister responsible for nuclear safety at the end of June 2023.

As provided for in Article L. 592-29 of the Environment Code, the Minister responsible for nuclear safety referred the matter to ASN for technical review of the creation authorisation application for the two EPR2 reactors at the Penly site. As part of its review, ASN informed EDF of its requests concerning:

- the accident analysis approach, with or without fuel meltdown,
- the safety reference frameworks for taking into account internal hazards,
- the classification approach used to determine the requirements applicable to SSCs providing a function necessary for demonstrating nuclear safety.

ASN issued assessments on the design review of equipment intended to form the nuclear steam supply system of these reactors and on their manufacture. Following its review, ASN approved the start of manufacture of certain equipment, such as the reactor vessel and steam generators. ASN inspected the manufacturing of this equipment to make sure the manufacturing processes used give enough guarantees that the materials will meet the quality standards.

ASN has also begun inspecting the supply chain for other equipment important for nuclear safety, in order to assess the suppliers' control of manufacturing activities and EDF's surveillance of these suppliers.

In addition to the technical review of the creation authorisation application, ASN has initiated a process to inspect the organisation set up by EDF to carry out its project. The aim of this process is to verify that the requirements relating to the protection of people and the environment to which EPR2 reactors must comply are taken into account in an appropriate manner during the design and construction phases of these reactors.

See Article 7 (Focus 8) and Article 14 (§ 14.1.2.1 and § 14.1.3.1).

#### **4.4.2. Challenges common to all the contracting parties**

Eight subjects have been identified as challenges for all the Contracting Parties to the Convention.

##### ***Managing extraordinary circumstances impacting the safe operation of nuclear installations***

**Action:** Contracting Parties are encouraged to develop and maintain strategies, approaches and contingency plans in managing extraordinary circumstances, such as Covid-19 pandemic, extreme natural disasters, armed conflicts, etc.

France has carried out several initiatives in the wake of the health crisis to learn lessons that will enable it to respond to unexpected challenges or deal with extraordinary circumstances.

This work has been carried out in several areas:

- an internal review conducted by EDF:

To ensure continuity of electricity production, the Nuclear Production Division (DPN) has set up an organisation led since 1 January 2023 by the Crisis Management Department and linked to EDF's Group Risk Department. This organisation is based on a business continuity guide that has been rolled out across all DPN units (sites and engineering units). This guide will be definitively implemented in 2025 and is based on feedback from the crises experienced by the DPN in recent years.

The COVID crisis of 2020-2021, experienced under fairly unprecedented conditions in terms of the technical and human management of a major health crisis and having lasted for a very long time, provided food for thought and raised questions about the Division's ability to maintain uninterrupted electricity production. During the winter of 2022-2023, another challenge was to maintain continuity of electricity production while the Group faced an unprecedented unavailability of its nuclear production capacity, linked in particular to the phenomenon of stress corrosion and the ten-yearly safety review outage programme. More recently, a new challenge was the organisation of business continuity for the Paris Olympic Games, which required the DPN's response system to be adapted to the very specific operating conditions imposed by the State. This response system focused in particular on consolidating the nuclear crisis management system by ensuring that the tools for responding to a nuclear crisis would remain operational in a context of heightened security measures put in place by the State. As a result, the nuclear crisis management centre, which was located close to the Olympic Village and therefore inaccessible for security reasons, was duplicated (backup) at a different site with the adaptation of resource deployment.

The measures implemented ensure the continuity of electricity production while guaranteeing the resources essential for managing the safety of nuclear power plants and nuclear crises. These measures are coordinated by an organisation that is separate from and independent of the nuclear crisis management team. It works closely with the Group Risk Department and has a network of specialists who can be mobilised immediately, regardless of the type of crisis (health, fuel, transport, cyber, etc.).

- in-depth analysis by ASN and IRSN of EDF's health crisis management:

The COVID-19 health crisis has led EDF to significantly review its organisations in order to continue to fulfil its responsibilities as a nuclear operator. This exceptional situation has severely disrupted nuclear power generation activities, disrupting essential behaviours and activities such as teamwork, physical meetings and maintenance. It has also required complex trade-offs between production, safety and health.

In 2021 and 2022, IRSN and ASN conducted an in-depth analysis of EDF's management of the COVID-19 health crisis. This in-depth analysis focused on four main areas:

- work reorganisation during the pandemic,
- challenges relating to communication and coordination,
- real-time management,
- traceability of feedback during the crisis.

This in-depth analysis showed that EDF has been able to adapt quickly and effectively to this crisis in order to maintain the safety of its facilities. This adaptation was led by the crisis organisation of the Nuclear Production Division, which enabled a high level of collective and individual mobilisation, both nationally and locally in the nuclear power plants. The in-depth analysis also showed that EDF relied on a principle of subsidiarity, which proved to be generally effective in defining and carrying out local, urgent, numerous and sometimes significant reorganisations of work in the context of a pandemic crisis.

- an analysis by the Steering Committee on Social, Organisational and Human Factors (COFSOH) of the factors that enabled civil nuclear industry organisations to remain resilient in response to the COVID crisis:

As part of the COFSOH, EDF, the CEA and Orano presented the feedback on their health crisis management. The COFSOH analysed the factors that contributed to the resilience of civil nuclear industry organisations during the COVID-19 crisis, and those likely to sustain resilience under more severe

circumstances. This analysis confirms that a balance must be struck between ‘arming ourselves by anticipating’ and ‘knowing how to react’. This idea is based on two observations:

- First, that the existence of a contingency plan—however incomplete or only partially suited—is preferable to the absence of any plan, as it provides a useful organizational framework;
- Second, that the adaptive mechanisms developed under ‘normal conditions,’ when extended, reorganized, and reinforced, constitute the essential basis for effective crisis response.
- an ASNR research project aimed at studying critical situations and the implementation of business continuity in a context of lasting and evolving disruption:

Following on from the lessons learned from the Covid-19 pandemic crisis, ASNR has developed the ADAPTER research project. The aim of this project is to study critical situations and the implementation of business continuity in a context of long term and evolving disruption (pandemic, armed conflict, climate change, etc.). In particular, it examines how organisations adapt and cope with the unexpected, but also how the pursuit of this objective contributes to defining what is ‘essential’, “critical” and ‘indispensable’ at different stages of the crisis. It is based on data collected from surveys conducted among French and Spanish operators.

#### ***Strengthening national regulatory capabilities taking into account new and innovative technologies***

**Action:** Contracting Parties should establish durable capacity building programmes to align regulatory capabilities with future needs.

In order to support the emergence of new technologies and anticipate future technical and regulatory challenges, ASNR is implementing a durable strategy to strengthen its capacities, combining oversight, review and assessment, research and international cooperation. The Authority is equipping itself with the human, technical and scientific resources necessary to adapt its oversight and review & assessment activities to the nuclear technologies of the future.

To take into account the emergence of new reactor technologies and the specific characteristics of these project developers, which are companies unfamiliar with nuclear power and its regulation, ASNR has set up a specific pre-licensing framework for SMRs in order to be as well prepared as possible for any creation authorisation applications for these innovative reactor projects.

Furthermore, as part of a proactive approach to anticipating future review and assessment needs, ASNR is conducting various research projects aimed at acquiring knowledge and skills in anticipation. One of the needs identified relates to the use of passive systems for safety, particularly for SMRs and AMRs currently under development. To this end, ASNR is leading the PASTIS (Passive Systems Thermalhydraulic Investigations for Safety) project, which aims to study the physical phenomena involved in passive safety systems designed to remove residual power from a light water reactor in incident or accident situations. Experimental research will begin in 2026 and will be open to collaboration at both national and international level. More broadly, ASNR is involved in several European research projects that contribute to strengthening its competences in a sustainable manner by anticipating future needs. For example, it is involved in the CONNECT-NM partnership, dedicated to materials of the future and develops different research projects regarding materials used in nuclear industry (metallic materials, concrete, polymers...). In the field of numerical simulation and artificial intelligence, ASNR coordinates the ASSAS european project (Artificial intelligence for Simulation of Severe AccidentS), based on the ASTEC severe accidents simulation code.

### ***Fostering international collaboration***

**Action:** Contracting Parties are encouraged to foster international collaboration and, as appropriate, to participate in different types of collaborative schemes for the review of SMR designs.

In a context marked by the emergence of small modular reactors (SMRs), France, through the Nuclear Safety and Radiation Protection Authority, is actively engaged in multilateral cooperation initiatives. The initiatives undertaken – whether through joint reviews, European or international working groups – reflect a commitment to building a consistent and rigorous approach to the assessment of SMR projects with the aim of ensuring a high level of safety for these reactors.

#### JER Nuward

On the initiative of ASN, a joint assessment of the safety options for the NUWARD SMR reactor project was carried out by the Finnish, Czech and French safety authorities. This is a first in Europe and marks an important step towards a harmonised approach to the assessment of SMRs.

This joint review examined several aspects of the NUWARD reactor design, including safety objectives and approach, the use of passive systems and the integration of two reactors within the same facility. In particular, the review enabled a comparison of the requirements, practices and experiences of the three regulators involved and identified opportunities for further development of national regulations and practices.

The second phase of the joint review of the safety options for the NUWARD SMR reactor was held with the addition of the Dutch (ANVS), Polish (PAA) and Swedish (SSM) safety authorities, alongside the French, Finnish and Czech authorities. This stage aimed to further the assessment of new technical issues, within a framework of enhanced European cooperation. The work carried out during this second phase focused in particular on containment barriers, the assessment of the radiological consequences of an accident, and the architecture of electrical and control systems.

The experience and conclusions of this second review phase reinforce the ASNR contribution to the various international discussions on harmonising safety requirements and authorisation processes for such reactor designs.

This initiative reinforces the ASNR position on the value of multilateral cooperation for the assessment of sufficiently mature reactor designs in an international context of design standardisation.

#### Thorizon

ASNR is participating with ANVS, the Dutch nuclear safety authority, in a preparatory review of the Thorizon One project. This review, conducted at an early stage of the Thorizon One design development, has the following main objectives:

- present the specific design of this reactor, its safety approach and the associated research and development programme,
- define the scope of the future request for assessment on the project's safety options in order to prioritise the mobilisation of review and assessment resources on the issues presenting the most significant industrial and safety challenges for the Thorizon One project.

This approach illustrates a shared desire for anticipation and international cooperation, with a view to enhancing safety from the earliest stages of development.

### EU SMR Prepartnership

France led the EU SMR prepartnership's WS2 – Licensing working group on small modular reactors (SMRs). This group carried out a comparative analysis of national regulatory frameworks concerning the steps for authorising the construction of a nuclear facility and proposed several actions to facilitate the process implemented in Europe prior to this authorisation stage.

One action focused on identifying, at an early stage, potential blocking points for SMRs related to safety requirements or their implementation. A study carried out at the request of the European Commission focused on 13 themes defined in collaboration with SMR project stakeholders. France was particularly active in ensuring that this study would enable a group of European regulators involved in SMR projects to compare their requirements, practices, and experiences.

### ENSREG SMR Task Force

This work is part of a European cooperation initiative aimed at facilitating the safe and harmonised deployment of SMRs while maintaining the highest nuclear safety standards. It is based on three main levers:

- the use of feedback from ENSREG member regulators, obtained from joint SMR reviews,
- an interaction with the European Industrial Alliance for SMRs (SMRs IA),
- the identification of cross-cutting issues, whether technical or organisational (regulatory challenges), and their resolution.

France is actively contributing to this work by sharing the knowledge it has acquired during previous reviews, particularly in the context of the NUWARD project and the EU SMR pre-partnership.

### WENRA

In 2025, WENRA has launched a review of the development of a generic approach for the design review of new reactor models. Such a framework would aim to harmonise national assessments, facilitate their mutual recognition between safety authorities, and provide designers with a better overview of shared regulatory expectations. ASNR is participating in this work.

### NHSI

In order to remove potential barriers to the development of SMRs, IAEA is mobilising its members through an initiative called "NHSI (Nuclear Harmonisation and Standardisation Initiative) aimed at developing and encouraging international cooperation to enable several safety authorities to perform joint assessment on the same reactor design, or to enable countries to take into account assessments already carried out by other countries in order to reduce their own assessment workload.

ASN has actively participated in this work.

### ***Foster international peer review missions and timely addressing of findings***

**Action:** Contracting Parties are encouraged to invite on regular basis IAEA peer review missions, including follow-up missions to confirm the status and timely implementation of peer review findings.

France actively participates in international peer review missions and regularly hosts these peer reviews. These reviews help to strengthen nuclear safety through the exchange of experiences, the identification of good practices and concrete areas for improvement.

Peer reviews are conducted in accordance with IAEA safety standards (IRRS, OSART) or WENRA safety requirements (TPR). All documents resulting from these reviews are available on ASNR website.

Through its involvement in peer reviews, France demonstrates a strong commitment to transparency and exemplarity in the field of nuclear safety. It ensures that recommendations are addressed in a timely manner through the development of national action plans and their follow-up in continuous improvement plans, as well as through the implementation of follow-up missions to confirm the progress made.

### **IRRS (Integrated Regulatory Review Service) missions**

ASNR has already hosted several IRRS missions:

- an initial mission in 2006,
- a second full-scope mission in 2014.

A third IRRS mission, initially planned for 2024, has been postponed to 2027 due to evolutions in the governance of nuclear safety and radiation protection control.

The recommendations of the IRRS missions have resulted in structured action plans, which were the subject of follow-up missions in 2009 and 2017.

The IRRS mission reports are published on ASNR website.

### **OSART (Operational Safety Review Team) missions**

On average, one OSART mission is organised each year in France to assess operational safety. The recommendations from these missions are incorporated into EDF's improvement plans. A follow-up mission is generally conducted within 18 months to assess the implementation of these recommendations.

Prior to the commissioning of the Flamanville EPR reactor, France requested an OSART mission. ASN analysed the conclusions of these missions in order to guide its inspection in view of its position on the commissioning of the reactor.

The OSART mission reports are published on ASNR website.

### **Topical Peer Review (TPR)**

France participated in the TPR reviews governed by European Directive 2014/87/Euratom:

- in 2017 on ageing management of nuclear reactors;
- in 2023 on the protection of nuclear installations against fire hazards.

France systematically publishes its national report containing its self-assessment, which is subject to peer review, as well as the action plan resulting from this review.

### ***Possible impact of global climate changes on the safe operation of nuclear installations***

**Action:** Contracting Parties are encouraged to address possible impact of climate change on nuclear installations, in particular those related to the increased frequency and intensity of extreme weather conditions.

Climate change represents a major challenge for the safety of nuclear facilities.

In France, it is systematically considered during periodic safety reviews carried out every ten years, based on IPCC projections. These assessments help anticipate natural risks associated with climate change, such as heat waves, rising sea levels and low river flows, which affect the operation and environmental impact of the facilities. EDF has also set up a climate monitoring system synchronised with IPCC publications, incorporating criteria in case of major climate events to trigger in-depth analysis.

In addition to taking climate change into account in its periodic safety review process, the EDF Group has developed the 'ADAPT project', which uses specific analysis methods to quantify the consequences of climate change at each site and over different time horizons (e.g. 2050, 2070, 2100) and identify solutions for adapting to climate change.

### ***Securing reliable supply chains***

**Action:** Contracting Parties are encouraged to share experience in securing supply chains and exchange information on practices in addressing NCSFI.

Combating fraud at all levels of the subcontracting and supply chain is a major challenge for the nuclear industry.

ASNR has stepped up its inspection programme of the supply chain for equipment that is critical to the safety of nuclear power plants. During these inspections, ASNR also checks the surveillance carried out by EDF of its suppliers and their subcontractors. In addition, ASNR has set up specific inspections targeting the risk of counterfeiting, fraudulent substitution and falsification of documents (CFSI).

ASNR regularly shares its experience of cases of CFSI and the inspection methods used at bilateral meetings with its foreign counterparts.

It also plays an active role in the NEA's Committee on Nuclear Regulatory Activities (CNRA), particularly in the Expert Group on Operating Experience (EGOE) and the Working Group on Supply Chain (WGSUP). ASNR has contributed to the establishment of simplified procedures for sharing information on recent CFSI cases. The aim is to quickly exchange information on cases that may affect the supply chains of several countries. These exchanges are based on a 'rapid information sharing form' used to inform other authorities and enable them to launch investigations within their area of competence. At the meetings of these groups, ASNR presented several cases illustrating the means, detection methods and treatment practices implemented in France.

See Article 13 (§ 13.4.3 and Focus 12, 13, 14).

### ***Strategies for ageing management in support of the operation of nuclear installations***

**Action:** Contracting Parties are encouraged to exchange experiences on the implementation of their ageing management strategies and effectiveness of ageing management practices from design to decommissioning, with a special focus on newly identified ageing processes on specific SSCs, when applicable.

Through its participation in the peer review coordinated by ENSREG, the organisation of international seminars by EDF, and the integration of international experience into its national strategies, France is fully involved in knowledge sharing and the continuous improvement of ageing management practices.

Directive 2014/87/Euratom establishes a peer review every six years on a technical aspect related to the safety of nuclear installations. The first review focused on ageing management. One of the objectives of this thematic review was to promote the sharing of experience at European level and to identify common issues. France, through ASN, IRSN and EDF, was heavily involved in this exercise, presenting its ageing management practices and the knowledge gained from EDF's R&D programmes.

In September 2023, EDF organised an international seminar on the operation of nuclear power plants beyond 60 years of service, with the aim of drawing on the experience of international players already involved in extending the service life of reactors in order to enrich its own reflection on ageing management beyond 60 years. The seminar brought together 250 representatives from major American, Japanese and European operators, technical and research organisations and international organisations. It provided an opportunity

for in-depth sharing of ageing management strategies, particularly with regard to reactor vessels, civil engineering structures, concrete ageing and the effects of irradiation on internal structures. During plenary sessions, operators presented their current actions to extend the operating life of their facilities, detailing their strategy on a range of strategic issues with a view to continuing operation beyond 60 years. Thematic sessions were then dedicated to potential technical barriers to continued operation. The lessons learned from this seminar have been incorporated by EDF into its roadmap for extending operating life, which has been submitted to ASNR.

### ***Strengthening emergency preparedness and response arrangements and fostering cross border collaboration***

**Action:** Contracting Parties are encouraged to strengthen diligent cross border cooperation, including participation in joint emergency exercises, and to foster cooperation between experts in nuclear and radiation safety in relation to emergency response.

Faced with the risk of major nuclear or radiological accidents, France has made preparedness a key pillar of its strategy for protecting the population. In 2014, it adopted a structured National Response Plan, which defines the organisation, priority actions and coordination mechanisms to be activated in the event of a crisis. This plan is implemented at all levels of government through the Off-Site Emergency Plans (PPIs) to ensure operational responsiveness throughout the country.

Through an active policy of exercises, feedback from real crises, international exchanges, integration into assistance networks, cross-border coordination and crisis communication, France is continuously strengthening its capacity to manage radiological emergencies. The Nuclear Safety and Radiation Protection Authority (ASNR) is actively involved in national, bilateral and international initiatives aimed at strengthening preparedness for radiological emergencies and cross-border cooperation. These actions are based on the establishment of robust and coordinated mechanisms and close cooperation with foreign partners.

### **A preparedness strategy based on exercises and the exchange of experiences**

France regularly organises national exercises at nuclear power plants. These exercises enable the actors involved to capitalise on their knowledge and experience in emergency management, particularly for the 300 or so field workers mobilised for each exercise. They enable:

- measuring the level of preparedness of each prefecture and other stakeholders involved;
- ensuring that plans and procedures for alerting and rapidly notifying international authorities are kept up to date and are well known to all managers and responders;
- training people who are likely to be involved;
- implementing the various aspects of crisis management, as well as the procedures set out in the various plans and guidelines (national plan, interministerial guidelines, emergency plans and local safeguard plans);
- contributing to informing the media and the public;
- developing an educational approach aimed at civil society, enabling everyone to contribute to their own safety by adopting the right behaviour.

In addition, ASN also participates in local exercises organised by operators, without the involvement of the public authorities. These exercises help to strengthen the training of expert and to formulate operational recommendations.

ASNR also participates in international exercises (IAEA ConvEx, NEA INEX, European Commission ECUREX) and hosts foreign delegations during national exercises. It also observes exercises conducted

abroad. These exchanges promote the dissemination of good practices and strengthen coordination and mutual understanding between authorities.

### **Development of cross-border cooperation**

Aware of the potential transnational effects of a nuclear accident, ASNR is developing cooperation with neighbouring countries.

In 2023, a trilateral working group was set up with Luxembourg and Germany to formalise operational arrangements for the exchange of information in the event of a crisis. These were successfully tested during the Civaux exercise in January 2024. The system tested is based in particular on the proactive exchange of information via the USIE (IAEA) and ECURIE (EU) platforms, the organisation of inter-authority videoconferences on the technical situation and recommendations issued in terms of measures to protect the population.

Based on these results, it was decided to continue these simulations on a regular basis, integrating them into national exercises and extending them to other neighbouring countries (Belgium, Switzerland).

### **Integration into international assistance networks**

France is a signatory to the IAEA's international conventions on early notification and assistance in the event of a nuclear or radiological accident.

ASNR has actively contributed to the development of notification and assistance tools for Member States proposed by the IAEA and the European Commission, in particular the IAEA's USIE tool. These tools are available at the ASNR emergency centre and are tested during exercises.

ASNR has a database listing the human and technical resources available in the event of an emergency and has been part of the RANET (IAEA) network, dedicated to international response to accidents, since 2008.

### **Information and coordination in emergency situations**

In addition to the IAEA's international conventions, France applies the Euratom Decision on the rapid exchange of information. ASNR is the competent authority for these conventions, ensuring the collection, synthesis and transmission of information to international organisations and potentially affected countries, in particular neighbouring countries.

At the national level, a structured crisis communication system is implemented in conjunction with local authorities (prefects, mayors) and national and international institutions. Brochures are distributed in advance to the public to explain the risks and measures to be taken. In the event of an incident, ASNR is involved in disseminating information to the media, the public, the authorities and foreign safety organisations.

### **Involvement in working groups on emergency preparedness**

ASNR actively participates in the HERCA working group on emergencies, which is responsible for proposing harmonised protection measures at European level, particularly in light of the lessons learned from the Fukushima Daiichi accident.

At the multilateral level, ASNR participates in the IAEA's EPreSC committee and the NEA's Working Party on Nuclear Emergency Matters (WPNEM), where it contributes to the development of international standards and coordination between authorities.

See Article 16 (§ 16.1.4, § 16.2 and Focus 19).

#### 4.5. Future main activities until the next review meeting in three years

ASNR oversight challenges for the next 3 years, with regard to nuclear reactors, concern:

##### *Authorisation to build EPR2 reactors in Penly*

EDF has launched a programme to build EPR2 reactors in France. The first pair of reactors is planned for the Penly site in Seine-Maritime, the second for the Gravelines site in the North and the third for the Bugey site in Ain.

Following public debate, EDF submitted a creation authorisation application for a BNI for the Penly site to the Minister responsible for nuclear safety at the end of June 2023.

As provided for in Article L. 592-29 of the Environment Code, the Minister responsible for nuclear safety has referred the matter to ASN for technical review of the creation authorisation application for the two EPR2 reactors at the Penly site. This review is currently underway and follows on from the review of the safety options for the EPR2 reactors, which was the subject of an ASN opinion in 2019 specifying the subjects of the safety reference framework to be further developed for a future creation authorisation application.

ASNR will issue its opinion on the creation authorisation application for the two EPR2 reactors at the Penly site in 2026.

##### *IRRS mission (2027)*

ASNR has already hosted several IRRS missions, an initial mission in 2006, followed by a second full-scope mission in 2014.

In September 2023, while ASN's IRRS mission was scheduled to take place in March 2024, France informed IAEA of its intention to postpone the mission. Indeed, maintaining the mission in 2024 carried the risk, due to potential changes in the governance of nuclear safety and radiation protection oversight, that certain parts of the assessment would lose their relevance, in particular those relating to the organization of control, the management system, as well as the action plan developed as part of the self-assessment.

The third IRRS mission is now planned for 2027.

##### *Perspectives for the operation of the existing fleet beyond 60 years*

In June 2023, ASN requested that EDF provide advance justification for the assumption that the current reactors will continue to operate until 60 years and beyond. In this regard, EDF, IRSN and ASN have identified the technical issues that require specific analysis, or even research and development, in order to consider continued operation beyond 60 years. Based in particular on reviews conducted with international experts, EDF has analysed each technical issue and identified the work to be carried out in the coming years.

These analyses are currently being reviewed by ASNR. In 2026, ASNR will issue a statement on the safety aspects of EDF's action plan for the continued operation of reactors beyond 60 years.

#### 4.6. Implementation of the principles of the Vienna Declaration

The Vienna Declaration, adopted in February 2015, sets out the principles relative to implementation of the objective of the Convention on Nuclear Safety, which is to prevent accidents that could have radiological consequences and to mitigate these consequences should they occur.

1. *New nuclear power plants are to be designed, sited, and constructed, consistent with the objective of preventing accidents in the commissioning and operation and, should an accident occur, mitigating possible releases of radionuclides causing long-term off-site contamination and avoiding early radioactive releases or radioactive releases large enough to require long-term protective measures and actions.*

For the design of the EPR reactor, three main improvement objectives with respect to the preceding reactors have been adopted, which figure in the *"technical directives for the design and construction of the next generation of pressurised water nuclear reactors"*:

- reduce the number of incidents with the aim of reducing the possibilities of accident situations arising further to such events;
- significantly reduce the probability of core melt;
- significantly reduce the radioactive releases that could result from all conceivable accident situations, including core melt accidents. The technical directives stipulate in this respect that:
  - *"for accident situations without core melt, there shall be no necessity of protective measures for people living in the vicinity of the damaged plant (no evacuation, no sheltering)"*;
  - *"low pressure core melt sequences have to be dealt with so that the associated maximum conceivable releases would necessitate only very limited protective measures in area and in time for the public. This would be expressed by no permanent relocation, no need for emergency evacuation outside the immediate vicinity of the plant, limited sheltering, no long-term restrictions in consumption of food"*;
  - *"accident situations with core melt which would lead to large early releases have to be "practically eliminated": if they cannot be considered as physically impossible, design provisions have to be taken to design them out. This objective applies notably to high pressure core melt sequences"*.

These EPR safety objectives are those of Principle No.1 of the Vienna Declaration on Nuclear Safety.

Produced jointly with IRSN, ASN Guide No. 22 contains recommendations with regard to safety for the design of pressurised water reactors. The guide focuses essentially on the prevention of radiological incidents and accidents and the mitigation of their consequences. It details the general design objectives and principles and makes recommendations to help meet regulatory requirements. It updates the technical directives adopted by ASN in 2000. The safety objectives are similar to those set out in the technical directives and correspond to those of principle No.1 of the Vienna Declaration on Nuclear Safety.

The Flamanville 3 creation authorisation decree issued in 2007 specifies that *"accidents with core melt which could lead to early large-scale releases are the subject of designed-in preventive measures, supplemented if necessary by operational provisions, the performance and reliability of which should consider this type of situation to be precluded"* and *"that in the event of an accident situation with low-pressure core melt, it would only be necessary to resort to population protection measures that are extremely limited in terms of scope and duration"*. Furthermore, for accidents without fuel meltdown (in the reactor core or pool), the objective is that the radiological consequences should be as low as reasonably achievable and, whatever the case, they must not lead to the need to implement population protection measures (no sheltering, no taking of stable iodine tablets, no evacuation).

In its commissioning authorisation application for Flamanville EPR, EDF provided elements demonstrating achievement of these objectives, elements which have been examined and have been reviewed by the Advisory Committee for Nuclear Reactors. ASN deemed this demonstration satisfactory.

2. *Comprehensive and systematic safety assessments are to be carried out periodically and regularly for existing installations throughout their lifetime in order to identify safety improvements that are oriented to meet the above objective. Reasonably practicable or achievable safety improvements are to be implemented in a timely manner.*

The Environment Code stipulates that BNI licensees must perform periodic safety reviews of their facility, taking international best practices into account (Article L. 593-18). *"This review must allow [...] updating of the assessment of the risks or inconveniences presented by the installation [...], taking into account more specifically the state of the installation, the experience acquired during operation, the development of knowledge and of the rules applicable to similar installations"*.

The periodic safety reviews thus provide the opportunity to conduct large-scale inspections and modifications to installations, intended to improve safety taking account of changes in requirements, practices and knowledge, as well as operational experience feedback. In addition to a verification of installation conformity, they include a safety reassessment aiming to determine the level of safety and to improve it in the light of:

- the French regulations and the most recent safety objectives and practices in France and abroad;
- the operational experience feedback for the installation;
- the operational experience feedback from other nuclear installations in France and abroad;
- the lessons learned from other installations or facilities involving risks.

More specifically, the safety objectives considered for the 4th periodic safety review of the 900 and 1300 MWe plant series were defined in the light of the safety objectives set for the third-generation reactors, and notably the EPR. In this respect, EDF has extended its safety case to the prevention and mitigation of severe accidents, including in extreme beyond-design-basis situations and is implementing major modifications.

In 2011, France began conducting complementary safety assessments further to the Fukushima Daiichi NPP accident: they fitted into a dual context: firstly, the conduct of a nuclear safety audit of the French civil nuclear facilities with regard to the Fukushima Daiichi events, and secondly, the organisation of the nuclear power plant stress tests required by the European Council at its meeting of 24 and 25 March 2011.

The complementary safety assessments were thus carried out following the European specifications for all nuclear installations, that is to say NPPs, research facilities, fuel cycle facilities and installations under construction (EPR, JHR and ITER).

Further to this review, ASN issued resolutions for the BNI licensees so that their material and organisational provisions can:

- prevent a severe accident or limit its progression;
- limit large-scale releases of radionuclides into the environment in the event of an accident;
- enable the licensee to fulfil its duties in an emergency situation.

EDF has introduced significant changes in its installations, with the aim of better preventing/mitigating situations involving total loss of electrical power and loss of the heat sink (reinforcement of the emergency organisation, creation of the FARN rapid intervention force, addition of one diesel generator set and one water source per reactor).

Lastly, Council Directive 2014/87/Euratom of 8 July 2014 introduced the holding of a peer review of a technical aspect relating to the nuclear safety of their nuclear facilities, at least every six years. The first of these Topical Peer Reviews held in 2017 addressed the subject of ageing management. Further to the peer review and its

conclusions, France defined improvement measures which were integrated in the national action plan produced in 2018. By the end of 2020 the actions had been carried out, enabling this plan to be closed.

3. *National requirements and regulations for addressing this objective throughout the lifetime of nuclear power plants are to take into account the relevant IAEA Safety Standards and, as appropriate, other good practices as identified inter alia in the Review Meetings of the CNS.*

France has established and maintains in effect a national legislative and regulatory framework relative to the nuclear safety of BNIs. French legislation and the regulations applicable to BNIs are based on the fundamental principle of the prevention of accidents with radiological consequences and the mitigation of the consequences should an accident occur.

The periodic safety reviews described above integrate the developments in safety standards, particularly those of the IAEA. With regard to the nuclear power reactors, the OSART missions conducted on the sites or at the licensee's head offices are also based on the IAEA standards and current best practices.

The regulatory requirements are subject to regular reviews, which take into account developments in international standards and documents (ICPR, AIEA, WENRA). The BNI Order and ASNR regulations broadly integrate the WENRA safety reference levels into French legislation.

More specifically, the preparation of any new technical regulation at ASNR involves the production of a "Document d'Orientation et de Justification" (Guidance and Justification Document) which presents more specifically the objectives of the text with the reasons for drafting or amending it, the regulatory texts and associated or related guides (upstream, to be adapted, created, modified or repealed, etc.). The international standards such as those issued by the IAEA and the recommendations and reference levels issued by the ICRP or WENRA are taken into account in this document.

Furthermore, the significant involvement of France in the work of the IAEA, as much on the CSS as in the five committees (NUSSC, RASSC, TRANSSC, WASSC, EPreSC) and in WENRA fosters the harmonisation of French regulatory requirements with international standards.

## C. REPORTING ARTICLE BY ARTICLE

### Article 6 Existing nuclear installations

#### ARTICLE 6 EXISTING NUCLEAR INSTALLATIONS

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

### 6.1. Nuclear installations in France

#### 6.1.1. Nuclear power reactors

The fleet of nuclear power reactors currently in operation covered by the scope of this Convention comprises 57 pressurised water reactors (PWR) built in successive standardised series. They are grouped in 18 nuclear power plants (NPPs), each comprising between two and six reactors (see the geographical location map in figure A-1 in Appendix A). All these reactors were designed by the same supplier, Framatome.

Were commissioned between 1978 and 1999 (see figure A-2 in Appendix A) following reactors:

- the 32 reactors of 900 MWe situated on the following sites: Bugey, Dampierre, Gravelines, Blayais, Tricastin, Chinon, Cruas and Saint-Laurent-des-Eaux,
- the 20 reactors of 1300 MWe situated on the following sites: Paluel, Flamanville, Saint-Alban, Belleville-sur-Loire, Cattenom, Golfech, Nogent-sur-Seine and Penly,
- the 4 reactors of 1450 MWe situated on Chooz and Civaux sites.

In December 2024, the average age of the reactors in service, based on the dates of the first divergence of the reactors, is distributed as follows:

- 42 years for the thirty-two 900 MWe reactors,
- 37 years for the twenty 1300 MWe reactors,
- 27 years for the four 1450 MWe reactors.

The 1650 MWe EPR reactor, located at Flamanville, was commissioned in May 2024.

#### 6.1.2. Reactors other than nuclear power reactors

Two research reactors are in service in France:

- the High-Flux Reactor (HFR), situated near the CEA's Grenoble site and operated by the Laue-Langevin Institute (ILL), a research institute comprising several European partners,
- the Cabri reactor, situated at the Cadarache centre and operated by the CEA, and intended mainly for experimental programmes that aim to achieve a better understanding of the behaviour of the nuclear fuel of pressurised water reactors in the event of a reactivity accident.

Two reactors are also under construction in France:

- the Jules Horowitz research reactor (JHR) built in Cadarache by the CEA, in partnership with EDF and Framatome, along with other foreign organisations: it will constitute a European experimental irradiation tool, at the disposal of the nuclear industry, research organisations and nuclear safety authorities and their technical support organisations. It will also produce radionuclides for nuclear medicine and the non-nuclear industry. On 19 July 2023, the Nuclear Policy Council approved the continuation of investment by the State and the nuclear industry to complete the construction of the Jules Horowitz research reactor, so that France will have this new facility operational by 2032-2034;
- the International Thermonuclear Experimental Reactor – ITER has been under construction since 2010 at the Cadarache site. It will be an experimental fusion reactor, whose objective is the scientific and technical demonstration of the control of thermonuclear fusion energy obtained by magnetic confinement of a deuterium-tritium plasma during long-term experiments with significant power (500 MW developed for 400 seconds). This international project is financially supported by China, South Korea, the United States, India, Japan, Russia and the European Union, which are providing some of the equipment for the project in kind.

The list of French research reactors in service and under construction is given in § A.3 of Appendix A.

## 6.2. Overview of safety-related events since the combined eighth and ninth cycles Review Meeting in 2023

ASNR is committed to informing its counterparts on significant events that have affected French nuclear facilities. The aim of this paragraph is to highlight a few notable events that have occurred on the nuclear fleet since the last review meeting:

### Focus No. 1: Stress corrosion affecting reactors in the French nuclear fleet

In autumn 2021, inspections revealed stress corrosion defects on stainless steel welds in the safety injection lines of Civaux N°1 nuclear power plant (N4 series) between the main primary system and the first isolation device.

Stress corrosion is a well-known phenomenon, but it was not expected in this material at these locations. Under significant mechanical stress, stress corrosion could lead to the failure of the safety injection lines, which are designed to ensure the cooling of the fuel in the event of an accident. EDF analysed the consequences of the failure of two safety injection lines in the cold leg and demonstrated that fuel cooling would remain assured.

In view of the results of the inspections carried out on the Civaux reactor, EDF decided to shut down its four N4 reactors, considered to be the most sensitive, as a precautionary measure, and launched an in-depth programme of checks and assessments on its reactors in operation, in some cases anticipating their shutdown in order to carry out checks.

This programme, together with studies performed in parallel, has identified factors that may influence the onset of stress corrosion, as well as the reactors that are most susceptible to it (N4 and P'4 reactors). It has been shown that weld repair during pipe fabrication is an influencing factor, when the repair is carried out under certain conditions. The geometry of the pipes and the thermalmechanical stresses to which they are subjected have also been identified as factors likely to influence the occurrence of stress corrosion. The difference in the geometry of the lines, which determines the position and magnitude of

thermal stresses, would explain the difference in sensitivity between reactor types. The oxygen content in the flow during operation may also play a role: this factor is still being studied.

This programme has enabled a prioritised inspection and repair strategy to be defined for the French reactor fleet. EDF has therefore carried out priority inspections on all N4 reactors. Ultrasonic inspections did not initially identify welds affected by stress corrosion, which required numerous destructive tests. As a result, EDF decided to replace the potentially affected sections of the safety injection lines in P'4 and N4 reactors as a preventive measure. EDF has also developed and implemented new, more effective ultrasonic testing, thereby avoiding any cutting of unaffected lines.

EDF extended the checks to welds that had been repaired on the safety injection and the residual heat removal systems. Finally, EDF has implemented a programme of random checks on the welds of other stainless steel pipes in auxiliary circuits connected to the primary system of the reactors, in order to verify that these pipes are not sensitive to stress corrosion.

At international level, EDF has informed its peers, in particular within WANO, and ASNR has also kept its foreign counterparts regularly informed, given that this phenomenon is also likely to occur in the reactors they regulate.

Following work carried out by an ad hoc group, WENRA issued recommendations, in particular concerning the consideration of stress corrosion cracks in the definition of the inspection programme for stainless steel welds in non-isolable sections of the primary system and the repair procedures for welds.

#### *Detection of cracks on two repaired welds on RHR system of reactor N°2 at Civaux NPP*

##### **Focus No.2: Detection of cracks on two repaired welds on the residual heat removal system of reactor N°2 at Civaux NPP**

Since the discovery of stress corrosion cracks (SCC) in 2021 at Civaux power plant, some sections of the residual heat removal system in reactor N°2 of this plant were replaced in 2022. Inspections carried out in 2025 on the welds of the replaced sections led to the detection of two crack indications.

EDF decided to remove these welds in order to carry out analyses on these welds, enhance its knowledge and support its R&D work.

The analyses carried out after cutting and sampling the pipes concerned revealed the presence of a stress corrosion crack on one of these two welds and a thermal fatigue crack on the other. Both cracks are small. EDF has demonstrated that cracks of this depth do not compromise the integrity of the pipes concerned.

Investigations are ongoing to determine the cause for these defects. They will provide information for deciding whether the in-service monitoring strategy for replaced pipes implemented across EDF's fleet of reactors needs to be revised, particularly with regard to the choice of welds to be subject to periodic inspections, the frequency of these inspections and the types of inspections to be carried out. At this stage, the inspections carried out by EDF on the new pipe sections installed since 2022 as part of the replacement of pipes susceptible to SCC have only revealed these two cracks, out of several hundred inspections carried out.

*Fire outbreaks on emergency diesel generator sets (EDGs)***Focus No. 3: Inspection campaigns following several fire ignitions on EDGs**

The ultimate backup diesel generator set (DUS) is an electrical power source installed in response to technical requirements issued by ASN following the accident at the Fukushima nuclear power plant. Their role is to supply power to the « hardened safety core » systems, which ensure fundamental safety functions in extreme situations.

The commissioning of the DUS for the 1300 MWe reactors was marked by several fire ignitions. Among these, the most significant were ‘candle fires’. This phenomenon is linked to the unusual design of the Fairbanks opposed-piston engine, which has two crankshafts at different heights. The upper crankshaft, located above the exhaust manifold, is lubricated by oil which, after the engine is shut down, can flow by gravity into the exhaust manifold. However, as the manifold is not designed to be oil-tight, the oil can reach the thermal insulation surrounding the manifold and soak into it. When DUS is started, particularly if the start-up is rapid and the diesel engine is running at its rated power, the oil soaked into the thermal insulation heats up and can reach its auto-ignition temperature (around 320 °C), thereby causing a fire. This risk is well known to US operators using Fairbanks engines.

Feedback on this type of engine, as well as its operational specificities, was initially little known to EDF. However, EDF quickly discovered the existence of operational experience, accompanied by recommendations, from US operators using Fairbanks engines. Based on this information, EDF defined significant measures and an action plan to remedy these situations. In particular, EDF proposed changes to the testing programme to limit oil accumulation in sensitive areas and promote its elimination through evaporation. The provisions set out in this action plan were subject to detailed review and close monitoring by ASN.

In addition, ASN carried out a joint inspection with the US nuclear safety authority (US-NRC) at the Fairbanks plant in Beloit, Wisconsin. Discussions with the engine manufacturer highlighted the need to strengthen the periodic testing programme.

*Water hammer in the auxiliary feedwater system (AFW) feed lines of reactor No. 2 at Flamanville NPP***Focus No.4 : Water hammer in the AFW feed lines of reactor No. 2 at Flamanville NPP**

On 11 November 2023, reactor No. 2 at Flamanville NPP was shut down and cooled by the steam generators (SG) following an incident. The operator used the SG blowdown, applying it successively to each SG. This operation requires switching the blowdown from one SG to another every 24 hours.

When switching from one SG to another, the operator stops the blowdown on one and starts it on another SG. At this point, the level of this SG is 45 % narrow range. However, interrupted by a phone call for another task, the operator does not start the AFW supplying this SG before starting the blowdown on this SG. Without a water supply, its level drops rapidly. When the level falls below 40 % narrow range, the low level alarm sounds. When he notes that the SG level is 37 % narrow range, rather than stopping the blowdown, the operator initiates a water make-up via the AFW: he increases the flow rate to 30 m<sup>3</sup>/h in less than 3 minutes. Noises in the SG lines were then heard by both operators and in the control room.

EDF's analysis of the event highlighted the following points:

- **inadequate monitoring of the SG level:** in the situation in question (reactor supplied by the AFW and not by the feedwater flow control system), a minimum level of 50 % narrow range had to be maintained. This instruction was not followed;
- **a lack of awareness of the risk of water hammer associated with falling below 40 % narrow range,** leading to the feedwater ring being drained. The excessively rapid increase in AFW flowrate resulted in an excessive influx of cold water, which led to an almost instantaneous condensation of the steam rising in the feedwater ring, thus generating a water hammer;
- **the non-application of an alarm sheet,** which stipulates that in the event of an unexpected or uncontrolled drop below the 50 % level, the AFW flowrate must initially be limited in order to prevent sudden condensation of the steam rising in the feedwater ring following its uncovering.

Water hammer can induce mechanical stresses that were not taken into account in the design and that could cause damage to the piping. In accordance with the decree of 10 November 1999 on the operational surveillance of the main primary system and main secondary system, this event required a partial requalification of the circuits affected by the water hammer. This partial requalification resulted in a thorough inspection and non-destructive testing of the feedwater and auxiliary feedwater lines concerned, particularly in the reactor building. These operations involved the installation of scaffolding and the prior insulation removal from the pipes. The checks carried out revealed no damage. However, these activities resulted in a significant dose impact.

#### *Uncontrolled drainage of the primary system of reactor N°3 at Tricastin NPP*

##### **Focus No.5 : Uncontrolled drainage of the primary system during a periodic test**

On 15 November 2024, the operator of reactor N°3 at Tricastin NPP was conducting a periodic test to check the operation of the emergency shutdown panel, which is designed to shut down the reactor in the event that the control room has to be evacuated. This periodic test involved testing a valve (3-way valve) connected to the primary system.

During the test carried out by an operator at the emergency shutdown panel, the primary level is monitored by an operator in the control room. At the end of the test, the operator in the control room stopped the ongoing monitoring of the primary level. He did not detect that the 3-way valve was oriented, given the I&C logic in this shutdown state, towards the boron recycle system and not towards the chemical and volume control system, which led to a drain of the primary system and therefore a drop in the water level (3 metres drop) and pressure in the primary system. This drop in the primary level was detected only after an hour by the operator in the control room.

Analysis of the event revealed a lack of knowledge of how this valve operates in this reactor state (set to boron recycle system and not chemical and volume control system) and inadequate monitoring of key reactor parameters.

The water level in the primary system remained above the minimum required level; however, the primary system pressure fell below the OTS limit. This event had no impact on the installation, public or the

environment. However, as the primary system pressure remained below the limit set by the OTS for approximately 35 minutes, this event was classified as Level 1 on the INES scale.

### *Leak in the primary system of reactor N°1 at Flamanville NPP*

#### **Focus No.6: Leak in the primary system of reactor N°1 at Flamanville NPP**

On 22 March 2025, while the operator of reactor N°1 at Flamanville nuclear power plant was conducting the final tests prior to criticality and divergence, following a scheduled shutdown for maintenance and refuelling, fire detectors located inside the reactor building were triggered.

In accordance with its procedures, the operating team called for external assistance. At the same time, it continued to analyse the situation. It determined that the fire alarm had not been triggered by a fire but by a leak of steam from the primary system. As the leak rate exceeded the threshold set by the general operating rules, the operating team applied the procedures for dealing with incidents and accidents, which require the pressure and temperature of the primary system to be reduced.

The leak rate was low enough to be compensated for by the usual primary make-up systems. This event had no other safety consequences.

The water from the leak was collected by dedicated systems within the reactor building. The containment of the reactor building remained intact during the event. This event had no consequences for the environment.

The operator put in place a temporary plugging measure that reduced the leak rate to a few litres per hour, allowing the core to be unloaded and the leak to be repaired under safe conditions.

The operator carried out investigations which showed that the leak originated from a crack in the connection between a purge line and a non-isolable section of the residual heat removal system.

On 25 March 2025, EDF reported a significant event at reactor N°1 of Flamanville nuclear power plant to ASNR due to incident and accident procedures application.

ASNR carried out a reactive inspection on 26 March 2025 to check how the event had been managed and the measures implemented by the operator to deal with the situation.

EDF carried out assessments to determine the causes of the leak. These assessments concluded that the crack was caused by vibration fatigue, even though this area had not been identified as being subject to such stresses. Before restarting the reactor, EDF carried out checks on other pipes and monitored the vibration level on the replaced pipe.

ASNR has asked EDF to provide an action plan to complete the analysis of the precise causes of this fatigue crack and to verify that similar pipes in other reactors do not present a similar risk.

### **6.3. Safety review of nuclear installation and associated safety improvements**

In accordance with the provisions of Article L. 593-18 of the Environment Code, the licensee is obliged to conduct a periodic safety review of its installations every ten years. The periodic safety reviews are an ideal opportunity to conduct large-scale inspections and modifications to installations, with a view to enhancing their safety taking account of changes in requirements, practices and knowledge, as well as operational

experience feedback. The mechanism of the safety review is presented in § 14.1. On completion of the periodic safety reviews, ASN may issue technical requirements for the continued operation of the installations (L. 593 - 19 of the Environment Code).

### 6.3.1. Nuclear reactor improvements

In view of the similarities between the reactors of a plant series, the periodic safety review of the reactors is in practice carried out in two complementary phases: a first "generic" phase common to all the reactors of a given series, as they were all designed to a similar model, and a second "specific" phase which takes into account the characteristics specific to each installation, notably the geographical location.

#### *900 MWe reactors*

At the end of 2025, 25 reactors of the 900 MWe series will have undergone their fourth ten-yearly outage and integrated the main modifications decided during the fourth periodic safety review.

As detailed in Article 14, the safety review of these reactors and the resulting improvements are carried out in the light of the new-generation reactors, such as the EPR, the design of which meets significantly reinforced safety requirements, particular regarding mitigation of the radiological consequences of accidents without core melt in order to significantly reduce the occurrence of situations requiring the implementation of protective measures and as well the reduction of the risk of an accident with core melt and the mitigation of its consequences. In this respect, EDF extended its safety case to include the prevention and mitigation of severe accidents, including in extreme situations beyond the design basis, and has defined major modifications.

Some of the modifications implemented, which are detailed below, have the following aims:

1. Reduce the probability of accident with core melt and the radiological consequences of accidents without core melt: implementation of the refilling of the steam generator auxiliary feedwater tank by the fire-fighting water production system, increasing the atmospheric discharge capacity of the turbine bypass system, interconnection of the ultimate backup diesel generator sets of the even and odd reactor numbers, lowering of the equivalent iodine limit of the radiochemical specifications of the primary system water, etc.;
2. Avoid massive releases and the long-term environmental effects of accidents with core melt: stabilisation of the corium under water by passive reflooding after dry spreading in the reactor pit and the adjacent Incore Instrumentation System room and removal of residual power from the containment without opening the venting device;
3. Have a diversified closed-loop cooling system in case of loss of spent fuel cooling;
4. Improving the hazard resistance of the installation: reinforcement of equipment or circuits to make them resistant to extreme earthquake, modifications (air heaters, ventilation systems, etc.) to reduce the temperature in the premises in heatwave situations, lightning protection measures, etc.

#### *1300 MWe reactors*

At the end of 2025, all reactors of the 1300 MWe series will have undergone their third ten-yearly outage and integrated the main modifications decided during the third periodic safety review.

