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FRANCE'S SEVENTH NATIONAL REPORT ON COMPLIANCE WITH THE JOINT CONVENTION

Joint Convention on the safety of the management of spent fuel and on the safety of the management of radioactive waste

October 2020

Cover photographs (from left to right):

- Drone view of the Manche waste repository, © Andra / Biplan
- Spent fuel storage pool at La Hague Orano plant, © Orano
- Rigid design gallery in the Underground Laboratory, © Andra / Stéphane Lavoué

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SUMMARY

This report is produced by France in accordance with the provisions set out in Article 32 of the Joint Convention on the safety of spent fuel management and the safety of radioactive waste management. It presents the latest developments regarding the safe management of spent fuel, of radioactive waste and the decommissioning of the nuclear facilities in France, in preparation for the seventh review meeting of the Joint Convention.

1| THE SAFETY OF RADIOACTIVE WASTE AND SPENT FUEL IN FRANCE

Nuclear activities are governed in France by a range of legislative and regulatory provisions, the objectives of which are public health and safety and protection of the environment.

Depending on the level of radioactivity, a distinction is made between activities regulated by the Public Health Code (medical activities for example), those subject to the regulations for Installations Classified for Protection of the Environment (ICPE) and, finally - beyond a certain threshold in terms of activity and specific activity – set by the Environment Code, those subject to the regulations for Basic Nuclear Installations (BNI) and Defence-related nuclear facilities and activities.

The goal of the radioactive materials and waste management policy in France is to achieve sustainable management of these substances, while protecting human health, safety and the environment and minimising the burden to be borne by future generations. It is thus based on four major principles:

- The industrial producers of radioactive waste and spent fuel are responsible for these substances, without prejudice to the liability of those who hold these substances in their role as persons or entities responsible for nuclear activities. They finance the management of radioactive waste and spent fuel as well as the decommissioning of their facilities. The corresponding funds must be secured by the creation of dedicated assets, under the control of the State.
- The quantity and the harmfulness of the radioactive waste must be minimised.
- The disposal in France of radioactive waste from abroad, as well as of radioactive waste resulting from the reprocessing of spent fuels and radioactive waste from abroad, is prohibited.
- As this is a subject that concerns society as a whole and which has consequences for future generations, the public must be involved in the decisions on these issues.

Implementation of these principles is built around a management framework consisting of three pillars:

- a specific legislative and regulatory framework;
- a public agency devoted to the management of radioactive waste, called Andra (French national radioactive waste management agency);
- a National Radioactive Materials and Waste Management Plan (PNGMDR), updated every three years.

For the report as a whole, the following terms correspond to the definitions given in the Environment Code, as recalled below:

- A radioactive substance is a substance containing natural or artificial radionuclides, the activity or concentration of which justifies radiation protection monitoring.
- A radioactive material is defined as being a radioactive substance for which subsequent use is planned or envisaged, if necessary after processing.
- A nuclear fuel is regarded as a spent fuel when, after being irradiated in the core of a reactor, it is removed once and for all.
- Radioactive wastes are radioactive substances for which no subsequent use is planned or envisaged.
- The purpose of spent fuel reprocessing is to extract the fissile or fertile substances from the spent fuels for subsequent use.
- The storage of radioactive materials or waste consists in placing these substances for a temporary period in an above-ground or near-surface storage facility specially fitted out for the purpose, with the aim of subsequently retrieving them.
- The disposal of radioactive waste consists in placing these substances in a facility specially designed to house them, potentially definitively, and with no intention of subsequently retrieving them.
- Deep geological disposal of radioactive waste consists in emplacing the radioactive waste in an underground facility specially designed for this purpose, complying with the principle of reversibility.

1.1. Regulatory framework

The legislative and regulatory framework is based primarily on the three European directives:

- the directive on the nuclear safety of nuclear installations (Directive 2014/87/Euratom of 8 July 2014 amending Directive 2009/71/Euratom of 25 June 2009);
- the directive on the responsible and safe management of spent fuel and radioactive waste (Directive 2011/70/Euratom of 19 July 2011);
- the directive on the basic radiation protection safety standards (Directive 2013/59/Euratom of 5 December 2013).