The studies carried out in this context lead to modifications that significantly improve the safety of the 1300 MWe reactors, particularly with regard to the objectives of:

- reducing the radiological consequences of design-basis accidents, in particular with implementing a modification to avoid the overflow of the affected steam generator in the event of a steam generator tube rupture, in order to limit releases;
- better consideration of certain external hazards, especially:
  - protection of equipment important to safety from projectiles generated by high winds;
  - increasing the capacity of air-conditioning systems in order to maintain, during heat waves, a temperature in the premises compatible with the operation of equipment important to safety;
  - prevention of the risks of explosion in the event of an earthquake by reinforcing the resistance of the hydrogen circuits in the nuclear island and by ensuring automatic shutdown of the electrochlorination installations in an earthquake situation.
- reducing the risk of uncovering the fuel assemblies in the pool, in particular by installing a device for automatic isolation of the suction line of the pool cooling system in case of detection of a very low water level in the pool;
- reducing the risk of early releases in the event of a severe accident, by limiting gaseous radioactive iodine releases with the implementation of sodium tetraborate baskets and lowering the iodine equivalent of the radiochemical specifications for primary system water.

The objectives of the fourth periodic safety review of the 1300 MWe reactors are similar to those of the fourth periodic safety review for the 900 MWe reactors. By 2026, the first 1300 MWe reactor will have completed its fourth ten-year review and incorporated the main modifications associated with the fourth periodic review.

#### **1450 MWe reactors**

The four 1450 MWe reactors have already undergone their second ten-yearly outage, during which the modifications resulting from the second periodic safety review were implemented.

The studies carried out in this context have led to modifications that significantly improve the safety of these reactors, particularly with regard to the objectives of:

- reducing the radiological consequences of design-basis accidents, notably by improving the tightness of the reactor containment (reduction of leaks associated with the sensitive penetrations, leaks at the PTR reservoir and installation of resin sealing coating on the internal containment wall) and improvement in the management of accident procedures for steam generator tube rupture;
- reducing the radiological consequences of accident with core melt and risks of early and significant releases, notably by the installation of sodium tetraborate baskets to limit releases of iodine and the reinforcement of certain equipment that contributes to containment integrity but were not initially designed to operate in the event of core melt (filtration system for the annulus between containment walls and ECCS/CSS leak reinjection system in the reactor building);
- reducing to a residual level the risks of uncovering a fuel assembly stored in the spent fuel pool by draining, particularly by installing automatic low-level closing systems for the drain valves and the suction valves;
- reinforcing of the protection of the installations against explosion risks (gas yards, protection of H<sub>2</sub> pipes, installation of H<sub>2</sub> detectors, control systems, ATEX equipment, etc.), against very hot weather (installation and replacement of the cooling units, replacement of sensitive electrical equipment, etc.), against seismic risks (“seismic event “, reinforcement of the platform between the turbine halls at Civaux, etc.)

The objectives of the third periodic safety review of 1450 MWe reactors are similar to those of the fourth periodic safety review of 900 MWe reactors.

### **6.3.2. Improvements to the high flux reactor (HFR) in the Laue-Langevin Institute (ILL)**

The safety improvements resulting from the last periodic safety review in 2017 aimed to increase the facility's ability to withstand internal and external hazards.

The main improvements concern:

- increased reliability of the polar crane lifting system on level D and reinforcing the polar crane on level C against extreme earthquakes;
- securing the tritium inventory by converting gaseous tritium into tritiated water;
- the addition of fire provisions: automatic extinguisher system in the reactor building areas for experiments and in the red zones;
- improving the leak-tightness reliability of the non-removable section of channel 2 and securing the assembly in the event of a seismic event.

## Article 7 Legislative and regulatory framework

### 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:*

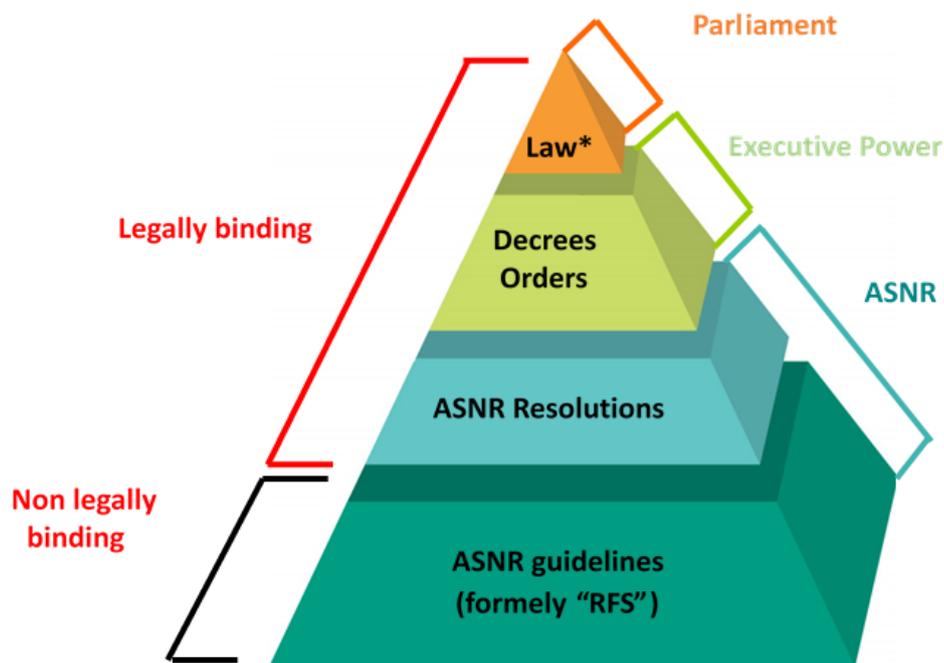
- i) the establishment of applicable national safety requirements and regulations;*
- ii) a system of licensing with regard to nuclear installations and the prohibition of the operation of a nuclear installation without a licence;*
- iii) a system of regulatory inspection and assessment of nuclear installations 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. Establishing a legislative and regulatory framework

### 7.1.1. Overview of the legislative and regulatory framework

The legislative and regulatory framework in France for nuclear facility safety and radiation protection is based on a four-level system:

- Level 1: laws enacted by Parliament,
- Level 2: decrees and orders issued by the Government,
- Level 3: resolutions drawn up by the nuclear safety and radiation protection authority,
- Level 4: guidelines drawn up by the nuclear safety and radiation protection authority.



\* Ordinances, bearing similar power than laws, can also be issued by the government after the review from the Parliament

Figure 1: Different levels of regulation

The Environment Code sets out a specific system for certain installations using radioactive or fissile materials or particle beams “owing to the risks or adverse effects they can present for public health and safety or protection of nature and the environment.” (Article L591-1). These installations are called “Basic Nuclear Installations” or BNIs. Nuclear reactors are among these. Public health and safety, protection of nature and the environment mentioned above, are called “protected interests”. These interests include nuclear safety and radioprotection.

The legislative and regulatory parts of the Environment Code contain most of the BNI creation authorisation provisions, their oversight and enforcement in this field. The provisions specific to BNIs are, with respect to the legislative part, contained in Articles L. 593-1 et seq. of this Code and, with respect to the regulatory part, in Articles R. 593-1 et seq. of the same Code.

The legislative provisions of the Environment Code (Articles L.591-1 to L.597-46) and the Order of 7 February 2012 setting the general rules relating to basic nuclear installations transpose Directive 2009/71/Euratom of 25 June 2009 establishing a community framework for the nuclear safety of nuclear installations. This Directive was modified by Directive 2014/87/Euratom of 8 July 2014.

The Environment Code also contains:

- the provisions specific to the roles and attributions of ASNR, in Articles L. 592-1 et seq. and R. 592-1 et seq. of the Environment code,
- the provisions regarding information, participation of the public (L. 121-1 and R. 121-1 and L. 123-1 et seq. of the Environment Code), the local information committees, transparency in nuclear matters and the right to information (L. 125-10 et seq. of the same Code),
- financial provisions, such as those concerning the creation of decommissioning assets (L. 594-1 and D. 594-1 of the same Code) but also those on the sustainable management of radioactive materials and waste (L.542-1 et seq. and R. 542-1 of the same Code),
- the provisions concerning nuclear pressure equipment (L. 557-1 et seq., L. 595-2 et seq. and R. 557-1-1 et seq. of the same Code).

Orders and ASNR regulations specifying the legislation also govern this field.

ASNR guides contain recommendations that specify safety objectives and describe practices that ASNR considers satisfactory to meet those objectives. They are not regulatory documents.

### 7.1.2. Ratification of international conventions and legal instruments

Article 52 of the French Constitution stipulates that the President of the Republic negotiates and ratifies treaties, including international conventions. The ratified conventions are published in the Official Journal of the French Republic (JORF).

The conventions linked to nuclear safety ratified and published by France notably include:

- the Convention on Nuclear Safety, published in the JORF by Decree of 31 October 1996. In 2015, the contracting parties to the convention, taking account of the lessons learned from the Fukushima-Daiichi NPP accident, adopted the Vienna Declaration on Nuclear Safety;
- the Joint Convention on the Safety of Spent Fuel Management and the Safety of Radioactive Waste Management, published in the JORF by Decree of 5 November 2001;
- the Convention on Third-Party Liability in the Field of Nuclear Energy (1960 Paris Convention). France also ratified the protocols signed on 12 February 2004, reinforcing the Paris convention of 29 July 1960 and the Brussels convention of 31 January 1963 concerning third-party liability in the field of nuclear energy;

- the Convention on Early Notification of a Nuclear Accident, published by Decree of 2 June 1989;
- the Convention on Assistance in the Case of a Nuclear Accident or Radiological Emergency, published by Decree of 2 June 1989;
- the Espoo<sup>3</sup> Convention on Environmental Impact Assessment in a Transboundary Context, published by Decree of 5 December 2001;
- the Convention on Access to Information, Public Participation in the decision-making process and Access to Environmental Justice<sup>4</sup>, published by Decree of 12 September 2002;
- the Euratom<sup>5</sup> Treaty, signed by France in Rome on 25 March 1957. It entered into force in 1958.

## 7.2. Content of the regulatory framework

### 7.2.1. National safety requirements and regulations

#### 7.2.1.1. Overview of the secondary legislation for nuclear safety

##### *The “BNI Order” of 7 February 2012*

Issued pursuant to Article L. 593-4 of the Environment Code, the Order of 7 February 2012 setting the general rules relative to BNIs, called the “BNI Order”, defines the general rules for the design, construction, operation, closure and decommissioning of basic nuclear installations, as well as the final shutdown, upkeep and surveillance of radioactive waste disposal facilities for the protection of the interests protected by Article L. 593-1 of the same Code (see § 7.1.1). It notably incorporates rules corresponding to the best international practices into French law. It takes up and reinforces prior regulations, more specifically giving a legal foundation for ASNR’s requests.

This Order contains:

- provisions on the licensee’s organisation and its responsibilities, detailed in the sections specifying the regulatory framework in chapters 10, 11, 12, 13, 14 and 19;
- provisions on the integrated safety management system, detailed in the sections concerning the regulatory framework in chapters 10, 13, 14 and 19;
- provisions concerning SSCs, so that they can perform the functions assigned to them, detailed in the sections specifying the regulatory framework in chapters 13, 14, 18 and 19; in particular, provisions of this Order require that the licensee identify the protection important components (PIC)<sup>6</sup> of the protected interests. These PICs undergo qualification, proportionate to the issues, with the aim in particular of guaranteeing their ability to fulfil their assigned functions with respect to the stresses and environmental conditions associated with the situations for which they are required;

<sup>3</sup> The Espoo convention requires the State in which a project is planned to examine its environmental consequences for the neighbouring States and stipulates that the State in which the project is planned must notify the affected part of the neighbouring State of any project liable to have a significant prejudicial transboundary impact on the environment. It enables the neighbouring State to take part in the environmental impact assessment procedure.

<sup>4</sup> The Aarhus convention comprises three objectives: to improve access by citizens and associations to environmental information, to enable extensive participation by them in the decision-making process and facilitate their access to justice with respect to damage caused to the environment.

<sup>5</sup> The purpose of the EURATOM Treaty is the development of nuclear energy while protecting the population and workers against the harmful effects of ionising radiation.

<sup>6</sup> PICs are defined as performing functions that demonstrate that interests are sufficiently protected.

- provisions concerning activities important for the protection of protected interests, detailed in the sections specifying the regulatory framework in chapters 12 and 13; in particular, provisions of this Order require the licensee to identify the activities important for the protection of protected interests (PIA)<sup>7</sup>. The activities, their technical inspections and the verifications and assessments are documented and traceable such that compliance with the defined requirements can be demonstrated a priori and subsequently verified a posteriori;
- provisions concerning water intake, effluent discharge and monitoring, detailed in the section specifying the regulatory framework in chapter 15;
- provisions concerning design, detailed in the sections specifying the regulatory framework in chapters 17 and 18;
- provisions concerning the management of emergency situations, detailed in the sections specifying the regulatory framework in chapter 16;
- provisions concerning the analysis and reporting of significant events, detailed in the sections specifying the regulatory framework in chapter § 19.6.

This Order also contains provisions regarding information of the public.

After ten years of application of this Order, its revision is in progress. The operators and ASN have thus drawn up the feedback on the application of this Order and have identified the provisions that require changes, namely the concepts of PICs and PIAs, the identification and processing of deviations, the oversight of the subcontracting chain, the general operating rules, non-radiological risks in the safety demonstration, waste management, decommissioning, emergency management and environmental protection provisions.

The ministry responsible for nuclear safety has entrusted ASN with the preparation of this revision. ASN has thus brought together the operators on several occasions, on each of the identified topics, in order to define the necessary developments and assess their impacts. ASN has endeavoured to simplify the provisions as far as possible and to ensure, in any case, that the text is not made more complex.

The revised version of this Order will be submitted for public consultation.

### ***Orders relative to pressure equipment***

BNIs comprise two types of pressure equipment:

- the nuclear pressure equipment (NPE) making up the main primary and secondary systems (MPS and MSS) for pressure water reactors and NPEs confining radioactive products;
- conventional pressure equipment (CPE) that contains non-radioactive fluids (or whose radioactivity can be disregarded).

The regulation provisions for pressure equipment are based on the following principles:

- the design and manufacture of the equipment must be able to meet the essential safety requirements, which are defined by national regulations on the basis of the annexes to European Directive 2014/68/EU of the European Parliament and Council of 15 May 2014 on the harmonisation of the laws of the Member States relative to the making available on the market of pressure equipment. These requirements concern both the analysis of the risks relating to the equipment, the appropriateness of the materials and manufacturing processes with respect to the intended uses, non-destructive inspections, etc. These requirements are

<sup>7</sup> PIAs are defined as participating in provisions that demonstrate that interests are sufficiently protected.

tailored to the nature of and the risks presented by the equipment, taking account of certain specific factors for NPE, including the radioactivity of the fluid;

- the compliance with these essential safety requirements must be ensured throughout the lifetime of the equipment, which is guaranteed via in-service monitoring requirements. Depending on the risk level, these requirements may include periodic inspections, or periodic requalification operations.

The main primary system and the main secondary system of PWRs are subject to specific in-service monitoring requirements, given the essential role of these systems and the potential implications if they break. The Order of 10 November 1999, thus requires the creation of a regulatory reference files specifying the non-destructive checks and examinations appropriate to the loads, situations and ageing modes which these systems are liable to encounter. They are subject to periodic requalification checks every ten years, with a hydraulic pressure test, under the direct supervision of ASNR. The performance of these checks coincides with the performance of the reactor periodic safety reviews.

The manufacture of pressure equipment is governed by two regulatory texts:

- for NPEs, the decree of 30 December 2015 (which also sets out the in-service monitoring requirements applicable to other NPEs than those that form the MPSs and MSSs of the PWRs).
- for CPEs, the European directive which is also applicable to CPEs intended for conventional installations.

#### 7.2.1.2. *Overview of regulations and guides issued by ASNR*

##### ***Technical regulatory resolutions issued by ASNR***

Pursuant to the Environment Code, ASNR can issue regulations to clarify the Decrees<sup>8</sup> and Orders<sup>9</sup> issued relating to nuclear safety and radiation protection. They are subject to homologation by the Minister in charge of nuclear safety or radiation protection (Articles L. 593-19 and L. 592-20 and Article R. 592-17 of the Environment Code). The purpose of this homologation is to ensure that the regulations adopted by ASNR comply with the higher-level regulations (Decree and Order) that they clarify. Homologation is all or nothing: the Ministers either approve or reject (grounds shall be given for rejection, see Article R. 592-20 of the Environment Code) and may in no case modify ASNR's resolutions.

ASNR's regulations notably clarify the provisions of the "BNI" Order. The technical regulation is consistent with that of the other European States, because it includes the "reference levels" of the Western European Nuclear Regulators Association (WENRA). These regulations take account of the lessons learned from operation of the installations. ASNR regulations are listed in Appendix B.

##### ***ASNR guides and basic safety rules***

On various technical subjects, ASN has developed basic safety rules (RFS in French) and then ASNR guides. These documents contain recommendations which clarify safety objectives and describe practices ASNR considers to be satisfactory to ensure compliance with them. They are not regulatory texts. A licensee may not follow these recommendations if it can demonstrate that the alternatives it proposes implementing are able to attain the objectives.

<sup>8</sup> A decree is a regulatory or individual act taken by the Prime Minister. This act is part of the powers reserved to the executive power by the Constitution.

<sup>9</sup> An order is an administrative act issued by an administrative authority other than the President of the Republic or the Prime Minister. An order is inferior to a decree. The order may be issued by ministers, prefects, mayors, presidents of departmental or regional councils.

The guides take account of the safety requirements for reactor design taken from the publications of the International Atomic Energy Agency (IAEA) and the reference levels, safety objectives or recommendations published by the Western European Nuclear Regulators Association (WENRA).

ASN has published Guide No. 35, which indicates how the WENRA reference levels for reactors have been incorporated into the regulations.

### **Focus No.7: Guide No. 35 - Application of WENRA safety reference levels for nuclear power reactors in operation**

The main mission of the WENRA association is to voluntarily harmonise the national regulations of its member countries, aiming for the highest level of safety reasonably possible. To this end, WENRA has developed a set of safety reference levels for operating nuclear power plants.

ASN Guide No. 35, published in 2023, allows the full breakdown of these safety reference levels, which relate to the technical and organisational provisions for controlling the risks of radiological accidents and their consequences. For each level, it identifies good practices and refers to the corresponding regulatory texts and ASN guides. For the reference levels that have not yet been transposed, the guide clarifies or completes the breakdown.

The guide is primarily applicable to operational nuclear power reactors, but its recommendations also serve as a reference for the design or construction of new reactors.

The list of RFS and guides can be consulted on ASN website.

#### **7.2.1.3. Process to produce regulatory and related documents**

The process for drafting a regulatory or para-regulatory text includes several stages described in ASN Guide No. 25.

The policy and justification document (DOJ) is the starting point for any new text. It presents the subject of the text and its nature (resolution, guide, etc.), the types of installations or activities concerned, the objectives of the text with the reasons of the drafting or revision, the associated or related regulatory texts and guides (upstream, to transpose, to create, to modify or to repeal, etc.), existing international standards and recommendations (IAEA, ICRP, WENRA) on the topic of the text.

It also indicates the organisation used to draft the text (working group, outside stakeholders), the steps involved in drafting and validation, and consultations whether mandatory or considered to be opportune, the schedule for the main steps in drafting up to the publication and entry into force of the text.

The stakeholders consulted are very diverse: environmental protection associations, local information committees, licensees, local authorities, administrations, various organisations.

## **7.2.2. Licensing system**

### **7.2.2.1. Overview of the licensing system**

The legislation makes provision for several BNI-related authorisations:

- the BNI creation authorisation (L. 593-7 of the Environment Code),
- the commissioning authorisation (L. 593-11 of the same Code),
- the authorisation to change the licensee (R. 593-41 of the same Code),

- the authorisation for BNI substantial modification (I and II of Article L. 593-14 of the same Code) and that for certain noteworthy modifications (L. 593-15 of the same Code).

Although decommissioning does not require an authorisation, once the licensee has notified both the Minister responsible for nuclear safety and ASNR of final shutdown of its BNI, it is carried out under the conditions prescribed in the decommissioning decree.

The following sections detail the provisions of the Environment Code.

### ***Safety options***

An industrial firm intending to operate a BNI may, even before initiating the authorisation procedure, ask ASNR for an opinion on some or all of the options it has adopted to ensure the safety of its facility (Article R. 593-14 of the Environment Code). The applicant is advised of ASNR's opinion, which may provide for additional studies and justifications that could be necessary for a possible creation authorisation application. This preparatory procedure does not take the place of the subsequent regulation reviews, but aims to facilitate them.

### ***Creation authorisation application***

The creation authorisation application for a BNI is filed by a licensee to the Minister responsible for nuclear safety and a copy of this application is sent to ASNR (R. 593-15 of the Environment Code). The application is accompanied by a file comprising a number of items, including the detailed plan of the facility, the impact assessment, the preliminary version of the safety analysis report, the risk management study and the decommissioning plan (R. 593-16 of the same Code).

When an ASNR opinion is issued in the conditions defined in Article R. 593-14, the preliminary version of the safety analysis report identifies the questions already studied within this context, the additional studies performed and the additional justifications provided, notably those requested by ASNR in its opinion. As necessary, it presents the modifications or additions made to the options which were the subject of ASNR's opinion (R. 593-18 of the Environment Code).

ASNR examines the BNI creation authorisation application (L. 592-29 of the Environment Code).

### ***Creation authorisation decree (DAC)***

Based on the technical examination carried out by ASNR and the results of the consultations, a preliminary draft decree authorising the creation of the installation is produced by the Minister responsible for nuclear safety, who sends it to the licensee (Article R. 593-25 of the Environment Code). The licensee has a period of two months to present its comments. The Minister also obtains the opinion of ASNR. The licensees and the Local Information Committee (CLI) can request a hearing of ASNR before it issues its opinion.

The Minister responsible for nuclear safety draws up the draft decree, which is submitted to ASNR for its opinion (R. 593-25 of the same Code). The BNI creation authorisation is granted by a decree from the Prime Minister issued following the report from the Minister in charge of nuclear safety (R. 593-26 of the Environment Code).

The creation authorisation decree defines the perimeter of the installation and determines the time until commissioning (Article L. 593-8 of the Environment Code). It does not set an authorisation duration. It mentions the essential components required for the protection of public security, health and safety, as well as

of nature and the environment, which are the protected interests listed in Article L. 593-1 of the Environment Code.

#### ***ASNR requirements in conjunction with the DAC implementation***

ASNR defines requirements relatives to BNI design, construction and operation, that it deems necessary for protection of the interests (public security, health and safety or protection of nature and the environment).

ASNR also defines the requirements regarding BNI water intake and BNI discharges. The specific requirements setting the limits on discharges into the environment from the BNI (whether under construction or in operation) are subject to homologation by the Minister responsible for nuclear safety.

#### ***Authorisation for the commissioning of a BNI***

Commissioning corresponds to the first use of nuclear materials in the installation (R. 593-29 of the Environment Code). In preparation for commissioning of the BNI, the licensee sends ASNR a file comprising the updated safety analysis report for the facility “as-built”, the general operating rules, the on-site emergency plan and the decommissioning plan.

The authorisation to commission a BNI is issued by ASNR. ASNR verifies that the BNI meets the objectives and rules defined by Articles L. 593-1 to L. 593-6-1 of the Environment Code. In this case, it authorises its commissioning, notifies the licensee of this authorisation and communicates it to the Minister responsible for nuclear safety and to the Prefect, as well as to the local information committee (R. 593-33 of the Environment Code). The BNI commissioning process is described in detail in § 19.1.

#### ***Authorisation for BNI modification***

Any substantial modification of the facility must undergo a procedure similar to that for a creation authorisation application (II of L. 593-14 of the Environment Code).

A modification is considered to be substantial in the following cases:

- a change in the nature of the facility or an increase in its maximum capacity;
- a modification of the elements which led to its authorisation;
- the addition, within the perimeter of the installation, of a new nuclear installation (R. 593-44 and 45 of the Environment Code).

The other modifications are "noteworthy" modifications of the installation and, depending on their significance, require either notification of ASNR or authorisation by ASNR (L. 593-15 of the Environment Code).

On 30 November 2017, ASNR adopted the resolution “noteworthy modifications” to BNIs, which specifies the criteria for distinguishing the noteworthy modifications requiring ASNR authorisation from those requiring notification, as well as the criteria concerning non-noteworthy modifications. This resolution also defines the requirements applicable to the management of noteworthy modifications, more particularly the internal check procedures to be implemented by the licensees. This resolution confirms the responsibility of the licensees for managing noteworthy modifications to their installations, while ensuring that they draw on an appropriate organisation, and enables ASNR to make its oversight more proportionate to the specific implications of each modification.

### ***Authorisations concerning the other facilities located within a BNI perimeter***

Within the perimeter of a BNI, are located the following:

- the BNI;
- equipment and installations necessary for operation of the BNI;
- equipment and installations classified for protection of the environment (ICPE)<sup>10</sup> which do not necessarily have a direct link with the BNI.

The equipment needed for operation of the BNI are entirely subject to the BNI system, even if technically they are comparable to classified installations.

The other equipment within the perimeter of the BNI, but not needed by it, and which by their very nature are subject to another administrative system (IOTA - installations, structures, works or activities with an impact on water – or ICPE) remain subject to this system (pursuant to I of Article L. 593-33 of the Environment Code). ASNR nonetheless has competence to take individual measures and oversee them.

### ***Decommissioning decree***

When the operation of a basic nuclear installation or part of such an installation is definitively shut down, the licensee must carry out decommissioning as rapidly as possible, in economically acceptable conditions (pursuant to Article L. 593-25 of the Environment Code).

The decommissioning file presented by the licensee undergoes the same consultations and inquiries as those applicable to BNI creation authorisation applications and in accordance with the same procedures.

The decommissioning of a facility is prescribed by a decree, issued after consulting ASNR. The decommissioning decree more particularly sets out the characteristics of decommissioning and its completion timeframe. Until the decommissioning decree comes into force, the installation remains governed by the provisions of its creation authorisation decree and ASNR requirements, which may be added to or modified if necessary.

Following decommissioning of the installation, ASNR submits a delicensing resolution to the Minister responsible for nuclear safety, for approval (L. 593-30 of the Environment Code). It is then removed from the list of BNIs.

### ***Environmental assessment***

The Environment code states that projects which, by their nature, scope or location, are liable to have significant impacts on the environment or human health, shall undergo an environmental assessment according to criteria and thresholds defined by the regulations and, for some of them, after a “case by case” review.

With regard to basic nuclear installations (BNI), the following are concerned:

- the creation of a BNI, substantial modifications, decommissioning of a BNI;
- commissioning of a BNI when the impact assessment updated on the occasion of the commissioning authorisation application has significantly changed;

<sup>10</sup> ICPEs are non-nuclear installations subject to specific regulations.

- noteworthy modifications if ASNR considers that they are liable to have noteworthy negative effects on the environment.

The environmental assessment is a process involving several steps:

- the production by the project owner of a report assessing the impacts on the environment (called the “impact assessment”). The environment shall be considered in its entirety: population and human health, biodiversity, land, soil, water, air and climate, material goods, cultural heritage and landscape, as well as the interactions between these components;
- the completion of the planned consultations, notably the consultation of the Environmental Authority, which issues an opinion on the environmental impact assessment report, and consultation of the public and any States concerned;
- the examination by the competent authority responsible for the resolution (Ministry responsible for nuclear safety or ASNR), of all the information presented in the impact assessment and received during the consultations held and from the project owner.

#### 7.2.2.2. *Involvement of the public*

##### ***Public debate***

Pursuant to Articles L. 121-8 and R. 121-2 of the Environment Code, the creation of a BNI is subject to the public debate procedure.

The public debate organised by the National Commission for Public Debate (CNDP) is an opportunity for all those who feel concerned to express their views and question the project owner on the appropriateness, the objectives and the characteristics of the project.

##### ***Public inquiry***

In addition to a public debate organisation, the BNI creation authorisation is issued after the public inquiry (R. 593-21 of the Environment Code).

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

Pursuant to the Environment Code, the Prefect opens the public inquiry at least in every municipality which has any part of its territory located within a 5 km radius of the installation perimeter. The duration of this inquiry, set by the Prefect, is a minimum of one month. The file submitted by the licensee to support its creation authorisation application, comprising in particular the impact assessment and the risk management study, is made available. In an understandable format, this file gives the inventory of the risks that the projected installation represents and an analysis of the measures taken to prevent them. It also includes a non-technical summary intended to facilitate the general public's understanding of the information it contains. The opinion issued by the Environmental Authority and the written reply from the licensee to this opinion are enclosed with the file.

On the occasion of the public inquiry, the States concerned are consulted. The authority competent to take the BNI authorisation resolution notifies the States concerned of the Order opening the public inquiry and sends them a copy of the inquiry file.

### Focus No.8: Public debates and public inquiries for EPR2 reactors

In February 2022, French President Emmanuel Macron announced his intention to launch a programme to build six EPR2 reactors. EDF and French Transmission System Operator (RTE) then contacted the National Commission for Public Debate (CNDP), which decided to launch a public debate on this industrial programme and the project for the first pair of EPR2 reactors in Penly, Normandy, which took place from 27 October 2022 to 27 February 2023.



As soon as a project has a significant impact on the environment according to criteria defined in the Environment Code, such as an airport, motorway or new nuclear facility, the project manager must contact the CNDP. Representatives of the commission visit the site to gain a clear understanding of local residents' expectations and the issues at stake in the proposed project. It defines and implements the most appropriate mechanisms to ensure that all those concerned by the project are informed about it and have the opportunity to discuss it before any decision is made.

This initial four-month public debate resulted in around 10,000 participants at 70 events, more than 2 million views of the debate on social media, 26 hours of debate available for replay, 1,590 opinions expressed and 229 questions answered by EDF on the platform, and a record 79 stakeholder reports published. The commission published its assessment<sup>11</sup>, report<sup>12</sup> and recommendations on 26 April 2023 at the end of the two-month regulatory period.

EDF published its resolution<sup>13</sup><sup>14</sup> on 28 June 2023 "to continue preparing the industrial programme for three pairs of EPR2 reactors, and in this context:

- initiate the creation authorisation application procedure (DAC) for the first pair of EPR2 reactors at Penly, as well as the other administrative procedures necessary for its completion, and apply to RTE for connection to the electricity transmission network;
- make commitments to ensure the successful territorial integration into the local community in Penly, and take its full place alongside local authorities and the State in the major construction project procedure implemented by the State."

The first authorisations for the Penly EPR2 project were obtained in June 2024 following a public inquiry held in February, allowing preparatory work to begin in autumn 2024. Ongoing consultation<sup>15</sup> with CNDP guarantors will enable information and dialogue with the public on the Penly project to continue throughout the construction period.

<sup>11</sup> <https://www.debatpublic.fr/sites/default/files/2023-04/PenlyEPR-Bilan-presidente.pdf>

<sup>12</sup> <https://www.debatpublic.fr/sites/default/files/2023-04/PenlyEPR-Compte-rendu.pdf>

<sup>13</sup> [https://www.debatpublic.fr/sites/default/files/2023-07/EPR2-Penly\\_D%C3%A9cision-MOA\\_vdef%2028-06-2023.pdf](https://www.debatpublic.fr/sites/default/files/2023-07/EPR2-Penly_D%C3%A9cision-MOA_vdef%2028-06-2023.pdf)

<sup>14</sup> [https://www.debatpublic.fr/sites/default/files/2023-07/EPR2-Penly\\_Note-accompagnement-EDF\\_Vdef%2028-06-2023.pdf](https://www.debatpublic.fr/sites/default/files/2023-07/EPR2-Penly_Note-accompagnement-EDF_Vdef%2028-06-2023.pdf)

<sup>15</sup> <https://projet-penly.edf.fr/>

In November 2023, EDF and RTE submitted the second project of the EPR2 programme to the CNDP, which decided to organise a public debate on the two EPR2 projects in Gravelines<sup>16</sup>, which began on 17 September 2024 and lasted four months.

In May 2024, EDF and RTE submitted the third project of the EPR2 programme to the CNDP, which decided to organise a public debate on the two EPR2 reactors in Bugey<sup>17</sup>, held from 28 January to 15 May 2025.

### **Creation of a Local Information Committee (CLI)**

The Environment Code states that “a local information committee is created for any site comprising one or more basic nuclear installations (...). This committee is tasked with a general duty of monitoring, information and consultation regarding nuclear safety, radiation protection and the impact of nuclear activities on people and the environment, with regard to the installations of the site. It disseminates the results of its work broadly in a form accessible to the greatest number”. (Article L.125-17).

CLI costs are financed by the State, the local authorities and their groupings (L. 125-31 of the Environment Code).

It is the Chairs of the Councils of the *départements* in which the BNIs are located who create these CLIs.

A CLI comprises elected officials (members of Parliament, of the Senate, councillors at regional, *département* and municipal levels), one of whom is elected Chair, representatives of environmental protection associations, trades union organisations of the BNI employees, persons appointed for their expertise in the nuclear or information fields and, if the BNI site is located in a *département* on the border with a foreign State, representatives from the regions of the States, environmental associations and qualified persons from these same regions (L. 125-20 and R. 125-57 of the Environment Code).

At least once a year, they organise a public meeting and produce an activity report which is made public (R. 125-62 of the Environment Code). They are tasked with regularly reporting to the public the information they receive from the licensees, ASN and the other State departments (R. 125-64 of the same Code). The representatives of ASN and of the other State departments may attend the committee meetings and their works (II of L. 125-20 of the Environment Code). The CLI Chairman may ask the licensee to organise a visit of the installation for the members of the CLI, in order to present its operation to them.

The CLI can address any nuclear safety and radiation protection queries to ASN (L. 125-27 of the same Code). In the same way as the licensees and the State, ASN must also communicate all documents and information needed by the CLI to carry out its duties (L. 125-24 of the same Code) and consult the CLI concerning any project subject to a public inquiry (L. 125-26 of the same Code). The same provisions state that ASN may refer to it, if necessary, in the other cases.

The CLI may be given a hearing by ASN Commission before ASN issues an opinion to the Government on a draft individual resolution concerning an installation (Article 3 of ASN resolution 2010-DC-0179 of 13 April 2010).

<sup>16</sup> <https://www.debatpublic.fr/projet-nouveaux-reacteurs-nucleaires-gravelines>

<sup>17</sup> <https://www.debatpublic.fr/construction-dune-paire-de-reacteurs-epr2-sur-le-site-du-bugey-5849>

### 7.3. System of regulatory inspection and assessment of nuclear installations

The law entrusts ASNR with oversight of nuclear installations. In the interests of administrative efficiency, ASNR has also been entrusted with oversight of pressure equipment and nuclear pressure equipment in BNIs and labour inspectorate in nuclear power plants. In addition, Ordinance 2016-128 of 10 February 2016 expanded the scope of ASNR oversight and regulation to the suppliers, contractors and subcontractors of licensees, including for activities performed outside BNIs.

Oversight and regulation of nuclear activities is a fundamental responsibility of ASNR. Its primary goal is to ensure that all BNI licensees effectively meet their obligations, notably their prime responsibility for nuclear safety and radiation protection of the public (see § 9.1). ASNR applies the principle of proportionality to guide its actions in order to adapt the scope and thoroughness of its oversight to the significance of the issues - nuclear, health and environment.

ASNR has a vision of oversight and regulation encompassing material, organisational and human aspects. The oversight priorities are defined with regard to the risks inherent in the nuclear installations, the behaviour of the licensees and the means they deploy to control them.

Oversight is carried out:

- before construction, in the frame of the review of the creation authorisation decree, by examination and assessment of the application files, documents and information supplied by the licensee. This oversight aims to ensure that the information and justifications provided are pertinent and adequate;
- during construction, by means of visits, inspections of all or part of the installation and during interventions with major safety implications, by means of documentary verifications and analysis of the results provided by the licensee. This oversight includes the assessment of the justifications provided by the licensee;
- during operation, by means of visits, inspections of all or part of the installation and during interventions with major implications (such as scheduled outages of nuclear reactors), by means of documentary verifications, by analysis of significant events, of the results provided by the licensee and the modification files. This oversight includes the assessment of the justifications provided by the licensee.

Following safety and radiation protection assessments, ASNR implements its oversight action by issuing resolutions, binding requirements, inspection follow-up letters and technical instructions, plus enforcement actions as applicable.

#### 7.3.1. BNI oversight procedures

ASNR oversight procedures are tailored to the specificities and risks of the installations (NPPs, research reactors, nuclear waste facilities, etc.) and are implemented by means of the following actions:

- inspection, generally on the site. This consists in performing, on a sample basis, checks to verify that a given situation complies with regulatory or technical standards, but also, where applicable, assessing the operator's practices in relation to current best practices (more details in § 14.2.3, § 19.2.4);
- analysis of the licensee's justifications to prove that its activities are acceptable in terms of radiation protection and safety (more details in § 14.1.3, § 18.1.3, § 18.2.3);
- analysis of operating experience feedback, more specifically through analysis of significant events (more details in § 19.6.4);
- approval of organisations and laboratories taking part in radioactivity measurements and radiation protection inspections, and as well as of organisations qualified for pressure equipment inspections;
- presence in the field, which is also frequent outside actual inspections.

When ASNR oversight actions reveal breaches of compliance with the regulations, enforcement measures (see § 7.4) may be imposed on the licensees.

### 7.3.2. ASNR organisation for BNI oversight

For the purposes of its oversight, ASNR has inspectors appointed and accredited by ASNR Chairman (L. 569-2 of the Environment Code and L. 1333-29 and 30 of the Public Health Code), subject to them having acquired the requisite legal and technical skills through professional experience, mentoring or training courses. They carry out their inspection activity under the authority of ASNR Director-General and have regularly updated practical tools at their disposal for the performance of their inspections. They take an oath and are bound by professional secrecy.

To obtain accreditation, an inspector must follow a course which depends on their field of accreditation: BNI inspection, nuclear aspects of medical activities, etc. While taking account of the particularities of each of these fields, the courses comprise:

- a core training course provided by a large extent by experienced inspectors, but also by external instructors;
- participation in inspections;
- immersion of up to 2 weeks in an installation or facility of the type that the inspector will be required to inspect;
- mentoring.

Account is taken of the inspector's past experience, so that they can validate a part of the course on the basis of equivalence.

The accreditation process generally takes 1 year. The fact that an inspector is undergoing accreditation does not prevent them from playing an active part in an inspection, depending on the capabilities already acquired.

ASNR has about 200 nuclear reactor inspectors, who can call on in-house experts (civil engineering, instrumentation and control, fuel etc). ASNR has no resident inspectors. The inspectors in the regional divisions (see § 8.1.2.2) are responsible for inspecting certain sites and also carry out inspections on all the sites in a regional division. In addition, to further strengthen the sharing of practices between the inspectors, each regional division inspector must carry out at least one inspection in an installation outside their division, every year.

In 2017, ASN created the position of chief inspector, whose main role is to coordinate inspection policy. This coordination concerns the construction and monitoring of the annual inspection programme, notably ensuring that inspection practices innovate in order to cover fields hitherto little addressed (skills of operators in the control room, licensee procurement policy, etc.). In this respect, the chief inspector leads certain inspections that are complex or entail significant challenges.

He pays particular attention to skills development (initial and continuing training) and to inspection practices development (development of cross-inspections, etc.). To do this, he takes part in inspections to assess the development needs.

Many tools are available to the inspectors for their inspections. There are documentary tools:

- general procedures and guides for inspections, such as inspection follow-up letter templates;
- inspection guides and guidance sheets, organised by topics, detailing the technical aspects that can be checked.

Digital tools have also been developed in recent years, in particular SIANCE, an inspection follow-up letters search tool using artificial intelligence, OURSIN, a tool to help with drafting of follow-up letters in the nuclear activities sector, or CANEVAS, for creating a detailed agenda.

The numerous thematic discussion networks and collaborative spaces are also forums for discussion and sharing of practices.

The inspection carried out by ASN is based on the following principles:

- the inspection aims primarily to verify compliance with the provisions that are mandatory under the regulations. It also aims to assess the situation with regard to the nuclear safety and radiation protection implications; it seeks to identify best practices, practices that could be improved and assess possible developments of the situation;
- the scope and depth of the inspection is adjusted to the risks inherent in the activity and the way they are effectively taken into account by those responsible for the activity;
- the inspection is neither systematic nor exhaustive; it is based on sampling and focuses on the subjects with the highest potential consequences.

The inspections may be unannounced or notified to the licensee a few weeks before the visit. They take place in the workplaces of the entity being inspected, while it is carrying out its activities. They may concern the head office departments or design and engineering departments of the nuclear licensees, the workshops or engineering offices of the subcontractors, the construction sites, plants or workshops manufacturing the various safety important components.

ASN uses various types of inspections:

- routine inspections;
- reinforced inspections, which consist in conducting an in-depth examination of a targeted topic by a larger team of inspectors than for a routine inspection;
- in-depth inspections, which take place over several days, concern a number of topics and involve about ten or so inspectors. Their purpose is to carry out detailed examinations and they are led by senior inspectors;
- inspections with sampling and measurements. These enable independent sampling checks to be carried out on discharges and in the environment surrounding the facilities, irrespective from those carried out by the operator;
- event-based inspections carried out further to a particularly significant event;
- worksite inspections, ensuring a significant ASN presence on the sites on the occasion of reactor outages or particular work, especially in the construction or decommissioning phases;
- inspection campaigns, grouping inspections performed on a large number of similar installations, following a predetermined template.

#### **7.4. Measures designed to ensure compliance with the applicable regulations and the authorisation conditions**

In certain situations, in which the actions of the licensee fail to comply with the regulations in force, including individual resolutions, or when it is important that appropriate action be taken to remedy the most serious risks without delay, ASN may resort to enforcement measures and impose the penalties provided for by law. Moreover, criminal infringement reports (violation, misdemeanour) can be issued by ASN inspectors and

transmitted to the competent local Public Prosecutor's Office, which will assess whether or not to initiate prosecution.

#### 7.4.1. Enforcement measures and administrative sanctions

ASNR has a range of tools at its disposal regarding a licensee, more particularly:

- the inspector's observations;
- the official letter from ASNR departments (inspection follow-up letter);
- formal notice from ASNR to comply with the regulations in force, within a given timeframe;
- enforcement measures or administrative sanctions, applied after a formal notice. These latter, as set out in law, are as follows:
  - deposit in the hands of a public accountant of a sum covering the total cost of the work to be performed;
  - the automatic completion of the work at the licensee's expense (the sums previously deposited may be used to pay for the work concerned);
  - suspension of operation of the facility until restoration of conformity;
  - a daily fine (an amount set per day, to be paid by the licensee until full compliance with the requirements of the formal notice has been achieved; this amount can be up to 10 million euros for a breach of the provisions applicable to BNIs);
  - administrative fine.

It should be noted that these last two measures are proportionate to the gravity of the infringements observed. Only the administrative enforcement committee, referred to by ASNR Commission, can impose an administrative fine when a formal notice, issued beforehand by ASNR against a licensee to require compliance of the activity with the regulations in force, has not been met by the latter.

The law also makes provision for interim measures to be taken to safeguard security and public health and safety or protect the environment. ASNR can therefore:

- temporarily suspend the operation of a BNI, with immediately notification of the Ministers responsible for nuclear safety, in the event of any serious and imminent risk;
- at any time, order the assessment and implementation of the necessary provisions if the above-mentioned interests are threatened.

#### 7.4.2. Criminal violations

The regulatory texts also make provision for criminal violations, misdemeanours or breaches. This is for example non-compliance with the provisions concerning the protection of workers exposed to ionising radiation, non-compliance with formal notice issued by ASNR, non-compliance with the provisions of ASNR resolutions, or irregular management of radioactive waste. If the event of violation that do not fall within the ASNR jurisdiction, such as for example an irregularity that could be a fraud, and especially so if a misdemeanour is concerned, a report is sent to the Public Prosecutor's Office.

Any violations detected are recorded in reports drawn up by the nuclear safety and radiation protection inspectors and transmitted to the Public Prosecutor's Office, which decides on what subsequent action, if any, is to be taken.

The Environment Code makes provision for criminal penalties, a fine or even a term of imprisonment (up to €150,000 and three years in prison), depending on the nature of the violation.

The number of formal notices served by ASN and the number of reports submitted to the Public Prosecutor's Office concerning the licensees from 2022 to 2024 are shown in Table 7-1.

<b>Year</b>	<b>Formal notice</b>	<b>Report transmitted to Public Prosecutor's Office</b>	<b>Number of labour inspection reports</b>
<b>2022</b>	1	1	2
<b>2023</b>	2	1	2
<b>2024</b>	2	2	3

*Table 7-1: Administrative measures and reports concerning the licensees from 2022 to 2024*

## Article 8 Regulatory Organisation

### ARTICLE 8 REGULATORY ORGANISATION

*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 Nuclear Safety and Radiation Protection Authority (ASNR)

The Nuclear Safety and Radiation Protection Authority (ASNR) is an independent administrative authority responsible for the oversight of nuclear safety and radiation protection for all civil nuclear activities. It was created through the merger of ASN and most of the Institute for Radiation Protection and Nuclear Safety (IRSN). It was established by Law No. 2024-450 of 21 May 2024 on the organisation of nuclear safety and radiation protection governance in response to the challenge of reviving the nuclear industry.

The Act gives ASN competence to issue technical resolutions clarifying the Decrees and Orders relating to nuclear safety and radiation protection. ASNR must be consulted by the Government on general regulatory texts within its areas of competence (L. 592-25 of the Environment Code).

ASNR examines all individual authorisation applications for BNIs. It grants all authorisations, with the exception of the creation authorisation, which is issued by the Government, further to the opinion of ASNR.

The Act also gives ASNR authority to impose requirements on the licensee throughout the lifetime of the facility, including during decommissioning, for example to request correction of a deviation or prevent a particular risk. The nuclear safety and radiation protection inspectors designated by ASNR are responsible for the oversight and control nuclear activities. Labour inspectorate duties in the NPPs is entrusted to ASNR inspectors, who for the purpose of these duties, are placed under the authority of the Minister responsible for labour.

ASNR's duties (set out in Articles L. 592-19 et seq. of the Environment Code) are presented succinctly below:

- ASNR is consulted on draft Decrees and Ministerial Orders of a regulatory nature dealing with nuclear safety (see § 7.2.1);
- at the request of the Minister responsible for nuclear safety, ASNR examines BNI creation authorisation applications, BNI decommissioning files, as well as substantial modification requests concerning these facilities (see § 7.2.2);
- ASNR verifies compliance with the general rules and specific requirements for nuclear safety and radiation protection applicable to BNIs, manufacturing and operation of nuclear pressure equipment. It issues the required approvals to the organisations taking part in inspections (see § 7.3);
- ASNR is involved in the management of radiological emergency situations. It provides technical assistance to the competent Authorities for the drafting of provisions within the emergency response plans to take account of the risks resulting from nuclear activities. When such an emergency situation arises, ASN assists the Government with all questions within its field of competence. It submits its recommendations on the

measures to be taken concerning medical, health or civil protection aspects, it informs the public about the situation, about potential releases into the environment and their consequences. For more details, see the specific chapter dedicated to Article 16 of the Convention;

- ASNR takes part in public education and 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 report to Parliament, to the Government and to the President of the Republic (Article L.592-31 of the Environment Code). It also uses various channels, written materials (annual report) the [www.asnr.fr](http://www.asnr.fr) website, the public information and documentation centre, press conferences, seminars and exhibitions. For more details, see § 8.1.3.

In addition, ASNR conducts and carries out research programmes to strengthen the national expertise capacity and to contribute to the development of scientific knowledge on nuclear and radiological risks. Part of these programmes concern BNIs, particularly reactors.

Finally, ASNR monitors radiation protection on a permanent basis throughout France and contributes to the radiological monitoring of the environment and people exposed to ionising radiation.

### 8.1.1. The independence of ASNR

ASNR is an independent administrative authority. In this capacity, it receives no instructions from the Government or the head of State, nor from any other person or institution. ASNR is a part of the State, but is not a ministerial department, does not answer to any Ministry, and is not subject to Prime Minister's arbitration in the event of disagreement with other public authorities.

Independence from the Government is consolidated by the method of appointment of the five Commissioners making up the Commission, which delivers ASNR's opinions to the Government and takes the main decisions: three of the commissioners, including the Chairman, are appointed by the President of the Republic, while the other two are appointed by the President of the National Assembly and the President of the Senate respectively. The duration of the mandate of the members is a non-renewable six years.

ASNR's independence is also guaranteed by the fact that the Commissioners cannot be revoked. A member may only be removed from office in the event of incapacity or resignation as confirmed by a majority vote of the Commissioners. The President of the French Republic may also remove any commissioner from office in the event of a serious failure to fulfil its duties.

This collegial way of working is a factor in the independence of ASNR.

The ethical rules governing ASNR Commissioners, notably those designed to ensure the independence and impartiality of the Commissioners and to prevent conflicts of interest, are specified in the Ethics Charter of ASNR Commissioners and staff, which is given in Appendix 1 to ASNR internal rules of procedure. These internal rules of procedure are the subject of a resolution published in the Official Bulletin.

### 8.1.2. ASNR organisation

#### 8.1.2.1. ASNR Commission

ASNR is led by a Commission consisting of five Commissioners appointed by decree on account of their competence in the fields of nuclear safety and radiation protection (Articles L. 592-2 et seq. of the Environment Code). ASNR Commissioners exercise their functions on a full-time basis.

The Commission defines ASNR's strategy. In this respect, it is involved in defining general policies, that is ASNR doctrines and guiding principles of ASNR actions in its core missions, which include regulation,

oversight, research, expertise, training, transparency, the management of emergency situations, radiation protection monitoring, radiological surveillance of the environment and people, international relations, etc. In accordance with the law, the Commission gives ASNR opinions to the Government and takes the main ASN decisions.

#### 8.1.2.2. ASNR departments

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

As ASNR was created on 1 January 2025 through the merger of the former ASN and IRSN, an organisational structure was defined, largely based on the existing structure of the former ASN and IRSN.

The head office thus consists of 11 technical departments, 12 cross-functional and support units (see Figure 8-1). Apart from cross-functional and support functions, the role of ASNR technical departments is:

- to deal with generic subjects concerning the activities for which they are responsible. They take part in developing general regulations and coordinate and drive the work of the teams in the regions responsible for field oversight of facilities and activities;
- to provide assessment in safety and radiation protection;
- to conduct research and provide assessment in safety and radiation protection.

ASNR's regional divisions operate under the authority of ASNR regional delegates who are the local ASNR representatives. The divisions conduct most inspections of nuclear facilities, radioactive material transport and other nuclear activities. They examine most authorisation application files submitted by operators within their geographical jurisdiction. They also support ASNR's technical departments that examine the major decisions. In emergency situations, they assist the "*département*" Prefect who is responsible for the protection of the population of the "*département*".

Each ASNR entity contributes to public information on nuclear safety and radiation protection, and helps to foster a culture of radiation protection among the public, tasks entrusted to ASNR by law.



Figure 8-1: ASNR - General Organisation

### Focus No.9: Creation of the Innovative Reactor Department

In response to the emergence of small modular reactors, ASNR has created a dedicated entity for the oversight of innovative reactors, composed of a team of experienced engineers whose missions are to:

- keep a watch on SMR projects that may be subject of a review;
- develop procedures and framework for assessment and oversight tailored to SMRs;
- ensure coordination within ASNR with the necessary related instructions (fuel cycle, waste, etc.);
- review and assess SMR projects and, ultimately, oversee the safety of these reactors in operation;
- participate in international initiatives related to SMRs (IAEA, NEA, WENRA, etc.).

### 8.1.3. Openness and transparency

Information of the public is one of ASNR's tasks, as enshrined in law. The Environment Code (Article L.592-1) states: "[ASNR] participates, in its areas of competence, in informing the public and ensuring transparency." As an independent administrative authority, ASNR is fully responsible for its communication, without being subject to external validation or arbitration.

ASNR communicates actively with the general public, the media, the institutional public and professionals, notably via its website and its Official Bulletin, which publishes all of its resolutions. Throughout the year, ASNR informs the citizens, the media, the institutional public and professionals of the situation of the Basic Nuclear Installations (BNIs) and nuclear activities with respect to the safety and radiation protection requirements. ASNR disseminates its research findings by publishing scientific articles and participating in

conferences. ASNR publishes the results of its expert assessment in safety and radiation protection in the form of expert opinions posted on its website. ASNR works to ensure that the public has reliable information on the nuclear risk and that they develop the right radiation protection reflexes in all circumstances. ASNR develops comprehensive communication vectors combining written publications, the website, the social networks, press relations and meetings and exchanges with the stakeholders. It provides access to the results of radiological monitoring of the territory and regularly publishes a report on the radiological states of the environment in France. It ensures that the principles of nuclear safety and radiation protection are understood by the widest possible audience, it produces explanatory documents and it endeavours to make even the most technical issues understandable. It offers training courses in its areas of expertise.

It presents its entire regulatory and oversight activity and the actions it takes, and widely disseminates its resolutions and position statements, explaining them where necessary. ASNR promotes the involvement of civil society and gives great importance to citizens contributing to decisions on nuclear safety and radiation protection: in this respect, it organises technical dialogue with stakeholders on major issues in order to build on and consolidate its review and assessment and consults the stakeholders and the public on its draft resolutions.

The website [www.asnr.fr](http://www.asnr.fr) lies at the heart of the public information system (between 40, 000 and 62, 000 visitors per month on average). ASNR makes a large number of resources available on [www.asnr.fr](http://www.asnr.fr):

- inspection follow-up letters,
- significant event notifications (as of level 1 on the INES scale),
- information notices and press releases,
- ASNR’s resolutions and key documents (Acts, Decrees, Orders, opinions, etc.),
- expert opinions on safety and radiation protection,
- the opinions and recommendations of its Advisory Committees of experts,
- the results of radiological monitoring of the territory,
- the annual report on the occupational exposure of workers to ionising radiation,
- etc.

Any citizen can address requests for information to ASNR, either on-line (at the address [info@asnr.fr](mailto:info@asnr.fr)) or by letter.

Most of reports, information notices, press releases and publications, and content of particular importance, are also available in English on ASNR website.

Every year, ASNR draws up a report on the state of nuclear safety and radiation protection in France, which is presented to Parliament and to the media (Article L. 592-31 of the Environment Code). This report is public and is available on ASNR website in French and English. Every year, ASNR also organises regional press conferences to report on the state of nuclear safety in the vicinity of the regulated nuclear installations.

ASNR strives to provide the Local Information Committees (CLIs) with tools and assistance to ensure proper information and dissemination to non-expert audiences. ASNR considers that effective operation of the CLIs contributes to safety and it maintains regular dialogue with them. It strives to provide the CLIs the most complete information possible, including by attending their public meetings (for more information on the CLIs, see § 7.2.2.2).

### 8.1.4. ASNR resources

#### 8.1.4.1. Human resources

At the beginning of 2025 (when it was established), ASNR had a total workforce around 2100 staff, including approximately 300 inspectors. Following its establishment, ASNR implemented a common employment plan for private sector employees and civil servants. An integration programme for new employees was also put in place.

The balanced age pyramid and the diversity of profiles in terms of recruitment, and thus of background, ensures that ASNR has the qualified human resources it needs to fulfil its mission. In addition, training, the way younger staff are integrated and the transmission of knowledge guarantee the skills required for the exercise of its missions. A mentoring system, allied with initial and continuous training, whether general, associated with nuclear techniques, or in the legal or communication fields, constitute essential aspects of the professionalism of ASNR staff.

#### 8.1.4.2. Financial resources

The human and operation resources supporting the execution of ASNR assigned missions are funded by the State's general budget and, in certain areas (research, training, etc.), ASNR's own resources.

In 2025 (year ASNR was founded), the ASNR budget amounts to €354 M., including €224 M. for staff expenses and €130 M. for investments and operating expenses. It covers all activities related to research, review and assessment and oversight of nuclear safety and radiation protection.

ASNR Commission issues a yearly opinion on the resources needed for the oversight and regulation of nuclear safety and radiation protection (opinion available on ASNR website).

### 8.1.5. ASNR's Advisory Committees

In preparing some of its resolutions, ASNR relies on the Advisory Committees' opinions and recommendations.

Advisory Committees (GPE) report to ASNR Director General. More specifically, the Advisory Committee for nuclear reactors (GPR) is consulted by ASNR concerning the nuclear safety and radiation protection of nuclear reactors. At the request of ASNR, the GPR analyses the conclusions of the technical expert analysis and issues an opinion along with recommendations.

The GPE comprise experts appointed in a personal capacity on the basis of their competence, from industry, academia and associations. They include foreign experts, which is a means of diversifying the approaches to the problems and benefiting from experience acquired abroad.

ASNR publishes the opinions issued by the GPEs, as well as the subsequent position statements released by ASNR.

## 8.2. The various State stakeholders involved in nuclear safety regulation and oversight

The regulation of nuclear safety and radiation protection in France depends essentially on three actors: Parliament, the Government and ASNR.

- Parliament intervenes in the field of nuclear safety and radiation protection, notably by adoption of laws;
- the Government exercises regulatory power:

○ it is in charge of issuing the general regulations concerning nuclear safety and radiation protection. The Environment Code also tasks it with taking major decisions concerning BNIs (creation authorisation and decommissioning decrees), for which it relies on ASNR's opinion. It also has a number of consultative bodies:

- the High Council for the Prevention of Technological Risks (CSPRT) which assists the Ministers responsible for Installations Classified for Protection of the Environment (ICPE), for nuclear safety and for industrial safety. One of its duties is to examine any draft regulation or any question concerning BNIs that the Ministers responsible for these subjects or ASNR deem useful. The CSPRT gives its opinion in all cases where the law or regulations so require, notably on draft decrees concerning BNIs;
  - the High Committee for Transparency and Information on Nuclear Safety (HCTISN). Any question concerning information about nuclear safety and its regulation and oversight can be referred to the High Committee by the Minister in charge of nuclear safety, by the chairmen of the competent committees of the National Assembly and the Senate, by the Chairman of the Parliamentary Office for the Evaluation of Scientific and Technological choices (OPECST), by the chairmen of the CLIs or by the BNI licensees.
- the Government is also responsible for civil protection in the event of an emergency;
- the definition and implementation of nuclear safety policy is the responsibility of the Minister in charge of nuclear safety;
- the nuclear safety and radiation protection mission (MSNR) of the Ministry for Ecological Transition, draws up, coordinates and implements the Government's duties concerning the nuclear safety and radiation protection of civil facilities.
- ASNR is the independent administrative authority in charge of regulation and oversight of nuclear safety, radiation protection and nuclear activities (for more details, see § 8.1). It carries out its duties in the fields of regulation, authorisations, oversight and support for the public authorities in the management of emergency situations. It contributes to informing the public and ensuring transparency in its areas of competence.

ASNR reports on its activities to the OPECST, at the latter's request, and sends it its annual report on the state of nuclear safety and radiation protection. Several times a year, ASNR is also called to hearings before Parliament about its activity, on subjects relating to nuclear safety and radiation protection and in the context of the budget bill.

Moreover, as set out by the Act establishing the general status of independent administrative authorities and independent public authorities, ASNR, in the same way as any other independent administrative authority:

- sends the Government and Parliament a report on the performance of its duties and on its resources, before 1 June. This report is made public;
- reports on its activity to the competent committees of the National Assembly and the Senate, at their request.

## Article 9 Responsibility of a licence holder

### 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 responsibility is set out in Article L. 593-6 of the Environment Code: “*The licensee of a basic nuclear installation is responsible for the control of the risks and inconveniences that its installation can present for the interests mentioned in article L. 593-1.*” These are protected interests defined in § 7.1.1, which notably concern, safety, radiation protection and protection of the environment.

This Article of the Environment Code also requires that the licensee “*puts in place and formalises an on-site emergency plan (PUI), an organisation and means for controlling incidents and accidents and mitigating their consequences for the abovementioned interests.*”

This Article also requires that the licensee “*puts in place and formalises an integrated management system that takes into account the requirements relative to the protection of the abovementioned interests in the management of the installation.*”

#### EDF

EDF S.A. is the named holder of the creation authorisation decrees for its BNIs and has responsibility as nuclear licensee. To do this, delegations of power are defined according to the management line. The management system implemented contributes to compliance with the rules of nuclear safety and radiation protection in the organisation and operation of the entity and, more generally, to the protection of the interests identified in Article L 593-1 of the Environment Code.

In accordance with the powers granted to him or her by the Board of Directors, the CEO has all the powers needed for EDF S.A. to exercise its duties as nuclear licensee. In particular, he or she determines the strategic orientations regarding nuclear safety and sets the general principles of organisation and resources to ensure that EDF S.A.'s responsibility as license holder is properly exercised, with the assistance of the Group Executive Director in charge of nuclear and thermal production (DPNT) and the Group Executive Director in charge of Projects and Construction Department (DPC).

He or she chairs the Nuclear Safety Council, which sets out the goals regarding all activities concerning fuel, operational engineering and modifications. He or she 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.

In order to define and implement these strategic orientations as organisational principles, the EDF SA CEO relies on the two Group Executive Directors within the EDF Group executive committee, as, given the powers delegated to them by the CEO, they guarantee that nuclear safety and radiation protection are taken into account within their respective perimeters (BNIs under construction / BNIs in operation). They are responsible

for drawing up the general organisational principles such as to ensure correct performance of the function of nuclear licensee by EDF S.A. on the BNIs within their perimeter and implement these principles within these BNIs. They ensure that the design and construction of BNIs throughout their lifecycle comply with the applicable nuclear safety requirements. They are the primary points of contact for the Nuclear Safety and Radiation protection Authority (ASNR).

The Group Executive Director in charge of the Nuclear and Thermal Fleet delegates powers to the Nuclear Production Department (DPN) Director, who is the representative of the EDF S.A nuclear licensee for all the facilities in operation.

The Director of a Nuclear Power Plant (NPP), to whom powers are delegated by the DPN Director, has the necessary means to ensure compliance with the regulations for the BNIs within the NPP under his or her responsibility.

In addition to this management line given responsibility for nuclear safety and radiation protection, each level of the company calls on the services of an Independent Safety Organisation (FIS) which provides an independent view of how the nuclear licensee performs its duties. Each level in the company organises the integration of the FIS into the ad hoc bodies, so that this independent view can be provided at the appropriate level. At each level of the company, the FIS reports to the manager of the level concerned. The Inspector General for Nuclear Safety and Radiation Protection ensures that nuclear safety and radiation protection concerns are correctly addressed for the EDF Group's nuclear installations, and reports to the CEO in this respect.

The EDF organisation is detailed in Appendix C.

### **CEA**

More particularly with regard to nuclear safety, CEA's safety policy is established, renewed and maintained in the form of a four-year continuous improvement plan. It is implemented annually by means of directives.

For the specific case of basic nuclear installations (BNIs), a protection of interests' policy is defined, through which CEA - as the nuclear licensee - ensures that priority is given to the protection of these interests, and that improvement of these measures is sought on a permanent basis. CEA is committed to implementing this policy, defines the objectives and specifies the strategy for attaining them.

The protection of interests' policy concerns BNIs, the operation of which is placed under the operational responsibility of the teams at the Energies Directorate (DES) in the Cadarache, Marcoule and Paris-Saclay centres, and applies throughout all phases in the lifetime of these facilities: design, construction, operation, final shutdown, dismantling, maintenance and surveillance.

The CEA organisation is detailed in Appendix C.

### **ILL**

In accordance with French regulations on BNIs, the members of the ILL Management Board make an explicit commitment to the priority given to the protection of interests, through the definition of a Protection of Interests Policy (PMPI). This policy gives the main guidelines for topics related to the protection of interests for a period of 5 years. ILL has also set up an integrated management system (IMS) which guarantees that compliance with the protection of interests' requirements is taken into account in all of its activities.

With regard to continuous improvement, following each annual IMS management review, the ILL Management Board sets strategic guidelines for the coming year, related to the protection of interest topics defined in the PMPI.

The ILL organisation is detailed in Appendix C.

### ***ITER Organization***

The ITER Organization (IO) is the operator responsible for the nuclear safety of BNI No. 174 to the French government. IO is responsible for the design, manufacture and construction of ITER, as well as its operation until final shutdown. Within IO, the Safety and Quality Department is responsible for all matters relating to environmental protection, nuclear safety and radiation protection.

### ***ASNR oversight***

ASNR oversight aims primarily to ensure that the licensees effectively meet their prime responsibility for risks and inconveniences management. To this end, ASNR makes use of the regulatory framework and individual resolutions, inspections, and if necessary, enforcement measures, in a way that is complementary and tailored to each situation, to ensure optimal control of the risks nuclear activities represent for people and the environment.

In its actions, ASN is particularly careful not to be a substitute for the licensee in the exercise of this responsibility, including when it issues technical prescriptions imposing requirements on a particular nuclear installation. In this respect, the assessments it carries out to prepare its decisions on a nuclear installation always refer to a file prepared by the licensee of that installation.

These assessments are based on in-depth technical discussions with the licensees, including the organisational aspects. It takes into account, in an integrated approach, all aspects of protection of people and the environment.

## **9.2. Transparency and public information by the licensees**

All licensees carry out public information actions and adopt a proactive approach to transparency, more specifically:

- they attend public meetings of CLIs to inform them about activities and events that have taken place;
- they take part in the work of HCTISN;
- they publish the annual report provided for in article L. 125-15 of the Environment Code; this report sets out:
  - the measures taken to prevent or limit the risks and inconveniences of the installation;
  - installation's incidents and accidents;
  - the results of radioactive and non-radioactive environmental discharge measurements;
  - the nature and quantity of radioactive waste stored on the facility site.

### **9.2.1. Measures taken by EDF**

EDF also carries out specific initiatives, which are outlined below.

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 sought and maintained with

the staff and its representatives, the subcontractors, the oversight bodies, the local communities, especially the CLIs (see § 7.3.2.4), and all other nuclear safety stakeholders.

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

In addition, EDF informs the public of any significant events occurring in its facilities, by publishing this on the website of the NPP, or in its external newsletter.

Finally, in 2022, EDF launched a public debate on its construction programme for six EPR2 reactors.

See Focus 8 in Chapter 7.

### **9.2.2. Measures taken by CEA**

In addition to the above actions, the CEA's senior management attends an annual meeting of all CLI representatives based in France at EDF, Orano and CEA facilities.

### **9.2.3. Measures taken by ILL**

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

- participation in the industrial risks regional information campaigns;
- updating of its website ([www.ill.eu](http://www.ill.eu)) with information concerning legislation, reactor safety, environmental monitoring, security, inspections, emergency exercises and incidents. The reinforcements made as a result of the stress tests further to the Fukushima Daiichi NPP accident and the “hardened safety core” concept are presented on the ILL website. Question-and-answer sections were included;
- participation in technical and scientific forums.

### **9.2.4. Measures taken by ITER Organization**

In addition to the actions carried out by all the operators mentioned above, the organisation of information for the public and communication channels are based, among other things, on ITER publications (website, annual reports, press releases, etc.), open days and site visits.

## Article 10 Priority given to safety

### 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. The regulatory framework

The Environment Code (Article L. 593-6) states that “*the licensee shall give priority to the protection of protected interests*”. These are the protected interests defined in § 7.1.1, which notably concern safety, radiation protection and protection of the environment.

The licensee accords this priority “*firstly by preventing accidents and mitigating their consequences on account of nuclear safety. It formalises this policy in a document that explicitly states this priority*”.

Furthermore, the BNI Order stipulates that the licensee shall be responsible for the dissemination to and the comprehension of this policy by any person liable to implement it, including subcontractors. It also requires that the licensee evaluate its policy for the protection of protected interests, as well as the effectiveness of its implementation, at least every five years (Articles 2.3.2 and 2.3.3).

In addition, this Order stipulates that “*the license defines and implements an integrated management system that ensures that the requirements relative to protection of the [protected] interests are always taken into account in any resolution concerning the installation. This system aims primarily to ensure compliance with the requirements of the acts and regulations, the authorisation decree, and the requirements and resolutions of ASN, and the conformity of the policy [concerning protection of protected interests]*” (article 2.4.1).

#### 10.2. Measures taken by EDF

At the highest level of EDF, the priority given to safety is enshrined in a Safety Policy signed by its CEO. This policy sets the requirements and principles so that priority is given to protection of interests, in all the decisions taken at all levels of the company, first of all by preventing accidents and mitigating their consequences in respect of nuclear safety.

This policy, which is inspired by international guidelines and safety requirements (IAEA SF N° 1 and GSR Part 2, INSAG 4 for 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 embody this, with the involvement of the industrial partners.

In addition to this EDF Group Safety policy, each NPP director draws up a Protection of Interests Policy presenting his/her commitment to giving priority to the protected interests and the principles involved in implementation thereof. Moreover, the DPNT, the DISC (Engineering and Supply Chain Department) and the DPC (Project and Construction Department) drew up a joint protection of interests’ policy which applies to any EDF-SA entity carrying out Protection Important Activities (PIA) on behalf of an NPP and to external contractors carrying out PIA. To simplify the implementation and assimilation by all those who need to be familiar with it and the application of this protection of interest’s policy, the first page is common to all these policies.

The responsibility for implementing this policy in each professional sector lies with the corresponding management line. It reaffirms the priority given to safety, to allow the sustainable use of nuclear energy, with strong commitments in terms of behaviour and safety culture, the search for constant progress, openness to international best practices, preparedness for emergency situations, transparency and dialogue. This policy is disseminated to each member of staff and to each contractor and subcontractor.

Each NPP director establishes an integrated management system for all the BNIs under his or her responsibility, which contributes to compliance with the rules of nuclear safety and radiation protection in the organisation and operation of their entity and, more generally, to the protection of the interests identified by the Environment Code. In this respect, he or she ensures that priority is given to protection of the abovementioned interests and its constant improvement, principally by preventing accidents and mitigating their consequences in terms of nuclear safety. He or she aims to ensure the development of continuous improvement and the adoption of best practices, including those identified internationally.

Continuous improvement is promoted and organised, calling on all the skills within the Group and also the international organisations with competence for nuclear safety. Operating experience feedback is collected, analysed, presented to the correct decision-making level and integrated. The Group's nuclear licensees regularly receive international assessments, in particular OSART and IAEA missions dealing with the topic "leadership and management for safety". Similarly, Peer Reviews are conducted jointly by WANO and the Nuclear Inspectorate (Independent Safety Branch of the DPN) on the fleet in service at an average rate of five per year. Their recommendations are taken into account in the improvement plans.

The independent safety assessment is carried out through the establishment of an independent safety chain at every level of EDF's organisation.

At the Nuclear Production Division (DPN) level, an Operational Nuclear Safety committee chaired by the Technical Deputy Director of the Division, allows a transverse safety analysis of operating events, with the participation of all unit managers.

With regard to development of the safety culture, EDF has produced the following, based on international practices:

- a safety culture guide, which presents the traditional approach followed by EDF and the common points of reference in terms of safety culture;
- a "Nuclear leaders" guide, which defines the expected behaviour of staff and their managers;
- a range of tools making it possible to determine a position, to debate and discuss safety practices within a unit, the departments and the safety teams;
- other provisions, such as operating experience feedback, or internal and international assessments (IAEA, combined EDF/WANO).

EDF reinforces the safety culture in each NPP, by developing the safety leadership and the corresponding "Safety Culture" roadmap. In order to reinforce the safety leadership, a Safety Perception Questionnaire (SPQ), based on the WANO document "Traits of a healthy safety culture", is conducted every two years, alternating with a self-assessment regarding safety management practices. These can be used to take account of feedback and any whistle-blower alerts from the staff as a whole and to have the results debated in the management and work collectives. The resulting lines of progress are incorporated into the multi-year Safety Culture roadmaps so that progress can continue to be made on safety issues, within the NPP and increasingly within the departments. These roadmaps comprise different types of improvement actions in response to the NPP and

departments diagnosis, covering training, the use of safety management levers and practices (risk assessment, work reliability enhanced practices, inspection/monitoring, etc.), but also the time set aside for sharing and for debate within the teams.

### 10.3. Measures taken by CEA

Nuclear safety is a major priority at CEA. The management of safety is built around:

- 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 (see Appendix C);
- a safety culture that is taught, maintained and developed;
- staff that are professional, skilled and capable of teamwork.

At the central level, the Chairman sets the broad guidelines 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 management. The Chairman also makes final strategic decisions.

In 2006, CEA adopted a security policy, incorporating nuclear safety, via a four-year continuous improvement plan.

The Nuclear Security and Safety Division (DSSN), which assists the Chairman, defines a protection of interests' policy for the BNIs under the Energies Division (DES). This protection of interests' policy is extracted from the four-year continuous improvement plan with respect to nuclear safety. This policy is the subject of a CEA letter of engagement, signed by the Chairman.

At the local level, the centre directors and facility managers ensure that it is applied in each facility for which they have responsibility. To this end, the letter of engagement signed by the Chairman is posted whenever possible within the BNIs.

For CEA, the DSSN applies nuclear safety doctrine (legislative texts, Orders, ASN resolutions) via prescriptive documents and recommendations or guides intended for the nuclear safety players.

Nuclear safety is organised at various levels:

- in the Energy Department (DES), the Deputy Director for Safety and Security, who reports to the Director of the DES, oversees safety issues for all BNIs, assisted by a support unit.
- at the local level, entities known as "safety cells" are in charge to validate safety files (design, periodic safety reviews, modifications, etc.) produced by the operating units. The file validation process may be reviewed by an Internal Safety Commission (CSI) which brings together experts from different safety fields to assess the validity of safety studies.

The oversight function is also carried out by "safety cells" or DSSN, entities separate from and independent of those constituting the line of action. The oversight function consists in assessing the effectiveness and adequacy of the actions taken and of their internal technical monitoring. At the level of the Chairman, the oversight function is performed by the General and Nuclear Inspectorate (IGN). The IGN carries out scheduled or reactive audits in response to significant events. When necessary, the IGN management may also take action on its own initiative.

CEA is also committed to a self-assessment approach based on a certain number of indicators for monitoring safety and the proper functioning of the organisation.

In addition, CEA continues to reinforce its organisation, notably:

- the organisation of technical support for facilities in certain fields of expertise;
- organisational arrangements concerning management of contractors;
- the organisation of decommissioning operations.

#### 10.4. Measures taken by ILL

Nuclear safety has always been and remains the priority at ILL. Management of safety at ILL is based inter alia on a clearly defined organisation.

The ILL Director assumes responsibility as nuclear licensee. In this field, two departments report directly to him/her:

- a Radiation Protection-Safety-Environment Department (SRSE),
- a Quality-Safety-Risks Unit (CQSR) providing an independent opinion on reactor safety.

The Deputy Director for Management of the BNI, Head of the Reactor Division, is given powers by the Director to assume responsibility for the operation, safety and security of the reactor and its annexes. In the field of safety, he/she calls on the services of a Safety Unit (CS) which reports directly to him/her.

The roles and responsibilities of the two entities – CQSR, reporting to the Director and CS, reporting to the Head of the Reactor Division – are clearly identified and described in the IMS mentioned in § 9.1. Thus, the CQSR is, in particular, responsible of carrying out independent safety checks and assessments.

The protection of interests' policy mentioned in § 9.1 is systematically handed over to new colleagues and providers performing activities that are important for protection and sent out to all staff every year, following the IMS management review.

All levels of the staff also periodically receive ILL internal training in safety culture. Furthermore, ILL staff are particularly aware of the safety, owing to the size of the ILL (small number of hierarchical levels): they are actively involved in improving the quality and safety of their activities, on a day-to-day basis, as well as in the IMS continuous improvement process.

#### 10.5. Measures taken by ITER Organization

Within the ITER Organization, the Safety and Quality Department is responsible for ensuring that nuclear safety is given priority consideration in the ITER project and throughout all its phases, in accordance with French regulations. It promotes initiatives to strengthen the safety and quality culture within the project. It reports directly to the Director-General, reflecting the importance of these issues for the project.

On 1 October 2024, the organisation of the ITER Organization's safety teams changed. The overall objectives of the reorganisation were as follows:

- to strengthen responsibility for nuclear safety in the operational units,
- to improve the organisation's efficiency in finding appropriate engineering solutions with an adequate level of safety requirements,
- provide the authorities with high-quality authorisation dossiers in accordance with the project schedule.

The ITER Organization is implementing all necessary measures to ensure that the risks it may pose to public safety, health and well-being or to the protection of nature and the environment are as low as reasonably achievable.

### 10.6. ASNR oversight of the measures taken by the licensees

ASNR oversees the BNI licensees to ensure that they give priority to the protection of interests (cf. definition at § 7.1.1), “*firstly by preventing accidents and mitigating their consequences on account of nuclear safety*”.

This oversight is carried out at three levels:

1. the inspections assess how the licensees give priority to protection of interests in their activities and evaluate the level of safety culture. These inspections can concern protection of interest’s policy, actions taken to coordinate and develop the safety culture, and correct assimilation of the safety culture by the players. The inspections can also examine how decisions are made if a nuclear safety problem arises. Apart from the usual documentary review and working situation observation techniques, ASNR inspectors may resort to individual interviews, for which they have been specifically trained: the aim of these interviews is to have the persons interviewed – who work in the field - explain their activity and its context (in particular the sense given to their work);
2. analysis of significant events, which provides a different perspective from inspection, both in terms of analysing the root causes of events and the proposal of preventive or corrective measures by the licensee: this offers a different view of the licensee’s safety culture;
3. a more general view is also obtained periodically during the safety management reviews on the licensees' premises. The conclusions of these reviews are presented to the Advisory Committee of Experts for Nuclear Reactors (see § 8.1.6).

ASNR monitors the BNI licensees' safety management policy and system by:

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

### 10.7. ASNR internal provisions

On behalf of the State, ASNR ensures the oversight of nuclear safety and radiation protection to protect people and the environment.

ASNR promotes the involvement of everyone in the performance of its duties.

The safety culture lies at the heart of ASNR’s values and practices.

ASNR adopts a thorough questioning attitude: it does not simply accept the licensee’s initial answers and continues its questioning until it obtains all necessary information (as was for example the case with regard to the carbon concentration anomaly affecting some large equipment of EDF’s reactors). If a deviation is detected, it always asks whether it could extend to other equipment or other installations. ASNR's organisation provides

for decisions to be determined collectively. This enables each person, regardless of their position in the hierarchy, to express themselves and be listened to in a receptive and constructive manner.

### Focus No.10: ASN safety culture

In 2023, ASN began work on its own safety culture, focusing on the question : « *How does ASN act to ensure the safety of its facilities and their operation ?* ».

ASN carried out this work with the assistance of the Economics and Management Laboratory of the University of Nantes. After a bibliographical analysis, the study turned to an analysis of ASN's organisational culture. The regulator's safety culture being "*the part of the organisational culture that influences the behaviour of individuals (staff and management), organisational units and the organisation in dealing with safety\**". Safety culture therefore reflects the way the organisation and individuals fulfil their roles and assume their responsibilities towards safety. It commits organisations and individuals to paying particular and appropriate attention to safety.

Edgar Schein (former american sociologist and MIT professor) offers a model to understand and identify organisational culture, based on 3 levels :

- the deepest level, associated with fundamental principles, which is the most difficult to access ;
- the intermediate level, known as *justifications* (less tangible but communicable elements such as values, beliefs, norms, expectations, philosophies, policies etc.) ;
- the visible level, known as artefacts (behaviours, organisational structures and processes, documents, ways of speaking, rituals, routines etc.)

Justifications and artefacts, which are more easily accessible, are necessary to identify the level of fundamental principles and to give them meaning.

As part of this work, it was decided to focus the analysis on the components of ASN's control policy for nuclear facilities, namely regulating nuclear activities according to the issues at stake, inspecting by strengthening the graduated approach, and imposing appropriate sanctions. Through individual and group interviews with ASN staff, field observations and interactions with the operator and the IRSN, the analysis highlighted the characteristic features of ASN's culture and identified internal subcultures in terms of:

- Hierarchy of issues : central departments focus on technical and regulatory aspects, while divisions also take the local environment into account. As one moves up the hierarchy (directors, executive committee, executive board, college), the issues become broader, incorporating political, economic and legal dimensions.
- Attitude toward time: central departments favour a long-term approach to develop in-depth expertise, while divisions are subject to tighter time constraints linked to the operation of nuclear facilities, with inspections carried out at regular intervals.
- Approach to control: ranging from regulatory dialogue focused on compliance to technical dialogue aimed at mutual understanding of risks.

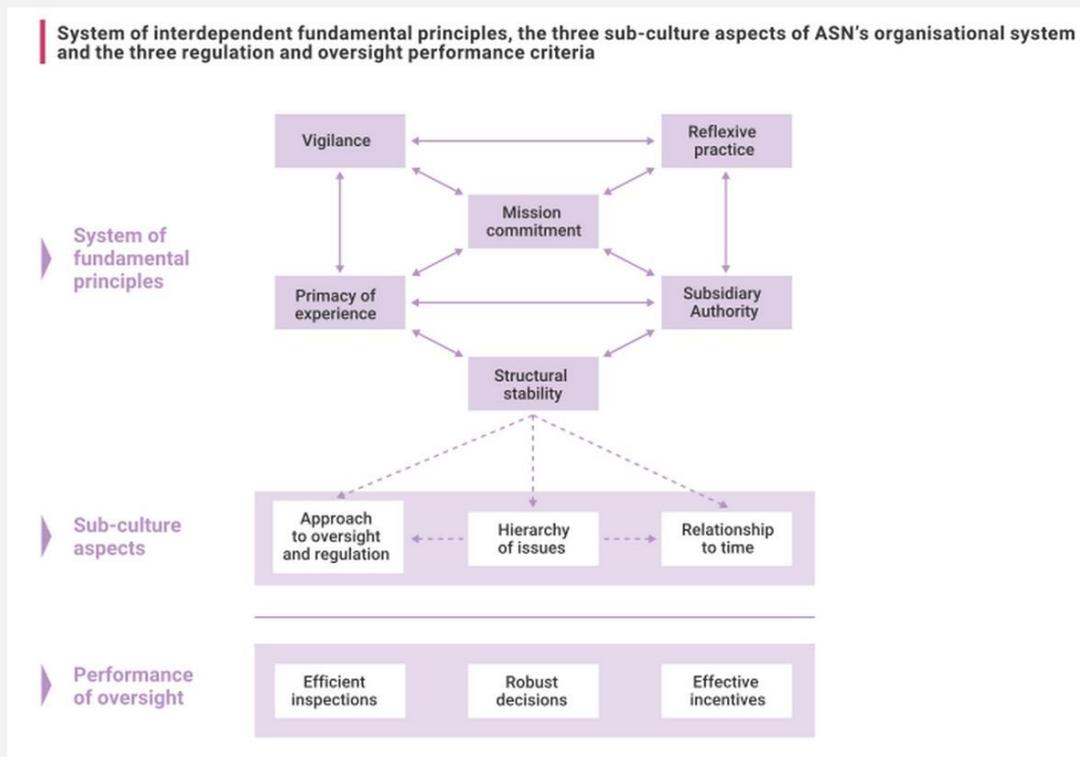
ASN's oversight is based on three key performance criteria:

- the effectiveness of inspections, combining efficiency and effectiveness,

- the robustness of decisions, which are collectively developed and understandable,
- effective incentives, or levers used with regard to a nuclear operator.

This work has provided an opportunity to re-examine ASN's frameworks for action and practices in a changing environment. It deserves to be continued in the context of the creation of ASNR.

\* *Guidelines for safety culture self-assessment for the regulatory body International Atomic Energy Agency (International Atomic Energy Agency, Vienna, Austria, 2019, p.5)*



## Article 11 Financial and human resources

### ARTICLE 11 FINANCIAL AND HUMAN RESOURCES

*1. Each Contracting Party shall take the appropriate steps to ensure that adequate financial resources are available to support the safety of each nuclear installation throughout its life.*

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

### 11.1. Financial resources

#### 11.1.1. The regulatory framework

The Environment Code requires that the licensee must “*have the technical, financial and human resources, described in a notice, and implement the means needed to exercise its responsibility*” (article L. 593-6).

The Environment Code requires that the authorisation for the creation a BNI 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 “*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*”. (Article L.593-7).

The BNI Order includes provisions requiring that the licensee put in place adequate resources – in particular financial resources – for defining, implementing, maintaining, evaluating and improving an integrated management system (article 2.4.2).

ASN Guide No. 30 recommends that “*the licensee’s financial resources enable it to deal with reasonably predictable economic risks which could have an impact on the protection of the protected interests, whether these risks are specific to the BNI (for example, unscheduled major maintenance operations), or global (for example, the market risk)*”.

The legal arrangement aims to secure the funding for nuclear costs, in compliance with the “polluter-pays” principle. The Environment Code defines the arrangements for securing the financing of the nuclear costs linked to the decommissioning of nuclear facilities, the management of spent fuels and the management of radioactive waste (articles L. 594-1 to L. 594-14). The Environment Code also stipulates that the licensees must make a prudent assessment of the costs of decommissioning their facilities, and the cost of managing their spent fuel and their radioactive waste (article L. 594-1). The nuclear licensees must thus make provision for this financing by creating a portfolio of dedicated assets equivalent to the anticipated costs. They are obliged to submit triennial reports on these costs and annual update notices to the Government. The securing of funding is under the direct supervision of the State. The General Directorate for Energy and the Climate (DGEC) is the competent administrative authority for this supervision: it analyses the situation of the licensees and may prescribe the necessary measures in the event that this is insufficient or inadequate. Whatever the case may be, the nuclear licensees remain responsible for the satisfactory financing of their long-term costs.

Finally, with regard to civil liability, the maximum amount of the licensee's liability for the nuclear damage caused by each nuclear accident is set at 700 million euros (Article 597-4 of the Environment Code). Each licensee is required to take out and maintain insurance or a financial guarantee for the amount of its liability.

### 11.1.2. Measures taken for nuclear power reactors

With a net installed power of 125 GWe worldwide as at 31 December 2024, for global production of 520.3 TWh, the EDF Group has one of the largest electricity production fleets in the world. On mainland France, the net production of electricity by EDF in 2024 was 479 TWh, including 361.7 TWh from nuclear production (62 GWe installed capacity), 50.6 TWh from hydraulic power (20 GWe) and 2.7 TWh from fossil fuels (5.5 GWe).

In 2024, the Group achieved consolidated sales of 118.7 billion euros, an EBITDA of 36.5 billion euros and a Group share of net income of 11.4 billion euros.

With regard to nuclear production in France, the EDF Board gave its approval in principle to the “Grand carénage” major overhaul programme in early 2015, the aim of which is to renew the French nuclear fleet, increase the safety level of the reactors and, if the relevant conditions are met, extend their continued operation.

Investments for the period 2022 to 2028, phase 2 of the Grand Carénage, were re-estimated at the end of 2024 at €36.1 billion in current euros, or €32.0 billion in 2021. In 2024, total investments will amount to €5.2 billion. These amounts include the cost of work related to stress corrosion, estimated at €1.3 billion in current euros (€1.2 billion in 2021) over the period 2022-2025. Industrial work will continue beyond 2028. Capital expenditure will remain high beyond this date.

This industrial programme is being gradually implemented in order to meet the objectives of the Energy Transition Act, of the multi-year energy programmes, of the ASN opinions and of the requirements and procedures involved in allowing reactor operation beyond 40 years.

Furthermore, to secure financing of its long-term nuclear commitments, EDF has in previous 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 2024, these dedicated assets represent a value of 40.3 billion euros (€37.5 billions in 2021). The three-yearly reports concerning these costs, and the annual update memoranda, are transmitted to the DGEC.

EDF thus has the financial resources to meet the safety needs of each nuclear facility throughout its lifetime.

### 11.1.3. Measures taken for research reactors

#### 11.1.3.1. CEA's Cabri reactor

Most of the CEA budget comes from the State. In this budget, 10 million euros are allocated annually to the Cabri facility, including about 2 million for safety. This amount is considered to be sufficient to cover the costs associated with safety (periodic safety reviews, preventive maintenance, periodic checks and tests).

With regard to the financial capacity for the decommissioning phase and in accordance with the regulations, CEA is setting up a provision for decommissioning, and for the management of the spent fuel and waste from the Cabri reactor, expected by the end of its operating lifetime. The estimate of this provision is presented to the DGEC in a three-yearly report; a memo updating this report is produced every year.

#### 11.1.3.2. The ILL high-flux reactor (HFR)

ILL, a private law company founded in 1967, is financed primarily by France, Germany and Great Britain, via its associates (CEA, CNRS, FZJ, UKRI) and is governed by an agreement between these three countries. This agreement has been prolonged by the signing of the 6<sup>th</sup> amendment which guarantees that ILL will have the funding it needs to operate during the period 2024 to 2033.

Within this framework, for the duration of operation of the ILL, the Management therefore presents a 10-year budget (investment and operation) to its French, German and British associates, twice a year. This multi-year budget comprises all the expressed needs and more particularly those related to the safety of the BNI: financing of sufficient and competent human resources, investments for the modifications made further to the periodic safety review and changes to the regulations, maintenance, etc. This balanced budget is voted by the ILL associates, twice a year.

The ILL's annual average budget is €100 M, 10% of which is devoted to reactor-related investments (safety improvements, overhaul, maintenance) and to modernisation of the scientific instruments.

With regard to the financial capacity for the decommissioning phase, spent fuel and waste management, and in accordance with the regulations, the ILL is setting up a provision for the decommissioning planned at the end of its operating life. The estimate of this provision is presented to the DGEC in a three-yearly report, with a memo updating this report being produced every year. Therefore, and in accordance with the ILL agreement, the Governments of the associates undertake to cover this provision by recognising a debt held by ILL on each one of them (which corresponds to coverage of the debt by an asset equal to the debt of the associates). This recognition is made every year. This process is also validated by the auditors.

#### **11.1.4. Oversight by the authorities**

As part of the examination of an application for creation authorisation of a new installation, the authorities make sure that the operator has the financial capacity to carry out the project while exercising its primary responsibility for safety throughout the various phases of the planned installation's life cycle (design, construction/manufacture, maintenance, periodic safety review, decommissioning, etc.).

The three-yearly reports presenting the evaluation of the costs related to decommissioning and waste management are examined by the DGEC. The DGEC asks ASNR to examine the technical hypotheses (notably those related to the reprocessing of spent fuels) underpinning these cost evaluations and notably to make sure the consistency between the evaluation of the costs presented by the licensees and the decommissioning, spent fuel and radioactive waste management strategy. An annual review report is submitted to the DGEC by ASNR regarding the analysis of the three-yearly reports of each licensee and the annual update memoranda.

## **11.2. Human resources**

### **11.2.1. The regulatory framework**

It is up to the licensee of a BNI to have sufficient, appropriate and qualified human resources. The regulatory requirements concerning the human resources that must be available to the licensee of a BNI are more particularly contained in the Environment Code (Article L 593-6) and the BNI Order (Article 2.1.1).

In addition, the BNI Order states that “*the protection important activities, their technical inspections, the verification and evaluation actions are carried out by persons with the necessary skills and qualifications*” (Article 2.2.2). 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 subcontractors.

Pursuant to ASN “emergency” resolution, the licensee must “*define the members and the skills of the emergency teams, according to the human actions required and the intervention conditions liable to be encountered. The licensee takes the organisational measures enabling it to ensure that these personnel and these skills can be mobilised at any moment and for an appropriate duration, in particular making provision for the necessary shift changes*”.

### 11.2.2. Measures taken for nuclear power reactors

At the end of 2024, the workforce of EDF's Nuclear Operations Division (DPN), responsible for operating the nuclear reactors, stood at 23,400, spread among the NPPs in operation including, since 3<sup>rd</sup> September 2024 the Flamanville EPR reactor and the 2 national engineering units. Engineers and management account for 37% of the workforce, supervisors 59% and operatives 4%.

To these 23,400 staff must be added EDF's human resources devoted to design, to new constructions, to engineering of the NPPs in service and the support functions and to dismantling of nuclear reactors:

- about 8,000 engineers and technicians in the engineering centres split among management (80%) and supervisors (20%);
- nearly 235 engineers and technicians from the nuclear fuel division (DCN);
- more than 750 engineers and technicians from EDF's research and development division (EDF R&D).

Since 2006, EDF has been devoting considerable efforts to guaranteeing the skill levels and the careers of the staff, by adopting a Forward planning of employes and skills (GPEC) approach, based on harmonised principles for all the NPPs, built up gradually from actual feedback from the field. These aspects are the subject of specific monitoring, coordination and oversight.

EDF has a coordinated national training organisation and a professionalisation unit for industrial performance devoted to developing and carrying out training courses. Generic training is available, in particular "design safety" and "operating safety" courses. The members of the emergency organisation follow regular training and exercises both locally and nationally. Some training exercises are organised jointly with the public authorities.

Between 2008 and 2018, the nuclear production division underwent a significant renewal of its human resources, with considerable turnover (12,000 new arrivals), which required a considerable amount of training. The new arrivals systematically follow an initial "Académie des Savoirs Communs" (introductory basic training) course of 8 weeks covering operation, the safety and quality culture, security and radiation protection. Depending on the work area, the course continues with an "Académie de Savoirs Spécifiques Métier" (specific professional training) course to learn the fundamentals of a given profession (e.g. operators). Over and above the basic and professional training courses, specific training on annual topics can be proposed in the professions on the basis of lessons learnt: for example, training devoted to lessons learnt about non-compliances with the operating technical specifications has been set up for all the operations teams. Since 2019, as part of the START 2025 programme, the Nuclear Production Division has been running an EDF Skills programme to further boost professional development initiatives by placing management back at the heart of skills management. Thus, Training Committees have evolved into "Skills Committees" in the plants in order to integrate, in addition to training activities, skills development activities through mentoring, training on mocks-up or simulators, immersion in other entities of the company or with industrial partners, re-internalisation of activities etc. The core of "just in time" training has been defined in order to ensure the performance of certain sensitive activities, notably by using simulators for operations or "mock-up spaces" for maintenance. For the professions in which the stakes are higher (control, safety engineer, etc.) an empowerment system is organised. Regular retraining is held and coordinated within the individual entities. Skills management at the DPN is based on operating experience feedback from the other international licensees. Systematic Approach to Training (SAT) is being gradually deployed in professions with safety implications. This effectiveness of this systematic approach is due to the fact that the training is tailored to meet the requirement, targets the right person and occurs at the right time. The professional development

programme (training, workplace observation, mentoring etc.) is designed to achieve competence objectives, according to the appropriate pedagogic options. A skills assessment and mapping tool has been developed and is currently being rolled out. This tool can be used to capitalise on the training carried out by each employee and as well on the coaching, mentoring, workplace observations, etc. It complements the interviews between each employee and their direct manager. It also ensures that the individual skills of employees and the collective skills of teams are acquired, maintained and developed over the long-term. Common core subjects define the organisations and the reference jobs. For these jobs, a reference framework creates the link between the activities carried out and the means of acquiring the skills.

With regard to nuclear engineering, a “Skills Development Plan” (PDC) approach has since 2006 involved all the units concerned (engineering, production and R&D). This approach aims to develop the skills of the engineering disciplines and, through a cross-cutting, forward-looking approach, helps the units prepare their Forward planning of employees and skills choices.

Three years ago, GIFEN (the French Nuclear Energy Industry Association) launched the Match Programme with all companies in its sector. This work to assess the adequacy of the nuclear industry's needs and resources to deliver on its programmes resulted in a report submitted to the Government in April 2023 (see §4.1.5).

In 2025, the EDF Group will adopt a nuclear workload plan, in particular to dynamically manage the EDF Group's needs in relation to the nuclear industry in France and internationally.

### 11.2.3. Measures taken for research reactors

#### 11.2.3.1. CEA's Cabri research reactor

Sufficient numbers of competent staff work on the Cabri reactor to carry out safety-related activities (operation, maintenance, studies):

- the head of the facility and his deputy,
- two safety engineers, who also have safety-criticality qualifications,
- two radiation protection officers in charge of monitoring the facility and the radiological monitoring of the personnel,
- workers in the support units and from the subcontractors for carrying out maintenance, periodic checks and tests.

The Cabri reactor personnel in charge of activities related to nuclear safety receive training specific to their positions, in particular through mentoring. They are qualified and empowered for the activities under their responsibility, in accordance with a procedure applied to all of CEA's BNIs:

- the separation of qualification and empowerment responsibilities;
- the confirmation of qualification by a manager;
- the confirmation of qualification, notably by validating the skills acquired during professional experience and not 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 empowerment decisions.

The head of the Cabri facility follows specific training before taking up the position. This training covers management of staff and operations, nuclear safety at CEA, the operational legal responsibilities of the licensee, radiation protection and waste management.

All of the Cabri reactor personnel follow a safety culture training programme drawn up by the Nuclear Safety and Security Division (DSSN). This training covers the theory, regulatory and operational aspects of the safety culture.

### 11.2.3.2. *The ILL high-flux reactor (HFR)*

ILL has sufficient and competent internal human resources enabling it to manage its activities and more particularly those related to the operation and safety of the reactor (studies, projects, maintenance, etc.). The subcontracting rate for these activities is very low (less than 20%).

Moreover, since 2016, in order to meet safety requirements, the ILL has appreciably increased the size of its teams. The institute thus increased the number of safety engineers in the safety unit (CS), reporting to the head of the Reactor Division, as well as in the quality-safety-risks unit (CQSR) reporting to Senior Management.

For surveillance of the facility and radiological monitoring of the personnel, the size of the radiation protection unit workforce was also increased and placed under the responsibility of a radiation protection engineer.

For environmental surveillance, the ILL set up a new laboratory in 2010, with a workforce composed of several technicians and one engineer.

Skills management for the ILL personnel required to intervene on Protection Important Activities (PIA) is handled by applying a dedicated IMS process. The unit heads are therefore responsible for ensuring that their colleagues are competent to carry out PIA within their scope of activity. They guarantee that these colleagues have followed all the regulatory and internal training necessary for performance of the PIA, including training using the mentoring system. The ILL Training Centre provides technical support for the unit heads with regard to deployment of the employee skills development plan.

To this end, the unit head identifies the skills needed for each activity and - for each employee - the training course required in order to obtain these skills. In this course, two types of training are possible:

- theoretical training, focusing on general knowledge of the nuclear sector and the resulting particularities at ILL (safety, security, radiation protection, quality, etc.) and on the specific technical and documentary knowledge needed to carry out activities or operations;
- practical training using the mentoring system, the purpose of which is to gain expertise in the various activities or operations in the field.

Particular attention is paid to the training and retraining of reactor operators, with a 8-week program enabling them to operate the reactor in all the operating domains specified by the General Operating Rules. The future reactor operator is also trained to operate the facility in an accident situation.

This training course comprises:

- an initial part taught by the INSTN, covering the general nuclear knowledge needed for reactor operation,
- a specific part taught jointly by the ILL and the INSTN, making a bridge between the general knowledge and the specific aspects of the ILL reactor, notably in the fields of neutronics, thermalhydraulics, instrumentation and control, and OHF,
- a final part, dedicated to “Reactor Operations” and taught by the ILL, the aim of which is to acquire the specific technical knowledge needed to operate the reactor. The reactor operator skills are also developed to include management of incident/accident operations and emergency situations, by means of simulation tools.