For many years now, the French Parliament has been continuously involved in the issue of the management of radioactive waste. It has thus been a key player in the development of the French radioactive waste management programme. Three important Acts have thus been passed in 30 years:

- Act 91-1381 of 30 December 1991 concerning research into radioactive waste management, concerning areas of research for the management of high level, long-lived waste;
- Programme Act 2006-739 of 28 June 2006 on the sustainable management of radioactive materials and waste, defining the general framework for radioactive waste management;
- and, more recently, Act 2016-1015 of 25 July 2016, specifying the conditions for creating a reversible deep geological repository for high-level and intermediate-level long-lived radioactive waste.

Other Acts relating to the safety of nuclear activities have implications for waste management or the decommissioning of facilities. In particular, Act 2006-686 of 13 June 2006 on nuclear transparency and safety (known as the "TSN" Act), created the French Autorité de sûreté nucléaire (ASN) as an independent administrative authority tasked, on behalf of the State, with the regulation and oversight of nuclear safety and radiation protection. Legislative provisions also define the procedures for public information and participation.

To a large extent, all these Acts are currently codified in the Environment Code. They are supplemented by implementing decrees and ministrial orders, along with regulations and recommendation guidelines issued by ASN.

1.2. The French national radioactive waste management Agency

Andra, the national radioactive waste management agency, is a State public institution, created by the 1991 Act. It notably has responsibility for designing, building and operating the waste disposal facilities and keeping up-to-date national inventory of radioactive materials and waste. This inventory, which is updated every three years, provides input data for the National Radioactive Materials and Waste Management Plan (PNGMDR).

1.3. The National Radioactive Materials and Waste Management Plan

The PNGMDR is produced and updated every three years by a pluralistic working group involving stakeholders, chaired jointly by the Ministry responsible for energy and ASN. The participants are more specifically the industrial firms that produce waste, the administrations, Andra and associations from the civil society.

This national plan inventories the existing radioactive materials and waste management routes and the technical solutions adopted. It identifies the foreseeable needs for storage or disposal facilities and specifies the capacity necessary for these installations as well as storage durations. It sets the general targets, the main time-frames and the schedules enabling these time-frames to be met while taking into account the priorities it defines. It determines the targets to be achieved for radioactive waste for which there is not yetfinal management solution. It organises the implementation of research and studies regarding the management of radioactive materials and waste. It determines the persons responsible for its implementation and the indicators for monitoring the progress of this implementation.

The preparation of the next Plan was the subject of a national public debate in 2019, for the first time. The fifth edition of the PNGMDR will be produced during the course of 2020, with a view to public consultation and publication in the first half of 2021.

2| NUCLEAR INSTALLATIONS IN FRANCE

There are numerous and diversified nuclear installations in operation in France:

- 56 power generating reactors (as of 30 June 2020);
- front-end nuclear fuel cycle facilities, including a uranium enrichment plant;
- back-end nuclear fuel cycle facilities, including a spent fuel reprocessing plant;
- research facilities, in particular in the field of nuclear power generation or in other fields, including the management of radioactive waste;
- radioactive waste reprocessing and conditioning facilities;
- radioactive waste storage facilities (interim solution);
- 3 radioactive waste surface disposal centres (final solution): two facilities for low and intermediate level, short-lived waste (one having ceased to receive waste in 1994 and the other in service) and a facility which receives very low level waste;
- a plant producing radiopharmaceuticals and irradiators;
- facilities undergoing decommissioning.

All of these facilities produce or manage radioactive waste. The nuclear power reactors and the research reactors use nuclear fuel which, after use, becomes spent fuel. The spent fuel assemblies are first of all stored on the sites of the facilities and then transferred to the reprocessing plant at La Hague, operated by Orano, or to the facilities operated by the Alternative Energies and Atomic Energy Commission (CEA), pending their reprocessing and then disposal of the residual waste.

Several nuclear facilities are currently under construction:

- an EPR type power generating reactor on the EDF site in Flamanville;
- the Jules Horowitz experimentation reactor on the CEA Cadarache site;
- the Diadem storage facility for high level waste on the CEA site in Marcoule;
- the ITER nuclear fusion installation on the Cadarache site.

The commissioning application for EDF's ICEDA activated waste (medium level, long-lived waste) conditioning and storage facility has recently been reviewed and the commissioning authorization was issued in July 2020.