#### 11.2.4. ASNR oversight

ASNR oversight regarding skills and human resources is based primarily on inspections. The workforces, hiring, training, monitoring of the skills of subcontractors and the organisation put in place by the licensee to manage these topics, are subjects regularly covered by the inspections. For this task, the inspectors rely in particular on ASN Guide no. 30 “BNIs risks management and inconveniences policy and licensees integrated management system”.

Since 2022, ASNR has been conducting inspection campaigns on the skills and training of reactor operating teams, which have shown that the skills management process of operating staff is well established in most nuclear power plants.

## Article 12 Human factors

### 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. The regulatory framework

The BNI Order stipulates that organisational and human factors must be taken into account in the same way as technical aspects when applying rules regarding the design, construction, operation, final shutdown, decommissioning, maintenance and monitoring of Basic Nuclear Installations (Article 1). The BNI Order requires that the nuclear safety case be made using a prudent deterministic approach, incorporating the technical, organisational and human aspects (Article 3.2).

The implementation of these principles was then clarified in ASN resolution concerning the safety analysis report of BNIs, known as the “RDS” resolution. Pursuant to this resolution, the safety analysis report must in particular cover the following subjects:

- the contribution of organisational and human measures to demonstrating the limitation of risks,
- the principles of the organisation implemented by the licensee and their appropriateness with regard to the demonstration of the nuclear safety case,
- the way organisational and human factors (OHF) are taken into account in the design.

This resolution stipulates that “*the safety analysis report describes and provides justification for the main design, construction and operating measures implemented by the licensee in technical, organisational and human terms to ensure conditions that allow the persons intervening to preserve nuclear safety.*”

Guide No. 22 on the design of pressurised water reactors recommends that:

- the socio-technical system shall be designed so as to create the best possible conditions for the personnel to perform the activities associated with operation of the installation;
- the design of the socio-technical system shall minimise the possibilities of inappropriate human actions and foster the ability of the personnel to detect and manage unforeseen events;
- the search for design provisions shall be gradual and, if necessary, iterative;
- the design provisions shall be validated using appropriate assessment methods and means (user tests, mock-ups, simulation, etc.) in conditions that are as representative as possible of those that will be encountered in operation.

## 12.2. Measures taken for nuclear power reactors

Organisational and Human Factors (OHF) are taken into account in the engineering and operating activities by:

- implementation of the approach of Socio-Organisational and Human (SOH)<sup>18</sup> impacts in any design, modification and decommissioning project with safety implications using the following operational mechanism:
  - a SOH expert present in each engineering unit, providing expertise to senior management and project managers,
  - a projects management structure within the units identifying the designs and changes with SOH implications and ensuring that the necessary measures are taken in all phases up to deployment in the nuclear fleet,
  - design managers incorporating human and organisational aspects, jointly with the operator and with the support of internal and external expertise, in particular for the field analyses, the validation phases, and to define the change management actions with the operator,
  - cross-functional units ensuring cooperation between engineering and the operator in the design and change work, followed by appropriation by each of the relevant professions at the sites;

This mechanism is implemented for projects with significant safety implications.

- support for actions to improve operation, carried out with the operational staff by HF experts, with a focus in recent years on Nuclear Leadership Initiatives and safety culture in collaboration with the Change Management Consultant deployed at each site.

## 12.3. Measures taken for research reactors other than nuclear power reactors

### 12.3.1. CEA reactors

In 2008, CEA set up an organisation dedicated to organisational and human factors. It comprises:

- specialists in the DSSN and in the safety support units of the CEA centres;
- contacts in the BNIs;
- correspondents in the safety units reporting to each centre director.

The specialists make up the centre of expertise which coordinates the network of OHF players. A network meeting is held for one day every year, to discuss OHF experience through testimonials from CEA employees and outside contributors.

These OHF players intervene to:

- perform OHF analyses in the facilities, following the emergence of identified problems or events;
- perform systematic OHF interventions during the periodic safety reviews, or for requests more specifically concerning the operation phases and the operations relating to the handling of fuel and experimental devices;
- integrate OHF into the various steps of the new facility design projects.

<sup>18</sup> The SOH approach is based on the identification of the impacts of the change for the professions concerned, in order to specify this change (whether technical or organizational), and to define the main actions to be carried out in terms of change management. Five types of impact are assessed with the teams involved during working groups: requirements and constraints, tasks and mission, skills and resources, process and coordination, tools, documentation and working environment.

Various training courses on OHF considerations are provided for activities presenting both safety implications and a significant OHF component, such as event analysis.

### 12.3.2. The ILL high-flux reactor (HFR)

Since 2019, the ILL has set up an OHF correspondent tasked with assessment (event analysis, OEF, etc.) and technical support (projects, training, etc.) in the field of organisational and human factors.

The management personnel in the reactor division and the radiation protection, safety, environment department, plus the safety engineers, received specific instruction in organisational and human factors.

For discussions on OHF and in order to stay abreast of changes in this field, ILL's OHF correspondent is a member of CEA's OHF network and in this capacity takes part in the annual days held by CEA.

## 12.4. ASNR oversight

ASNR oversees the steps taken by the licensee to include and improve the integration of organisational and human factors into all phases of a nuclear reactor lifecycle, by means of inspections or during reviews of authorisation applications.

With regard to the engineering activities during the design of a new facility or the modification of an existing one, ASNR checks that the licensee correctly deploys the SOH approach enabling it to take account of people and organisations in the development of systems and in the changes to equipment and organisations.

ASNR also oversees the activities carried out for the operation of existing reactors, throughout their service life. ASNR in particular checks the steps taken by the licensee to incorporate organisational and human factors on a day-to-day basis, the organisation of work and the intervention conditions by the workers or the subcontractor personnel, all of which can have an impact on the safety of facilities and workers, along with skills, training and qualifications management carried out by the licensee.

Finally, ASNR checks the analysis of operating experience feedback concerning reactor design, construction and operation. ASNR more particularly checks the licensees' organisation for analysing events, the methodology employed and the depth of the analyses carried out to ensure that the underlying causes (organisational and human) of events are looked for and, lastly, the development and implementation of the follow-ups to the analyses, whether in the short, medium or long term.

These checks are carried out by means of documentary examination, observation of the work situation, including on a full-scale simulator, and interviews.

### Focus No.11: Increasing complexity of reactor operating framework

Since reactors first came into service, operating procedures have become significantly more complex, particularly with regard to general operating rules (GOR). This complexity can cause operators to lose sight of the meaning of their tasks, with potential impacts on risk control.

In response to these findings, EDF aims to simplify the operating framework to make it easier for operators to read and use, and to ensure the operability of facilities, using an approach that is proportionate to the safety issues at stake. EDF has initiated short- and medium-term simplification measures, as well as a long-term project to overhaul its GOR.

In response to this observation, in 2024 ASN brought together industry stakeholders for a series of discussions organised by the Steering Committee on Social, Organisational and Human Factors

(COFSOH) on the complexity of activities related to the operation of nuclear facilities. A summary of these discussions will be published in 2025.

At the same time, ASN is currently funding a thesis on the parameters and dynamics of complexity in reactor safety governance in France. The results of this thesis are expected at the end of 2025.

## Article 13 Quality Assurance

### 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. The regulatory framework

The BNI Order (Articles 2.5.1 to 2.5.7) includes general provisions that the licensee must follow for the protection important components and activities (PIC<sup>19</sup> and PIA), such as to guarantee that they effectively protect interests, including the safety of the installation. More specifically, the licensee must define the requirements that each protection important component or activity must comply with so that it can fulfil its role as stipulated in the safety case. Therefore, these requirements are referred to as “defined requirements”. In addition:

- the PICs must be qualified so as to guarantee their ability to perform their functions with regard to the loadings and ambient conditions associated with the situations in which they are needed;
- the PIAs must be carried out in such a way as to comply with the defined requirements for these activities and for the PICs concerned by these activities. They must be carried out by persons with the necessary skills and qualifications and checked by an independent person.

The BNI Order (Article 2.4.1) stipulates that the licensee must define and implement an integrated management system enabling it to ensure that the requirements concerning protection of the interests of the BNI system are systematically taken into account in all decisions concerning its facility. The licensee must thus set up, formally define and seek to improve an integrated management system ensuring that the requirements concerning the protection of the protected interests are taken into account in the management of its facility.

This Order also requires that:

- the detected deviations and significant events be corrected with due diligence and that preventive and corrective measures be implemented (Article 2.6.1);
- the licensee monitors its contractors and checks that the organisation implemented to guarantee quality does indeed operate satisfactorily (Article 2.2.3).

ASN Guide No. 30 presents recommendations on the policy for the protection of protected interests and on the licensee’s integrated management system.

#### 13.2. Measures taken for nuclear power reactors

In order to control the protection of interests throughout the lifecycle of a BNI (design, construction, operation, decommissioning), the management of the Nuclear and Thermal Production (DPNT), of the Engineering and Supply Chain (DISC) and Projects and Constructions (DPC) drew up a joint “Policy on the

<sup>19</sup> The PICs are broader than the systems, structures and components (SSC) defined by the IAEA.

protection of Interests” document (PMPI) specifying the responsibilities and organisational principles implemented to meet the provisions of the regulations. A reference framework defines the integrated management system (IMS), the protection important components and activities and the provisions for managing the activities governed by the IMS (including the management of deviations and significant events). This document applies to the units operating the BNI and the entities of EDF carrying out activities related to the protection of interests on behalf of BNI licensees in France.

In this respect, each NPP director defines an integrated management system which complies with the regulatory provisions of the Environment Code and the BNI Order.

The integrated management system is part of the Management System (Integrated Management System for the DPN) and its purpose is to ensure that the requirements concerning the protection of interests stated in Article L. 593-1 of the Environment Code are taken into account when performing the activities by the IMS. The activities by the IMS are the activities important for interests and activities explicitly required by a regulatory text to be part of the IMS (example: OEF processing, significant events processing, regulations compliance watch, document management, contractor monitoring, etc.). This system is a means of creating and periodically updating the list of PICs and corresponding defined requirements (ED), consistently with the Safety Analysis Report applicable to the BNI, along with the list of PIAs and corresponding ED, consistently with the principles adopted.

The IMS is based on the principle of continuous improvement: it is described, implemented, assessed and continuously improved via annual reviews.

The activities governed by the IMS are carried out by the BNI operator or entrusted to national entities or subcontractors. The following organisational provisions shall be adhered to:

- each entity (EDF SA, subsidiaries of the EDF Group and subcontractors) working for a BNI operator applies the joint protection of interests’ policy and ensures that the various persons involved in performance of the PIA under its responsibility has understood the risks and the corresponding stakes. For subcontractors, this policy is referenced in the contracts;
- each EDF SA entity performing activities governed by the IMS of a BNI operator implements a management system capable of controlling its activities. This system specifies the measures implemented in terms of organisation and resources to control these activities; it is based on documented information;
- each EDF SA entity working on behalf of a BNI operator develops the safety culture of the persons involved in performing activities governed by the SGI and under its responsibility;
- each EDF SA entity working on behalf of a BNI operator performs an annual analysis of the control of the activities governed by the IMS (including the PIA). It sends the senior management of the BNI licensee a summary of the analyses performed for use in the BNI licensee’s management review;
- each BNI operator and each EDF SA entity entrusting all or part of the performance of an activity governed by the IMS to a BNI operator or an outside contractor, requires the implementation of a management system such as to ensure the control of this activity. For the subcontractors, these requirements are defined in the General Quality Assurance Specification (SGAQ) which is referenced in the contracts, or in the contractual documents; the requirements of the SGAQ applicable to contracts with an impact on protected interests are those of standard ISO 19443.

### ***Consideration of CFSI (Counterfeit, Fraudulent and Suspect Items) risks***

With regard to the risk of possible fraud or counterfeit (Counterfeit, Fraudulent and Suspect Items - CFSI - as defined by the IAEA), EDF has, since 2017, put in place specific provisions aiming at preventing and detecting these risks during manufacturing and operation, notably:

- the creation of a whistle-blower system guaranteeing anonymity, usable by EDF employees but also by any external person;
- the appointment of an "ethics and compliance" reference person within each EDF entity. This correspondent is there to be consulted by the EDF entity staff regarding potential fraud and counterfeit risks concerning the activities EDF itself performs within this entity;
- the appointment of a member of the management of each NPPs responsible for ensuring CFSI risk control for nuclear activities,
- awareness-raising actions on the importance of integrity, the safety culture and CFSI risk;
- manufacturing inspection measures on suppliers' premises focusing on the detection of CFSI issues;
- the implementation of cross-checks in the manufacturing chain,
- the incorporation of the CFSI risk into the supplier qualification process;
- the General Quality Assurance Specification appended to EDF contracts with its suppliers requires them to take CFSI risk into account, particularly as part of the supervision of their subcontractors. It sets out the procedures for alerting EDF in the event of suspected CFSI.
- data integrity and conservation.

Since the beginning of 2021, the entities of the EDF Group as a whole have initiated a process of ISO 19443 standard certification, the provisions of which comprise specific requirements on training, detection, supplier monitoring and information with respect to the CFSI aspects. A large number of EDF entities are already certified as ISO 19443 standard compliant (for the others, this is in progress).

CFSI risk management was strengthened in March 2024 through commitments made by EDF Group CEO to ASN.

### ***Relations with subcontractors***

The maintenance of reactors in the French nuclear power fleet is to a large extent subcontracted by EDF to subcontractors. This industrial policy is a choice of EDF. A system of prior subcontractors' qualification has been put in place by EDF. It is based on an assessment of the technical know-how and the quality organisation of the subcontractor companies.

To ensure the quality of the services provided, EDF monitors the activities entrusted to its Contractors which does not relieve them from their contractual responsibilities, notably those concerning the application of the technical and quality assurance requirements. Contracts between EDF and its subcontractors 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 subcontractors' services, contract holders are selected based on an analysis of financial bids combined with an evaluation of technical bids, enabling the "best bidder" to be chosen. The quality and performance of subcontractors is now taken into account more effectively thanks to the exemption from public procurement rules that EDF has been able to invoke since May 2024 for purchases of services contributing to the safety of its facilities.

Finally, the Social Specifications, a constituent part of the contracts drawn up by the Nuclear Sector Strategic Committee (CFSIN), establish transparent and shared rules. They aim to guarantee the know-how, qualifications, skills and experience of those working on site. This reference framework takes into account, as essential criteria, nuclear safety, radiation protection, occupational risk prevention and quality of life at work.

### 13.3. Measures taken for research reactors other than nuclear power reactors

#### 13.3.1. CEA reactors

According to the BNI Order, each CEA centre and each operational division defines its integrated management system for the areas under its responsibility. In practice, it is up to the facility heads to implement in their own local system the rules defined for the centre in which their facility is located and those of the operational division to which they report. The defined requirements for the PICs and PIAs are formally identified in this local system.

The management system of the Energies Division and the Cadarache centre (where reactors CABRI and RJH (under construction) are located) includes issues related to quality, health, safety and environment. It is certified compliant with standards ISO 9001, ISO 14001 and OHSAS 18001.

In addition, the Energies Division, which is responsible for Cabri reactor, organises regular audits of its units or their contractors, in order to measure the progress made and assess the ability of the suppliers and contractors to meet CEA's quality requirements.

For Cabri reactor, these audits concern both the quality of activities linked to the research programmes and the quality of the activities linked to their safe operation. For instance, in 2024, three audits concerned maintenance, safety culture and a BNI subcontractor.

#### 13.3.2. The ILL high-flux reactor (HFR)

ILL has adopted an integrated management system (IMS) which has the primary aim of ensuring compliance with the requirements concerning protected interests. The IMS structure is based on an approach in which the processes are grouped into categories and cover all the ILL activities linked to the protection of interests:

- “operational” processes for the core activities at ILL (operation of the reactor and the scientific instruments for scientific output),
- “support” processes for the activities supporting the core activities (human resources, safety, radiation protection, etc.),
- “control” processes, for the activities specific to the integrated management system (continuous improvement, documentation management, etc.).

Operation of the IMS is based primarily on:

- the process coordinators, who ensure that their process is correctly applied and improved,
- the quality, safety, risks unit (CQSR), which guarantees the overall consistency and improvement of the IMS,
- the management's engagement which, via the Protection of Interests Policy, sets the short and medium-term priority strategic lines and ensures that the human resources needed for operation of the processes are available.

The “safety” process comprises the identification methodology and the list of PICs and PIAs, along with the corresponding defined requirements. The operational PIAs undergo a risk assessment beforehand to define the hold points in the activity which cannot be lifted without a prior technical inspection.

A process defines the monitoring of the contractors working on PIAs, which relies on specifically trained managers. In addition, audits of the working personnel are carried out by the CQSR in accordance with an annual programme or in response to a particular event.

Continuous improvement of the system and of the protection of interests is ensured by the anomalies and deviations management and OEF processes, but also via process reviews and IMS management reviews, as well as internal audits, or spot checks carried out by the CQSR.

## **13.4. ASNR oversight**

### **13.4.1. Quality assurance in the construction and operation of reactors**

During its inspections on sites under construction or in operation, ASNR focuses on checking that the provisions defined by the BNI Order for PICs and PIAs are complied with, and that the licensee follows the procedures and requirements it has defined in this respect in its management system. More specifically, for the PIAs, the adequacy of resources for the tasks, staff training, working methods and the quality of the documentation associated with the operations are thus checked, along with the procedures for licensee monitoring of protection important operations and their technical inspections.

### **13.4.2. Quality aspects related to the use of suppliers and subcontractors**

The supply of PICs and realisation of PIAs (maintenance, studies) for the French NPP fleet reactors are partly subcontracted to external companies. ASNR’s role is to check that even when suppliers and subcontractors are used, licensee continues to fully exercise its responsibility for the safety of its installations. This oversight of licensee’s control of the quality of the goods and services supplied and constituting PICs or PIAs can thus concern:

- on the one hand the arrangements adopted by the operator to inform all subcontractors of the provisions necessary for application of the BNI Order;
- on the other, licensee’s monitoring of these suppliers.

For the purposes of oversight activity, ASNR carries out inspections at the suppliers and issues binding requirements on the licensee regarding the activities carried out by these suppliers and on the monitoring carried out by the licensee.

As part of its oversight of NPE manufacturers, ASNR conducts inspections at manufacturers’ premises to verify that these manufacturers meet the safety requirements of the regulations with which they are required to comply.

With regard to the choice of the subcontractors performing PIAs in electronuclear reactors, ASNR checks, pursuant to the legislative provisions adopted in 2016, that the licensee:

- assesses the bids, on the basis of the criteria related to the protected interests;
- ascertains beforehand that the companies it is considering using have the technical capability to carry out the work in question and control the associated risks.

ASNR has reinforced its oversight of the EDF supply chain of PICs for NPPs. As part of this oversight, ASNR examines compliance with the regulatory requirements applicable to PIAs for manufacturing operations, the

ability of the suppliers to manufacture equipment meeting the safety requirements and how the risk of fraud is addressed. During these inspections, ASN also checks EDF's monitoring of its suppliers and their subcontractors.

ASN also carries out inspections in the various engineering departments on the monitoring of the contractors involved in the design studies.

In addition, ASN is raising awareness among suppliers. A specific educational guide for suppliers in the nuclear sector has been published (see Focus No. 12).

### **Focus No.12: Practical guide for suppliers - Guide to design and manufacturing requirements for equipment suppliers and their subcontractors**

Control of the supply chain is particularly important for the safety of nuclear facilities, both those in operation and those in the planning stage. Operators, suppliers and subcontractors : the quality of equipment that is important for the safety of facilities is everyone's business and everyone's responsibility.

Discussions with representatives of the nuclear industry have highlighted the need to better disseminate requirements for safety-critical equipment and to improve the traceability of manufacturing activities, in particular to reduce the risk of fraud.

With the publication of a practical guide, ASN aims to make the regulatory objectives and requirements for the design and manufacture of equipment for nuclear facilities more accessible.

This guide is the result of more than two years of work and discussions with industry. It sets out the pillars of a robust supply chain for equipment that plays an essential role in preventing, detecting or limiting the consequences of an accident at a nuclear facility. It emphasises certain fundamental principles:

- Ensuring the appropriate transfer of safety requirements to subcontractors:

Specific requirements related to the nuclear field must be communicated throughout the subcontracting chain as needed, without imposing excessive requirements.

- Identifying and tracing all manufacturing activities that are likely to affect the safety of the nuclear facility:

To guarantee the quality of the materials manufactured, checks must be carried out during these activities and any discrepancies must be traced and dealt with.

- Prevent and detect the risk of fraud:

Staff awareness must be ensured, supplied components must be checked, and measures must be strengthened to ensure the integrity of manufacturing data, the archiving of important documents proving the quality of the manufactured equipment, and the collection and processing of internal reports.

### 13.4.3. Risks of CFSI (counterfeits, fraudulent and suspect items)

The fight against fraud at all levels of the subcontracting and supply chain is a point of vigilance for the entire nuclear sector, particularly in the context of the construction of new reactors. It is primarily the responsibility of the operators, who are responsible for nuclear safety, to prevent and detect fraud and to take the necessary measures to deal with proven cases.

In 2016, ASN began to consider the modification of BNI inspection practices in response to irregular situations. In so doing, it questioned other regulation and oversight administrations, its foreign counterparts and the licensees with regard to their practices, in order to learn pertinent lessons.

In 2019, ASN hired two people from administrations regularly faced with these problems: the gendarmerie and national police force. These new recruits brought the benefit of their experience, proposing new approaches, notably regarding possible enforcement measures and relations with the prosecution offices, and to develop the actions already under way, particular with regard to inspection.

These new inspections are conducted:

- in the EDF and Orano head office departments, with the aim of examining how these groups have incorporated prevention of the risk of fraud into their procurement policies and the state of progress in the handling of certain confirmed cases of fraud they have identified;
- on the nuclear sites, integrating an in-depth search for proof of performance of activities, for example by verifying the effective presence of a person who certified that they performed or checked a given activity on a given date;
- on the premises of suppliers to address the risk of fraud in the subcontracting chain with the aim of raising awareness to fraud risks.

In light of the findings of these inspections, the Commission conducted a hearing with the chairman and CEO of EDF about the CFSI and the actions it intends to implement to strengthen the fight against fraud in the subcontracting and supply chain, for its reactors in operation and those under construction or planned (see Focus 13 Chapter 13).

#### **Focus No.13: Strengthening the fight against fraud in the subcontracting and supply chain**

On 26 February 2024, ASN commission conducted a hearing with the Chairman and CEO of EDF about the CFSI. ASN asked EDF about the actions it intends to implement to strengthen the fight against fraud in the subcontracting and supply chain, for its reactors in operation and those under construction or planned (EPR2).

ASN has asked EDF to formalise an action plan as soon as possible to identify and address the root causes that can lead a stakeholder or organisation to commit fraud. ASN has also asked EDF to formalise its strategy for dealing with cases already detected.

In response, EDF has defined additional actions to those already in place with regard to ongoing irregularities affecting operating reactors and the Flamanville EPR. EDF has also provided CFSI diagnostic elements as well as a strategy to raise the level of quality control of supply chains and manufacturing of equipment for nuclear installations in the medium term. This strategy is based on three axes:

1. the involvement of the entire nuclear sector in the fight against CFSI. EDF is showing its willingness to encourage manufacturers to declare deviations from specifications during manufacturing and to deal with them as quickly as possible.
2. the strengthening of EDF's detection capabilities and the acceleration of the processing of suspected CFSI, particularly with regard to manufacturing surveillance.
3. better structuring within EDF of the roles of project management and internal project supervision, particularly with regard to manufacturing control for the operational fleet.

The president of ASN took a stand on these action plans and strategy in a letter dated 26 March 2024. He asked EDF to implement them with the utmost rigour, to carry out a review of the supervision exercised by EDF in the past during the manufacturing of equipment for nuclear reactors, and to substantiate the analysis of the causes of any irregularities that may have occurred in the manufacturing plants of EDF's suppliers and their subcontractors.

ASNR will monitor the progress of these action plans and will continue its enhanced inspection programme on this topic in the coming years.

ASNR shares its experience of CFSI cases and the inspection methods used during bilateral meetings with its foreign counterparts and within international working groups (see Focus 14 Chapter 13).

#### **Focus No.14: Sharing information on CFSIs in international working groups**

ASN has been actively involved in the creation, within the Expert Group on Operating Experience (EGOE) and Working Group on Supply Chain (WGSUP) of the AEN's CNRA, of simplified procedures for sharing information on recent CFSI cases. ASNR chairs these groups.

The aim is to quickly exchange information on cases that have been discovered and that may affect the supply chains of several countries, so that other authorities can launch investigations within their areas of competence. These exchanges are carried out using a 'rapid information sharing form'.

At the meetings of these groups, ASN presented several cases in 2022, 2023 and 2024, explaining the detection methods and treatment practices in France.

## Article 14 Assessment and verification of safety

### ARTICLE 14 ASSESSMENT AND VERIFICATION OF SAFETY

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

- i) comprehensive and systematic safety assessments are carried out before the construction and commissioning of a nuclear installation and throughout its life. Such assessments shall be well documented, subsequently updated in the light of operating experience and significant new safety information, and reviewed under the authority of the regulatory body;*
- ii) verification by analysis, surveillance, testing and inspection is carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable national safety requirements, and operational limits and conditions.*

### 14.1. Assessment of safety

#### 14.1.1. The regulatory framework

The Environment Code contains a creation authorisation procedure, which may be followed by a number of authorisations during the life of a nuclear installation, from its commissioning up to final shutdown and decommissioning, including any modifications made to the facility. These aspects are detailed in § 7.2.2.

The Environment Code specifies the content of the file required **for the creation authorisation** of a nuclear installation (Article R. 593-16). This file in particular includes the preliminary version of the safety analysis report, which comprises the inventory of risks presented by the installation and the analysis of the measures taken to prevent these risks or mitigate their consequences. The drafting of the preliminary version of the safety analysis report, the required content of which is specified in Article R. 593-18, is thus based on a safety assessment of the installation.

The Environment Code specifies the content of the required file **for the commissioning authorisation** of a nuclear installation (Article R. 593-30). This file comprises the safety analysis report containing the update of the preliminary version of the safety analysis report and the information allowing to assess the conformity of the installation built with the provisions of the creation authorisation decree. The BNI Order requires that the nuclear safety case be made using a prudent deterministic approach, incorporating the technical, organisational and human aspects (Article 3.2).

With regard to **modifications to the installation occurring during operation**, the “modifications” resolution specifies the criteria for distinguishing the noteworthy modifications requiring ASNAR authorisation from those requiring notification. Noteworthy modifications include the changes made by the licensee:

- to the systems, structures and components (SSCs) of the installation, their authorised operating conditions, the elements which led to its authorisation or its commissioning authorisation or, as applicable, its decommissioning conditions;
- and liable to affect public health and safety or the protection of nature and the environment.

This resolution defines the content of the modification file (including the safety analysis report update) as well as the requirements applicable to the management of noteworthy modifications, more particularly the internal control procedures to be implemented by the licensees.

The Environment Code specifies that the licensee of a BNI must periodically carry out a **periodic safety review** of its installation, taking into account international best practices (Article L. 593-18). “*This review shall allow [...]*”

*an update of the assessment of the risks or detrimental effects presented by the installation [...], notably taking account of the condition of the installation, experience acquired during operation, changes to existing knowledge and to the rules applicable to similar installations”.*

Independently of the authorisation and review procedures, the Environment Code provides for the possibility for ASN “*in the event of a threat to the interests mentioned in Article L. 593-1*” to prescribe, at any time, the assessments and the implementation of necessary provisions (Article L. 593-20).

The “RDS” resolution explains the expected content of the safety analysis report:

- demonstration that the technical, organisational and human provisions adopted enable a level of risk that is as low as reasonably achievable under economically acceptable conditions;
- the description of the incidents and accidents that could occur and the provisions taken to prevent them, limit their probability or mitigate their consequences;
- assessment of the potential consequences, whether or not radiological, of the incidents and accidents considered.

## **14.1.2. Assessments made at the various stages in the lifetime of the installations**

### *14.1.2.1. Before operation*

In accordance with the regulations, when applying for the authorisation to create the nuclear installation, the operator submits a preliminary version of the safety report, which presents the safety assessment of the facility.

#### ***EPR2 reactors***

A high level of safety is sought for the EPR2 reactors, with the following objectives:

- the prevention and mitigation of the consequences of simple initiating events liable to occur in the various reactor states. Accidents that may occur in the fuel storage pool are also considered. The following were carried out in order to meet these objectives:
  - the automation systems design aiming at returning the installation to its normal operating range before actuation of the protection systems;
  - design studies for the safeguard systems (ECCS-RHRS, MSRT, EFWS, RBS, ...) and their support systems,
- the extension of the design domain to operating conditions with multiple failures, which led to the dimensioning of DEC-A (Design Extension Condition) provisions, such as diversified reactor trip signals or the cooling of the spent fuel pool by the 3rd spent fuel cooling system train;
- deterministic consideration of the internal hazards (including, as for simple initiating events, a single failure);
- deterministic consideration of external hazards with high severity levels;
- the “practical elimination” of accident situations, which could lead to large or early releases, by implementing design, manufacturing and operational monitoring provisions and equipment, such as the two “Feed and Bleed ” and "Severe Accident" depressurisation lines;
- the consideration of core melt accident situations. The DEC-B (Design Extension Conditions) provisions aim to preserve long-term containment and to limit releases. Control of releases also implies the systematic identification and processing of all situations which could lead to containment bypass;

- the use of Probabilistic Safety Assessments in addition to the deterministic approach for the choice of the multiple failures to be considered:
  - level 1 PSA, the aim of which is to quantify the risk of core melt below an overall target of  $10^{-5}$  per unit and per year of operation;
  - level 2 PSA, the aim of which is to quantify the risk of releases into the environment for the various scenarios resulting from the level 1 PSA and thus confirm the analyses of practical elimination of situations leading to large or early releases, as well as the analyses showing that the releases associated with core melt sequences at low pressure only require population protection measures that are limited in both space and time.

### ***JHR Reactor***

The safety case presented in the JHR safety analysis report is based on implementation of the principle of defence in depth for all installation states. Its aim is to demonstrate that the provisions at the design stage in accordance with the various levels of defence of depth, are able to reduce the risks of accidents, whether or not radiological, and the scale of their consequences, to levels that are as low as possible in economically acceptable conditions. In this respect, the JHR project pays particular attention to containment, which notably led to the creation of a leak collection zone around the singularities (penetrations and airlock) of the reactor containment.

In order to improve the safety of a technological irradiation reactor, this approach was systematically applied in order to ensure that the defence in depth approach was consistent between the installation and the experiments carried out inside it. Thus, even if it enables similar activities to be carried out, the JHR reactor represents significant developments compared to the OSIRIS reactor concerning both the experiments and safety.

In accordance with the BNI Order, the nuclear safety case for the JHR reactor was performed using a prudent deterministic approach supplemented by probabilistic insights:

- the incident and accident operating conditions, characterised by an initial state and a postulated initiating event leading to a sequence of effects, and the mitigation situations (including controlled severe accidents, such as a BORAX type explosive reactivity accident) are the subject of a deterministic safety analysis;
- the list of hazards liable to compromise the safety of the installation is defined by the BNI Order, differentiating between internal hazards and hazards originating outside the installation. They are the subject of a deterministic or probabilistic safety analysis.

### ***ITER experimental fusion reactor***

The nuclear safety provisions were submitted to ASN as part of the creation authorisation application of ITER in 2010. The Preliminary Safety Report presented during the public inquiry is the document in the creation authorisation application file that contains the safety demonstration. On this basis, and following reviews by ASN with the support of IRSN and the Advisory Committee of experts, Decree No. 2012-1248 of 9 November 2012 authorised the creation of ITER facility.

In order to ensure the protection of personnel, the public and the environment, the ITER Organization has developed a safety approach based on two main safety functions:

- the containment of hazardous materials (chemical and/or radioactive) within the facility,
- protection against exposure to ionising radiation (see § 18.3.2).

These safety functions are considered in all circumstances, including in the event of an accident. To this end, all risks present in the facility are analysed in the safety case, whether they originate from the fusion reaction and its consequences, conventional hazards present in the facility, or the natural and industrial environment of the site.

Possible failures of the facility's systems that could have an impact on workers, the public or the environment are analysed and grouped into types of accident scenarios. Each of these scenarios is analysed in depth and the necessary provisions are put in place to prevent them from occurring, facilitate their detection and limit their consequences. In this regard, accidental loss of plasma, cooling pipe rupture and vacuum loss in the vacuum chamber are among the scenarios analysed.

Conventional hazards are also taken into account for the ITER facility. In particular, fire and explosion inside buildings, heat release, flooding inside buildings, projectile impacts on nearby equipment, interaction between pressurised pipes ('pipe whipping'), and chemical, mechanical, magnetic and electromagnetic risks are considered.

Finally, various potential external risks are studied. These include external fire, external flooding, extreme weather conditions (rain, snow, wind, storms, etc.), hazards related to transport routes, aircraft crashes and earthquakes.

These risks are taken into account from the design stage for mechanical equipment and civil engineering structures to limit their consequences in terms of impact on workers, the public and the environment.

At the ITER facility, the need to ensure containment is linked in particular to the presence of radioactive materials such as tritium and activation products (activation of dust resulting from the erosion of component materials exposed to plasma, gases, impurities, water from cooling circuits, corrosion products, etc.). Controlling the risk of release is based on the principle of containment, which ensures that general safety objectives are met in all normal, incidental and accidental situations. It consists of interposing static barriers (tokamak vacuum chamber, processes used for tritium, etc.) and dynamic barriers (ventilation/filtration and detritiation systems) between radioactive or hazardous materials and the environment.

#### 14.1.2.2. *In operation*

##### ***Safety assessment at the commissioning stage***

In accordance with the regulations, when applying for a commissioning licence, EDF updates the safety assessment carried out at the creation authorisation stage.

The application for a commissioning licence includes an update of the safety report. The safety report includes a nuclear safety demonstration based on in-depth analyses, including deterministic and probabilistic studies.

The safety demonstration for the Flamanville EPR reactor was carried out in accordance with the following safety objectives:

- reducing the number of incidents in order to reduce the possibility of accidental situations arising from such events;
- significantly reducing the probability of core meltdown;
- significantly reducing radioactive releases that could result from all conceivable accident situations, including accidents with core melt.

These safety objectives are those set out in Principle 1 of the Vienna Declaration on Nuclear Safety.

## *The periodic safety reviews*

### EDF reactors

In accordance with the regulations, EDF carries out periodic safety reviews of its reactors every ten years taking account notably of the condition of the facility, the experience acquired during its operation, changes to knowledge and the rules applicable to similar facilities. The “safety reassessment” part leads to the implementation of modifications designed to improve safety.

The safety reassessment is based on in-depth analyses, comprising deterministic and probabilistic assessments, incorporating operating experience feedback, former periodic safety reviews, evolution of knowledge and new regulatory requirements. These analyses lead EDF to define a range of material or operational modifications which improve safety, in accordance with the orientations adopted at the beginning of the review. In most cases, these modifications are grouped into modification batches, which offers greater consistency in the batch of modifications and industrialisation of their implementation: this thus facilitates planning, documentary updating and operator training.

Given the similarity between the reactors in a plant series, the periodic safety reviews of the reactors are carried out in two complementary phases: a first “generic” phase, common to all the reactors of a given plant series, which were designed using a similar model; a second “specific” phase, which takes account of the characteristics specific to each facility, notably its geographical location.

Many reactors have reached or will soon reach the time for their fourth periodic safety review (see article § 6.3). This fourth periodic safety review presents particular challenges: :

- some equipment are reaching their design-basis lifetime. The studies concerning the conformity of the installations and the management of equipment ageing therefore need to be reviewed to take account of the degradation mechanisms actually observed and the maintenance and replacement strategies adopted by EDF;
- the safety reassessment of these reactors and the resulting improvements must be carried out in the light of the new-generation reactors, such as the EPR, the design of which meets significantly reinforced safety requirements, notably with regard to the mitigation of the radiological consequences of accidents without core melt in order to significantly reduce the occurrence of situations involving the implementation of population protection measures, and as well the reduction of the risk of accident with core melt and the mitigation of their consequences.

In this respect, EDF extended its safety case to include the prevention and mitigation of severe accidents, including in extreme situations beyond the design basis, and has defined major modifications.

In 2023, EDF began the generic phase of the fifth periodic safety review of 900 MWe nuclear reactors. As such, EDF has submitted its review objectives and programme file for the fifth periodic safety review, which specifies the major areas of analysis, in particular the ageing management of the installation and the anticipation of the effects of climate change (see Focus 15).

### **Focus No.15: Objectives of the fifth periodic safety review of 900 MWe reactors**

The fifth periodic safety review of the 900 MWe reactors (32 reactors commissioned between 1978 and 1987) will define the conditions for their continued operation beyond 50 years.

The fourth review led to numerous improvements. As a result, ASN considers that this fifth review should focus primarily on compliance, ageing management and on strengthening the consideration of the effects of climate change.

The review will therefore focus on:

- verifying the compliance of the facilities with the applicable requirements, maintaining the qualification of the equipment and managing the ageing for operation up to 60 years;
- the effects of climate change, both on the management of hazards risk (sea level rise, heat waves, etc.) and on the environmental impact, particularly in terms of water intakes and consumption.

The fifth periodic safety review of the 900 MWe reactors will also consolidate the significant safety improvements implemented at the reactors during their fourth periodic safety review, which aimed to bring them close to the safety level of third-generation reactors.

As with previous periodic safety reviews, in order to take advantage of the standardised nature of its 32 reactors of 900 MWe, EDF plans to carry out this fifth periodic safety review in two stages:

- a 'generic' periodic safety review phase, covering topics common to all 900 MWe reactors, both in terms of risk management and the management of inconveniences presented by the facilities. This generic approach enables the mutualisation of studies on ageing management, obsolescence and plant compliance, as well as those relating to safety reassessment and the design of modifications to the plants;
- a 'specific' periodic safety review phase, which applies to each reactor individually and will take place between 2030 and 2041. This phase allows for the integration of the specific characteristics of the reactor and its environment, such as the level of natural hazards to be considered, the specific features of the territory, other uses of water resources and the condition of each reactor.

#### CEA's Cabri reactor

CEA carries out periodic safety reviews on its BNIs every ten years. The periodic safety review comprises several parts:

- an analysis of the experience acquired during the previous decade, entailing a comparison with operating experience feedback from similar installations,
- an examination of the conformity of the installation (compliance with the safety reference framework and with regulatory requirements, qualification of the PICs, ageing of the civil engineering structures and main equipments, condition of the functional systems such as nuclear ventilation, obsolescence of electrical equipment),
- a safety reassessment, incorporating all internal and external hazards.

The CEA has implemented modifications resulting from the latest review that contribute to improving safety.

#### The ILL HFR reactor

During the last periodic review, in 2017, the ILL placed particular emphasis on:

- technical and regulatory conformity,
- verifications by means of analysis and tests of the PIC technical requirements,
- handling, fire and explosion risks management,

- management of risks linked to extreme natural hazards,
- the safety reassessment by updating the deterministic analysis of reference plant conditions

The safety improvements carried out under the periodic safety review aimed to increase the facility's ability to withstand internal and external hazards and ensuring compliance of reactor control functions.

### ***Modifications made during operation***

During the operation phase, the licensees regularly implement modification to equipment and the operating rules. These modifications can be the result of processing of deviations or operating experience feedback. In any case, they are based on an assessment of their safety consequences.

## **14.1.3. ASNR oversight**

### **14.1.3.1. Before operation**

#### ***EPR2 reactor***

As provided for in Article L. 592 29 of the French Environment Code, the Minister responsible for nuclear safety requested ASN to conduct a technical review of the creation authorisation application for two EPR2 reactors at the Penly site.

This review, which is currently underway, follows on from the review of the safety options for EPR2 reactors, which was the subject of an opinion issued in 2019 in which ASN considered that the general safety objectives, the safety reference framework and the main design options were generally satisfactory. In this opinion, ASN also identified areas for further study with a view to a future application for authorisation to create BNIs.

In 2024, ASN informed EDF of its requests regarding the reference frameworks for internal hazards and the classification approach adopted to determine the requirements applicable to components performing a function necessary for demonstrating nuclear safety.

In addition to the technical review of the creation authorisation application, ASN has initiated a process to audit the organisation set up by EDF to carry out its project. The aim of this process is to verify that the requirements relating to the protection of people and the environment to which EPR2 reactors must comply are taken into account in an appropriate manner during the design and construction phases of these reactors.

With regard to the equipment of the primary and secondary systems of these reactors, ASN continued in 2024 its control of their design and manufacture. Between 2021 and 2024, ASN issued its opinion on the design options for the main equipment, such as the reactor vessel and steam generators. In addition, ASN approved the start of manufacturing for certain equipment, such as the reactor vessel and steam generators.

In parallel with the assessment of the design documentation, the supply of components for this equipment is subject to controls, particularly for large forged components. The aim of these controls is to verify that the manufacturing processes selected offer sufficient guarantees to produce materials that meet the required quality level.

ASN has also launched the control of the supply chain for other equipment important for nuclear safety intended for EPR2 reactors, in order to assess the suppliers' management of manufacturing activities and EDF's monitoring of these suppliers.

**CEA's JHR reactor**

In March 2006, CEA submitted a creation authorisation application to the Ministers in charge of nuclear safety, for the JHR research reactor with a power of 100 MW on the CEA Cadarache site.

For the purposes of the creation authorisation application, ASN examination notably covered the design of the installation's civil engineering in particular with regard to hazards (fire, combination of external or internal hazards), the classification and qualification process, the containment, incidental and accidental situations and severe accidents and their radiological consequences, in particular the BORAX accident.

The Government authorised its creation through Decree 2009-1219 of 12 October 2009, after a favourable opinion issued by ASN following its examination.

In December 2021, CEA sent the installation safety analysis report to ASN ahead of the commissioning authorisation application. With the support of the IRSN, ASN has drawn up a roadmap defining the topics that will be the subject of an early review and assessment, in particular the general approach to analysing the safety of the installation, the architecture of the backup and ultimate cooling systems, the I&C and the risk of criticality.

In September 2024, the CEA submitted a request to the Ministry for Energy Transition to amend 2009 Authorisation Decree in order to extend the commissioning deadline by nine years to 14 October 2037.

**ITER experimental fusion reactor**

Fusion facilities pose specific challenges in terms of nuclear safety and radiation protection, with risks that differ from those of fission reactors. These include tritium containment, radiation protection against intense neutron flux, and the management of tritiated and activated radioactive waste. The ITER project is a research fusion reactor project, whose design and experimental programme are evolving over time.

The French regulatory framework for BNIs (in particular the BNI decree of 7 February 2012), which favours a goal-based approach, provides a proportionate framework for all nuclear installations, with a level of vigilance commensurate with the risks they present (in terms of safety, environmental protection and radiation protection for people). It was within this framework that authorisation for the creation of ITER was granted, i.e. at a very early stage when many of the technical provisions of the ITER project, which is a research project, had yet to be defined. Various holdpoints were defined in ASN resolution in conjunction with the authorisation creation decree (cf § 7.2.2).

The integrity of the tokamak in operation is essential to ensure the containment safety function. In this regard, in 2022, geometric non-conformities were discovered in the vacuum chamber sectors of the tokamak before they were welded. ASN did not lift the hold point on the assembly of the tokamak, mainly due to these geometric non-conformities in the sectors to be assembled. Since then, the ITER Organization has undertaken repairs to the affected sectors, revised its welding strategy, and now plans to weld them once they are all in place.

Finally, in 2023 and 2024, the ITER Organization defined a new experimental programme for the ITER project with a new reference scenario, modifying some major design choices (e.g. replacement of beryllium by tungsten for the vacuum chamber blanket modules).

In this context, ITER has proposed to demonstrate safety in successive stages, with each demonstration stage covering the next operational stage. This approach allows, within the framework established by the creation authorisation decree, the construction work to progress and then the operational programme to be developed

step by step. The technical reviews are thus carried out by ASNR as closely as possible to the project's development stages, as the uncertainties inherent in an experimental project such as ITER are resolved. This specific approach has been discussed with the ITER Organization, resulting in the definition, in 2025, of a schedule for the production and review of the necessary technical files.

#### 14.1.3.2. *In operation*

##### ***Flamanville EPR reactor***

In May 2006, EDF submitted an application to the Ministers in charge of nuclear safety and radiation protection, for the authorisation to build a 1,650 MWe EPR reactor on the Flamanville site, which already houses two 1300 MWe reactors. The Government authorised its creation through Decree<sup>20</sup> 2007-534 of 10 April 2007, after a positive opinion issued by ASN following the examination process. After the issue of this Creation Authorisation Decree and the building permit, construction of the Flamanville EPR reactor began in September 2007.

EDF sent its partial commissioning authorisation application in March 2015. ASN reviewed this application and in October 2020 issued the corresponding authorisation, which enables fresh fuel and startup neutron sources to be allowed onto the site and stored in the pool.

EDF updated in 2021 its request for authorisation to commission the EPR reactor. This application includes a complete update of the file, incorporating the conclusions of the review and assessment conducted by ASN since 2015. This file thus contains the safety report, the general operating rules, the decommissioning plan, the emergency plan, an update of the initial impact study for the purposes of its environmental and risk assessments.

ASN has examined the design of the installation and its safety case. Discussions were held with EDF throughout the construction of the reactor. Between 2007 and 2023, ASN held 28 meetings of its Advisory Committees of experts and requested more than a hundred opinions from the IRSN to carry out its review. The review regularly drew on the contributions of the inspections carried out on the construction site, in the suppliers' factories or within EDF's engineering entities. ASN thus performed inspections on civil engineering construction activities, equipment manufacturing and assembly, the tests on the installation and on the preparation for operation. ASN also carried out labour inspections on the construction site.

Throughout the project, ASN maintained a lively exchange with its foreign counterparts overseeing an EPR reactor project. These exchanges enabled to share the conclusions of the safety reviews and the lessons learned from each project. This was particularly the case with regard to the various anomalies observed in the reactor core at Taishan (China), including the fuel cladding leaks observed in 2021.

The design of the Flamanville EPR reactor meets the ambitious safety objectives set for third-generation reactors. It leads to a significant reduction in the probability of core meltdown and radioactive releases in the event of an accident compared to second-generation reactors. In particular, the EPR reactor design includes severe accident management systems and is resistant to extreme levels of external hazards.

Following its review and inspections, ASN authorised the commissioning of the EPR reactor in Flamanville by the resolution of 7 May 2024. This authorisation allows EDF to load the nuclear fuel into the reactor and to

<sup>20</sup> This decree was modified in 2017 and 2020 to extend the time allowed for commissioning of the reactor.

proceed with the start-up tests and then the operation of the reactor. The conclusions were published in a public report<sup>21</sup>.

### ***Periodic safety reviews***

For the periodic safety reviews of the facilities, ASN initially issues a position statement on the proposed review objectives and programme from the operator for the review and in particular the compliance verification that it will carry out and the safety objectives that it intends to achieve for the continued operation of its facilities. ASN then examines the conclusions of the conformity verification and the studies associated with the safety reassessment performed by the licensee, supplementing them by inspections as necessary. For the purposes of this examination, ASN relies on its internal expertise and on the Advisory Committees of experts. It mobilises significant resources over several years. Following this examination, ASN may set to the operator binding technical requirements notably concerning the implementation of the provisions proposed by the licensee, or request additional provisions.

For the 4<sup>th</sup> periodic safety review of the 900 MWe and 1300 MWe nuclear reactors, ASN issued a position statement on the objectives of this periodic safety review: the safety objectives to be adopted for this review were defined in the light of the objectives applicable to the new generation of reactors. These objectives applied to the existing reactors are those of principle n.1 of the Vienna Declaration on Nuclear Safety (VDNS) which is formulated for new reactors.

Following the review of the generic phase of the 4<sup>th</sup> periodic safety review for 900 MWe reactors, ASN issued a resolution at the beginning of 2021 on the conditions for their continued operation. ASN underlined the ambitious objectives of the fourth periodic safety review of the 900 MWe reactors and the substantial work done by EDF during this generic phase. It has also underlined the extensive modifications planned by EDF, the implementation of which brings about significant safety improvements. These improvements in particular concern management of the risks linked to hazards (fire, explosion, flooding, earthquake, etc.), the safety of the spent fuel pool and the management of accidents with core melt.

ASN prescribed the implementation of the major safety improvements planned by EDF as well as a number of additional provisions it considers necessary to achieve the objectives of this periodic safety review in order to bring the level of safety of the 900 MWe reactors close to that of the most recent reactors (third generation).

EDF - from 2020 to 2031 - carries out the specific phase of the fourth periodic safety review of each of the 900 MWe reactors. The report concluding the review gives rise to a public inquiry. Then, ASN submits for public consultation the draft of requirements it deems necessary for continued operation of each of the reactors.

Following the review of the generic phase of the 4<sup>th</sup> periodic safety review for 1300 MWe reactors, ASN issued a resolution on 1<sup>st</sup> July 2025 on the conditions for their continued operation.

### ***Noteworthy modifications to the installations***

ASN examines the acceptability of the noteworthy modifications subject to its authorisation. These modifications may result from operating experience feedback or from changes made to the safety case. They are sometimes linked to reactor equipment modifications.

<sup>21</sup> <sup>21</sup> [EPR review report](#)

## 14.2. Verification of safety

### 14.2.1. The regulatory framework

Provision is made for the verification of the safety by various legislative and regulatory measures establishing the periodic safety reviews, in-service monitoring of NPE, controls on PICs and PIAs and the processing of the deviations discovered.

The Environment Code states that the licensee of a nuclear installation must periodically conduct a **periodic safety review** of its installation, taking account of international best practices (Article L. 593-18). In addition to the safety reassessment described in § 14.1.2.2, this review shall include the assessment of the compliance of the installation with all applicable rules, in order to verify its safety; the applicable rules are derived from regulations and guides, authorisation documents, and operator’s applicable documents.

The Articles (Article 2.4.1, 2.6.1, 2.6.2 and 2.6.3) of the BNI Order specify the provisions that licensee must comply with to ensure that the nuclear installation meets the applicable requirements. It in particular requires that the licensee define and implement an integrated management system, notably with the aim of verifying compliance with the requirements of laws and regulations, the authorisation decree and the binding requirements and resolutions of ASN and provisions concerning the detection and processing of deviations.

ASN Guide No. 21 sets out recommendations for dealing with non-compliance deviations affecting safety important equipment, without rendering this equipment unavailable. Indeed, the general operating rules specify the timeframe for restoring the availability of the affected equipment, but do not cover a situation in which the deviation compromises the availability of the equipment in certain conditions (for example in the event of an earthquake). This Guide more particularly focuses on:

- specifying the objectives in terms of timeframe for the correction of these deviations, by explaining the notion of “timeframe appropriate to the issues” mentioned in the BNI Order (Article 2.6.3);
- determining the procedures for analysing the combined effect on the installation of several non-compliance deviations, that the licensee must carry out pursuant to this same Order (Article 2.7.1).

In addition, the regulations comprise various provisions concerning ageing management, notably:

- provisions requiring in-service monitoring of certain non-replaceable nuclear pressure equipment, such as the reactor pressure vessels (Article R. 557-14-2 of the Environment Code);
- provisions which require that, as of the design stage, equipment ageing be taken into account, notably the alteration of materials over time and the consideration of ageing phenomena under irradiation (Order of 30 December 2015 on nuclear pressure equipment);
- design, construction, testing, inspection and maintenance provisions, which ensure that the qualification of the SSC is maintained as long as required (Article 2.5.1 of the BNI Order);
- provisions requiring periodic surveillance programmes on equipment, designed to verify that there are no faults or that - if there are - they do not develop, and as well a programme to monitor the material properties degradation modes and a document to precisely identify the actions to which the equipment has been subjected (Order of 10 November 1999);
- provisions concerning the monitoring of the ageing of SSC, notably provisions at the design stage to facilitate monitoring of the anticipated ageing mechanisms and detect deterioration or unexpected behaviour, which could occur during operation of the BNI (Guide No. 22).

## 14.2.2. Verifications performed by the licensees

### 14.2.2.1. *Periodic checks and tests, in-service inspections, conformity check during the periodic safety reviews*

Checks and tests, in-service inspections and monitoring of operation are carried out to ensure that the physical state and the operation of a nuclear installation continue to be in accordance with its design, applicable safety requirements, and operational limits and conditions.

The periodic tests on safety important equipment contribute to monitoring the availability of this equipment and **ensure compliance with the required characteristics**. The periodic test rules for safety important equipment are incorporated into the general operating rules of the reactors. They set the nature of the technical inspections to be performed, their frequency and the criteria for determining the satisfactory nature of these checks. The periodic test rules are regularly revised to take account of modifications to the installation and in the light of operating experience feedback.

The actions that contribute to the management of ageing and conformity (surveillance, maintenance, inspection, processing of detected deviations, replacement of equipment) serve to ensure that the facilities comply with their safety baseline requirements, that is to say all the rules governing the safe operation of the facility. These actions must be carried out on a daily basis.

The periodic safety review is an ideal framework for verifying the sufficiency and effectiveness of the provisions implemented to maintain the **compliance of the installations**.

On the occasion of the periodic safety reviews, EDF deploys substantial means to verify the compliance with the applicable safety reference framework, particularly based on:

- the examination of plant unit conformity (ECOT), which supplements the existing operating and maintenance provisions (periodic tests, maintenance programmes), by means of physical and/or documentation inspections,
- the complementary investigations programme (PIC), the aim of which is to support the assumptions concerning the absence of in-service degradation in areas not covered by the preventive maintenance programmes,
- the processing of non-compliance deviations identified during the operation of the installations,
- the provisions for ageing management and obsolescence and the particular tests to be carried out during the ten-yearly outage inspections.

These provisions are carried out in addition to routine maintenance, in-service monitoring and processing of any deviations detected during operation.

With regard to the possibility of fraud or counterfeit (CFSI as defined by the IAEA), EDF adapted its surveillance practices, notably making greater use of inspections or cross-checks (see Section 13.2).

### 14.2.2.2. *Ageing management*

#### ***Nuclear power plants***

For its nuclear power reactors, EDF has implemented an **ageing management** strategy based on three lines of defence: anticipation of ageing in the design, monitoring of the actual condition of the installations and the repair, renovation or replacement of equipment actually or potentially affected.

Ageing management is based in particular on design, operating, in-service monitoring and routine maintenance measures, supplemented by exceptional maintenance. It notably contributes to maintaining the qualification of the PICs. In this respect, it comprises:

- analyses of the ageing mechanisms and of the capability for continued operation of the components for all the reactors, with regard to the behaviour of the equipments to demonstrate the ageing management of this equipment,
- a specific analysis of each reactor to verify that the generic analyses do indeed cover the particularities of each reactor, and so to demonstrate the reactor's ability for continued operation,
- maintenance programmes, periodic tests, renovations,
- obsolescence management programmes decided nationally or locally.

#### **Focus No.16: Knowledge capitalisation on ageing mechanisms**

The CAPCOV (Capitalisation of Knowledge on Ageing Mechanisms) R&D process aims to capitalise on, update and facilitate access to scientific knowledge available at EDF on the ageing of materials for EDF stakeholders involved in ageing management.

A collection of reports written by R&D experts summarises the knowledge available at EDF on each ageing mechanism. The reports are regularly reviewed and updated in line with developments in scientific knowledge, feedback from the operator and international experience. CAPCOV knowledge is integrated into a structured database and knowledge base called CAPCOV, which offers several types of access to this knowledge tailored to the needs of EDF specialists in ageing management, from full-text search to advanced navigation and multi-criteria selection.

Over the period 2021-2024, a quarter of the ageing mechanisms have been reviewed and eight have been updated, including the integration of additional knowledge acquired on stress corrosion. This knowledge results from lessons learned on inconel alloy and stainless steel from operator tests, studies and models developed by R&D on the subject. In particular, a supplementary test programme has been launched following experience feedback on the auxiliary lines : crack initiations tests to better understand the effects of component surface finish and ambient temperature, and propagation tests to better predict the effects of hardening and temperature.

#### ***Anticipating the operating life of the current nuclear power plant fleet***

With a significant proportion of France's nuclear reactors having been commissioned in the 1980s, it is important to anticipate their decommissioning sufficiently in advance and avoid a cliff effect on the French electricity system. The ten-year horizon for periodic safety reviews is too short to anticipate certain fundamental issues affecting the operating lifetime of reactors, in particular to prepare for the modifications and maintenance operations required to ensure continued safe operation, in light of the heavy investment that would be necessary.

In order to anticipate the safe shutdown phase of the current fleet of reactors, EDF, IRSN and ASN identified in 2023 the technical issues that will require specific analysis, or even research and development work, to support consideration of continued operation beyond 60 years. Then, based in particular on a review conducted with international experts and an international seminar held in September 2023, EDF prepared an analysis of each issue previously identified and proposed a course of action (research or studies to be undertaken, advanced modelling to be developed and validated, components replacement or other modifications to be

considered, etc.) with the aim of addressing obstacles to potential operation beyond 60 years in a timely manner. These elements were submitted to ASNR in early 2025 and are being evaluated by ASNR experts in preparation for a meeting of the Advisory Committee of experts for Reactor in 2026, which will be followed by a general position statement from ASNR on the perspectives for continued operation beyond 60 years.

### ***Reactors other than nuclear power reactors***

CEA manages the ageing and obsolescence of the safety important structures and equipment (PIC), in order to ensure compliance with the defined requirements.

For CEA's nuclear installations, and in particular the Cabri reactor, the rules governing the periodic checks and tests are included in the general operating rules. Analysis of the results of the periodic checks and tests and the visual inspection are used for over time monitoring of the civil engineering structures and PICs. Moreover, the review performed during the periodic safety review is a means of checking that the installation complies with its safety reference framework.

For the Cabri reactor, on the occasion of the last periodic safety review, the condition of the civil engineering was examined with respect to the risks related to its ageing. Visual assessments (whether or not destructive) highlighted certain localised faults or deterioration: renovation work was therefore carried out (renovation of portions of the tightness liner of the reactor building and on the roofs of the building annexes).

The obsolescence of the electrical equipment is a particular subject. For the Cabri reactor, a diagnostic of the high and low voltage electrical networks showed the need for an upgrade with replacement of certain electrical distribution equipment.

In 2019, the ILL launched an ageing management plan based on identification of the ageing mechanisms of PICs concerned by these mechanisms and the corresponding monitoring activities (nature, scope and frequency). This plan will be continued and its scope extended in the 2027 review. The obsolescence topic is covered in the maintenance plans.

This ageing management plan was first applied to the reactor containment by periodic checks and tests (evolution of the leakage rate and condition of the concrete containment) and on the reactor block by monitoring the fluence of its components and replacing them if necessary. It was then expanded to cover the polar crane and the casks handling gantry, with implementation of trend monitoring appropriate to the expected degradation mechanisms. By 2027, this plan will be extended to cover all safety important equipment, which is already subject to periodic trend monitoring of inspected parameters, a maintenance plan and compliance checks with its technical and safety requirements.

### **14.2.3. ASNR oversight**

ASNR ensures that the verification procedures established by the operator are appropriate, whether they are part of maintenance, periodic testing or programmes for verifying compliance, maintaining qualification or managing ageing. It also authorises the most significant modifications to the general operating rules, particularly with regard to periodic tests.

In addition, ASNR carries out very regular inspections of each nuclear installation to verify that the provisions established by the operator are being properly implemented.

As part of the periodic safety review, ASNR verifies during its inspections that the measures implemented by the operator are sufficient and effective to maintain the compliance of the installations and manage their ageing. It then oversees the implementation of the verification programmes defined by the operator. In

particular, ASNR has put in place a specific enhanced inspection plan for the fourth ten-year inspections of each of EDF's 900 MWe reactors.

Finally, the f ageing management in installations was the subject of the first Topical Peer Review stipulated by Council Directive 2014/87/Euratom. This review gave rise to the drafting of a report on generic conclusions and a report on country-specific results. On this basis, the national action plans drawn up by the countries were submitted in September 2019. France issued its final report in 2021, marking the completion of all planned actions.

## Article 15 Radiation protection

### 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. The regulatory framework

The regulatory framework was updated in 2018 to ensure transposition of the new Euratom 2013/59 Directive, published on 5 December 2013, into French regulations (Public Health, Labour and Environment Codes).

This framework applies to all nuclear activities, that is mainly the activities entailing a risk of exposure of persons to ionising radiation linked to the use either of an artificial source, or of a natural source. This framework therefore applies to Basic Nuclear Installations.

Article L. 1333-2 of the Public Health Code recalls the general principles of radiation protection (justification, optimisation, limitation), which were laid down at the international level by the International Commission on Radiological Protection and reiterated in Directive 2013/59/Euratom.

ASN Guide No. 22 contains the requirements for optimisation of radiation protection at the reactor design stage.

The Environment Code states that the licensee of a nuclear installation must define an organisation responsible for advising it regarding all questions related to the risks and detrimental effects of ionising radiation (Article R. 593-112). This organisation is built around a competence centre which acts as radiation protection adviser as defined by the Public Health Code (Articles R. 1333-18 and R. 1333-19).

The BNI Order contains provisions on radiation protection, in particular on the discharge of radioactive effluents and on waste management.

#### 15.1.1. Protection of workers

The Public Health Code, the Environment Code and the Labour Code contain provisions for the protection of workers within nuclear installations.

As per the Labour Code, the employer must take all necessary steps to ensure the safety and protect the health of the workers (Article L. 4121-1 et seq. of the Labour Code) and therefore implement measures to protect workers against the risks from ionising radiation.

The Labour Code makes provision for collective protection measures (Articles R. 4451-18 to R. 4451-20). The licensee is responsible for taking collective protection measures to ensure compliance with the principles of radiation protection (Articles L. 593-42 of the Environment Code and L. 1333-27 of the Public Health Code). Any area in which the workers are liable to be exposed to levels of ionising radiation exceeding certain defined thresholds must be identified and marked out. Specific and appropriate signage shall be provided (Articles R. 4451-22 to R. 4451-25 of the Labour Code).

The Labour Code (articles R.4451-58 and 59) states that workers exposed to radiation must receive initial and periodic (every three years) training in radiation protection. The topics covered during these training sessions are also set out 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:

- dose limits for workers;
- dosimetry and medical monitoring of workers.

#### 15.1.1.1. *Dose limits for workers*

The dose limits for workers are defined in Article R. 4451-6 of the Labour Code:

- for the whole body, the effective dose exposure limit value is 20 mSv for twelve consecutive months;
- for the organs or tissues, the limit values are set at:
  - 500 mSv for the extremities and skin; for the skin, this limit applies to the average dose over a total surface of 1 cm<sup>2</sup>, irrespective of the exposed surface;
  - 20 mSv for the crystalline lens of the eye.

Finally, in a radiological emergency situation, the total effective dose of a response worker over his lifetime shall in no case exceed 1 sievert (Article R. 4451-9 of the Labour Code).

#### 15.1.1.2. *Dosimetry monitoring of workers*

The Labour Code requires that the results of individual dosimetry monitoring be transmitted to the ionising radiation exposure information and monitoring system (R. 4451-66), the management of which is entrusted to ASNR (R. 4451-134).

The Labour Code stipulates that ASNR shall “draw up, in the form of a report submitted to the Minister responsible for labour and published after consultation with the social partners, an annual summary of the worker exposure measurement results, including the ionising radiation exposure levels, taking account notably of the professional activities and the nature of the exposure, along with an analysis of these data.” (R. 4451 - 134).

The Labour Code also stipulates that “the worker shall have access to all of their individual dosimetry monitoring results and to the effective dose concerning him or her.” and that they “may, where appropriate, consult the system manager, the occupational physician or the radiation protection advisor. The latter may only disclose the results to which they have access.” (R. 4451-67).

### 15.1.2. **General protection of the population**

Several provisions of the Public Health Code help protect the public against the risks of ionising radiation as a result of nuclear activities. They concern:

- dose limits for the general public;
- discharge limits in the environment;
- radiological monitoring for the environment.

#### 15.1.2.1. *Dose limits for the general public*

The dose limits for the public are:

- the effective annual dose limit 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<sup>2</sup> area of skin) (Article R1333-11 of the Public Health Code).

The method for calculating doses, as well as the methods used to estimate the dosimetric impact on a population, are set out in the decree of 1 September 2003, which defines the methods for calculating effective doses and equivalent doses resulting from the human exposure of individuals to ionising radiation.

#### 15.1.2.2. *Environmental discharge limits*

The Environment Code gives ASNR competence for setting out requirements concerning effluent discharges by nuclear installations (L. 593-10).

The BNI Order imposes several general provisions, in particular the limitation of discharges from the design stage and the use of the best available techniques.

In addition, ASNR specified, in its “Discharges” resolution the requirements applicable to nuclear installations concerning water intakes, effluent discharges into the receiving environment or the nuisance caused by these installations to the public and the environment. Together with the other regulatory texts applicable to nuclear installations, it constitutes the minimum regulatory framework in this area.

In addition to these general provisions, ASNR specifies in two types of individual resolutions the specific requirements applicable to each nuclear installations or to several nuclear installations on the same site, relating respectively to the “limits” on water intakes and discharges into the environment and the “procedures” for such intakes and discharges. The latter resolution specifies, in particular, the minimum controls that the operator must implement before discharging effluents, as well as the monitoring of the environment that could be affected.

#### 15.1.2.3. *Radiological monitoring of the environment*

The French regulations require that the licensees of nuclear installations carry out radiological monitoring of the environment around their facility (BNI Order and “Discharges” resolution).

More specifically, the monitoring carried out must aim in particular at:

- quantifying discharges of radioactive substances and verifying compliance with any applicable limit;
- detecting a malfunction of the installation (article 4.2.2).

The Public Health Code provides for the creation of a national environmental radioactivity monitoring network (RNM) managed by ASNR which has the two-fold goal of information transparency - by providing the public with the results of this monitoring and information about the radiological impact of nuclear activities in France - and quality for the environmental radioactivity measurements, by setting up a system of laboratory approvals, issued by ASNR resolution (Article R. 1333-25). If they are to be input into the RNM database, the measurements must have been performed by laboratories approved by ASNR.

The Public Health Code requires that the average individual doses received by the population as a result of authorised nuclear activities be estimated at least once every five years and be included in a public report published on the Authority’s website (Article R.1333-27).

## 15.2. The provisions implemented

### 15.2.1. Radiation protection of workers

#### 15.2.1.1. *Monitoring of workers*

Pursuant to Article R.4451-66 of the Labour Code, an external exposure monitoring system for persons working in facilities in which ionising radiation is used has been put in place. This system is based primarily on the mandatory wearing of passive dosimeters for workers liable to be exposed and enables for verification of compliance with regulatory limits applicable to workers.

The data recorded indicate the cumulative exposure dose over a given period. They are collated in the SISERI system managed by ASN and are published annually.

At the national level, the SISERI system consolidates the following data:

- passive external dosimetry, the results of which are supplied by the dosimetry organisations;
- operational external dosimetry, the results of which are sent in by the radiation protection advisers for the BNIs;
- monitoring of internal exposure, the results of which are supplied by the medical biology laboratories or the occupational health units, and the internal doses calculated by the occupational physicians;
- other data concerning the monitoring of flight crews, radon exposure or naturally occurring radioactivity.

In accordance with article R. 4451-134 of the Labor Code, ASN draws up a report on the monitoring of workers exposed to ionizing radiation.

#### 15.2.1.2. *Optimisation of radiation protection of workers*

##### *Nuclear power reactors*

Pursuant to the principle of optimisation of radiation protection, EDF implements a dose optimisation approach based on four pillars:

- **reduced contamination of systems:** the controlled injection of zinc into the primary system is a means of reducing the contamination of the systems. To date, this system has been implemented on reactors that have undergone steam generators replacement and has demonstrated its effectiveness in reducing Dose Equivalent Rates (DeR) for the first operating cycles following the replacement of these components. The actions pursued today to reduce the source term focus primarily on the processing of certain radionuclides, such as  $^{110}\text{Ag}^m$ ;

More specifically, with regard to  $^{110}\text{Ag}^m$ , EDF defined a new treatment strategy in 2022 for the reactors concerned, with various developments currently being tested:

- optimisation of “cold shutdown” process with low-temperature oxygenation;
- use of macroporous resins in purification systems,
- appropriate duration for the purification phase with primary pumps in operation, tailored to the specific reactor outage configuration for maintenance.

EDF is also continuing its multi-year programme to clean up residual heat removal system (RHRS) and chemical and volumetric controls system (CVCS) on reactors where reducing the source term is a priority. For the period 2022 - 2024, 8 interventions were carried out on the NPP fleet. This programme is updated every year according to the evolutions of the radiological status of each reactor and the dosimetric gains

evaluated over 5 years, to confirm the priority intervention. Feedback from the reactors cleaned out during the 2022-2024 period shows a dosimetric gain of 576 man-mSv confirming the benefits and effectiveness of these operations in order to reduce worker dosimetry.

In addition, EDF has been working since 2024 on a new long-term programme to reduce the source term of certain reactors. Two new processes are being prioritised:

- experimentation with the treatment of ‘hot spots’ present in facilities using “ultrasound” technology;
- a feasibility study for more comprehensive decontamination of the primary system and main auxiliary systems on reactors in operation, based on feedback from operations commonly referred to as ‘Full System Decontamination’ (FSD) carried out on the two reactors at the Fessenheim power plant as part of their permanent shutdown, and on several reactors internationally (particularly in Germany).

- **preparation for interventions and dose optimisation:** the process, common to all nuclear sites (EDF and contractor staff) is based on the following key points:

- perform a forecast dosimetry evaluation for each operation (collective and individual dose),
- carry out an optimisation analysis of these operations according to the potential dosimetry,
- set a collective and individual dosimetry target for each operation not to be exceeded, as a result of this optimisation analysis,
- carry out experience feedback work, with analysis of deviations and good practices to be used for the benefit of future operations.

During the radiation protection equipment studies and development programmes run by EDF with the manufacturers, two new equipments are being rolled out:

- each power plant is gradually being equipped with a “Gamma Camera” to improve characterisation of the source term, optimise processing actions and dosimetry;
- a new “high-performance beta” measurement probe, ECHO, also complements the range of “contamination meters” in order to improve the measurement of low levels of contamination in environments where the radiological atmosphere can fluctuate.

- **use and dissemination of experience feedback:** to limit the doses received by the workers, EDF set up alert thresholds in the operational doses management application common to all NPPs. These thresholds are set at 13 mSv for the pre-alert and 18 mSv for the alert. If the pre-alert threshold is reached, and in coordination with the workers, physicians and radiation protection officers, the individual dosimetry is optimised over 12 months. If an alert threshold is reached, access to areas with a risk of exposure to ionising radiation is then temporarily suspended.

EDF performs a targeted monitoring on the most exposed jobs, which has contributed to stabilise the trend seen over the 2019-2021 period. Between 2022 and 2024, only 3.2 % of workers will exceed the 6 mSv threshold. In 2023, this corresponds to 1,568 workers exposed above the 6 mSv threshold. The activities concerned mainly relate to maintenance in the mechanical engineering and fabrication fields, worksite logistics (including insulation and scaffolding), maintenance in the automation and electrical fields, metallurgical testing and radiation protection work. The average individual dose is also maintained at less than 1 mSv per worker (0.99 mSv in 2024). These results have been achieved despite major maintenance work and modifications to EDF's nuclear fleet (ten-yearly outage of 900 MWe and 1300 MWe reactors), with a significant programme of interventions related to the ‘Stress Corrosion’ event over the 2022-2023 period. Over 2022-2024, EDF has got a number of hours worked in nuclear areas above the historical threshold of 7 million hours per year.

- **implementation of specific processes for activities involving a significant risk of exposure to radiation:** they apply to access to a prohibited area (dose equivalent rate higher than 100 mSv/h), to limited stay areas (dose equivalent rate higher than 2 mSv/h) and to performance of radiographic inspections. Specific organisations were also designed and formally adopted, and each site is periodically assessed by teams from a Nuclear Inspection unit (independent of the operating sites) with regard to its compliance with common baseline requirements defining the targets and performance to be achieved.

Significant dose reductions are thus been achieved. The collective dose per year and per reactor has decreased from 2.4 man-Sv in 1992 to an average of 0.69 man-Sv per reactor over the last ten years. With regard to the individual dose, the dosimetry of the most exposed workers has been greatly reduced. Since 2015, no worker has exceeded 15 mSv over one year. For the period 2022 - 2024, no worker was exposed to an annual dose greater than 14 mSv, and an average of 120 workers received an annual dose higher than 10 mSv (or 0.2 % of the workers).

#### **Focus No.17: Events relating to external contamination of workers at Cattenom, Tricastin and Saint-Laurent-des-Eaux nuclear power plants (ESR level 2)**

In 2023 and 2024, three cases of worker contamination were detected during checks carried out at the exit of the controlled area of the reactor building at Cattenom (2 February 2023), Tricastin (6 June 2024) and Saint-Laurent-des-Eaux (25 October 2024) sites. In each case, the person was taken care of by the medical unit, which located the radioactive particle causing the contamination on the cheek, foot and head, respectively. Each particle was removed.

The workers involved were installing thermal insulation in the reactor building (Cattenom and Tricastin) and decontaminating the reactor pool (Saint-Laurent-des-Eaux), respectively.

In each case, the dose received by the worker, based on conservative assumptions, exceeded the regulatory limit for the equivalent dose to the skin, set at 500 millisieverts for a 1 cm<sup>2</sup> area of skin.

EDF reported three significant events relating to radiation protection. Due to the exceeding of a regulatory exposure limit for a worker, these events were classified as level 2 on the INES scale (International Nuclear and Radiological Event Scale, graded from 0 to 7 in order of increasing severity).

Following the reporting of each event, ASN carried out an inspection at the plant concerned to verify that EDF had taken all necessary measures to manage the event adequately and to analyse its causes.

#### **CEA's Cabri reactor**

The assessment of the radiological risks for the workplaces is part of an optimisation process. Thus, whole-body dose constraints for the CEA employees were set at 1 mSv over one year.

The optimisation process on Cabri takes the form of:

- a workplace study comprising an initial calculation phase upstream of the test to be performed on the new loop, identifying the operations for which the risk of external exposure is in principle significantly higher than the others,
- dosimetry experience feedback (OEF): analysis of the operational dosimetry results allows for the consolidation of the evaluations made by calculation,
- updates of the workplace study to take account of OEF and supplement the evaluation by performing 3D calculations on particular operations.

The effectiveness of the system in place is proven by the record of doses received by the personnel of the facilities and the personnel of subcontractors over the years 2022-2024:

- over this period, the annual collective dose for the CEA employees assigned to the Cabri research reactor was on average 1.3 man-mSv; that of the employees of subcontractors working on the Cabri reactor was on average 0.43 man-mSv;
- over this period, no CEA employee and none of the employees of the subcontractors was exposed to an annual effective dose higher than 1 mSv.

### ***The ILL HFR reactor***

The ILL Director is assisted by the Radiation Protection Safety Environment Department (SRSE), which advises him on the application of the regulations and the implementation of the prevention policy in the fields of conventional safety and radiation protection. With regard to the prevention of the risks of exposure to ionising radiation, the SRSE acts as a Radiation Protection Competence Centre as defined by the Labour Code and the Environment Code.

The optimisation of radiation protection is based on:

- the radiation protection instructions issued by the Radiation Protection Competence Centre. These may be general instructions or instructions specific to a high-risk worksite or experiment;
- the participation of radiation protection technicians in defining work procedures to set out the means of prevention and protection, along with any radiation protection measures to be taken during the operation,
- the production of formal dosimetry forecasts in the work permit applications,
- the performance of in-depth optimisation studies for worksites on which the forecast collective dose is higher than 10 man-mSv and/or the forecast individual dose is higher than 2 mSv.

The effectiveness of the overall radiological protection system in place is demonstrated by the dose history. More specifically, over the past three years (2022, 2023 and 2024), no employee received an annual dose higher than 3 mSv and the collective dose (including the ILL personnel, guest researchers and contractors, or about 2,000 people) over this period was less than 88 man-mSv.

More specifically, in 2022, the replacement of the H1/H2 beam tube, a component of the reactor block, resulted in a collective dose of 10.2 man-mSv, well below the dose of 22 man-mSv generated by the same operation in 2005.

## **15.2.2. Radiation protection of the public**

### **15.2.2.1. Discharge of radioactive effluents**

#### ***Nuclear power reactors***

Since the start of PWR operation, EDF has been working to reduce and control discharges from its installations. As a result, EDF operators focus on limiting discharges, mainly by improving the effluent collection and treatment circuits and by reducing its production at source. These steps have led to a concrete reduction in the activity of liquid effluent discharges (except for tritium and carbon 14), which has now reached a floor level of about 0.2 GBq/reactor/year since 2008 (discharge activity divided by 100 since 1985 and divided by 10 since 1994).

Tritium and carbon 14 discharges, which are directly correlated with the power output by the units, remain stable.

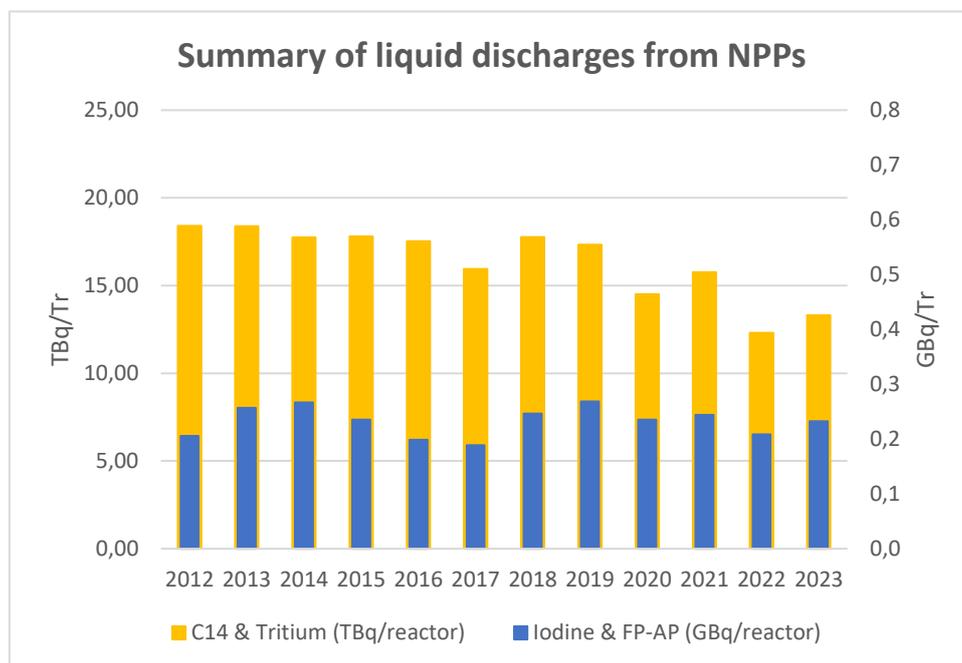
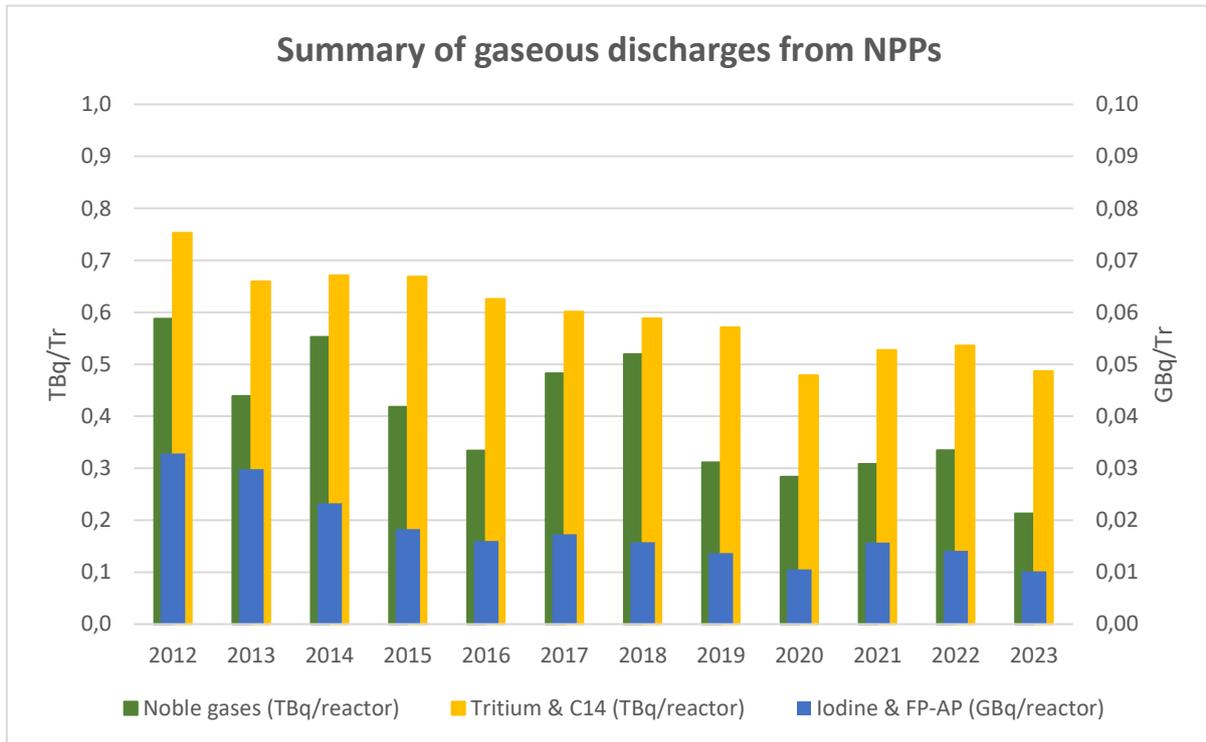


Figure 15-1: Summary of liquid and gaseous radioactive discharges from NPPs in TBq and GBq per unit (2012 – 2023)

FP: other fission products / AP: other activation products

C14: Carbon 14

For 2023, the annual average discharge values of liquid and atmospheric radioactive effluents per reactor, all plant series included, are given in the following table:

Settings	Discharges of liquid radioactive effluents (GBq reactor/year)	Discharges of gaseous radioactive effluents (GBq reactor/year)
Carbon 14	8.9	153
Iodine	0.0045	0.010
Tritium	13309	487
Fission products - Activation products	0.2	0.0013
Noble gases	Not applicable	213

Table 15-1: Average annual liquid and gaseous radioactive discharges per reactor for 2021

Regarding public exposure, the dose that can be attributed to liquid and gaseous radioactive effluent discharges from operating sites is mainly due to tritium and carbon 14. This dose is less than 10  $\mu$ Sv/year, level below which a possible “health” risk is considered by the international organisations (ICRP, IAEA) to be negligible.

#### Reactors other than nuclear power reactors

##### CEA's Cabri reactor

The liquid discharges generated by the CABRI reactor, like other CEA BNIs involved in liquid discharges, are managed in dedicated facilities. The facility which receives the effluents from the CABRI reactor is determined according to the activity and nature of effluents. The gaseous discharges are released through the reactor outlet. The gaseous discharge limits are controlled and monitored continuously.

The gaseous discharges and liquid discharges from Cabri's reactor are low. For the period 2014-2023, the gaseous discharges are shown in Figure 15-2 below.

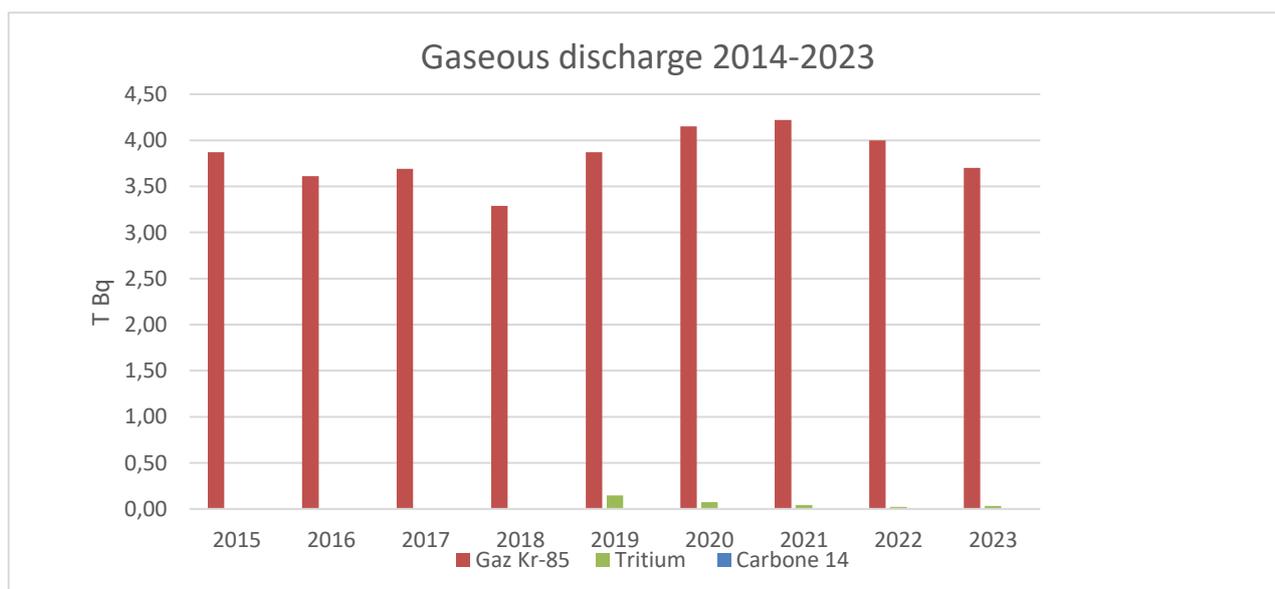


Figure 15-2: Cabri gaseous discharges in TBq

ILL

The annual variability of gaseous and liquid discharges is directly correlated with the major maintenance work on the HFR, such as changing reactor block components or work on installations containing tritiated deuterium.

The gaseous and liquid discharges are shown in Figures 15-3 and 15-4.

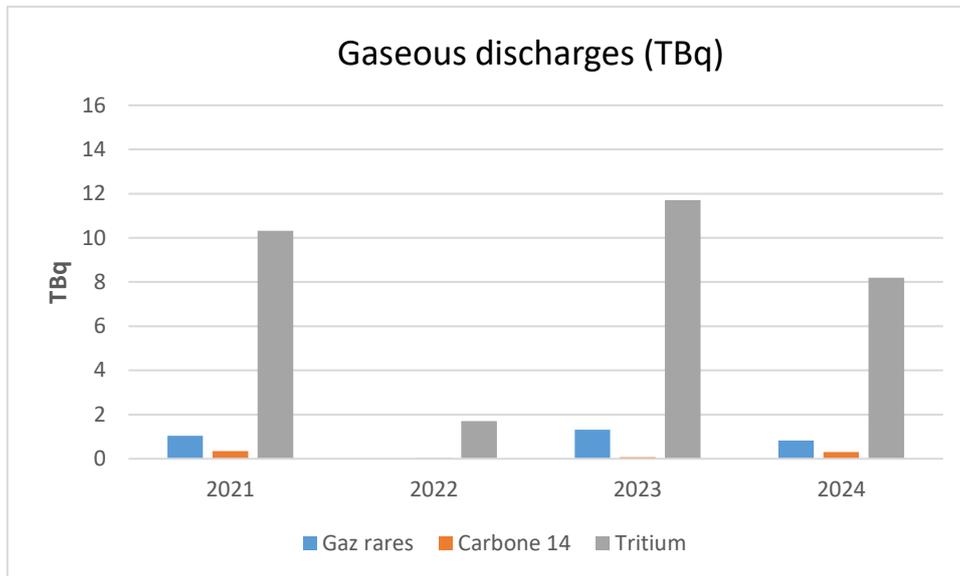


Figure 15-3: ILL gaseous discharges in TBq

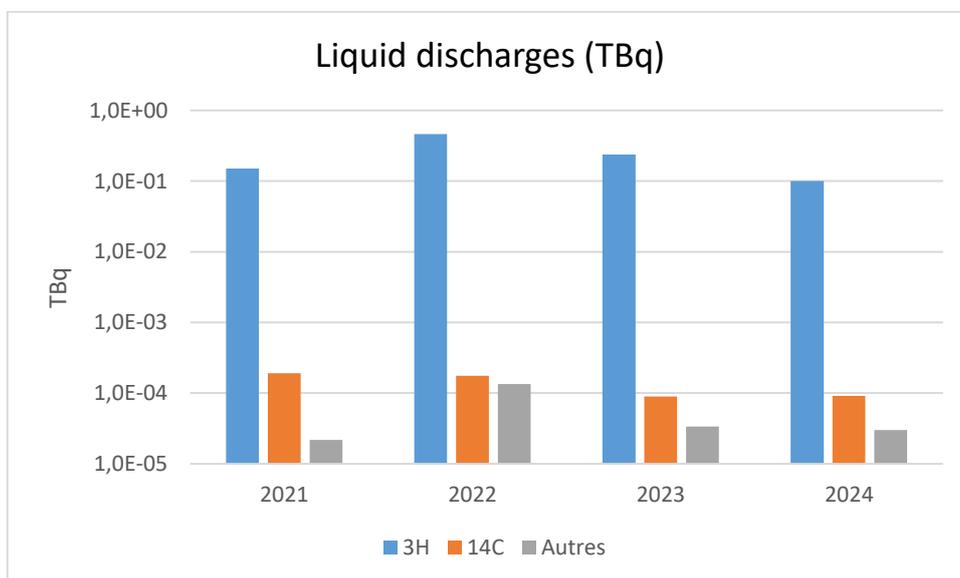


Figure 15-4: ILL liquid discharges in TBq

### 15.2.2.2. Environmental monitoring

Monitoring of the radiological state of the environment is carried out by:

- the licensees who carry out monitoring around their installations:
  - EDF has set up a programme for environmental monitoring appropriate to each of its nuclear installations. It comprises a fixed programme of continuous and periodic measurements (daily to annual,

representing more than 40,000 measurements per year for each NPP - see Appendix D). At its own initiative, EDF supplemented this surveillance with radio-ecological monitoring carried out every year on all nuclear sites in operation. This monitoring has been performed on the entire fleet since 1992 and gives a spatio-temporal overview of the radiological state of the environment of the installations;

- CEA has set up a programme to monitor the environment around the Cadarache site which houses the Cabri research reactor;
- the ILL has set up a programme to monitor the environment around the HFR site.
- ASNR has a legal duty to monitor environmental radioactivity nationwide. More specifically, ASNR has its own monitoring networks in the vicinity of the nuclear facilities and thus conducts regular monitoring, complementing that carried out by the nuclear licensees (Andra, CEA, EDF, French Navy, Orano, etc.). ASNR uses two approaches:
  - continuous on-site monitoring using independent systems (remote-monitoring networks) providing real-time transmission of results, plus an alert function in the event of an unusual rise in the measured radioactivity:
    - the recently refurbished Téléray network, based on 450 measurement detectors;
    - the Hydrotéléray network, which comprises 7 monitoring stations located on the major rivers;
    - the OPERA continuous air sampling network with measurements in the laboratory.
  - laboratory processing and measurement of samples taken from various compartments of the environment (air, water, soil and foodstuffs), whether or not close to installations liable to discharge radionuclides.

All the measurement results obtained are entered into the Réseau National de Mesures de la radioactivité de l'environnement (RNM), which is accessible via the Internet and whose mission is to contribute to the monitoring of the population's exposure to ionizing radiation and to inform the population.

IRSN's analysis and interpretation of all the environmental measurements are presented regularly in a [report](#) that is made public (latest report for the years 2021–2023).

### 15.3. ASNR oversight

#### 15.3.1. Exposure of workers

One of ASNR's duties is to check compliance with the regulations relative to the protection of workers liable to be exposed to ionising radiation in nuclear installations. The scope of ASNR's oversight covers all workers active on the sites, both licensee and external contractor staff, for the entire operating cycle of the facility.

This oversight takes two main forms:

- performance of inspections:
  - specific to radiation protection, 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 EDF head office departments responsible for the company radiation protection policy and the consistency of its implementation on the various sites.
- 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 established by the licensee concerning application of the regulations.

In addition, ASNR conducts each year an annual campaign of “tightened” inspections in a geographical area, on the topic of protection of workers against ionising radiation. These tightened inspections involve a team of around ten inspectors and experts from ASNR, for a day and a half per NPP. Their purpose is to inspect simultaneous several radiation protection topics in order to obtain an overview of the radiation protection organisation in the plant, based notably on numerous field observations.

The topics inspected are the organisation and management of radiation protection, the integration of operating experience feedback, the management of worksites, the application of the optimisation approach, the management of radiological cleanliness and of radioactive sources. During radiation protection inspections, ASNR checks that the competence centre carries out all the expected tasks, that it is organised and staffed in accordance with the ministerial decree and the general operating rules. ASNR also checks the regulatory compliance of the frequency and content of the training provided. Scenario-based exercises were also used to check the organisation for dealing with contaminated workers and the response to alarms related to detection of atmospheric contamination inside the reactor building.

This type of inspection campaign allows to evaluate the system for the collection and the analysis of the licensee’s operating experience feedback (results from practices used in the field, analysis of events that have occurred).

### **15.3.2. Exposure of the public**

ASNR carries out inspections to check that the licensees are complying with the regulatory provisions regarding management of discharges. ASNR also carries out inspections, with sampling and measurement, with the support of laboratories. In addition, the licensees regularly send liquid and gaseous radioactive effluent samples to an independent laboratory for analysis. The results of these “cross-checks” are communicated to ASNR. This programme of cross-analyses defined by ASNR is a way of ensuring that the accuracy of the measurements performed by the licensee laboratories is maintained over time.

Moreover, as with the field of occupational radiation protection and using the same principle, ASNR carries out annual “tightened” inspection campaigns in a geographical area on the topic of environmental protection and in particular on compliance with regulatory requirements regarding management of discharges. These inspections consist of unannounced situational exercises designed to assess the organisation and means of containment in the event of an accidental spill of hazardous liquids on site.

## Article 16 Emergency preparedness

### 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. Emergency plan and programmes

### 16.1.1. The regulatory framework

The organisation of the public authorities in the event of a nuclear or radiological incident or accident is defined by **the Prime Ministerial circular of 26 September 2023** concerning the Government organisation for the management of major emergencies, repealing the previous circular dated 1<sup>st</sup> July 2019, along with a range of texts concerning nuclear safety, radiation protection, public order and civil protection.

The **Act of 13 August 2004** on the modernisation of civil protection provides for an updated inventory of risks, an overhaul of operational planning, the performance of exercises involving the population, information and training of the population, and an operational monitoring and alert system. Several decrees implementing this Act, codified in Articles L 741-1 to L 741-32 of the Domestic Security Code, in particular concerning the civil protection response organisation plans (ORSEC) and off-site emergency plans (PPI), clarified it in 2005.

The **Act of 25 November 2021** aims to consolidate the French civil protection model. It notably confirms the importance of the local safeguard plan (PCS) at municipal or intermunicipal level in territorial management of emergencies, making it mandatory for any municipality exposed to a natural, industrial or nuclear risk. It also creates the obligation to hold an exercise to implement this plan at least every 5 years.

The **circular of 27 May 2009** defines the principles governing the respective responsibilities of a BNI licensee and of the State with regard to the distribution of iodine. This circular requires that the licensee finance the public information campaigns within the perimeter of the PPI and carry out permanent preventive distribution of the stable iodine tablets, free of charge, through the network of pharmacies. Outside the area covered by the PPI, stocks of tablets are created to cover the rest of the country. In this respect, the ministries responsible for health and for the interior decided to constitute the stocks of iodine tablets which are put in place and managed by the Santé Publique France (Public Health France agency). The prefect is responsible for drawing up a specific plan (Orsec Iodine Plan) at departmental level to define the arrangements for distributing stable iodine from national stocks. He defines the modalities for distribution to the population in their *département*, relying in particular on the mayors for this. This arrangement is described in the circular dated 11 July 2011.

Pursuant to this circular, the Prefects have drawn up plans to distribute iodine tablets in a radiological emergency situation, which may be the subject of exercises as part of the territorial implementation of the major nuclear or radiological emergency national response plan.

The **circular of 18 February 2011** specifies national doctrine for the use of emergency response and care resources in the event of a terrorist act involving radioactive substances. These provisions, which also apply to a nuclear or radiological accident, aim to implement a unified nationwide methodology for the use of resources, in order to optimise efficiency. They are to be adapted to the specific situations encountered.

The “**Medical intervention in the case of a nuclear or radiological event**” **guide**, the drafting of which was coordinated by ASN, accompanies the circular of 2 May 2002 on the organisation of medical care in the event of a nuclear or radiological accident, bringing together all useful information for the medical respondents in charge of collecting and transporting the injured as well as for the hospital personnel providing treatment in the health care facilities.

### 16.1.2. Emergency and contingency plans

The “**Major Nuclear or Radiological Emergency**” **national response plan** describes the government’s preparedness and enables radiological emergency situations of all types to be addressed. It supplements the existing local planning arrangements (PUI – on-site emergency plan and PPI – off-site emergency plan). It also includes the international nature of emergencies and the mutual assistance possibilities in the case of an event. This plan is based on 8 reference situations (uncertainty situation, accident in a facility with immediate and short-duration release, etc.), to which a global response strategy is applied. The provisions of this plan are implemented locally by means of the Off-Site Emergency Plans (PPI).

The purpose of the **on-site emergency plan (PUI)**, drawn up by the licensee, is to bring the facility to a controlled state and to mitigate the consequences of the accident. It defines the organisational actions and the resources to be implemented on the site. It also includes the provisions for rapidly informing the public authorities. Pursuant to Article R.593-30 of the Environment Code, the PUI is one of the documents to be included in the file sent by the licensee to ASNR for the commissioning of its facility.

The licensee’s obligations in terms of emergency preparedness and management are set out in the “BNI Order”. ASN “emergency” resolution specifies the obligations of the licensees regarding emergency preparedness and management, along with ASNR expectations regarding the content of the PUI. This resolution also transposes certain reference levels established by the Western European Nuclear Regulators Association (WENRA) and takes account of the lessons learned from the Fukushima Daiichi accident (emergency management premises, means of communication, exercises simultaneously affecting several facilities). It requires that the emergency response teams take part in at least one simulation or exercise per year and specifies the information that the licensee must transmit to the authorities.

The **off-site emergency plan (PPI)** is drawn up by the Prefect of the *département* concerned, pursuant to Decree of 13 September 2005. The PPI specifies the initial population protection actions to be taken, the tasks of the various units concerned, the systems for giving the alert, and the human and material resources liable to be engaged in order to protect the population. The population protection measures notably include:

- sheltering and awaiting instructions: the persons concerned, alerted by a siren, take shelter at home or in a building - with all openings completely closed - and wait for instructions from the Prefect over the radio;
- ingestion of stable iodine tablets;

- evacuation: the populations are then asked to prepare a bag, secure their home, leave it and go to the nearest assembly point;
- restrictions or a ban on the consumption or sale of foodstuffs.

The implementation of these measures is decided by the Prefect. However, the PPIs also comprise a “reflex” phase, which provides for the immediate alerting -by the operator on the basis of criteria defined in its internal emergency plan- of the population generally located within a 2 km radius around the facility, along with initiation of reflex actions, such as sheltering and awaiting instructions.

For the emergency phase, reference values are defined in Article D. 1333-84 of the Public Health Code:

- an effective dose of 10 mSv for sheltering;
- an effective dose of 50 mSv for evacuation;
- an equivalent dose to the thyroid of 50 mSv for the administration of stable iodine.

The estimated doses are those assumed to have been received until releases into the environment are brought under control, generally calculated over a period of 24 hours. In the case of doubt on the duration of the releases, the duration considered for the calculation does not exceed one week.

Furthermore, a reference value of 100 mSv received for the duration of the radiological emergency situation and comprising all exposure routes is defined in Article R. 1333-82 of the Public Health Code for application of the optimisation principle.

The PPIs currently enables to plan the public authorities’ response in the first hours of the accident in order to protect the population living within a radius around the affected reactor which, until 2016, was 10 km and which has since then been raised to 20 km. The PPI also include preparation for an “immediate” evacuation within a 5 km radius and the implementation of consumption restriction measures as of the emergency phase. Extension of the PPI perimeter from 10 to 20 km is in line with international guidelines. These distances are valid for nuclear power reactors. These distances are different for other types of BNIs.

The PPI falls within the framework of the ORSEC system, which describes the protection measures implemented in large-scale emergencies. Consequently, beyond the perimeter established by the PPI, the modular and progressive *département* or zone ORSEC plan fully applies. The “ORSEC” system (organisation of the civil protection response) is a *département* level programme to organise the response to a disaster. It allows rapid and efficient implementation of all the necessary means, under the authority of the Prefect. This system comprises general provisions applicable in all circumstances and provisions specific to certain particular risks or linked to the operation of specific facilities (off-site emergency plans in particular).

The **Local Safeguard Plan** (PCS) aims to clarify the emergency management actions at municipal level.

### 16.1.3. The national and local emergency situation stakeholders

In an emergency situation, the main parties involved and resolution-makers are:

- the licensee of the affected nuclear facility, which deploys the response organisation and the resources defined in its on-site emergency plan (PUI);
- the Prefect of the *département* in which the facility is situated, who takes the necessary decisions to ensure the protection of the population, the environment and the property threatened by the accident. He acts within the context of the PPI and the civil protection response organisation plans (ORSEC). He keeps the population and the mayors informed;

- the mayor of the municipality, due to his closeness to the community, plays a role in planning ahead for and supporting the population protection measures;
- ASNR, which oversees the licensee’s actions in terms of nuclear safety and radiation protection. In an emergency situation, it is up to ASNR to submit recommendations to the Government and the Prefect. These recommendations are based on the analysis of the situation carried out by ASNR experts, which covers the diagnosis of the situation (understanding the situation of the affected facility, consequences for the population and the environment), the prognosis (evaluation of the possible developments, especially radioactive releases), as well as the measurements available. These recommendations relate in particular to the public health protection measures to be implemented.

In the event of a major emergency requiring the coordination of numerous players, an **interministerial crisis committee (CIC)** is activated. Within the CIC, the relevant departments of the Ministries concerned, together with ASNR, work together to advise the Government on the protective measures to be taken. They provide the information and advice to understand the state of the facility, the significance of the incident or accident, its possible developments, and the measures required to protect the population and the environment.

Table 16.1 shows the position of the public authorities, ASNR and the licensees in a radiological emergency situation. These players each operate in their respective fields of competence and responsibilities with regard to assessment, decision-making, action and communication, for which regular audio-conferences are held. The exchanges lead to decisions and orientations concerning the safety of the facility and the protection of the population. Similarly, relations between the communication units and the spokespersons of the emergency centres ensure that the information given to the public and the media is consistent.

	RESOLUTION	EXPERTISE	ACTION	COMMUNICATION
<b>Public authorities</b>	Government (CIC) Prefect (COD)	-	Prefect (PCO) Civil protection	Prefect (COD)
	ASNR (Crisis Centre) and representative at Office of the Prefect	ASNR Météo France	ASNR (mobile units)	ASNR
<b>Licensees</b>	National and/or local level	National and/or local level	Local level	National and/or local level
<i>CIC: Interministerial Crisis Committee</i> <i>COD: Departmental Operations Centre</i>		<i>PCO: Operational command post</i>		

Table 16-1: Position of the various players in a radiological emergency situation

#### 16.1.3.1. ASNR’s organisation for emergency situations

ASNR has an on-call service 24 hours a day, 7 days a week. Its role is to manage low-intensity situations (which do not directly trigger a PUI) and, if necessary, sets up the crisis centre.

When a BNI’s PUI is triggered, the licensee of this BNI activates ASNR alert system. This system allows rapid mobilisation of ASNR staff to activate the various units in the crisis centre and carry out various local missions (support for the Prefect, mobilisation of the mobile unit, on-site liaison, etc.). This system also sends the alert to the staff of the General Directorate for Civil protection and Emergency Management (DGSCGC), the Interministerial Emergency Management Operations Centre (COGIC), Météo-France and the ministerial

operational monitoring and alert centre (CMVOA). For events outside BNIs (sources, transports, etc.), ASNR has a toll-free number for the nuclear activity licensees.

ASNR crisis centre is organised around an emergency division and various specialist units (technical units, communication, international relations, etc.). In particular, it has 3 technical units (facility assessment, radiological consequences assessment and health) to assess the situation and provide expert input for the preparation of recommendations to the public authorities. It also has a unit devoted to international relations in order to manage information exchanges with the European Commission, the Member States (WebECURIE), the IAEA (USIE) and the neighbouring states in the event of a transboundary accident.

Finally, ASNR crisis centre liaises with local teams, i.e. inspectors sent to the Departmental Operations Centre (COD) to support the prefect and the mobile unit teams responsible for deploying measurement equipment in the field. The ‘mobile environment unit’ is responsible for the technical coordination of environmental measurements, direct measurements of radioactivity or samples taken from the environment, and the examination of packages damaged in case of accident during the transport of radioactive materials. The ‘mobile human unit’ enables internal contamination measurements on individuals. Finally, laboratories in ASNR premises carry out expert assessments of human exposure (radiotoxicological analyses, whole-body radiation measurements, dosimetric reconstruction) and analyse samples taken from the environment.

ASNR crisis centre is connected to several independent telecommunication networks, providing direct or dedicated links, some of which are secure. It has IT equipment tailored to its functions, in particular for the direct transmission of technical data from the operator or from the radioactivity monitoring network in environment.

ASNR’s crisis centre resources and organisation are regularly tested during national emergency exercises and is activated for actual incidents or accidents.

### 16.1.3.2. EDF’s preparedness

The emergency organisation of the EDF nuclear fleet is designed to take account of emergency situations, in order to prevent all radioactive releases into the environment or, failing which, mitigate them.

It is based on two levels:

- the local level on each site under the supervision of the unit manager or his representative. It is structured into teams (or command posts - PC) covering the four broad areas necessary for emergency management (expertise, resolution, action and communication);
- the national emergency organisation (ONC), which supports the local level with the provision of specialists from EDF head office departments.

It comprises human and material resources that can be mobilised 24/7, when called by an NPP.

#### *At local level*

On each of the NPPs in operation, about 70 persons can be mobilised within one hour:

- the operating team in charge of the affected reactor constitutes the local command post (PCL), under the responsibility of the shift operations supervisor;
- the local strategic management command post (PCD) is assisted by two expert teams:
  - the local emergency response team (ELC), in charge of analysing the state of the installation and predicting developments;

- the emergency command post (PCC), responsible for assessing the consequences of the accident on the population and the environment.

These two teams inform the national technical teams (EDF and ASN) and keep the local PCD regularly informed of events that could change the emergency management strategy;

- The resources command post (PCM) is responsible for all site intervention and logistics actions:
  - personnel protection and the management of assembly points;
  - management of telecommunications for all the command posts;
  - organisation of works and specific interventions on equipment;
  - logistical support to external emergency units and to emergency response teams.

It is the responsibility of the director of the PCD to assess the significance of the event, based on predetermined criteria, for triggering the PUI.

### ***At national level***

The national emergency organisation must be operational in its Paris and Lyon premises within two hours. It mobilises about 50 people and alerts 300 others. It comprises a support unit from the reactor designer, Framatome.

The national strategic management command post (PCD-N) is directed by the DPN on-call manager. 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 Chair, to the public authorities and to ASN at the national level. It is supported by a national emergency technical team (ETC-N) which has two roles:

- provide the PCD-N with a diagnosis and prognosis of the situation of the site;
- propose opinions and recommendations to the site for management of the installation and an assessment of the environmental consequences.

EDF has also deployed the nuclear rapid intervention force (FARN), integrated into the EDF emergency organisation, which is capable of rapidly providing material and human aid to a site in difficulty, following the resolution of the national emergency director (PCD-N). Since 1 January 2016, the FARN is fully operational for the entire EDF NPP fleet.

The FARN is based on four sites and operates under a national structure (Crisis Management Department). It is made up of NPPs professionals trained for emergency situations, who practice for 50% of their time. Its training programme comprises a minimum of five annual exercises, involving about a hundred people on the EDF nuclear NPP sites for one week, plus about ten command post exercises.

The FARN can therefore:

- intervene within 24h hours, in continuity and in support of the teams on the site concerned, where the access infrastructures could be partially destroyed;
- restore access to the site, in conjunction with the authorities;
- work independently for several days on a partially destroyed site (non-seismic tertiary buildings, for example);
- performing safety tasks by providing additional resources to the installations (ultimate heat sink, cooling of the deactivation pool, etc.);
- provide long-term support to the NPP, particularly in terms of diesel fuel supply and other technical support missions;
- provide permanent liaison with the site management and teams.

Following the accident at the Fukushima-Daiichi NPP, two other major changes were defined to reinforce the robustness of emergency preparedness:

- the construction of local emergency centres (CCL) on each site, capable of withstanding extreme hazards, and designed to replace the existing emergency management premises, is scheduled by 2026. The Flamanville CCL has been in service since 2020. These CCLs provide the emergency response teams with protection from external hazards and possible radioactivity on the site;
- changes to the PUI so that an emergency organisation can be set up, even partially at the local level, for the most severe hazards occurring on the site. In these cases, the operations supervisor is able, if necessary, to initiate the mobilisation of organisations, with support from the national level as applicable, and using dedicated telecommunications resources. The emergency preparedness organisation is thus made more adaptable by gradual local activation of the PUI (on-site emergency plan) and the distribution of tasks, in the event of site access difficulties. In this context, a training programme has been launched to prepare operating teams for the unexpected, using role-playing exercises supported by tools, to share objectives, define priorities and allocate tasks.

#### **Focus No.18: Managing extraordinary circumstances**

As part of its business continuity plan for electricity production, the Nuclear Operation Division (DPN) has set up an organisation led by the Crisis Management Department since 1 January 2023 and coordinated with EDF's Group Risk Management Department. This organisation is based on a business continuity guide that has been rolled out across all DPN units. This guide will be fully implemented by 2025 and is based on the lessons learned from crises experienced by the DPN in recent years. The COVID crisis of 2020-2021, which unfolded under fairly unprecedented conditions in terms of the technical and human management during a major, long-lasting health emergency, provided valuable insights for thought and reflection about the Division's ability to maintain uninterrupted electricity production. During the winter of 2022-2023, another challenge was to maintain continuity of electricity production while the Group faced an unprecedented unavailability of its nuclear production capacity, due in particular to the phenomenon of stress corrosion and the ten-yearly outage programme. More recently, a new challenge has been the organisation of business continuity for the Paris Olympic Games, which has required adapting the DPN's response system to ensure that crisis tools remain fully operational despite the increased security measures put in place by the government. As a result, the nuclear crisis management centre (LTCN) was duplicated (backup) at a different site from the usual one, with the necessary adjustments for the mobilisation of resources.

These provisions therefore enable to maintain continuity of electricity production while guaranteeing the resources essential for managing the safety of nuclear power plants and nuclear crises. These provisions are ultimately managed by an organisation that is complementary to and independent of nuclear crisis management, closely linked to the Group Risk Department and whose network of correspondents can be mobilised immediately, regardless of the type of crisis encountered (health, fuel, transport, cyber, etc.).

### 16.1.3.3. CEA preparedness

In the event of an emergency on a facility operated by CEA, the latter mobilises its emergency response organisation, on the one hand to manage the situation in the facility and on the other hand to ensure relations with the public authorities. This organisation includes a local level and a national level.

The center affected by the emergency (local level):

- manages the response within the CEA centre concerned;
- ensures communication with the local media, in coordination with the Prefecture;
- is responsible for relations with the Prefecture and ASNR's crisis centre.

The CEA administration (central level):

- directs 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 central levels are assisted by the local (PCD-L) or national PCD-N) strategic management command posts.

- the PCD-L is under the responsibility of the director of the centre or his representative. It comprises a decision-making unit, a local technical emergency team (ETC-L), an oversight team, an operational team, a communications unit and a press unit;
- the PCD-N is under the responsibility of the Chairman or his representative. It comprises a decision-making unit, a central emergency technical team (ETC-N), a communications unit and a press unit.

The communication and press units, in agreement with the PCD-L or the PCD-N, prepare press releases, answer external calls and manage interviews.

It is the responsibility of the director of the CEA centre affected by the emergency or his representative to assess the significance of the event, based on predetermined criteria, for triggering the PUI.

### 16.1.3.4. Preparedness of the Institut Laue-Langevin (ILL)

In the event of an emergency on the facility operated by the ILL, the latter mobilises its emergency response organisation, on the one hand to manage the situation in the facility and on the other hand to ensure relations with the public authorities.

ILL plays a role at local and national levels.

In an emergency situation, ILL:

- manages the response inside the facility;
- ensures communication with the media, in coordination with the Prefecture;
- is responsible for relations with the Prefecture and ASNR's crisis centre;
- is responsible for relations with the public authorities at national level.

To perform these duties, ILL relies on its strategic management command post, the PCD:

- the PCD is placed under the responsibility of the ILL Director and the Head of the Reactor division, or their representatives. It comprises a decision-making unit;
- the PCD relies on an emergency technical team (ETC), a technical command post (PCT) and a communications unit (communication delegate and media PCD).

With the agreement of the PCD, the communication delegate and the communication correspondents draft press releases and internal communication, handle interviews and answer external queries.

It is the responsibility of the Head of the Reactor Division or their representatives to assess the significance of the event, based on predetermined criteria, for triggering on-site emergency plan.

The ILL is equipped with an emergency command post (PCS3) which remains functional even in the event of the seismic, flooding or chemical accident hazards considered for definition of the “hardened safety core”.

#### **16.1.4. Training and exercises**

##### ***Local nuclear emergency exercises at EDF, CEA and ILL***

The provisions for maintaining the skills of the EDF staff, obtained through training and exercises, are defined in the site’s on-site emergency plan (PUI), in compliance with the “Emergency” resolution. In accordance with this regulation, each site establishes, keeps up to date and implements a multi-year programme of exercises and a calendar for the coming year. The emergency exercises held by the public authorities are included in this calendar. At least one emergency exercise is thus carried out every year in each facility.

Training and skills maintenance mainly involve emergency exercises organised regularly by CEA during the course of the year. These exercises use the local and national emergency units with the technical emergency teams and the command structure. Each team member takes part in several types of exercises depending on the facility or activity concerned.

Every year, ILL carries out exercises, some of which include triggering of the PUI and one performed with the participation of the external response forces (local response forces of CEA and/or the SDIS). The scenario writers and participants are chosen so as to ensure that all the emergency team members participate in turn.

##### ***National nuclear emergency exercises***

Jointly with the General Secretariat for Defence and National Security (SGDSN), the DGSCGC and ASND, ASNR prepares the annual programme of national nuclear and radiological emergency exercises concerning nuclear installations and radioactive substances transport operations. This programme is announced to the Prefects by means of an interministerial instruction and takes account of the lessons learned from actual situations (national and international) and the exercises held the previous year.

The exercises enable those involved to build on knowledge and experience in the management of emergency situations, in particular for the 300 or so persons mobilised in the field for each exercise. They enable to:

- assess the level of preparedness of each Prefecture and the other stakeholders involved;
- ensure that the plans and procedures for early alerting and notification of international organisations are kept up to date and are well-known to all the managers and responders;
- allow training of those liable to be involved;
- implement the various aspects of emergency preparedness, along with the procedures stipulated in the various plans and reference framework: national plan, interministerial reference framework, emergency plans and local safeguard plans;
- contribute to informing the media and the populations;
- develop a educational approach aimed at civil society, enabling everyone to contribute to their own safety by adopting appropriate behaviour.

ASNR is also involved in the preparation and performance of other emergency exercises with a nuclear safety aspect organised by other players such as:

- its counterparts in charge of nuclear security (defence and security high official – HFDS – at the Ministry for energy) or defence-related installations (ASND);
- international bodies (IAEA, European Commission, NEA);
- the Ministries (Health, Interior, etc.).

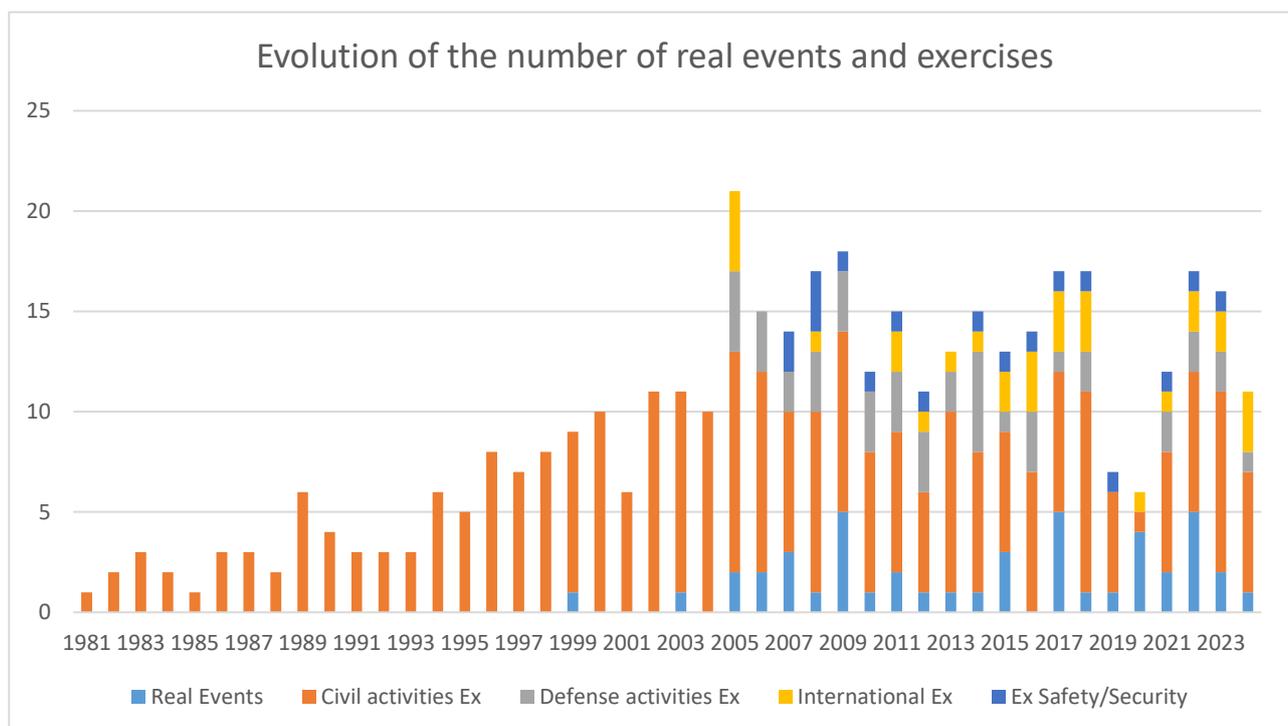


Figure 16-1: Number of exercises and emergency situations

Meetings to gather feedbacks are organised immediately after each exercise in each emergency centre and then at ASNR a few weeks after the exercise. ASNR, along with the other players, endeavours to identify best practices and the areas for improvement highlighted during these exercises. Experience feedback debriefing meetings are also held to build on the lessons learned from actual situations which have occurred.

Every year, ASNR also brings all the stakeholders together to learn the lessons from the exercises in order to improve the organisation as a whole. These meetings enable the stakeholders to share their experience through a participative approach. They have highlighted the importance of having scenarios enabling the prefectures' objectives (involvement of the municipalities in the PPI perimeter, testing of the ORSEC iodine plan, etc.) to be met, developing of clear and precise alert messages for prefects, and organising nuclear risk awareness sessions for all public authority actors.

The exercises also highlighted:

- the need to increase the frequency of exercises involving a simulation of the *Interministerial Crisis Committee* (CIC);
- the importance of communication in an emergency situation, in particular:
  - to inform the public and foreign authorities as rapidly as possible and thus avoid the spread of rumours liable to hamper good emergency management, in France and in other countries;

- by announcing larger perimeters for restrictions on consumption and sale when these decisions are based on deposition simulations: these perimeters are then reduced when field measurements become available;
- the need to increase the number of exercises or drills simulating a transport accident, involving both the field and the decision-making centres parts;
- the value of providing the decision-makers with a clear view of the radiological consequences in the form of maps.

### ***International exercises and cooperation***

ASNR cultivates international relations in order to discuss best practices observed during exercises held in other countries. ASNR therefore:

- took part in the INEX 6 international exercise in 2023, organised under the auspices of the NEA and one of the main goals of which was the management of the post-accident phase of a nuclear accident;
- received foreign delegations as observers of exercises organised by France (exercise in 2023, on the Chooz NPP and on the research reactor in Grenoble);
- took part as an observer of exercises organised abroad (Switzerland in 2022, South Africa in 2024);
- took part in the ConvEx exercises organised under the auspices of the IAEA, and ECUREX, under the auspices of the European Commission.

In addition, with regard to international assistance, ASNR has a database listing the national technical and human resources available in the event of an accident or radiological emergency and, since August 2008, has been one of the competent authorities that has registered their international assistance resources with the Response and Assistance Network (RANET).

## **16.2. Information of the public and neighbouring States**

As shown in Table 16.1, various stakeholders are involved in communication in a radiological emergency situation. Relations between the communication units and the crisis centres spokespersons ensure consistency in the information given to the public and the media.

The licensee responsible for the nuclear installation that caused the radiological emergency immediately informs the competent authorities of the occurrence of the radiological emergency situation. The Prefect ensures that the population and the mayors are informed. The role of ASNR is to support public authority communication, by providing explanatory information on the situation, putting the risks into perspective and reporting on the environmental radioactivity monitoring results.

ASNR is involved at several levels in the dissemination of information to:

- the media and the public: ASNR contributes to information of the media, the public and the stakeholders in different ways (press releases, press conferences); it is important that this action be done in close coordination with the other entities involved in communication (Prefect, licensee at local and national levels, etc.);
- institutional players: ASNR keeps the Government, relevant ministries and the SGDSN informed, the latter being responsible for informing the President of the Republic and the Prime Minister;
- foreign nuclear safety regulators.

### ***Informing the public***

French regulations (Article R.741-26 of the Domestic Security Code and the Order of 5 January 2006 on public consultation regarding the off-site emergency plan for certain installations, Environment Code (Article R.125-11)) contain requirements for information of the public about the nature of accident risks linked to the facilities, the potential consequences of accidents, the safety measures in place and the actions to be taken in the event of an accident, notably with the production of brochures about the provisions contained in the PPI and their proactive distribution to the population.

For each exercise, local authority (Prefecture) organises a public meeting to inform the public about the exercise, the nuclear risk and the behaviour to adopt in the event of an accident

The Mayor also acts as source on information and awareness-raising for the population.

### ***Transboundary coordination***

Given the potential repercussions of an accident on other countries, it is important that the information and response by the various countries concerned be as coordinated as possible. IAEA and the European Commission thus propose tools to the Member States for notification and assistance in the event of a radiological emergency. ASN made an active contribution to the production of these tools, more specifically the IAEA tool called USIE (Unified System for Information Exchange in Incidents and Emergencies). These tools are tested during exercises.

France has signed the two international conventions on the early notification of a nuclear accident and on assistance in the event of a nuclear accident or radiological emergency, adopted by IAEA on 26 September 1986, and applies the Euratom Council decision of 14 December 1987 concerning Community arrangements for the early exchange of information in the event of a radiological emergency. ASN acts as the competent national authority under these two Conventions. As such, it collects and summarises information in order to send or receive the notifications and transmit the information required by these conventions to the international organisations (IAEA and European Union) and to the countries concerned by potential consequences on their territory, in particular the neighbouring countries, to enable them to take the necessary population protection measures.

In 2014, the HERCA and WENRA associations adopted a joint approach aiming to improve cross-border coordination of protection measures during the first phase of a nuclear accident. The approach recommends:

- in normal situations, exchanges between countries to promote improved mutual knowledge and understanding of their emergency response organisations;
- in emergency situations:
  - if the emergency organisations receive sufficient information to be able to function normally during the first hours of an emergency situation, efforts are made to align the population protection measures in neighbouring countries with those decided on by the country in which the accident occurred;
  - in a situation, even if highly improbable, which would require urgent measures to protect the population but in which very little information is available, predetermined "reflex" measures to be implemented by the country in which the accident occurred.

In order to implement these principles, a minimum coordinated level of preparation is necessary. HERCA and WENRA thus consider that in Europe:

- evacuation should be prepared for the local population living in a radius of up to 5 km around the NPPs, with sheltering and ingestion of stable iodine tablets for persons living in a radius of up to 20 km around the nuclear power plants;
- an overall strategy should be defined to ensure the capability, if necessary, of extending population evacuation up to a 20 km radius, and sheltering and ingestion of stable iodine tablets up to a 100 km radius.

ASNR participates in the ‘Emergencies’ working group reporting to the HERCA association. This group is responsible for proposing harmonised European measures to protect the public in the event of an accident in Europe or further afield, in light of the lessons learned from the accident at the Fukushima Daiichi nuclear power plant.

#### **Focus No.19: Strengthening cross border cooperation**

In 2023, ASN set up a working group with Luxembourg and Germany to establish operational arrangements for the exchange of information in a radiological emergency situation.

As part of this work, ASN has invited Luxembourg and Germany to test new methods of exchange and coordination between authorities during the crisis exercise at Civaux nuclear power plant in January 2024. This system is based in particular on a regular cycle of videoconferences between neighbouring countries, coordinated with the crisis management by the prefecture, to discuss the technical situation of the damaged installation as well as the actions planned to protect the population.

Since Civaux nuclear power plant is located far from the German and Luxembourg borders, these cross-border actions were simulated only between authorities.

This exercise enabled to test the operational effectiveness of the exchange mechanisms put in place. Given the positive feedback from this experimentation, it is planned to continue with other neighbouring countries, building on national exercises.

#### ***Bilateral relations***

ASNR has bilateral relations in the field of emergency management with its European counterparts, notably with Germany, Belgium, Luxembourg and Switzerland.

Within this context, delegations from Germany and Luxembourg were invited to observe a national exercise in the emergency centre in October 2023. In January 2024, Luxembourgers and Germans took part in the exercise in Civaux (see Focus 19), during which the alert and information chain for the units, local authorities and neighbouring countries (Germany and Luxembourg) was tested.

ASN staff were reciprocally invited to observe exercises for the response to a nuclear or radiological emergency abroad (see § 16.1.4).

## Article 17 Siting

### 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 the 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. Evaluation of site-related factors

### 17.1.1. The regulatory framework

The Environment Code specifies the different procedures in force for the creation, commissioning, modification, shutdown and decommissioning of a BNI, which are outlined in § 7.2.2 of this report. In particular, the application for a BNI creation authorisation must include a preliminary version of the safety report.

The Environment Code (article R. 593-18) defines the content of the preliminary version of the safety report: the safety analysis report sets out, among other things, the hazards the BNI can present in the event of an accident, whether it is of a radiological nature or not. To this end, it describes the accidents that could occur, whether their cause originates on or off the site, and their consequences. The licensee takes particular account of the impact of installations that could increase the risks of accident and their effects.

Article 3.1 of the BNI Order stipulates that "*application of the principle of defence in depth is based notably on appropriate siting, taking particular account of the risks of natural or industrial origin to which the installation is exposed*".

Article 3.6 of the BNI Order specifies the external hazards to consider. The acceptable methods for characterising the site-related hazards are set out in Basic Safety Rules (RFS) or guides, particularly concerning the site geology (RFS 1.3.c), the seismic conditions (RFS I.2.c and RFS 2001-01), the risks related to the industrial environment and communication routes (RFS 1.2.d), the risk of external flooding (Guide No. 13). More specifically:

- RFS 2001-01 recommends using a deterministic approach to define the seismic loads to consider in the safety case. This approach includes determining the maximum historically probable earthquake (MHPE), then defining the safe shutdown earthquake (SSE) by adding a further degree of intensity. It must be verified that the installation can be brought to and maintained in a safe shutdown condition after an earthquake at least equivalent to the safe shutdown earthquake. Consequently, some systems, structures and components (SSCs) have seismic requirements ("seismic-classified" SSCs) given their role in safety;

- Guide No. 13 takes into account the lessons learned from the flooding of Le Blayais site in 1999. It details the recommendations for assessing and quantifying the risks of external flooding of the BNIs and defining the appropriate means of protection to cope with. The hazards to take into consideration are defined on the basis of an in-depth review of knowledge in the various areas concerned, especially hydrology and meteorology (eleven different hazards considered). It is based on deterministic methods, incorporating markups and combinations integrated into the hazards, taking account of a probabilistic exceedance target of  $10^{-4}$  per year.

### 17.1.2. Measures taken at the reactor design stage

The risks associated with the site-related factors (seismicity, hydrology, meteorology, industrial environment and communication routes) are analysed in the studies relating to external hazards. The studies take into account the Basic Safety Rules (RFS) and guides concerned.

The safety analysis report includes a specific “site and environment” chapter, addressing the subjects concerning the characteristics of the sites. This chapter identifies the site-related factors that could affect the safety of the installation.

#### *Earthquakes*

The seismic risk is taken into account in the design of the installations. Operators of future reactors (EPR2, RJH) use the deterministic methodology of RFS 2001-01 to define the seismic risk taking into account the characteristics of their site.

Furthermore, EDF has selected the following for the EPR2:

- a "seismic event" approach which is implemented in order to prevent an essential SSC from being damaged by equipment that is not seismic-classified in the event of an earthquake;
- loss of the off-site electrical power supplies further to an earthquake insofar as they are not designed to withstand the earthquake. This is to be considered in the safety;
- the SSE resistance requirements of the fire protection provisions (fire sectorisation, fixed fire detection and extinguishing systems) contributing to nuclear safety.

In the event of major disruption to roads and engineered structures limiting access to the site after an earthquake, the emergency response organisation calls on the public authorities who, in addition to triggering the off-site emergency plan (PPI) if necessary, take specific measures so that the necessary personnel can access the site.

#### *External flooding*

Flooding is a risk that is taken into account in the design of the installations.

#### Nuclear power reactors

EDF conducts a safety analysis for each site, drawing up a list of the SSCs necessary to reach and maintain a safe shutdown condition. In order to guarantee the absence of water in the premises housing the SSCs to be protected in the event of flooding, EDF has adopted a two-step approach:

- comparison of the water height likely to be reached at the various possible water entry points;
- identification of the physical and operational provisions aimed at protecting the installation against these water inflows;

- the physical provisions concern civil engineering, specific equipment (electrical, instrumentation and control (I&C), mechanical, etc.);
- the operational provisions concern alert systems in the event of a foreseeable hazard that could lead to flooding of the site, agreements with organisations within EDF or external, local procedures.

#### Reactors other than nuclear power reactors

The CEA has conducted the safety analysis of the JHR reactor, identifying the premises housing equipment or systems enabling the reactor to be placed and maintained in a safe shutdown condition.

The installation elevation and the installation design (including the drainage systems) are sufficient to exclude the possible consequences of water upwelling (groundwater rising, rainfall, rivers or bodies of water floods, breach of structures, tanks or pipes). Construction measures have also been taken to limit the risks of water runoff on the site. They consist notably in providing sloped surfaces directing water away from the buildings and installing a rainwater drainage network.

#### ***Climatic conditions***

The design of the reactors includes protection against external hazards related to climatic conditions. These include protection against snow and wind, cold temperatures and heat waves.

#### Nuclear power reactors

The approach adopted by EDF for EPR2 reactors design aims to ensure:

- the resistance to snow and high winds of buildings and structures that contribute to safety;
- the resistance to snow and high winds of the equipment located outside the building and also contributing to safety;
- the maintaining of satisfactory ambient conditions for systems whose failure could jeopardise fulfilment of the fundamental safety functions. Ventilation, heating and cooling systems are designed for this purpose.

The effects of snow and high winds are analysed in accordance with rules for constructions (NV65 or Eurocodes).

#### Reactors other than nuclear power reactors

The CEA has taken into account the climatic conditions associated with extreme temperatures, wind and snow in the design of the JHR. The civil engineering structures and the roofs are designed for the maximum reference loads defined for the Cadarache centre. Physical provisions are put in place to maintain, in extreme temperature conditions, an acceptable ambient temperature in the premises housing SSCs that play a role in reaching and maintaining the reactor in a safe shutdown condition.

#### ***Industrial environment and communication routes***

The risks due to the industrial environment and the communication routes are assessed in each site's safety analysis report, taking account of the local particularities (inventory of the installations, industries and types of goods transported in the neighbourhood, airfields or airports located within a radius that could impact the facility).

### Nuclear power reactors

EDF's safety case for the design of EPR2 reactors is based on:

- a deterministic approach by ascertaining that the distance at which the physical phenomena have an impact is less than the distance separating the SSCs, necessary to fulfil the safety functions, from the source of the abovementioned physical phenomena;
- a probabilistic approach when the deterministic approach cannot exclude the risk; this consists in checking that the probability of unacceptable radioactive releases is sufficiently low ( $\leq$  about  $10^{-7}$ /reactor.year per family of hazards and  $10^{-6}$ /reactor.year for all external hazards caused by human activity – see RFS I.2.d).

In accordance with the safety objectives of 3<sup>rd</sup> generation reactors, the design EPR2 reactors has been reinforced against aircraft crashes. In addition to the deterministic consideration of the impact of a commercial aircraft, ASN asked EDF to deterministically take into account the effect of the inadvertent impact of a military aircraft crash, with the aim of demonstrating that it would not lead to radioactive releases out of the site, or only to minor releases.

### Reactors other than nuclear power reactors

Given the industrial environment and communication routes, CEA analysed specific external hazards (off-site explosion, drifting of toxic or explosive clouds, emission of clouds or slicks of toxic substances or radiological hazard) on the JHR facility.

A probabilistic study based on the actual air traffic, by aircraft type, of the risk of an aircraft crash on the "potential" targets of the JHR facility was performed to define the characteristics of this hazard for the JHR reactor.

#### **17.1.3. ASNR oversight**

During the examination of the creation authorisation application, ASNR examines the natural or anthropogenic external hazards associated with the site, which are assessed on the basis of the latest available knowledge. The examination focuses on the hazard levels and the design and operational provisions planned by the operator to deal with these hazards. This examination is similar to that carried out for the periodic safety reviews. ASNR also ensures that in the design, the licensee includes either margins or possibilities of adapting the installation, given that the installation is intended to be operated for several decades.

## **17.2. Impact of the installation on individuals, society and environment**

### **17.2.1. The regulatory framework**

The Environment Code specifies the different procedures in force for the creation, commissioning, modification, shutdown and decommissioning of a BNI, which are outlined in § 7.2.2 of this report. In particular, the application for a BNI creation authorisation must include an impact assessment.

The Environment Code (article R. 593-17) indicates the content of the impact assessment, which must more specifically present:

- the significant impacts that the installation project could have on the environment, distinguishing the different phases of construction and operation of the installation;
- the evaluation of public exposure to ionising radiation due to the installation, taking into account the irradiation caused directly by the installation and the transfers of radionuclides by the various vectors, including food chains.

### 17.2.2. Measures taken for the reactors

The impact assessment is one of the documents submitted by the licensee to ASN at the time of the creation authorisation application. This assessment is updated in the application for commissioning. It includes a study of the impact of the radioactive or chemical effluent discharges in the environment and public health, and a presentation of the measures taken to avoid, reduce and/or mitigate the effects of the facility.

### 17.2.3. ASN oversight

In the course of these procedures, ASN examines the impact assessment submitted by the licensee, particularly regarding environmental discharges of liquid or gaseous radioactive or chemical effluents resulting from normal operation of the installation and the assessment of their impacts on man and the flora and fauna. ASN checks in particular that the licensee implements the best techniques available to avoid these discharges or, failing this, to reduce them as much as reasonably practicable.

On completion of its examination, ASN issues requirements setting in particular the authorisation limits for environmental radioactive or chemical discharges associated with normal operation of the installation, the discharge conditions and the associated monitoring provisions (see § 15.1.2.2).

## 17.3. Re-evaluation of site-related factors

### 17.3.1. The regulatory framework

The Environment Code (Article L. 593-18) states that the licensee of a nuclear installation performs periodic safety reviews of its installation taking the best international practices into consideration. *"This review must allow [...] updating of the assessment of the risks or inconveniences presented by the installation [...], taking into account more specifically the state of the installation, the experience acquired during operation, the development of knowledge and of the rules applicable to similar installations"*. Pursuant to this article, the external hazards must be reassessed as part of the ten-yearly periodic safety reviews, taking the development of knowledge into account and updating the SARs accordingly.

### 17.3.2. Measures taken for the reactors

#### *Periodic safety review*

The risks associated with site-related factors (seismicity, hydrology, meteorology, industrial environment and transport routes) are analysed in studies relating to external events and are reassessed during periodic safety reviews or following certain exceptional events.

Changes in these factors are identified in a chapter of the safety report updated on this occasion, and the safety case is updated if necessary, taking into account these updated factors.

With regard to the climatic conditions, EDF carries out climate monitoring in order to assess any potential changes in the hazards resulting from climate change and to verify their impact on the design of its installations. In this respect, EDF has implemented an approach, carried out with the same frequency as the publication of the reports of the Intergovernmental Panel on Climate Change (IPCC), defining:

- the climatic hazards whose development is conceivable or certain, which could lead to a reassessment of the safety reference framework values;
- the criteria concerning climatic events that trigger an in-depth analysis (notion of major climatic event), in order to guarantee the conservative nature of the climatic hazards over the period between two safety reviews.

### **Focus No.20 : The ADAPT project – A systemic and evolutive approach to anticipate the future adaptation of the nuclear power fleet in the context of climate change**

In addition to taking climate change into account in its periodic safety review process, the EDF Group has developed a systemic and evolutive approach to ensure the long-term resilience of the Group's electricity generation facilities to climate change. For nuclear and thermal facilities in operation, this approach is embodied in the 'ADAPT project'.

The systemic approach is implemented across all real estate, logistics, technical and human elements that play a role in the electricity generation of a nuclear installation. The evolution under climate change of all components that have an impact on electricity generation activities is studied:

- Water resources at production sites: river flows, sea level, water quality, water consumption, etc.
- Capacity of industrial facilities to produce electricity: plant efficiency, operating margins, etc.
- Ability of the supply chain to perform its functions: supply (fuel, spare parts, etc.), working conditions, subcontracting, etc.
- Territories located around the nuclear facility to ensure the sustainability of their symbiosis.

To this end, the ADAPT project draws on all the expertise of its R&D division – via its climate department – to understand all aspects of climate change (e.g. scientific watch, retrieval of climate projections used to prepare IPCC reports, academic partnerships, etc.) and quantify – using specific methods – the local consequences at each site and over different time horizons (e.g. 2050, 2070, 2100).

This insight enables the assessment of climate change consequences on all components involved in electricity generation, to identify climate change adaptation solutions, to further develop their feasibility and industrial maturity, and to plan their deployment across EDF's nuclear reactor fleet within a timeframe appropriate to the challenges.

#### **17.3.3. ASNR oversight**

As part of the periodic safety reviews, ASNR examines the natural or anthropogenic external hazards associated with the site, which are assessed on the basis of the latest knowledge available (see § 14.1.3.2).

In addition, ASNR reviews experience feedback and the potential impact on the definition of hazards included in the safety reference framework.

#### **17.4. Consultation with other Contracting Parties likely to be affected by the installation**

The principle of consultation of States concerned by a project is internationally enshrined by both the European Directive 2011/92/EU of 13/12/11 concerning the assessment of the effects of certain public and private projects on the environment, and the Espoo convention. In French law, this principle is implemented in the Environment Code.

If a project is likely to have significant impacts on the environment of another State (member of the European Union or party to the "Espoo" Convention), the government, as part of the BNI creation authorisation procedure, notifies this State of the public inquiry opening order and sends it a copy of the investigation file. The authorities of the foreign State are given a deadline to express the State's intention to participate in the

public inquiry, which cannot begin until this deadline has expired (Article R. 122-10 of the Environment Code). The States concerned are therefore consulted during the public inquiry.

Pursuant to article 37 of the treaty instituting the European Atomic Energy Community and to article R. 593-26 of the Environment Code, the creation authorisation for a facility likely to discharge radioactive effluents into the environment can only be granted after consulting the European Commission.

## Article 18 Design and construction

### ARTICLE 18 DESIGN AND CONSTRUCTION

*Each Contracting Part takes appropriate measures 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 mitigate 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 analyses;*
- 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.*

## 18.1. Implementation of defence in depth

### 18.1.1. The regulatory framework

The BNI Order (Article 3.1) requires application of the principle of defence in depth. Thus, at the design stage of BNIs, this leads to the implementation of successive defence levels (intrinsic characteristics, material provisions and procedures), to prevent incidents and accidents and, should prevention fail, to mitigate their consequences.

In particular, for the design of the EPR and EPR2 reactors, three main objectives of improvement with respect to the preceding reactors have been set. They are mentioned in the technical directives for the design and construction of the next-generation pressurised water nuclear reactors:

- reduce the number of incidents with the aim of reducing the possibilities of accident situations resulting from such events;
- significantly reduce the probability of core melt: the technical directives stipulate in this respect that *"improving defence in depth [...] should lead to an overall core melt frequency of less than  $10^{-5}$  per reactor-year, taking uncertainties and all types of failures and hazards into account"*. The consideration of all initiating events that could lead to core melt is a new approach compared with that for previous reactors;
- significantly reduce the radioactive releases that could result from all conceivable accident situations, including core melt accidents. The technical directives stipulate in this respect that:
  - *"for accident situations without core melt, there shall be no necessity of protective measures for people living in the vicinity of the damaged plant (no evacuation, no sheltering)";*
  - *"low pressure core melt sequences have to be dealt with so that the associated maximum conceivable releases would necessitate only very limited protective measures in area and in time for the public. This would be expressed by no permanent relocation, no need for emergency evacuation outside the immediate vicinity of the plant, limited sheltering, no long-term restrictions in consumption of food";*
  - *"accident situations with core melt which would lead to large early releases have to be "practically eliminated": if they cannot be considered as physically impossible, design provisions have to be taken to design them out. This objective applies notably to high pressure core melt sequences."*

Defined in 2000, these safety objectives are those of Principle No.1 of the Vienna Declaration on Nuclear Safety.

Produced jointly with IRSN, ASN Guide No. 22 contains recommendations with regard to safety for the design of pressurised water reactors. Although this guide applies primarily to the design of new-generation PWRs, its recommendations may also be used as a reference when seeking improvements to be made to reactors in service, for example as part of their periodic safety reviews, in accordance with Article L. 593-18 of the Environment Code and Articles 8b and 8d in European Council Directive 2014/87/Euratom of 8 July 2014.

The guide focuses essentially on the prevention of radiological incidents and accidents and the mitigation of their consequences. It details the safety objectives and the general design principles and makes recommendations to meet regulatory requirements. The recommendations focus in particular on defence in depth and the safety case.

ASN Guide No. 22 thus constitutes a reference in France for the design of new reactors and serves as a tool for presenting, in an international context, French practices in the field of nuclear safety. It updates the technical directives adopted by ASN in 2000. The safety objectives are similar to those set out in the technical directives and correspond to those of principle No.1 of the Vienna Declaration on Nuclear Safety.

### 18.1.2. Measures taken for the reactors

In its present form, the principle of defence in depth is based on the implementation of five successive and sufficiently independent levels of defence, of which the first four are the licensee's responsibility:

1. the first level aims to prevent abnormal operation and failures by the quality of design and manufacturing;
2. the second level consists in detecting incidents and taking steps that will firstly prevent them from leading to an accident, and secondly restore a situation of normal operation or, otherwise, place and maintain the facility within the authorised operating range;
3. the purpose of the third level is to control accidents that could not be avoided or, failing this, prevent the situation from worsening by regaining control of the facility in order to reach a safe state and maintain it;
4. the fourth level consists in managing accident situations that could not be controlled so as to mitigate the consequences, notably for persons and the environment;
5. the fifth level of defence in depth, which targets emergency management by the public authorities, aims at mitigating the radiological consequences of radioactive releases that could result from accident conditions.

#### *EPR2 reactor*

The safety of the EPR2 reactor is based on the abovementioned levels and taking into account at the design stage:

- severe accidents (implementing in particular an area enabling, if necessary, the corium spreading and its cooling);
- multiple failures that could lead to core melt: additional safety systems have been designed to prevent core melt during these sequences;
- a redundancy and diversification of the emergency power supply: an emergency generator set (EGS) for each of the three safety trains, a 4<sup>th</sup> shared EGS, an EGS using diversified technology dedicated to preventing core melt in a DEC-A type situation (limitation of the consequences of common cause failures), and finally an EGS dedicated to limiting the consequences of an accident with core melt;

- the application of the defence in depth principle to the Fuel Building (see § 18.3.2);
- an increased resistance of the installation to external hazards: it has been in particular decided to consider the aircraft risk independently of the probability of event occurrence, by a protection of the installation relying on both the principle of geographical separation and the existence of a physical barrier (airplane crash shell).

### ***JHR Reactor***

The design of the JHR reactor is based on the defence in depth concept. Under the fourth level of defence in depth, the JHR reactor considers severe accidents at the design stage. The accident considered for the installation is the BORAX-type explosive reactivity accident. Vents with appropriate filters are included in the design to mitigate the consequences of a severe accident.

Furthermore, the installation has specific design provisions to take into account the external hazards risk. For this, the installation incorporates a system of aseismic bearing pads, accelerometers triggering a complete fast emergency shutdown, a specific airplane crash-resistant design of the reactor building and its nuclear auxiliary building, as well as provisions for protection against the effects of a tornado or lightning.

### **18.1.3. ASNR oversight**

#### ***EPR2 reactors of Penly 3 and 4***

ASN, with IRSN technical support, analysed the safety options for EPR2 reactors (then known as EPR-NM), in particular the application of the defence-in-depth principle.

Following its review, ASNR considers that the objective of independence for EPR2 systems at level 4 of defence in depth from the other levels represents a step forward for safety.

#### ***JHR reactor***

During the examination of the creation authorisation application for the JHR reactor, ASN examined the provisions associated with implementation of the defence in depth principle.

ASNR checks in particular that the licensee implements, in the manufacturing and construction phases, the materials, standards and design codes applicable for the first level of defence in depth.

## **18.2. Incorporation of proven technologies**

### **18.2.1. The regulatory framework**

The BNI Order (Article 2.5.1) requires the qualification of protection important components (PIC) to be proportionate to the risks: it aims in particular to guarantee their ability to fulfil their functions in the situations in which they are needed. Appropriate design, construction, tests, inspection and maintenance provisions must be implemented to enable this qualification to be maintained over time.

Nuclear pressure equipment (NPE) is subject to both the BNI regulation and another specific regulation. On this account, it has to comply with essential safety requirements set by the regulations and verified during a conformity assessment. These requirements concern in particular the design and manufacture of equipment and materials. They imply in particular that the materials have characteristics appropriate to the expected loads. The conformity of these characteristics can be demonstrated by relying on harmonised standards or by performing assessments or specific tests. Likewise, the manufacturing methods and techniques must be

appropriate and guarantee the absence of defects. To ensure this, some processes (such as welding) and the operators performing them must be qualified and the non-destructive testing must be carried out by qualified personnel.

Lastly, for certain components which risk having heterogeneous characteristics, all the material production operations and the manufacturing operations must be subject to "technical qualification". The purpose of this qualification is to ensure that the component characteristics ultimately meet the specifications everywhere. This problem concerns, for example, large equipments (e.g. a reactor vessel head), because their size makes them particularly vulnerable to metallurgical defects such as carbon segregation, which weaken their mechanical characteristics.

### 18.2.2. Measures taken for the reactors

Design codes are used for classified equipment. The nuclear industry produces detailed rules concerning the state of the art and good industrial practices, which it brings together in "design codes". These codes (RCC - *Règles de Conception et de Construction* – Design and Construction Rules) have been drawn up for the design, manufacture and commissioning of electrical equipment, civil engineering structures, mechanical equipment and fuel assemblies of NPPs. These industrial codes are drafted by AFCEN, the French association for rules on design, construction and in-service monitoring of nuclear steam supply systems, which comprises 60 French and international industrial firms, including EDF, Framatome and the CEA.

The manufacturer of a nuclear pressure equipment is responsible for its compliance with the applicable safety requirements to guarantee the absence of failure throughout its operating life. These requirements are defined by a European Directive concerning pressure equipment (PE) and are supplemented by requirements specific to nuclear pressure equipment, which also take into account their importance for the safety of the installation. The manufacturer defines and applies rules that provide evidence of compliance with these requirements. These rules are given in the design and construction code for these equipments (RCC-M) published by AFCEN.

The RCC-M code includes in particular a method for controlling the risk of heterogeneity: the manufacturer must identify the parameters that can influence the risk of heterogeneity resulting from the operation in question, check their effects through a test programme on a dedicated part, then check these parameters on the production parts through an acceptance test programme.

With regard to safety, qualification is the demonstration that a safety important component is capable of fulfilling its functions under the conditions (temperature, pressure, humidity, irradiation, earthquake, etc.) to which it is likely to be subjected.

An equipment can be qualified by either test or analysis (studies), or a combination of the two:

- qualification by testing consists in exposing a piece of equipment ("model") to loads representative of the normal and accident conditions it must be resistant to: the test programme is broken down into successive test sequences to represent the loads the equipment is likely to be subjected to. This method, for example, is the one used most often for electrical equipment. It is also used for other equipment, such as valves;
- qualification by analysis can be performed:
  - either by analogy with an equipment already qualified by tests, on the basis of predetermined rules (similar technology and dimensions, etc.): this method is used in particular for valves and pumps;
  - or by calculation with a simulation model representative of the equipment relying on qualified method or calculation codes: this method is used in particular to substantiate the mechanical design;

- or by operating experience, when the conditions experienced have been at least as severe as those the equipment must be able to "withstand".

A safety classification approach is applied to equipment that plays an important role in safety. This approach allows to define appropriate requirements in terms of design, manufacture, qualification, operation and in-service monitoring, proportionate to their importance for safety. Equipment can be classified under the prevention of incidents and accidents, the mitigation of their consequences or protection against hazards, and according to their type (mechanical, electrical, etc.).

### ***EPR2 reactor***

The qualification approach described above is applied to EPR2 reactor. Several equipments are nevertheless subject to specific approaches:

- for the instrumentation and control (I&C), a specific approach was adopted for its design in order to provide the appropriate substantiations. It is based on the control of the different steps of the industrial process, namely the specification of the design requirements, the design process, production and integration (assembly of the various system components), each of which include verifications; a final independent validation step constitutes an additional precaution. This approach is supplemented by functional diversification which enables hypothetical faults in design or in the execution of certain functions to be compensated by means of other functions using different physical signals or processing methods;
- for the reactor vessel, a specific qualification process has been adopted. Test pieces made from the same material as the reactor vessel will be irradiated in areas near the core and subjected to mechanical tests at various times during the life of the installation with the aim of predicting the behaviour of the vessel material (particularly in terms of the transition threshold for ductile-fragile mechanical behaviour);
- for the 'double drum' device (DDM - Double DruM) in the lower internals of the reactor vessel, a specific qualification on a mock-up is currently being carried out to validate the performance of this device. This device, installed in the vessel bottom head, will channel the flow between the vessel inlet and the core inlet, thereby resolving the issues related to neutron flux fluctuations and grid wear discovered during the operation of the first EPRs commissioned worldwide.

For the EPR reactor, the safety classification approach for the equipment and systems is based on the importance of the safety function they fulfil, their importance as a confinement barrier and the releases, within the installation and into the environment, that could result from their failure.

### ***JHR reactor***

The qualification process applies to equipment, depending on its nature and function, according to two categories:

- for all the active safety-classified equipment, the conventional approach of qualification by tests or analyses as described in § 18.2.2 has been applied;
- for the passive equipment, the qualification approach consists in checking their resistance to the accident conditions, particularly the loads to which they are subjected.

Combinations of the abovementioned methods were particularly used for the JHR equipment due to the extensive technologies already in use in other French BNIs.

Alongside this, several equipment has undergone specific approaches:

- a fuel element qualification programme has been deployed to cover the fabrication process, behaviour when irradiated, hydraulic behaviour and validation of the locking and handling system,
- a qualification programme for the aluminium alloy material used in certain components of the reactor block aims to qualify the forging routes and the welding process and to assess the behaviour of the material and its welds when subject to irradiation,
- a qualification programme for the absorbent cluster control mechanisms has validated the general design (early qualification phase), the main technological choices (functional validation tests on mock-ups) and all the expected performances (qualification on test loop),
- a specific test programme is underway to test the reduction of the effects of the fluid-structure interaction and thus the risk of vibration for all the reactor block structures, given the high hydraulic flow velocities expected in the reactor block internal structures,
- the qualification programme for the aseismic bearing pads addresses four areas: manufacture and characterisation, possibility of replacing these pads, proof of durability and validation of the monitoring plan.

### 18.2.3. ASNR oversight

#### 18.2.3.1. *Equipment other than nuclear pressure equipment*

For reactors' components or equipment, ASNR's examination focuses on:

- the design and manufacturing requirements for the components/equipment, in view of the importance of their role in the safety case. The safety classification approach which serves to identify and differentiate the main applicable requirements, including the applicable standards or industrial codes to be used, is the subject of a specific examination;
- the qualification for accident conditions, which aims to verify that the equipments used for incidents and accidents situations fulfil their functions under the corresponding environmental conditions (temperature, relative humidity, radiation, etc.). ASNR devotes a particular attention to the qualification of equipment for severe accident conditions.

For the EPR2 reactor, the objective of ASNR's review of the equipment qualification process under accident conditions conducted as part of the review of the creation authorisation application for the reactors 3 and 4 at Penly is to ensure that these equipments are qualified at the commissioning stage of these reactors. In particular, the qualification profiles (envelope conditions for temperature, pressure and irradiation, etc. for which the equipment must be qualified) are subject to specific review. The qualification assessments focus on systems whose design has evolved since the Flamanville EPR reactor and for which there is no experience feedback.

#### 18.2.3.2. *Nuclear pressure equipment (NPE)*

The oversight by ASNR and the approved organisations is carried out at the different stages of design and manufacture of the NPE. It involves an examination of the technical documentation of each equipment and inspections in the workshops of the manufacturers, as well as at their suppliers and subcontractors.

For the PWRs, ASNR assesses the conformity of the NPE of the main primary and secondary systems. In this context, ASNR ensures the oversight of the manufacture of the NPE that will be part of the primary and secondary systems of the nuclear steam supply system (NSSS). ASNR may rely on an approved organisation to

carry out this task. This organisation is then mandated by ASNR to perform some of the inspections on the level N1 equipment. In addition to this oversight, ASNR and the approved organisations undertake the examination of technical documentation and surveillance actions of the NPE assembly operations carried out on the site. If these examinations are satisfactory with respect to the regulatory requirements, ASNR issues the NPE certificate of conformity.

The approved organisations assess the regulatory compliance of the level N2 and N3 NPE. These organisations are called upon directly by the manufacturer. The activity of these organisations is regularly inspected and audited by ASNR.

ASNR also conducts inspections of EDF and its manufacturer Framatome concerning assembly of the NSSS and preparation of the hydrostatic tests, as well as inspections of the organisations mandated by ASNR to oversee these activities.

### 18.3. Design choices

#### 18.3.1. The regulatory framework

The BNI Order (Article 3.1.II) requires *"a cautious design approach, integrating design margins and wherever necessary introducing adequate redundancy, diversification and physical separation of the protection important components that fulfil functions necessary for the safety case"*.

The BNI Order (Article 3.2) requires that *"the safety case [be] carried out in accordance with a cautious deterministic approach, [integrating] the technical, organisational and human dimensions. »*.

The BNI Order (Article 3.9) requires that it be shown that *"accidents likely to lead to significant releases of hazardous materials or to dangerous effects off-site with kinetics that would not permit the timely implementation of the necessary measures to protect the population are physically impossible or, if this physical impossibility cannot be demonstrated, that the provisions implemented on or for the installation make such accidents extremely unlikely with a high degree of confidence."*

ASN Guide No. 22, developed with IRSN, contains recommendations for the design of pressurized water reactors. The guide deals mainly with the prevention of radiological incidents and accidents and the mitigation of their consequences. It specifies the safety objectives and general design principles and makes recommendations to meet regulatory requirements.

In this guide, ASN also defines the conditions for considering human actions in the safety case. These conditions thus set the minimum time to consider, from the time an event is detected, to allow for the performance of a human action (30 minutes in the control room and 1 hour on site but outside the control room) and requires proof of the feasibility of the human actions thus credited.

#### 18.3.2. Measures taken at the design stage for the new reactors

##### *EPR2 reactors*

Some of the EPR2 reactors design choices result from the safety objectives set for the 3rd-generation reactors, notably reduction of the probability of core melt situations and significant reduction of the radioactive releases that can result from core melt situations (system for ultimate removal of heat from the reactor building, core catcher etc).

Other design choices stem from the objectives assigned to the 3rd level of defence in depth for the events initiated in the Fuel Building (presence of three cooling trains, possibilities of water make-up in the spent fuel pool etc.).

EDF has also adopted certain technical choices for the I&C systems and the man-machine interface:

- the digital technology used jointly for the instrumentation, the conventional I&C and the safety-classified I&C offers advantages in terms of physical diversification, but also in terms of man-machine interface with a computerised interface (the Process Information and Control System - PICS) and a conventional interface (the Safety Information and Control System - SICS);
- separate I&C functions have been designed for normal operation and for incident and accident prevention;
- the allocation of tasks between the operators and the technical systems, particularly through the selection of automation, has been defined in such a way as to make optimal use of the human operator's capabilities.

Moreover, feedback from the design, construction and commissioning of the world's first EPRs has been taken into account in the design of the EPR2:

- the core (fuel, rods, instrumentation, etc.) and primary and secondary circuits of the EPR2 design are similar to those of the Flamanville EPR, with the addition of a new flow distribution device in the reactor vessel bottom head (DDM), based on feedback from the operation of the first EPRs commissioned worldwide;
- the technology of primary circuit depressurisation valve, i.e. tandem-type (two valves installed in series for each of the three safety valves) is similar to that used in the French fleet in operation (and therefore different from that used in the Flamanville EPR);
- the primary motor pump units will be made watertight using hydrodynamic seals that are more effective than those installed on the Flamanville EPR;
- the safety systems consist of three trains instead of four for the Flamanville EPR, thus simplifying the design and operation of the facility;
- the reactor building is a thick single wall with a metallic liner offering a level of protection against external threats equivalent to that of the Flamanville EPR;
- improving the facility's resistance to external threats: in particular, it was decided to consider the aircraft risk independently of the probability of occurrence of the event, and to base the protection jointly on the principle of geographical separation and the existence of protective walls. The containment design consists of thick single walls for the fuel building and for the auxiliary safety building housing the control room (BAS3), one of which is protected by a double wall;
- improving the facility's resistance to internal threats: the design of separate building structures (safeguard auxiliary building, diesel buildings, etc.) aimed to limit the consequences of internal threats, where relevant, within the division concerned (reducing interconnections between divisions through isolation or decoupling measures);
- the 'two-room' concept of the Flamanville EPR (which allows access to certain parts of the reactor building while the reactor is in operation) is not applied in order to simplify construction;
- the emergency power supplies have been reinforced and diversified with an emergency generator set (EGS) for each of the three safety systems, a fourth shared EGS, and an EGS using diversified technology dedicated to preventing core meltdown in a DEC-A type situation (limiting the consequences of common cause failures) and finally a GES dedicated to limiting the consequences of a severe accident;

- improvements have been made to the heat sink with a main pumping station (unclassified), a separate safety heat sink, and a diversified safety heat sink with an air cooler, enabling to credit the principle of geographical separation and eliminate the aircraft shell from the Flamanville EPR's heat sink, which simplifies the pumping station compared to the Flamanville EPR.

### ***JHR Reactor***

The consideration of operational experience feedback from similar installations has led to design choices such as:

- the creation of a leak recovery zone which can collect leaks at the singular points of the reactor building containment;
- the installation of underwater air lock doors to exclude loss of containment in the event of an accidental drop in the water level of the pools;
- the choice of a main primary system in which the deactivation tank is replaced by a purification/filtration system ensuring the continuous treatment of the primary fluid downstream of the main heat exchangers;
- the overpressurisation of the secondary system in comparison with the main primary system in order to prevent the contamination of the secondary system in case of a primary/secondary leak, and as well the implementation of a monitoring of the secondary system pressure;
- provisions in the design for the prevention and mitigation of the consequences of hazards (internal fire, projectile emission, extreme climatic conditions, external flooding and earthquake).

Furthermore, for the fourth level of defence in depth, provisions are made as from the design stage to mitigate the consequences of a BORAX-type explosive reactivity accident.

Human and Organisational Factors (HOF) have been integrated from the start of the JHR design project with establishment of human factors integration plans which take into account the HOF requirements as of the definition phase and continue through the development and production phases up to testing.

The lessons learned from HOF feedback have led to the following:

- design work stations integrating an ergonomic approach: activities to perform, available means and equipment;
- set up a work organisation that takes into account the specific role of the operators, in normal, incident and accident situations;
- specify from the start of design the role given to humans in the operation of the installation and the organisation of the operating teams (management of reactor and interfacing with the management of experiments);
- give the operators adequate man-machine interfaces that enable them to get a proper representation of the situation;
- separate geographically and as distinctly as possible the activities of different natures in the reactor building (Reactor Operation Compartment and Experimental Devices Operation Compartment, etc.) and identify the potential interactions between these activities to deduce complementary design and/or operating measures from them.

Emphasis has been placed in particular on the centralisation of information to the JHR control room and the backup control room. The design of the operator consoles in the control room has integrated the data

centralisation needs, the selection of data to display and the control systems to assign to the operators based on their functions and activity (organisation of information and modes of presentation).

### ***ITER project***

The risk of internal and external exposure to ionising radiation must be taken into account in the design of ITER. Along with the containment of radioactive materials, this is one of the two essential safety functions of the facility.

With regard to the risk of external exposure, in order to ensure that the design is adequate and, if necessary, to upgrade it, the ITER Organization has produced radiological maps, i.e. calculations of equivalent dose rates at every point in the facility. These calculations take into account the design as planned and the three operating modes envisaged:

- mode 0, when the tokamak is in operation and up to 24 hours after the accidental loss of plasma;
- mode 1, which follows mode 0 and corresponds to the shutdown phase of the facility for maintenance with human presence;
- mode 2, which also corresponds to a shutdown phase of the facility for ‘heavy’ maintenance (highly activated components must be handled automatically and without human presence).

The purpose of these studies is to verify that the design criteria are met, which are themselves defined in accordance with the radiation protection zoning to be implemented in the facility. Additional radiation protection may be provided in the event of a discrepancy between the calculated equivalent dose rates and the design criteria.

Radiation protection considerations during the design phase will be supplemented by operational provisions (establishment of zoning, analysis and layout of workstations, continuous monitoring of external exposure by measuring ambient dose rates, radiological monitoring of personnel, etc.).

The risk of internal exposure on ITER, mainly linked to the incorporation of tritium into the human body, either by inhalation or transcutaneously, is controlled in particular by the implementation of collective protection measures, in particular static and dynamic containment systems. The static system located closest to the process includes the tokamak vacuum chamber, the processes used for tritium and the maintenance cells. The dynamic system is provided by ventilation and detritiation systems. In design situations, including accident situations, the detritiation system will contain tritium in the air in the premises and recover it, thereby limiting the risk of it being released outside.

### **18.3.3. ASN oversight**

#### ***EPR2 reactor***

ASN reviewed the safety options for the EPR2 reactor and issued an opinion on the subject in 2019. This review, carried out with IRSN support, covered all the major design choices for the reactor at an early stage (*basic design*). The Advisory Committee for Nuclear Reactors issued an opinion on this review.

ASN considered that the general safety objectives, the safety reference framework and the main design options were satisfactory overall. ASN's opinion identified the issues to be examined in greater depth in the subsequent stages.

Since 2023, ASN has been examining the application for the authorisation of creation of the first two EPR2 reactors, Penly 3 and 4. This examination, which will last three years, will cover the entire safety demonstration and design.

ASN has worked with IRSN to define an examination strategy that takes advantage of the work carried out prior to the commissioning of the Flamanville EPR whenever it is applicable to the design of the EPR2 (mitigation measures for accidents with core meltdown, design-basis accident studies, etc.). Certain topics specific to the EPR2 (system design, hazards and associated probabilistic safety studies, etc.) are subject to in-depth review.

At the same time, ASN carries out inspections in the engineering departments responsible for the detailed design studies or for monitoring the subcontracted design studies.

### ***JHR Reactor***

ASNR's examination of the creation authorisation application focused more specifically on the design of the installation's civil engineering, particularly with respect to hazards (fire, combined off-site or on-site hazards), the classification and qualification approach, the reactor containment, the incident and accident situations and severe accidents, notably the BORAX accident, and their radiological consequences.

## Article 19 Operation

### ARTICLE 19 OPERATION

*Each Contracting Part shall take 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 to 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. Initial authorisation

### 19.1.1. The regulatory framework

The Environment Code specifies that commissioning corresponds to the first use of radioactive materials in the installation (Article R. 593-29).

The Environment Code details the content of the commissioning authorisation application file submitted to ASN by the licensee (Article R. 593-30):

- the safety analysis report (SAR);
- the general operating rules (GOR)<sup>22</sup>;
- the on-site emergency plan (PUI);
- the decommissioning plan;
- the updated installation impact study;
- the updated risk assessment.

<sup>22</sup> The general operating rules (GOR) cover the operation of the reactors. They are drafted by the licensee and are the operational implementation of the hypotheses and conclusions of the safety assessments constituting the nuclear safety case.

The Environment Code indicates that ASN authorises commissioning of the installation after having verified that it "*complies with the objectives and rules defined by the regulations*" (Article R. 593-33).

The Environment Code indicates that before performing or completing the authorisation procedure, partial commissioning may be authorised by ASN resolution for a limited period in the following cases (Article R. 593-35):

- for the performance of specific operating tests requiring the introduction of radioactive materials into the installation;
- for the introduction of nuclear fuel into the perimeter of the reactor before the first loading of fuel into this reactor.

### 19.1.2. Measures implemented by the licensees

#### *Commissioning of the Flamanville EPR*

EDF submitted a commissioning authorisation application for Flamanville EPR in 2015, accompanied by the file specified in § 19.1.1. EDF has updated this file several times since then.

On site, the operating teams are set up well in advance and are trained to develop the personnel skills required for the installation and to disseminate the safety culture.

Startup tests are carried out to verify that all the protection important components function correctly and to declare that the components concerned are available. These tests are carried out in addition to the appropriate inspections and tests carried in the factory or on specific installations. They represent a transition step towards normal operation of the various systems constituting the reactor. They comprise:

- pre-operational tests, which include:
  - the preliminary tests and initial startup tests of the equipments and functions, which do not involve interaction between the primary system or the auxiliary systems and the secondary systems;
  - the cold and hot functional tests of the primary and secondary systems before loading the fuel;
- "first startup" tests (operational tests): fuel loading, pre-critical tests, tests at different power levels with performance checks.

During the startup test periods, an organisation is put in place to enable all concerned parties to fully exercise their roles and responsibilities:

#### **Focus No.21: EPR commissioning**

On 7 May 2024, ASN authorised the commissioning of the Flamanville EPR reactor. This authorisation enabled EDF to load the nuclear fuel into the reactor and carry out start-up tests and then operate the reactor. After the reactor was loaded between 8 and 15 May 2024, the reactor vessel closure operations were completed. On Monday 2 September 2024, the Nuclear Safety Authority gave EDF the go-ahead to proceed with the divergence operations for the Flamanville EPR reactor. The plant teams carried out the necessary activities for the first nuclear reaction in the reactor. Divergence consists of establishing a stable nuclear reaction at very low power.



The first divergence was achieved on 3 September at 3:54 p.m. This is an important step in the start-up operations. This first nuclear reaction marks the start of the gradual ramp-up of the Flamanville EPR. Following this ramp-up, the Flamanville EPR was connected to the national grid for the first time on 21 December 2024. The teams are fully committed to continuing the testing programme (load reductions, reactor trip,

island testing, etc.) that will enable the reactor to reach full power.

### 19.1.3. ASNR oversight

#### *Flamanville EPR reactor*

ASN has reviewed the application for authorisation to commission the Flamanville EPR reactor. In particular, ASN has verified that the facility complies with the objectives and rules set out in Articles L. 593-1 to L. 593-6-1 of the Environment Code and in the texts adopted for their implementation.

ASN's review focused on the design, safety demonstration, impact study, general operating rules and internal emergency plan.

In addition, ASN ensured the oversight of the EPR reactor construction. In this context, ASN carried out inspections on execution activities, which encompass site preparation after the creation authorisation decree, manufacture, construction, qualification, assembly and testing of structures, systems and components, both on the construction site and on the manufacturers' premises, particularly for the manufacture of the NPE (see § 18.2.3). The purpose of these inspections, conducted proportionately to the potential risks, is to:

- verify the quality of execution of the equipment manufacturing activities, of construction of the installation, of radiation protection and environmental protection;
- ascertain that the startup tests programme is satisfactory, that the tests are correctly implemented and that the results comply with requirements;
- ensure that the feedback from the construction and startup tests phase is integrated in continuous improvement process of the licensee's Integrated Management System (IMS);
- ensure that the licensee takes the necessary steps to duly prepare the teams that will be in charge of operating the installation after commissioning.

ASN has carried out around 600 inspections related to the EPR project since work began in 2007.

Following its review, ASN authorised the commissioning of the Flamanville EPR by resolution dated 7 May 2024. This authorisation allows EDF to load the nuclear fuel into the reactor and carry out start-up tests, followed by operation of the reactor. ASN published its [review report](#) when it issued the authorisation for the reactor to be commissioned in May 2024.

### Focus No. 22: ASN inspections prior to authorisation for the EPR to be commissioned

ASN examined the application for authorisation to commission the Flamanville EPR reactor.

ASN's review covered the design, the safety demonstration, the impact assessment, the general operating rules and the internal emergency plan. This review was carried out with the support of IRSN. In the course of this assessment, ASN sought the opinion of the advisory committee of experts on the main points of the design and safety demonstration (safety classification, accident studies, design of safety systems, safety demonstration of fuel storage and handling, protection against the effects of internal or external hazards, probabilistic safety assessments, severe accidents and their radiological consequences).

ASN's review also took into account the results of tests carried out on the site and feedback from EPR reactors commissioned abroad. To this end, ASN has maintained regular relations with the Finnish and Chinese nuclear safety authorities in order to benefit from their experience in the construction, start-up tests, preparation for operation and operation of EPR reactors.

In addition, ahead of the commissioning of the Flamanville EPR, France asked the IAEA to carry out an OSART mission in 2019. This was followed by a mission in 2021 to assess whether the recommendations and suggestions identified had been taken into account. The 2021 mission concluded that the conclusions of the 2019 mission had been satisfactorily taken into account. ASN has analysed the conclusions of these missions, in particular to guide its inspection with a view to taking a position on the commissioning of the reactor.

Since 2022, ASN's inspections have focused mainly on the completion of the installation, the performance of tests and the operator's preparations. In particular, ASN carried out a one-week review inspection in 2023. This inspection involved 15 ASN inspectors and 11 IRSN experts. EDF's responses to ASN requests resulting from this inspection were the subject of a new inspection in early 2024. Following these inspections, ASN considers that EDF has set up an appropriate operating organisation.

## 19.2. Operational limits and conditions

### 19.2.1. The regulatory framework

The Environment Code specifies the content of the files to be submitted for the commissioning authorisation application of a basic nuclear installation (Article R. 593-30). This file contains, among other things, the safety analysis report (SAR) and the general operating rules (GOR).

One section of the GORs indicates the BNI operating conditions and limits; this section is called "operating technical specifications".

In application of the "noteworthy modifications" resolution, ASNR is notified of any significant change in the GORs: it is subject to ASNR authorisation before being implemented if it has a significant impact on the safety of the installation.

### 19.2.2. Measures taken for nuclear power reactors

The operating technical specifications (STE), which constitute chapter III of the general operating rules of the EDF reactors, define the normal operating conditions based on the design and sizing hypotheses and require the systems necessary to maintain the safety functions, in particular the integrity of the radioactive substance

containment barriers and the monitoring of these functions in the event of an incident or accident. They also stipulate the action to take in the event of temporary failure of a required system or if a limit is exceeded, situations which constitute degraded mode operation.

The technical specifications evolve to integrate the lessons learned from their application and the modifications made to the reactors. The licensee can amend them temporarily on an ad hoc basis, for example to carry out an operation in conditions that differ from those initially considered in the nuclear safety case. In such cases the licensee must demonstrate the relevance of this temporary modification and define adequate compensatory measures to control the associated risks.

The unavailability of any item involved in a required safety function or any crossing of a normal operating limit constitutes an event. For each operating range, the technical specifications define the action to take following an event: fallback state, fallback (initiation) time or repair time. Fallback state is a reactor state in which the required safety functions are ensured over the long term. Transition from the initial operating range to fallback state is made by applying normal operating procedures.

### **19.2.3. Measures taken for reactors others than nuclear power reactors**

The technical specifications are the general rules applicable to the operation of research reactors. They define the areas of operation. These reference documents are supplemented by a set of operational documentation such as procedures and instructions managed by the relevant units which ensure that all operations are carried out in compliance with the applicable rules.

The experimental devices have their own safety baseline requirements which include the interfaces with the reactor in terms of safety (e.g. reactor shutdown in response to a device alarm).

### **19.2.4. ASNR oversight**

ASNR examines the acceptability of the permanent noteworthy changes to the BNI operating limits and conditions subject to its authorisation. These changes can stem from operational experience feedback or changes made to the safety case. They are sometimes related to physical modifications to the reactors.

ASNR is sometimes also required to examine licensee applications for authorisation of temporary modifications to the operating limits and conditions in order to manage any unforeseen event.

During its inspections, ASNR checks that the licensee complies with the operating limits and conditions and, if applicable, the compensatory measures associated with the temporary modifications. It also checks the consistency between the modifications made to the facilities and the normal operating documents, such as operational control instructions, the alarm sheets, the operating limits and conditions and the training of the persons responsible for applying them.

## **19.3. Procedures for operation, maintenance, inspection and testing**

### **19.3.1. The regulatory framework**

The BNI Order (Article 2.5.1) stipulates those measures for analyses, construction, testing, inspection and maintenance must be taken to guarantee the ability of the SSCs to fulfil their assigned functions. These provisions are supplemented for certain equipments, notably the NPE for which in-service monitoring requirements are defined.

### 19.3.2. Measures taken for nuclear power reactors

The periodic tests of the SSCs are described in chapter IX of the GORs. This chapter indicates the necessary tests to ensure the availability of the equipments and their ability to fulfil their functions as provided for in the safety case. The test programmes are updated when the facility undergoes changes, particularly during the periodic safety reviews.

EDF has a maintenance policy for the nuclear fleet in operation that is structured to enhance the reliability of the equipment and systems, in order to guarantee throughout the installation's life cycle that they are capable of fulfilling their assigned functions with respect to the loads and ambient conditions that can prevail in the situations for which they are required.

The elementary equipment and systems that must have basic maintenance programmes are identified from the key issues concerning the nuclear fleet (safety, radiation protection, environment, regulation, assets, availability, costs, occupational safety). The basic maintenance programmes specify the nature and frequency of the preventive maintenance activities. They are subject to a continuous improvement process based on operational experience feedback from the SSCs. The preventive maintenance activities are planned on a schedule that takes into account their conditions of performance (reactor in operation or during periodic outage, for example) and their frequency. They are scheduled in compliance with the conditions provided for in the GORs. The maintenance activities that concern the protection important components (PIC) are subject to the following requirements:

- preparation of the maintenance work, including the preparation of a file drafted, checked and approved by qualified personnel,
- performance of the maintenance work using appropriate human and material resources,
- requalification after the maintenance work, which consists in checking operation of the equipment or system to ensure that the required design-basis performance is maintained or restored further to the work,
- putting back into operation after the maintenance work when equipment availability is demonstrated further to requalification,
- detecting and processing deviations: any deviation with respect to a defined requirement is identified, undergoes a formal analysis, curative actions and, if applicable, corrective and preventive actions,
- production of a work report to turn the experience feedback to good account.

### 19.3.3. Measures taken for reactors other than nuclear power reactors

#### *The HFR reactor of the Laue Langevin Institute (ILL)*

The ILL's IMS defines a documentation structure and clear documentation management rules in relation to the protection of interests. The operational documents (operation, maintenance, periodic inspections and tests) form part of this documentation. They are obligatorily drawn up or verified by the personnel directly concerned by the activities or installations covered by the document. The applicable versions of these documents are accessible to everyone in read mode via dedicated computerised directories.

For each PIC, a maintenance plan is established to ensure the long-term durability of the originally defined and verified equipment requirements and functionalities. The aim of the periodic tests and inspections of the PICs is to verify that they effectively maintain these requirements and functionalities over time. These tests and inspections and their frequency are specified in GOR No. 5. The control process for these tests and inspections is described in a specific process of the IMS.

### ***The CEA's Cabri reactor***

The PICs are subject to periodic inspections and tests to check they are functioning in compliance with the requirements defined in the safety case and to ensure their availability. The nature and frequency of the inspections and tests are described in the GORs. Satisfactory performance of these inspections and tests, at the planned frequency, makes it possible to state that the items concerned are available and fulfil their required safety function.

Furthermore, some safety important equipments are subject to preventive maintenance which takes into account both the manufacturer's maintenance specifications and operational experience feedback from these equipments. The aim of these preventive maintenance campaigns is to reduce risks of failures of these items and maintain them in a fit state to fulfil their function with the required performance levels. This preventive maintenance is carried out periodically in accordance with validated procedures and accompanied by a risk assessment if the intervention could affect safety.

#### **19.3.4. ASNR oversight**

ASNR verifies that the periodic tests of safety important equipments do effectively check their proper functioning and level of performance. It carries out this verification when examining the reactor commissioning authorisation application, and when applications for authorisation to modify the GORs are made. During inspections, it also verifies that these periodic tests are carried out in accordance with the test programmes stipulated in the GORs.

Maintenance is also subject to regular checks by ASNR during its inspections. As part of its oversight function, ASNR also conducts an annual examination of operational experience feedback from the reactors which may lead it to ask EDF to make changes to its maintenance programmes.

NPE items undergo regular inspections to check that the licensee carries out the required in-service monitoring operations. Furthermore, the 10-yearly hydrostatic tests of PWR primary and secondary systems required by the regulations are carried out in the presence of ASNR, which issues a requalification report before the reactor is put back into service. The relevance of the in-service monitoring programmes is moreover reassessed under the supervision of ASNR during the periodic safety reviews in the light of operational experience feedback.

## **19.4. Procedures for responding to operational occurrences and accidents**

### **19.4.1. The regulatory framework**

The Environment Code specifies the content of the files to be submitted for the commissioning authorisation of a basic nuclear installation (Article R. 593-30). This file contains, among other things, the safety analysis report (SAR) and the general operating rules (GOR). One section of the GORs details the strategies and reactor operating rules for an incident or accident situation.

After commissioning, ASNR is informed of the noteworthy modifications to these rules, the most significant of which are subject to ASNR authorisation (see §7.2.2.1).

### **19.4.2. Measures taken for nuclear power reactors**

Parameters representative of the state of reactor operation are monitored continuously by automatic systems and by the operators.

On 900, 1300 and 1450 MW reactors, if predefined criteria representative of an incident or accident situation are exceeded, the operators are required to proceed with application of the “safety guidance document” (DOS), either in application of the operating technical specifications (STE), or directly following the actuation of specific alarms in the control room (particularly in the event of triggering of automatic reactor protection systems). The DOS enables the operators to diagnose the situation and guides them to the relevant incident or accident operating rule, depending on the parameters affected and the current reactor operating range (under power, in shutdown state, primary system closed or open, etc.).

On the Flamanville EPR reactor, an automatic diagnosis system replaces the DOS and provides the team with the results of an orientation calculation and proposes an operating strategy. This diagnosis is activated automatically when criteria representative of the incidental or accidental operating domain are met, or upon declaration by the operator when required by the Operating Technical Specifications.

The operating rules in incident and accident situations are based on the "state-based approach" (*Approche Par Etat* or "APE" in French), which leads to the application of strategies developed according to the identified physical state of the nuclear steam supply system (NSSS) irrespective of the events that led to this state. The priority aim of state-based approach is to prevent the risk of core melt.

In the hypothetical event of core melt occurring, the priority would then be to secure the containment. The operational strategy in this case is supported by the Severe Accident Management Guidelines (SAMG) which are designed for the management of new and complex phenomena in severely degraded situations.

The resolution to apply the SAMG, which marks the abandonment of the state-based approach procedures, is taken on criteria concerning the core outlet temperature and the dose rate in the reactor containment.

#### **19.4.3. Measures taken for reactors other than nuclear power reactors**

*For the Cabri reactor (CEA)*, the analysis of the alarms and operating parameters measured and transmitted to the reactor control room can lead the operators to implement incident or accident operating procedures. These procedures describe the operational control applicable in such situations, the objectives being to bring the reactor to and maintain it in a safe condition and to mitigate the consequences of the incident or accident.

The operating rules applicable in such situations are described in the general operating rules (GOR).

The operation of incident and accident situations is carried out from the control room unless the accident situation has made it unavailable (fire, for example). In this case, accident management is transferred to a rack situated in a backup room. These backup control racks are used in the emergency exercises.

The management of severe accidents, particularly further to loss of core cooling, calls upon specific procedures.

*For the HFR (ILL)*, the GORs define the general actions to carry out in the event of an incident or accident.

The particular instruction “Organisation in PUI activation situation” describes the action to take out of normal operating situations, and the conditions for switching to accident mode organization. This document allows the transition from normal or incident operation to an emergency situation defined in the PUI. The criteria for triggering the PUI are indicated in it, as are the particular instructions that must be applied according to the situation.

#### 19.4.4. ASNR oversight

##### 19.4.4.1. Nuclear power reactors

ASNR examines the incident or accident operating rules as part of its examination of the reactor's commissioning or if they have undergone modifications that are subject to ASNR authorisation. ASNR regularly checks the processes to produce and validate the incident or accident operating rules and instructions, their relevance and how they are implemented.

To do this, ASNR can run a situational exercise for the installation's operating teams to check the methods of applying the above-mentioned rules and managing the specific equipment used in accident operating situations.

##### 19.4.4.2. Reactors other than nuclear power reactors

Through its inspections and during exercises, ASNR checks the operating teams' management of the incident and accident situation procedures.

When any modification is made to the installation, ASNR also checks that the licensee has assessed the impact of the modification on the operating procedures.

### 19.5. Engineering and technical support

#### 19.5.1. The regulatory framework

The Environment Code and the BNI Order contain several provisions concerning engineering and technical support, in particular:

- to obtain the creation authorisation for a BNI, the licensee must "have the technical capabilities enabling it to conduct its project in compliance with the [protected] interests » (Environment Code, Article L. 593-7);
- to ensure the control of the activities under its responsibility when BNI creation is authorised, the licensee must:
  - "have, either in-house or through its subsidiaries, the technical skills guaranteeing the understanding and embracing of the abovementioned activities" (BNI Order, Article 2.1.1);
  - "have sufficient in-house technical capabilities to take any resolution and implement any protective measures that prove necessary (for example in the event of a deviation or accident)" (BNI Order, Article 2.1.1);
  - limit, as much as possible, the number of subcontracting levels; the performance of services or work important for the protection of interests cannot be entrusted by a service provider of the operator to subcontractors beyond second-tier level (Article R. 593-13 of the Environment Code).

Furthermore, "the licensee cannot entrust the operational responsibility and control of operation of a [BNI] to an outside contractor (Article R. 593-13 of the Environment Code).

#### 19.5.2. Measures taken for nuclear power reactors

EDF has its own national engineering centres with appropriate design, construction and operating skills to support the NPPs.

Maintaining design integrity throughout the life of a nuclear reactor is the subject of INSAG 19. Thus, to guarantee the design integrity, EDF has put in place the "Design Authority" and "Responsible Designers".

This is because after the initial design, numerous changes take place during the life of the installation, due to operational experience feedback, changes in safety requirements, economic reasons (e.g. extension of the operating cycles), ageing, etc. The understanding of the design as a whole, the interaction between the systems and with the operating rules must be maintained over the long term in order to preserve safety when changes are made.

The subcontracted operations, maintenance in particular, are subject to contracts and monitoring, as required by the regulations. EDF puts in place the necessary provisions to control the risks associated with the subcontracted activities and updates them regularly. The preparation of reactor outages has thus been reinforced, more particularly to guarantee the availability of human and material resources.

### 19.5.3. Measures taken for reactors other than nuclear power reactors

The CEA has facility support units that bring together skills in the different fields involved in operating the facilities. This support is provided in particular by the DSSN and units which intervene in their areas of competence. These units provide the facilities with the assistance of specialists in diverse technical areas such as seismic risks, parasismic engineering, fire, criticality, chemical risks, pressure equipment, structural mechanics, thermomechanics, instrumentation and I&C, containment-ventilation, measurements, impact assessments (environmental and adverse effects) and the HOFs. These technical support units establish contracts with the subcontractors called upon by the facilities for maintenance of the equipments. These technical support units are different from the nuclear safety support units.

The ILL has several project engineers capable of managing projects from start to finish and a design office for installation design. Furthermore, the ILL staff includes specialists in mechanical design, neutronics, criticality, electrotechnology, electronics, instrumentation and I&C. These specialists assist the project teams and safety engineers either directly or through the monitoring of service providers.

### 19.5.4. ASNR oversight

ASNR carries out inspections in the head office departments of the nuclear reactor licensees, the workshops or design offices of the subcontractors, the construction sites, and the plants or workshops manufacturing safety important components.

ASNR checks the conditions surrounding the preparation (schedule, required resources, etc.) and performance of the subcontracted activities (relations with the licensee, monitoring by the licensee, etc.). It also checks that the workers have the necessary means (tools, operating documentation, etc.) to perform their tasks, in particular when these means are made available by the licensee.

#### Focus No.23: Inspection of suppliers of materials important for nuclear safety

In 2024, ASNR carried out 68 inspections of the supply chain for safety-critical equipment intended for nuclear power plants. These inspections enabled the control of manufacturing by these suppliers to be assessed, as well as the monitoring carried out by licensees.

Of these inspections, 45 concerned the manufacture of nuclear pressure equipment (NPE) and 23 the supply of safety-critical equipment for nuclear facilities in the cycle, future EPR2 reactors and EDF reactors in operation. The inspections took place in France, Spain, Italy and Japan, at manufacturing plants and their subcontractors (in particular forges and foundries). ASNR was thus able to check the quality of manufacture and the fulfilment of responsibilities by manufacturers, bodies authorised to assess the conformity of pressure equipment and operators in terms of supply monitoring.

These inspections revealed good practices in the execution of activities entrusted to suppliers as well as progress in the dissemination of safety culture, thanks in particular to the implementation of ISO 19443. However, they also highlighted a lack of knowledge and dissemination within the subcontracting chain of certain regulatory or technical requirements (see Focus No.12), a lack of control of certain special processes, and the need to improve the quality of the monitoring carried out by EDF on its suppliers.

These results were shared with the EDF so that they could be used to implement improvement measures.

## 19.6. Reporting of incidents significant to safety

### 19.6.1. The regulatory framework

The Environment Code requires basic nuclear installation licensees to notify ASN without delay of any accidents or incidents that occur due to operation of that installation which could significantly prejudice the protected interests (Article L. 591-5).

The BNI Order (Article 2.6.4) details the information to be provided in the notification: characterisation of the event, description and chronology of the event, actual and potential consequences, measures already taken or envisaged to address the event provisionally or definitively.

The BNI Order (Article 2.6.5) requires the notification to be supplemented within two months by a report indicating the conclusions the licensee has drawn from the analysis of the event and the measures it is taking to improve safety or radiation protection and to prevent recurrence of the event.

ASN has published guides describing the principles and criteria for reporting significant events.

### 19.6.2. Measures taken for nuclear reactors

Detection of events (deviations, anomalies, incidents, etc.) by the licensee and the implementation of corrective measures decided on after analysis play a fundamental role in accident prevention.

Prioritising the anomalies should enable the most important ones to be addressed first. The regulations have defined a category of anomalies called “significant events”.

The criteria for reporting significant events to the public authorities take account of:

- the actual or potential consequences of these events on the workers, the general public, patients or the environment;
- the main technical, human or organisational causes of these events.

This reporting process is part of an approach to continuously improve safety and radiation protection. It enables other licensees to benefit from the lessons learned from the event.

The number of significant events (excluding generic events) reported by EDF from 2016 to 2024 and rated on the INES scale (excluding those rated level 0) is shown in Table 19.3. The examination of the breakdown of the number of ESS's (including ESS's not rated on the INES scale) by reporting criterion shows that around half of them stem from failure to comply with the operating technical specifications (49% of events reported under criterion 3, noncompliance with technical specifications).

INES level	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	57	65	74	83	83	78	87	70	68
2	0	4	0	2	0	0	0	2	2

Table 19-2: Evolution of the number of significant events rated on the INES scale in the EDF nuclear power plants between 2016 and 2024 (excluding generic events)

Furthermore, several similar events or events resulting from common causes have affected several nuclear reactors. They are grouped under the term generic safety significant events (see Table 19.4).

INES level	2016	2017	2018	2019	2020	2021	2022	2023	2024
1	2	2	5	3	8	1	2	0	1
2	0	2	0	2	0	0	0	1	0

Table 19-3: Evolution of the number of generic safety significant events rated on the INES scale in the EDF nuclear power plants between 2016 and 2024

No Level-1 events occurred on the CABRI and RHF research reactors over the 2022–2024 period.

### 19.6.3. ASN oversight

ASNR examines all the reported significant events. Criteria to classify an event as significant are defined in an ASN guide.

ASNR analyses the initial notification to check the implementation of immediate corrective measures, to decide whether to conduct an on-site inspection to analyse the event in depth, and to prepare for informing the public if necessary.

ASNR analyses the report submitted by the licensee and checks that the licensee has analysed the event pertinently, has taken appropriate steps to remedy the situation and prevent it from recurring, and has circulated the conclusions of the event analysis. The events having the greatest potential implications are subject to an in-depth analysis to check that the licensee has effectively identified all the root causes of the event and that all appropriate measures have been taken to prevent its recurrence and, if necessary, ASNR requests further actions. If this analysis reveals information that warrants international dissemination, it is subsequently published in the IAEA and NEA's database. Furthermore, to guarantee rapid dissemination of the information, ASNR endeavours to inform its foreign counterparts as quickly as possible when a significant event occurs in France by using the international organisations and the bilateral or multilateral agreements and conventions to which it is party.

Lastly, during its inspections ASNR examines compliance with the rules regarding the detection and reporting of significant events. ASNR checks the licensees' organisation for analysing events, the methodology employed and the depth of the analyses carried out to ensure that the underlying causes (organisational and human) of events are looked for and, lastly, the development and implementation of the follow-ups to the analyses, whether in the short, medium or long term.

ASNR also conducts an annual review of the observable event trends in order to identify weak signals or subjects to examine in greater depth.

## 19.7. Operational experience feedback

### 19.7.1. The regulatory framework

The BNI order (Articles 2.4.1 and 2.7) requires the licensee to implement an integrated management system that includes provisions enabling it to identify and process the significant events, and to gather and use the experience feedback from the operation of its facility or other facilities, whether similar or not, in France or abroad, or resulting from research and development.

### 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 OEF consists in drawing the lessons from the past to improve the future. EDF's operating experience today represents more than 2,000 reactor-years.

The EDF events-related OEF process is organised around the following phases:

- the events collection, selection, weighing-up and codification phase,
- the analysis phase, including the definition of curative, corrective and preventive actions when necessary. For the most significant events, EDF uses a method of in-depth events analysis drawn from international standards,
- the phase of implementation of the defined corrective or preventive actions, integrating the oversight of implementation and verification of their effectiveness,
- the phase of sharing OEF with the work teams.

This system is in place in all the EDF NPPs and nationally. This system is subject to annual efficiency reviews.

The perimeter of the EDF OEF loop includes, in addition to the events resulting from the operation of its own reactors, the analysis of events recorded in the IAEA and WANO databases, a selection of the events having occurred on reactors of foreign licensees with which EDF has cooperation agreements (EPRI, ESKOM, CGNPC, EDF Energy in particular) and an annual review of the events occurring in other industries (ARIA database of the Ministry of Ecological Transition).

Lastly, through its participation in various committees and international organisations, EDF shares OEF on good practices and international standards, and in the area of nuclear R&D.

EDF takes into account the recommendations and suggestions resulting from the Peer Review missions of WANO (four EDF sites per year), OSART (one site per year) and the "follow-up" missions.

### 19.7.3. Measures taken for reactors other than nuclear power reactors

The collection and analysis of operational experience at the CEA takes place at three levels:

- at installation level, the installation manager is responsible for analysing any anomalies, deviations and events that occur;
- at the centres level, where taking OEF into account consists more specifically in organising and promoting exchanges between the facilities and the centres. On this account, an OEF leader is appointed in the centre safety 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 DSSN to make sure that the various units consult one another, and to ensure the integration of OEF and the exchange of best practices. The DSSN also draws up an assessment of the significant events and defines the lines of improvements. The OEF is also integrated in the documents that the DSSN is responsible for producing.

At the ILL, the OEF process is described in the IMS. The process coordinator collects the information from the ILL's activities based in particular on the analyses of anomalies, the operating reports and the audit results. At least once a year the process coordinator also selects the relevant information concerning other French and foreign nuclear installations.

After analysing this information, a report is drawn up and shared with the personnel concerned depending on the nature and importance of the OEF, either by circulation of the report or via a presentation and discussion meeting. These reports are accessible to everyone on the documentation data base of the IMS.

#### 19.7.4. ASNR oversight

During its inspections in the nuclear reactors and the EDF head office departments, ASNR checks the licensee's organisation and the steps taken to learn the technical and organisational lessons from operational experience feedback.

Every year, ASNR also examines the global OEF from the French and foreign reactors and periodically OEF concerning fuel behaviour: the conclusions of its expert assessments are submitted to the Advisory Committee for Nuclear Reactors to obtain its opinion.

ASNR also endeavours to disseminate experience feedback from French nuclear installations during bilateral or multilateral discussions with its counterparts within other safety organisations. ASNR also participate in various discussion forums within the IAEA, the NEA and the European Union. It contributes to the various existing databases in these fields. For example, ASNR is a member of NEA working groups: the *Working Group on Regulatory Oversight* (WGRO) which is divided into two groups of experts, one addressing reactors in operation (EGOE) and the other on the exchange of information on the EPR (EPR IEF); the *Working Group on New Technology* (WGNT) which focuses more specifically on experience feedback from the construction of new reactors; the Working Group on Policy and Licensing (WGPL) and, finally, the Working Group on Supply Chain (WGSUP).

### 19.8. Management of spent fuel and radioactive waste on the site

#### 19.8.1. The regulatory framework

European Directive 2011/70/Euratom of 19 July 2011 establishes a community framework for the responsible and safe 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. Like the directive of 25 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 regulators and the licensees. The content of this directive has been transposed in France, more specifically through the Environment Code and its provisions relative to waste and the waste act. The policy regarding nuclear waste is detailed in the Joint Convention report.

The BNI Order specifies the requirements for waste management, and in particular:

- the licensee shall define, as from the design stage, measures to prevent and reduce, particularly at source, the production and the harmfulness of the waste produced in its installation (Article 6.1);

- the establishing of a waste zoning plan delimiting the areas of potential nuclear waste production within the BNI. In this context, the licensee defines the characteristics of the waste storage areas according to the type of waste (Article 6.3);
- the requirements associated with packaging of the waste. Producers of radioactive waste are asked to package their waste taking into consideration the requirements associated with their subsequent management, and more particularly their acceptance at the disposal facilities (Article 6.7).

ASN "packaging" resolution specifies the requirements regarding waste packaging for disposal and the conditions of acceptance of waste packages in the disposal facilities.

### 19.8.2. Measures taken for nuclear power reactors

#### *Spent fuel management*

EDF uses two types of nuclear fuel in the pressurised water reactors:

- uranium oxide (UO<sub>2</sub>) based fuels enriched of uranium-235,
- fuels consisting of a mixture of depleted uranium oxide and plutonium oxide (MOX).

After three to five years in the reactor, used fuel assemblies are stored in the plant's fuel storage pool. After a few years, they are transferred to Orano's reprocessing plant at La Hague.

#### *Radioactive waste management*

The arrangements of managing the waste resulting directly from operation of the reactors include: "waste zoning", collection, sorting, characterisation, treatment and packaging, storage and shipping.

Collection is an important 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).

The radioactive waste resulting from the operation of PWRs is essentially very low, low or intermediate level short-lived waste. EDF ensures that the production of radioactive waste from reactors is kept to a minimum by limiting its production at source as part of a continuous improvement process. The volume of short-lived waste produced annually per unit has thus been divided by approximately three since 1985.

The very low-level waste, is shipped to a dedicated repository situated in Morvilliers: the Cires (Industrial centre for grouping, storage and disposal), managed by Andra and which entered service in 2003.

The low and intermediate level waste are:

- either directly compacted on site in metal drums and sent to the Aube repository (CSA) to be further compacted and disposed of definitively after concreting in drums. Some non-compactable waste is packaged in metal boxes. The most radioactive waste is packaged on site in concrete containers and stored directly at the CSA;
- either, when they are incinerable and low-level, shipped in plastic drums to the CENTRACO incineration unit at Cyclife France, while low-level contaminated scrap metal is sent to the melting unit at the same plant in metal crates. This treatment reduces the volume of waste and thus saves CSA storage resources.

In addition, certain exceptional reactor maintenance operations may require the replacement of very large components such as reactor vessel heads. This special waste is stored on site and then either at the CSA or at Cires.

### 19.8.3. Measures taken for research reactors

#### *Waste management*

The majority of the waste produced by the operation of the research reactors (CEA and ILL) is routed to the disposal facilities managed by ANDRA.

At the ILL, radioactive waste is sorted and packaged in such a way as to optimise the filling of final waste packages for transport to the appropriate disposal sites.

Low- and medium-level waste is packaged in 5m<sup>3</sup> mesh-lined, pre-concreted containers. This waste is sent to the Aube repository (CSA).

Low- and medium-level incinerable solid waste is sent to the CENTRACO plant of Cyclife France after being compacted in 200-litre plastic drums for incineration. The residual ash and clinkers from incineration are conditioned in 400-litre thick metal drums and definitively disposed of at the CSA repository.

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.

For the CEA's CABRI reactor, the waste generated comes from routine operating activities and is sent to the appropriate ANDRA facilities or stored on site for waste with no immediate disposal option (DSFI).

#### *Spent fuel management*

The spent fuel from the research reactors is transferred to the La Hague plant.

### 19.8.4. ASNR oversight

With regard to radioactive waste management, ASNR's oversight aims at verifying on the one hand correct application of the waste management regulations on the production sites (for example with respect to waste zoning, packaging or the controls performed by the licensee), and on the other hand the safety of the facilities dedicated to radioactive waste management (waste treatment, packaging, storage and disposal facilities).

During its inspections, ASNR examines the organisation and measures taken by the sites in terms of waste management, from sorting through to packaging, and spent fuel management. It also checks the operation of the waste storage and treatment areas.

## APPENDIX A – List and location of nuclear reactors in France

### A.1 Location of the nuclear reactors

The 57 nuclear power reactors in operation as at 27-11-2024 are distributed over French territory as shown in the following map. In addition, two research reactors are in operation: the HFR of ILL in Grenoble (East) and the Cabri reactor of CEA/Cadarache (South).

Besides, one research reactor is under construction (JHR) in the South of France at CEA/Cadarache.

## Nuclear power plants in France

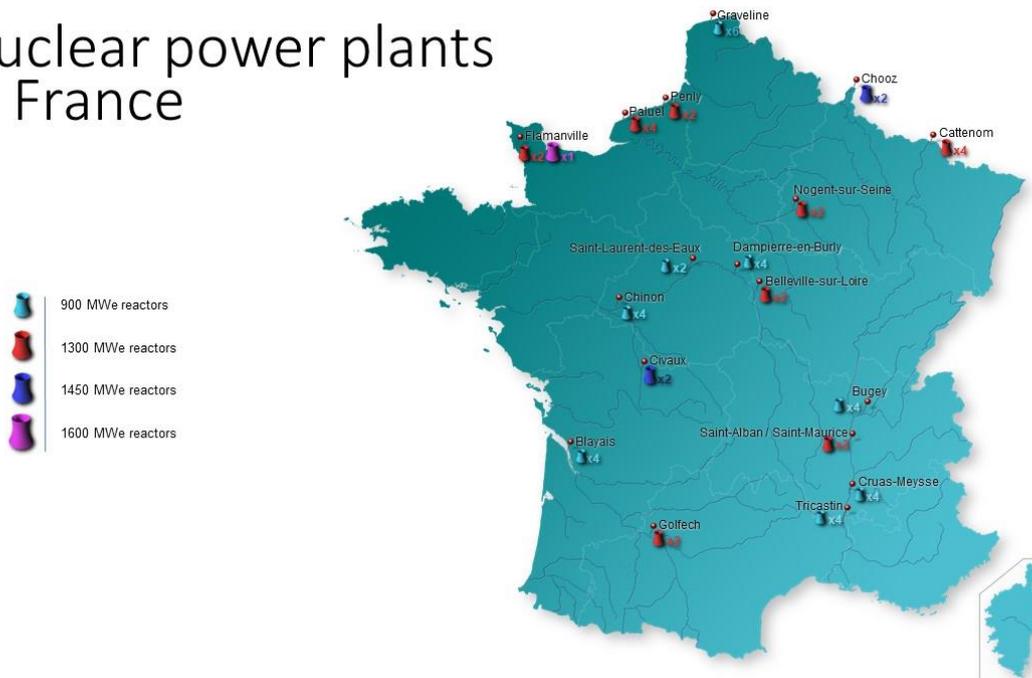


Figure A-1: Map of France showing the 18 sites of the nuclear power reactors in operation

## A.2 List of nuclear power reactors

NAME AND LOCATION OF THE FACILITY	Type of facility
BUGEY NPP (reactors 2, 3, 4 and 5) 01980 Loyettes	4 PWR reactors CP0 900 MWe
DAMPIERRE-EN-BURLY NPP (reactors 1,2,3 and 4) 45570 Ouzouer-sur-Loire	4 PWR reactors CP1 900 MWe
LE BLAYAIS NPP (reactors 1,2,3 and 4) 33820 Saint-Ciers-sur-Gironde	4 PWR reactors CP1 900 MWe
TRICASTIN NPP (reactors 1,2,3 and 4) 26130 Saint-Paul-Trois-Châteaux	4 PWR reactors CP1 900 MWe
GRAVELINES NPP (reactors 1,2,3,4,5 and 6) 59820 Gravelines	6 PWR reactors CP1 900 MWe
ST-LAURENT-DES-EAUX NPP (reactors B1 and B2) 41220 La Ferté-St-Cyr	2 PWR reactors CP2 900 MWe
PALUEL NPP (reactors 1,2,3 and 4) 76450 Cany-Barville	4 PWR reactors P4 1300 MWe
CHINON NPP (reactors B1, B2, B3 and B4) 37420 Avoine	4 PWR reactors CP2 900 MWe
FLAMANVILLE NPP (reactors 1,2 and 3) 50830 Flamanville	2 PWR reactors P4 1300 MWe 1 PWR reactor EPR 1600 MWe
CRUAS NPP (reactors 1,2,3 and 4) 07350 Cruas	4 PWR reactors CP2 900 MWe
SAINT-ALBAN NPP (reactors 1 and 2) 38550 Le Péage-de-Roussillon	2 PWR reactors P4 1300 MWe
CATTENOM NPP (reactors 1,2,3 and 4) 57570 Cattenom	4 PWR reactors P'4 1300 MWe
BELLEVILLE-SUR-LOIRE NPP (reactors 1 and 2) 18240 Léré	2 PWR reactors P'4 1300 MWe
NOGENT-SUR-SEINE NPP (reactors 1 and 2) 10400 Nogent-sur-Seine	2 PWR reactors P'4 1300 MWe
GOLFECH NPP (reactors 1 and 2) 82400 Golfech	2 PWR reactors P'4 1300 MWe
PENLY NPP (reactors 1 and 2) 76370 Neuville-lès-Dieppe	2 PWR reactors P'4 1300 MWe
CHOOZ B NPP (reactors 1 and 2) 08600 Givet	2 PWR reactors N4 1450 MWe
CIVAUX NPP (reactors 1 and 2) BP 1 86320 Civaux	2 PWR reactors N4 1450 MWe

Table A-1: Nuclear power reactors in operation

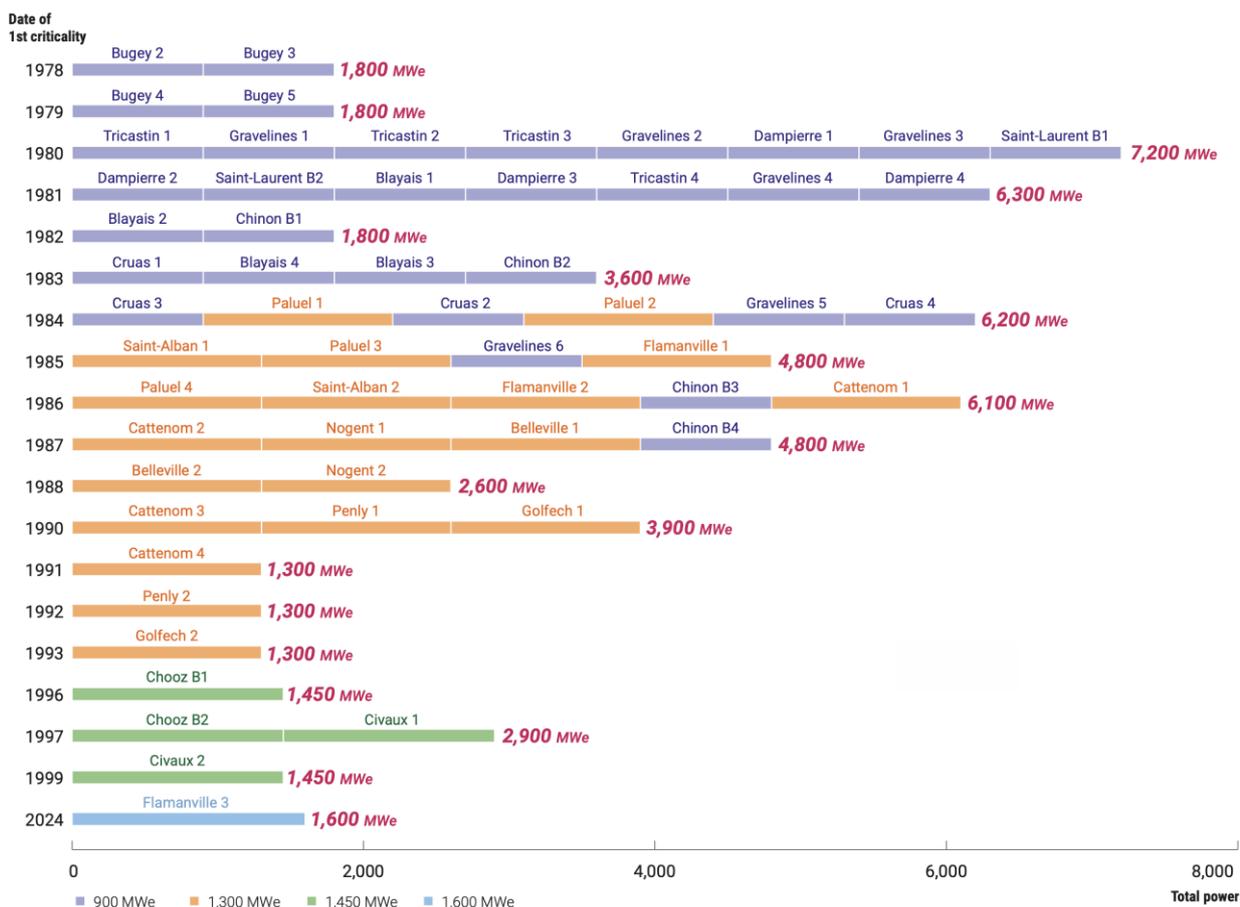


Figure A-2 : Chronology of the first criticality of French nuclear power reactors in operation

### A.3 Reactors other than nuclear power reactors in operation and under construction

NAME AND LOCATION OF THE FACILITY	Licensee	Type of facility and thermal power
Cabri (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Research reactor 25 MW-th
High Flux Reactor (HFR) 38041 Grenoble Cedex	Institut Max von Laue Paul Langevin (ILL)	Research reactor 57 MW-th
JULES HOROWITZ (JHR) (Cadarache) 13115 Saint-Paul-lez Durance Cedex	CEA	Research reactor 100 MW-th

Table A-3: Research reactors<sup>23</sup> in operation and under construction

<sup>23</sup> Research reactors that are permanently shut down, being dismantled or decommissioned - outside the scope of the Convention - are not included in this list.

## APPENDIX B – Main legislative and regulatory texts as at end of 2021

### B.1 Codes, acts and regulations

- Planning Act 2006-739 of 28 June 2006 relative to the Sustainable Management of Radioactive Materials and Waste (Articles 3 and 4).
- Act No. 2015-992 of 17 August 2015 relative to Energy Transition for Green Growth (LTECV).
- Act No. 2017-55 of 20 January 2017 on the general status of independent administrative authorities and independent public authorities.
- Act No. 2023-491 of 22 June 2023 on accelerating procedures related to the construction of new nuclear facilities near existing nuclear sites and the operation of existing facilities.
- Act No. 2024-450 of 21 May 2024 on the organisation of nuclear safety and radiation protection governance to meet the challenge of reviving the nuclear industry
- Environment Code:
  - Book I – Part II – Chapter V (Articles L. 125-10 to L.125-40); Provisions specific to nuclear activities;
  - Book V – Part IV – Chapter II (Articles L. 542-1 to L.542-14); Provisions specific to the sustainable management of radioactive materials and waste.
  - Book V – Part IX (Articles L. 591-1 to L.59-7-46). Nuclear security and basic nuclear installations.
- Public Health Code: Articles L 1333-1 et seq. and R.1333-1 et seq., relative to the general protection of individuals against the hazards of ionising radiation.
- Labour Code: Articles 4451-1 et seq. and R.4451-1 et seq., relative to the protection of workers against the hazards of ionising radiation.
- Decree No. 2005-1158 of 13 September 2005 relative off-site emergency plans concerning certain fixed structures or installations and taken in application of article 15 of the law No. 2004-811 of 13 August 2004 relative to the modernization of civil security.
- Decree 2018-437 of 4 June 2018 relative to the protection of workers against the hazards of ionising radiation (articles 7 to 11: transitional provisions).
- Decree 2019-190 of 14 March 2019 codifying the provisions applicable to basic nuclear installations, the transport of radioactive substances and transparency in the nuclear field (articles 4, 8 to 11: transitional provisions).
- Decree No. 2023-1104 of 28 November 2023 on various provisions relating to periodic reviews of nuclear power reactors and the shutdown of basic nuclear installations.
- Decree No. 2023-1261 of 26 December 2023 specifying the categories of operations related to the construction of nuclear power reactors that may be undertaken as of the date of issuance of the environmental permit.
- Decree No. 2024-296 of 29 March 2024 defining the concept of immediate proximity in the context of measures to accelerate procedures relating to the construction of new nuclear facilities in the vicinity of existing nuclear sites and making various procedural adjustments.
- Order of 1 September 2003 defining the methods for calculating effective doses and equivalent doses resulting from the exposure of individuals to ionising radiation.

- Order of 5 January 2006 on public consultation on the draft off-site emergency plan for certain installations, pursuant to Article R. 741-26 of the Domestic Security Code.
- Order of 7 February 2012 setting the general rules concerning basic nuclear installations.
- Order of 10 November 1999 relative to the monitoring of operation of the main primary system and the main secondary systems of nuclear pressurized water reactors.
- Order of 30 December 2015 relative to nuclear pressure equipment.
- Order of 20 November 2017 relative to the in-service monitoring of pressure equipment and simple pressure vessels.
- Ordinance No. 2016-128 of 10 February 2016 on the transposition, for the legislative part, of the Directive of 8 July 2014.
- Ordinance No. 2016-1060 of 3 August, 2016 modifying the rules applicable to environmental assessment.
- Ordinance No. 2016-128 of 10 February 2016 extending the range of oversight exercised by ASN to suppliers, service providers or subcontractors of licensees, including for activities carried out outside BNIs.

## B.2 ASN resolutions

Resolution 2010-DC-0179 of 13 April 2010. Hearings of licensees and CLIs before adoption of opinions or resolutions.

Resolution 2013-DC-0360 of 16 July 2013. Control of detrimental effects and impact on the environment.

Resolution 2014-DC-0417 of 28 January 2014. Control of fire risks.

Resolution 2014-DC-0444 of 15 July 2014. PWR shutdowns and restarts.

Resolution 2014-DC-0462 of 7 October 2014. Control of the criticality risk in BNIs.

Resolution 2015-DC-0508 of 21 April 2015. Study of waste management and the inventory of waste produced in the BNIs.

Resolution 2015-DC-0532 of 17 November 2015. BNIs safety report.

Resolution 2016-DC-0578 of 6 December 2016. Prevention of risks resulting from the dispersal of pathogenic micro-organisms (legionella and amoeba) by PWR secondary system cooling installations.

Resolution 2017-DC-0587 of 23 March 2017. Conditioning of radioactive waste and the conditions of acceptance of the radioactive waste packages in the disposal basic nuclear installations.

Resolution 2017-DC-0588 of 6 April 2017. Conditions for water intake and consumption, discharge of effluents and monitoring of the environment around PWR reactors.

Resolution 2017-DC-0592 of 13 June 2017. Obligations on BNI licensees in terms of preparedness for and management of emergency situations and the content of the on-site emergency plan.

Resolution 2017-DC-0616 of 30 November 2017. Noteworthy modifications to basic nuclear installations.

Resolution 2020-DC-0688 of 24 March 2020. Qualification of organisations tasked with the inspection of nuclear pressure equipment.

Resolution 2021-DC-0713 of 23 September 2021. Framework for the performance of certain tests and analyses relating to nuclear pressure equipment.

Resolution 2021-DC-0714 of 23 September 2021. Integration into a basic nuclear installation of certain nuclear pressure equipment undergoing conformity assessment.

Resolution No. 2023-DC-0770 of the Nuclear Safety Authority of 7 November 2023 amending Resolution No. 2017-DC-0616 of the Nuclear Safety Authority of 30 November 2017 on significant modifications to basic nuclear installations.

## APPENDIX C – Organisation of nuclear reactor licensees

### C.1 EDF organisation for nuclear reactors

The EDF Group, one of the world's top ten energy companies, is a limited company (EDF S.A.) with a board of directors, which is active along the entire electricity value chain. It is present in all areas of the electricity industry: nuclear, renewables and fossil energy productions, transport, distribution, marketing, energy efficiency and management units, as well as energy trading. In France, Électricité de France S.A. is the main electricity production company and is today the only one to operate nuclear power reactors.

The EDF Group is operating in an unprecedented context of nuclear revival, whether in terms of extending the operating life of existing power plants or building a programme of six EPR2 reactors. To meet these challenges, a new organisational structure was introduced on 1 April 2024. It covers the nuclear business and DIRES (innovation, corporate responsibility and strategy).

The EDF group's nuclear organisation is mainly built around five departments (see Figure C-1):

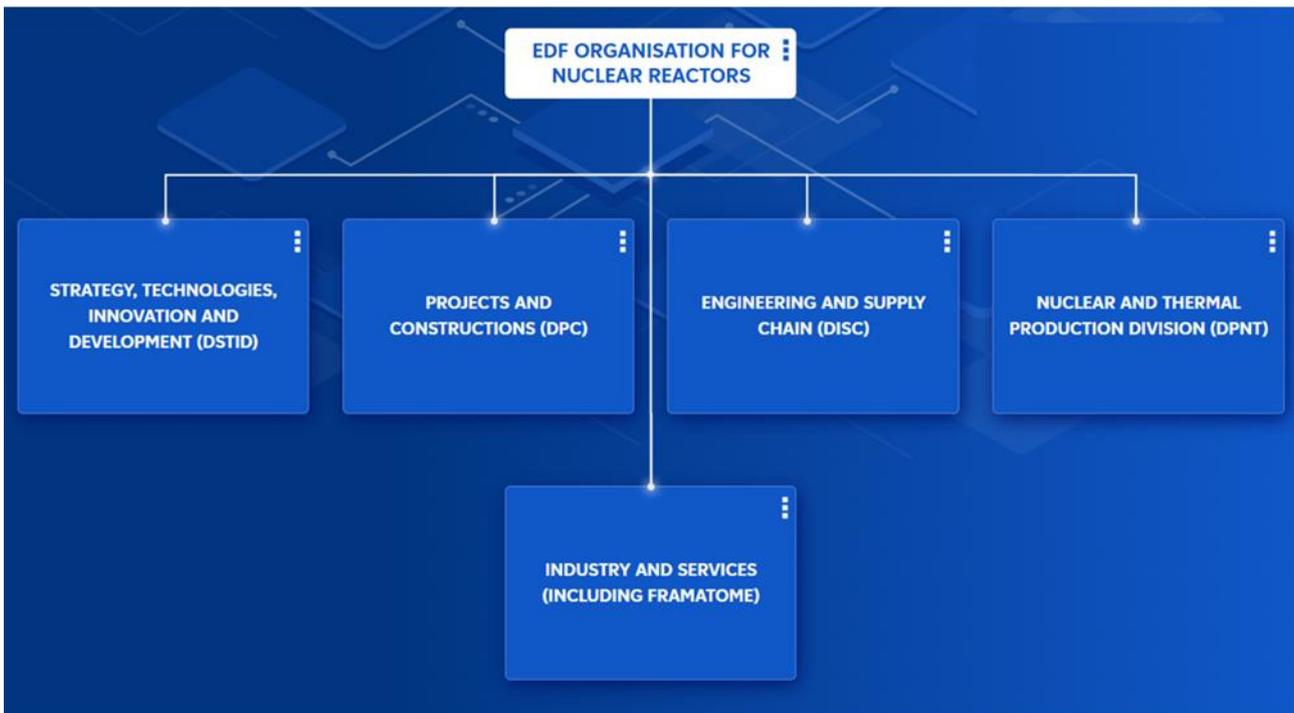


Figure C-1: Organisation of the EDF SA Group

- the Strategy, Technology, Innovation and Development Department (DSTID) brings together the Group's strategic activities for preparing for the future and planning. It is responsible for project management for nuclear construction projects, drives international nuclear development and acts as the technical and product authority. DSTID guides and challenges technological choices to ensure the performance of the Group's businesses.
- the Project and Construction Department (DPC), which manages major nuclear projects in accordance with safety, security, quality, cost and schedule requirements until handover to the operating teams.
- the Engineering and Supply Chain Department (DISC), which delivers studies, equipment and services on time, on budget and to the required quality standards, harmonising methods, tools and product/process

standards for new projects and modifications to the extended company's existing facilities. This new department brings together all nuclear engineering and supplier-related activities: industrial policy, qualification, industrial purchasing, procurement, contract management, manufacturing monitoring, etc.

- the Nuclear and Thermal Production Department (DPNT), which is responsible for the operation and maintenance of existing nuclear and thermal facilities and new projects coming on stream. It is continuing to roll out the Grand Carénage and START 2025 programmes and is drawing on feedback from major projects to implement standardisation practices.
- the Industry and Services division, which oversees operational activities in design and engineering, manufacturing and industrial services for nuclear boilers, fuel, control systems (Framatome) and any future industrial subsidiaries. It is also Chairman of the Executive Board and Chief Executive Officer of Framatome.

These five departments are responsible for the design and construction of new reactors (in France, the Flamanville EPR and EPR2s), for maintaining the safety of the nuclear fleet in operation at the highest level and for ensuring the success of the work to renovate and to continue the operation of the existing fleet in complete safety, for developing an industrial sector for nuclear dismantling and management of radioactive waste, for reinforcing the performance and innovation of nuclear engineering, at the service of new construction projects, of the major overhaul programme, or of dismantling projects.

With regard to operation of the nuclear reactors, the DPNT includes in particular:

- the Nuclear Power Operations Division (DPN), with all the sites in operation (NPPs: Nuclear Power Plants), the National Operational Engineering Unit (UNIE) and the Operational Technical Unit (UTO);
- the Nuclear Fuel Division (DCN);
- the Programme and Strategy Division;
- the Dismantling and Waste Projects Department (DP2D).

### C.1.1 Principles of nuclear safety and radiation protection responsibilities within EDF S.A.

EDF S.A. is the named holder of the creation authorisation decrees for its BNIs and has responsibility as nuclear licensee.

Nuclear safety and radiation protection are applicable to all BNIs operated by EDF SA, as well as to radioactive substance transports from and to them. This concerns all persons working in or finding themselves in a BNI in whatsoever capacity. In this respect, the EDF Group has defined and implemented a policy reaffirming:

- the priority given to the protection of the interests mentioned in Article L. 593-1 of the Environment Code (public health and safety, protection of nature and the environment), primarily by preventing accidents and mitigating their consequences in accordance with the demands of nuclear safety;
- and the constant search for improvements in the measures taken to protect these interests.

As nuclear licensee, EDF S.A.'s operational **responsibilities in terms of nuclear safety and radiation protection are delegated to three levels:**

- the Chairman of EDF S.A,
- the national entities: in charge of BNI construction and operation projects and the design of BNI modifications,
- the nuclear production sites.

Each of these levels of delegation and competence is **in charge of developing a management system** which contributes to the **rules of nuclear safety and radiation protection** in the organisation and operation of its entity and, more generally, to the **protection of the interests** identified by the Environment Code. It thus guarantees the **priority granted to the protection of the above-mentioned interests**.

§ C.1.2.1 to § C.1.2.4 of this appendix summarise the responsibilities of these 3 levels.

In addition to this **management line** given responsibility for nuclear safety and radiation protection, each level of the company calls on the services of an **Independent Safety Organisation (FIS)** providing an **independent view** of how the nuclear licensee performs its duties. The FIS ensures that priority is given to nuclear safety by exercising a **role of verification and advice** for the management.

Each level in the company organises the integration of the FIS into the *ad hoc* bodies, so that this independent view can be provided at the appropriate level. At each level of the company, the FIS reports to the manager of the level concerned.

In the event of any serious breach of the nuclear safety rules, the FIS is duty bound to sound the alert which may, if necessary, be sent to the next higher management level.

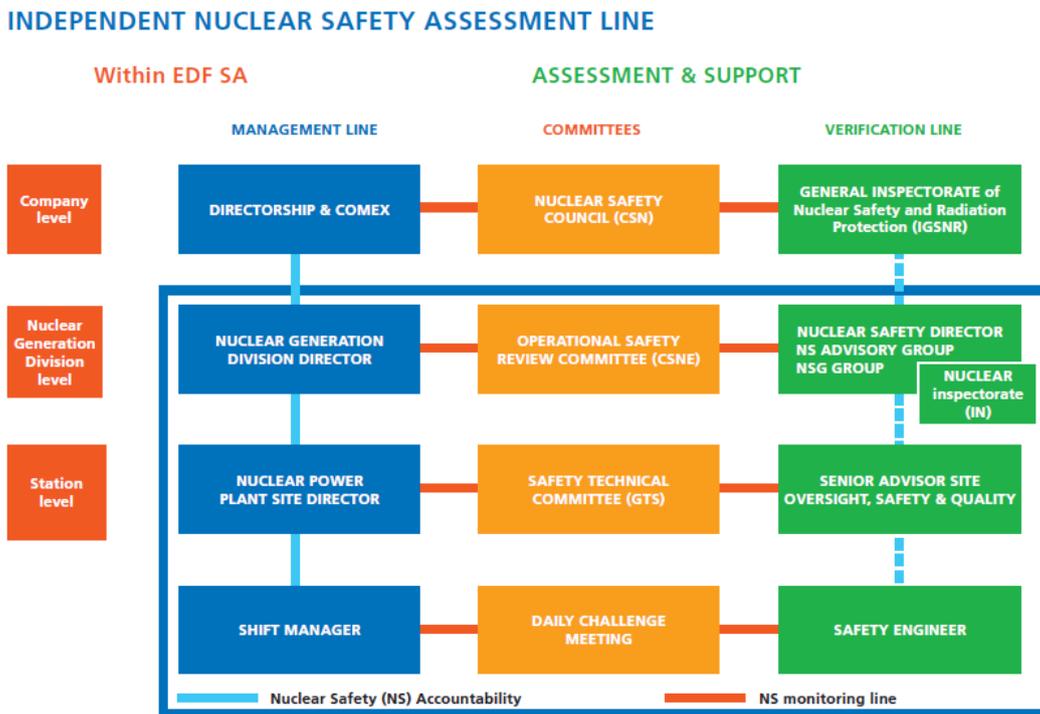


Figure C-2: The Independent Safety Team (FIS)

**C.1.2 Assignment of responsibilities for nuclear safety and radiation protection within EDF S.A.**

In its capacity as nuclear licensee, the EDF S.A. legal person is represented by the following natural persons:

*C.1.2.1 At EDF SA Chairman level*

Under the delegation of powers granted to his or her by the Board of Directors, the **CEO** has all the powers needed for EDF S.A. to exercise its capacity as nuclear licensee. He or she in particular determine the strategic

orientations regarding nuclear safety and set the general principles of organisation and resources allowing the correct performance of EDF S.A.'s responsibility as nuclear licensee, with the assistance of the Group Executive Director in charge of nuclear and thermal production and the Group Executive Director in charge of engineering and new nuclear projects

He or she chairs the **Nuclear Safety Council** and ensures the 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.

In order to define and implement these strategic orientations as organisational principles, the EDF SA CEO relies on the following within the EDF Group executive committee:

- for BNIs under construction (EPR2), on the Group Executive Director in charge of the Project and Construction Department, to whom he or she delegates the powers necessary for exercising the function of nuclear licensee, as of the submission of the creation authorisation application and up to transfer of responsibility for them to the entity in charge of operation,
- for the BNIs in operation<sup>24</sup> on the Group Executive Director in charge of the Nuclear and Thermal NPP fleet, to whom he or she delegates the powers necessary for exercising the function of nuclear licensee, as of their transfer.

**The two Group Executive Directors** are the guarantors that nuclear safety and radiation protection are taken into account within their respective perimeters (BNIs under construction / BNIs in operation respectively), within the EDF Group executive committee.

They are responsible for drawing up the general organisational principles such as to ensure correct performance of the function of nuclear licensee by EDF S.A. on the BNIs within their perimeter (design-construction projects / reactors in operation respectively) and implement these principles within these BNIs. They ensure the consistency of the main orientations and actions of the different sectors of EDF SA that may affect nuclear safety and radiation protection. They more specifically aim to guarantee that priority is given to nuclear safety in the investments and asset selections decided on by the Chairman. They ensure that the design and construction of BNIs throughout their lifecycle comply with the applicable nuclear safety requirements. They are the points of contact for the nuclear safety and radiation protection Authority (ASNR)

**The Inspector General for Nuclear Safety and Radiation Protection** ensures that nuclear safety and radiation protection concerns are properly taken into account for the company's nuclear facilities and reports to the CEO in this respect

#### *C.1.2.2 Within the entities in charge of "new nuclear" projects*

The EPR2 Project Director takes all the steps needed for EDF S.A. to exercise its capacity as a nuclear licensee. He or she ensures that priority is given to protection of the abovementioned interests, first of all through **design, construction and commissioning** (up to transfer of responsibility to the entity in charge of operations), aiming to **prevent accidents and mitigate their consequences** in terms of nuclear safety.

<sup>24</sup> The licensee's responsibility is transferred in two stages: within a perimeter limited to the equipment needed for storage of the new fuel assemblies in the pool at arrival of the first fuel element in the BNI (partial commissioning), and then on the entire BNI when the first assembly is loaded into the vessel (commissioning).

On behalf of the Group Executive Director in charge, the **Technical Department (DT)** has the role of ensuring the **control and implementation of the technical baseline requirements for the new nuclear projects and for the existing NPP fleet**. It is assisted by the Industrial Department (DI) to ensure involvement by the industrial sector in drawing up these baseline requirements.

*C.1.2.3 Within the entities in charge of BNI operation and BNI design and modification at EDF SA:*

The following are concerned: the Nuclear Operations Division and the Programme and Strategy Division.

Under the powers delegated to him or her by the Group Executive Director in charge of the Nuclear and Thermal Fleet and under their authority, the **DPN Director** is the representative of the EDF S.A nuclear licensee for all the facilities in operation.

He or she take all the steps needed for EDF S.A. to perform its duties as nuclear licensee. He or she develops a management system which contributes to compliance with the rules of nuclear safety and radiation protection in the organisation and operation of their entity and, more generally, to the protection of the interests identified by the Environment Code. In this respect, he or she ensures that **priority is given to protection of the abovementioned interests and its constant improvement**, principally by **preventing accidents and mitigating their consequences in terms of nuclear safety**. He or she aims to ensure the development of continuous improvement and the adoption of best practices, including those identified internationally.

The principles of this management system are applied on the sites in operation, under the responsibility of the **Unit Directors (NPP)**.

For the BNIs he or she operates, the DPN Director carries out the duties of nuclear licensee throughout the lifetime of these BNIs. He or she may be required to make a final ruling on the resolutions taken within the nuclear sector of EDF S.A. with regard to the BNIs for which they are responsible. This responsibility is exercised more particularly within the bodies comprising cross-participation by the entities of the sector.

The **Group Executive Director in charge of the Nuclear and Thermal Fleet** acts as Backer for nuclear safety and radiation protection for the BNIs in operation within his or her perimeter.

**The Project Manager is the Nuclear Operation Division for the BNIs in operation.**

The Group Executive Director in charge of the DISC appoints the **Fleet Engineering, Dismantling and Environment Division (DIPDE)** as the **Design Authority** for BNIs in operation, on behalf of the Backer and Project Owner. In this respect, the **Director of the DIPDE** guarantees that the design status of the facilities within this perimeter and their modifications throughout their lifecycle are in conformity with the baseline safety requirements in force.

For this purpose, the **Design Authority** draws on the expertise of the engineering centres appointed as **Responsible Designers**, whether reporting to the Nuclear and Thermal Fleet Department (DPNT) or the DISC.

The **Nuclear Fuels Division is Project Manager for activities related to the nuclear fuel cycle**, as well as **Project Manager for the removal of radioactive waste**.

*C.1.2.4 On the nuclear sites:*

The **Flamanville 3 Development Director is the representative of the nuclear licensee, EDF S.A.**, under delegation from the Flamanville 3 Project Director.

The **Directors of the nuclear power plants are the representatives of the nuclear licensee, EDF S.A.**, for those facilities for which they have been delegated responsibility by the Director of the DPN.

More specifically, these unit directors take all steps needed for the exercise of this responsibility, in all the phases of the process for which the company is responsible, they:

- draw up and implement a protection of interests' policy;
- propose and implement the principles of organisation and operation that ensure compliance with nuclear safety and radiation protection rules, as well as the effective exercise of the responsibilities of EDF S.A. as nuclear licensee;
- rely on a management system and ensure verification of compliance with the requirements through appropriate internal monitoring. In this respect, each NPP Development Director (or site director) ensures that priority is given to Safety when categorising the issues being addressed. They aim to ensure the development of continuous improvement and the adoption of best practices, including those identified internationally;
- report the information relating to nuclear safety and radiation protection to the Director of the Flamanville 3 Project / Director of the DPN, for the BNIs in operation. They are the points of contact for the national and local competent authorities in the area of nuclear safety and radiation protection for the aspects specific to the installations under their responsibility.

## C.2 Organisation of CEA

At the CEA, in terms of safety, which includes nuclear security, there are three levels of delegation of responsibilities:

- the Chairman, head of the CEA and, as such, the nuclear licensee of the reactors;
- the directors of the centres, local representatives of the Chairman, more specifically with regard to his or her duty as nuclear licensee;
- the facility managers, responsible for ensuring compliance with the regulations and internal rules applicable to their facility at all times.

To guarantee that the safety objectives are duly taken into consideration for the through-life support of the reactors, the director of Energies signs an annual safety objectives contract with the Chairman, formally setting out the objectives. Execution of this objectives contract is monitored by the Nuclear Safety and Security Department on behalf of the Chairman.

## C.3 ILL organisation

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 (“the associated”), in partnership with its 10 scientific member states (Spain, Italy, Switzerland, Austria, Czech Republic, Slovenia, Slovakia, Poland, Sweden and Denmark). It operates a high flux neutron reactor entirely dedicated to scientific research.

The Institute is currently organised into four divisions.

The director and the four division heads make up the ILL Management Board.

The Radiation Protection Safety and Environment Department (SRSE) and the Quality Safety Risk Cell (CQSR) report directly to the Director of ILL.

As regards management of the BNI and the installations defined in the safety report, the director delegates his responsibility as licensee to the head of the reactor division. For the protection of interests, the latter relies on a safety cell that is directly attached to him. As head of the BNI, the head of the reactor division is ultimately responsible for deciding on the safety of the operating conditions of the reactor, the instruments and the experimental devices.

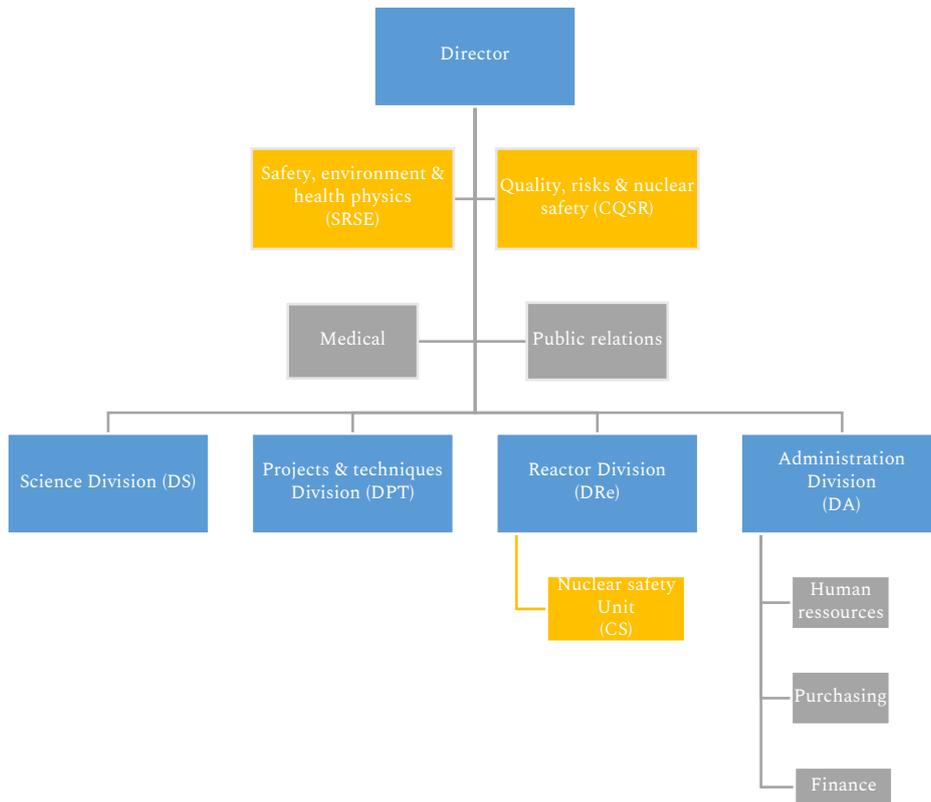


Figure C-3: Organisation of ILL

## APPENDIX D – ENVIRONMENTAL MONITORING

Environment monitored or type of monitoring	Nuclear power plant
Air at ground level	<ul style="list-style-type: none"> <li>• 4 stations continuously sampling atmospheric dust on fixed filter with daily measurements of total <math>\beta</math> activity (<math>\beta G</math>). <math>\gamma</math> spectrometry if <math>\beta G &gt; 2</math> mBq/m<sup>3</sup></li> <li>• for each of the stations, <math>\gamma</math> spectrometry on the monthly grouping of daily filters</li> <li>• 1 continuous sampling station under the prevailing winds with weekly measurement of tritium (3H)</li> </ul>
Ambient radiation	<ul style="list-style-type: none"> <li>• 10 monitors with continuous measurement at the site limits (monthly readings)</li> <li>• 4 monitors at a distance of 1 km with continuous measurement and recording</li> <li>• 4 monitors at a distance of 5 km with continuous measurement and recording</li> </ul>
Rain	<ul style="list-style-type: none"> <li>• 1 station under the prevailing wind (continuous sampling) with measurement of <math>\beta G</math> and 3H on bi-monthly mixture</li> </ul>
Environment receiving liquid discharges	<ul style="list-style-type: none"> <li>• Sampling in the river and upstream at mid-discharge, for each discharge (riverside NPP), or sampling after dilution in cooling water and bi-monthly sampling at sea (coastal NPP): measurement of <math>\beta G</math>, potassium (K) and 3H</li> <li>• Continuous sampling of 3H (daily average mixture)</li> <li>• Annual sampling in the aquatic sediments, fauna and flora, with measurement of 3H, <sup>14</sup>C and <math>\gamma</math> spectrometry</li> </ul>
Groundwaters	<ul style="list-style-type: none"> <li>• 5 sampling points (monthly check) with <math>\beta G</math>, K and 3H measurement</li> </ul>
Soil	<ul style="list-style-type: none"> <li>• 1 annual sample of the surface layer of the soil with <math>\gamma</math> spectrometry</li> </ul>

Plants	<ul style="list-style-type: none"> <li>● 2 grass sampling points (monthly check) <math>\gamma</math> spectrometry. Periodic measurements of 3H, carbon 14 (14C) and total carbon</li> <li>● Annual campaign on the main agricultural crops with measurement of 3H, 14C and total carbon, plus <math>\gamma</math> spectrometry</li> </ul>
Milk	<ul style="list-style-type: none"> <li>● 2 sampling points (monthly check) with <math>\gamma</math> spectrometry and annual measurement of 14C and 3H</li> </ul>

*Table D.1: Nature of environmental monitoring around the NPPs*

## APPENDIX E - Bibliography

### E.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.8, March 2025.
- /3/** Convention on Nuclear Safety – National Report for the Second Extraordinary Meeting
- /4/** Annual reports from the Nuclear Safety Authority (ASN).  
<http://www.asn.fr/Informer/Publications/Rapports-de-l-ASN>
- /5/** EDF – The Inspector General's Report on Nuclear Safety and Radiation Protection
- /6/** CEA – Annual reports on nuclear safety and radiation protection  
<http://www.cea.fr/Pages/surete-securite/priorite-securite-surete.aspx>
- /7/** ILL - Annual reports.  
<https://www.ill.eu/fr/a-propos-de-ill/documentation/annual-report/>
- /8/** ITER – Annual reports  
<https://www.iter.org/fr/transparence-securite-nucleaire-rapport-dinformation>
- /9/** French national report on the state of implementation of the Joint Convention obligations, October 2025.  
<https://www.french-nuclear-safety.fr/content/download/200237/file/National%20report%20of%20France%20for%20the%208th%20RM.pdf>

### E.2 Websites

The abovementioned documents, or at least the key points of their content, as well as other relevant information concerning the subject of this report are available on the Internet. The following sites may in particular be consulted:

- Légifrance: [www.legifrance.fr](http://www.legifrance.fr)
- ASNR: [www.asnr.fr](http://www.asnr.fr)
- CEA: [www.cea.fr](http://www.cea.fr)
- EDF: [www.edf.fr](http://www.edf.fr)
- ILL: [www.ill.eu](http://www.ill.eu)
- ITER: [www.iter.org](http://www.iter.org)
- IAEA: [www.iaea.org](http://www.iaea.org)
- French national network of environmental radioactivity monitoring (RNM): [www.mesure-radioactivite.fr](http://www.mesure-radioactivite.fr)

## APPENDIX F - List of main abbreviations

<b>AFCEN</b>	French association for rules on design, construction and in service monitoring of nuclear steam supply systems
<b>ANCCLI</b>	National Association of Local Information Committees and Commissions
<b>ANDRA</b>	French national radioactive waste management agency
<b>ASC</b>	Auxiliary steam generators feedwater system
<b>ASN</b>	Autorité de Sûreté Nucléaire (French nuclear safety authority)
<b>ASNR</b>	Autorité de Sûreté Nucléaire et de Radioprotection (French Authority for Nuclear Safety and Radiation Protection)
<b>BNI</b>	Basic nuclear installation
<b>CEA</b>	French Alternative Energies and Atomic Energy Commission
<b>CFSI</b>	Counterfeit, Fraudulent and Suspect Items (IAEA definition)
<b>CIRES</b>	(ANDRA) Industrial centre for collection/grouping, storage and disposal
<b>CLI</b>	Local Information Committee
<b>CNS</b>	Convention on Nuclear Safety
<b>CODIRPA</b>	Steering committee for managing the post-accident phase of a nuclear accident or radiological emergency situation
<b>CQSR</b>	Quality, safety, risks unit (ILL)
<b>CSA</b>	(ANDRA) Aube waste disposal facility
<b>CSPRT</b>	French High Council for Technological Risk Prevention
<b>DAC</b>	Creation authorisation decree
<b>DCN</b>	(EDF) Nuclear Fuel Division
<b>DES</b>	(CEA) Energy Division
<b>DGSCGC</b>	General Directorate for Civil Security/protection and Emergency Management
<b>DIPNN</b>	Engineering and New Nuclear Project Division (EDF)
<b>DOS</b>	Safety options dossier
<b>DPN</b>	(EDF) Nuclear Operation Division
<b>DPNT</b>	(EDF) Nuclear and Thermal Production Division
<b>DSSN</b>	(CEA) Nuclear Security and Safety Division
<b>DUS</b>	Ultimate backup diesel generator set
<b>ECOT</b>	(EDF) Plant unit conformity examination programme
<b>ECURIE</b>	European Community Urgent Radiological Information Exchange
<b>EDF</b>	Électricité de France
<b>EGS</b>	Emergency Generator Set
<b>ELC</b>	Local emergency team
<b>ENSREG</b>	European Nuclear Safety Regulators Group
<b>EPR</b>	European Pressurised Reactor
<b>EPRI</b>	Electric Power Research Institute

<b>ESS</b>	Events Significant for Safety
<b>ETC-N</b>	(EDF) national emergency technical support team
<b>FARN</b>	Nuclear rapid intervention force
<b>FIS</b>	Independent Safety Organisation (EDF)
<b>FRAMATOME</b>	Formerly AREVA-NP, NSSS maker
<b>GOR</b>	General operating rules
<b>GPEC</b>	Forward planning of employes and skills
<b>GPE</b>	Advisory Committee of experts
<b>GPR</b>	Advisory Committee of Experts for Nuclear Reactors
<b>HCTISN</b>	High Committee for Transparency and Information on Nuclear Security
<b>HERCA</b>	Head of the European Radiological Protection Competent Authorities
<b>HFR</b>	(Laue-Langevin Institute) High-flux reactor
<b>IAEA</b>	International Atomic Energy Agency
<b>ICPE</b>	Installations classified for protection of the environment
<b>ICRP</b>	International Commission on Radiological Protection
<b>IGN</b>	(CEA) General and nuclear inspectorate
<b>ILL</b>	Laue-Langevin Institute
<b>IMS</b>	Integrated safety Management System
<b>INES</b>	International Nuclear Event Scale
<b>INSAG</b>	(IAEA) International Nuclear Safety Group
<b>IRRS</b>	Integrated Regulatory Review Service
<b>IRSN</b>	French Institute for Radiation Protection and Nuclear Safety
<b>ITER</b>	International Thermonuclear Experimental Reactor
<b>JHR</b>	Jules Horowitz Reactor
<b>MEP</b>	Multi-year energy programme
<b>MPS</b>	Main Primary System
<b>MSNR</b>	Nuclear Safety and Radiation Protection Mission
<b>MSS</b>	Main Secondary System
<b>NEA</b>	Nuclear Energy Agency (OECD)
<b>NPE</b>	Nuclear Pressure Equipment
<b>NPP</b>	Nuclear Power Plant
<b>NSSS</b>	Nuclear steam supply system
<b>OEF</b>	Operating experience feedback
<b>OHF</b>	Organisational and Human Factors
<b>OPECST</b>	Parliamentary Office for the Evaluation of Scientific and Technical Choices
<b>ORANO</b>	Formerly AREVA-NC, fuel cycle company
<b>ORSEC (plan)</b>	Disaster and emergency response organisation (plan)
<b>OSART</b>	Operational Safety Review Team
<b>PCC</b>	(EDF) controls command post

<b>PCD</b>	Strategic management command post
<b>PCD-L</b>	(CEA) Local strategic management command post
<b>PCD-N</b>	(EDF) National emergency director
<b>PCL</b>	(EDF) Local command post
<b>PCM</b>	(EDF) Resources command post
<b>PIA</b>	Protection Important Activity
<b>PIC</b>	Protection Important Component
<b>PNGMDR</b>	National radioactive materials and waste management plan
<b>PPI</b>	Off-site emergency plan
<b>PSA</b>	Probabilistic safety assessment
<b>PSR</b>	Periodic safety review
<b>PUI</b>	On-site emergency plan
<b>PWR</b>	Pressurised water reactor
<b>QSE (System)</b>	(CEA/DES) Integrated Management System “Quality, health, security, safety, environment”
<b>RANET</b>	(IAEA) Response and Assistance Network
<b>RCC</b>	Design and construction rules
<b>RCCA</b>	Rod Cluster Control Assembly
<b>RFS</b>	Basic safety rules
<b>RIC</b>	Incore instrumentation Room
<b>RIS</b>	Safety injection system
<b>RNM</b>	French national environmental radioactivity monitoring network
<b>SAMG</b>	Severe Accident Management Guidelines
<b>SG</b>	Steam Generator
<b>SGDSN</b>	General Secretariat for Defence and Civil Protection
<b>SISERI</b>	Ionising radiation exposure monitoring information system
<b>SMR</b>	Small Modular Reactor
<b>SOH</b>	(EDF) approach to take account of Socio-Organisational and Human aspects
<b>SSE</b>	Safe Shutdown Earthquake
<b>SSC</b>	Systems, structures and components
<b>TPR</b>	Topical Peer Review (EU)
<b>TSN</b>	Transparency and Nuclear Safety Act
<b>UNIE</b>	(EDF) Operation Engineering Unit
<b>USIE</b>	Unified System for information Exchange in Incidents and Emergencies
<b>WANO</b>	World Association of Nuclear Operators
<b>WENRA</b>	European Nuclear Regulators’ Association