Two Andra radioactive waste disposal facility projects are currently being studied:

- Cigéo, a disposal project (repository) in a deep geological formation for high level waste and intermediate level, long-lived waste;
- a sub-surface repository for low level, long-lived waste.

Former uranium mines also produced mining waste rock and residues during the processing of the ore to extract the uranium.

3| OVERVIEW MATRIX

Below is the summary table in accordance with the guidelines of the Joint Convention.

Type of responsibility	Long-term management	Financing	Current practice / Installations	Planned installations
Spent fuel	Treatment then disposal of resulting waste.	The owner finances the treatment of its spent fuels and the disposal of the resulting waste. Dedicated assets are ring-fenced.	La Hague reprocessing plant	Cigéo deep geological disposal facility (under study).
Waste from the nuclear fuel cycle	Disposal	The producer of the waste finances its management. Dedicated assets are ring-fenced	LLW/ILW-SL wastes are disposed of in the CSA and VLLW in the Cires; storage for the other waste.	New disposal centres for HLW, ILW-LL and LLW-LL (under study).
Waste not from energy production	Disposal routes must be set up for certain waste.	The producer finances.	Disposal centres for VLLW and LLW/ILW-SL waste. Management by decay for very short-lived waste (less than 100 days).	Projects ongoing for substances containing radium and other waste (LLW-LL).
Decommissioning	Dismantling in as short a time as possible after shutdown. Post-operational clean-out that is as thorough as possible.	The licensee finances. Dedicated assets are required by law.	Dismantling in as short a time as possible after shutdown.	
Sealed sources removed from service	Return to manufacturer. Disposal or recycling routes being implemented.	System of insurance between users and suppliers or deposit of a bond with Andra.	A few sources are disposed of in the CSA and Cires. Storage in specific facilities.	New disposal centres for HLW, ILW-LL and LLW-LL (under study). Storage in the Cires.
Ore extraction and preparation waste	Stabilised in-situ and reinforced monitoring.	Responsibility of licensee (Orano)	Stabilised mines.	N/A

Table 1: Overview matrix for France

4| THE CHALLENGES FOR FRANCE IDENTIFIED AT THE 6TH REVIEW MEETING

The five challenges identified for France at the sixth review meeting are recalled below. For each of them, the measures implemented and the progress made are summarized.

4.1. Continuation of the geological disposal programme for High and Intermediate Level, Long-lived waste

Several milestones have been reached for the Cigéo deep geological disposal project. In January 2018, ASN issued its opinion on the project's safety options dossier. ASN considers that at this stage, the Cigéo project has reached a satisfactory level of technical maturity, but it did issue some recommendations, particularly concerning the management of packages of bituminous waste. An international peer review mission was organised on this subject and submitted its report to ASN in June 2019.

Following the public debate held in 2019 prior to the fifth edition of the PNGMDR, recommendations were also made regarding the management of high level waste and intermediate level, long-lived waste. The joint decision by the Ministry responsible for energy and the ASN Chairman, dated 21 February 2020, specified how these are to be taken into account.

ASN will take account of all these elements and include them in its opinion on the management of high level waste and intermediate level, long-lived waste, planned for 2020. Andra intends to submit the creation authorisation application in 2021 (see § 5.7.4).

4.2. Decommissioning of fuel cycle facilities (such as the UP2-400 plant in La Hague)

A new approach to the oversight of decommissioning and legacy waste retrieval projects has been put into place by ASN in order to encourage licensees to increase the control of the various phases of their projects, ensure greater compliance with the deadlines set with respect to the legislative requirement for dismantling as rapidly as possible, as well as more accurate evaluation of the long-term costs to be funded, given the risks and uncertainties inherent in this type of project (see § 5.4, § 6.4).

4.3. Consolidation of the management strategy for very low level waste, more specifically that resulting from the decommissioning of facilities

The management of very low level activated waste was a specific topic of the public debate held in 2019. The joint decision by the Ministry responsible for energy and the ASN Chairman of 21 February 2020 underlines the need to find new disposal capacity and indicates that the Government will change the regulatory framework applicable to the management of this waste, in order to introduce a new possibility for targeted exemptions so that very low level metallic radioactive waste can be reused, on a case by case basis, after melting and decontamination. The next PNGMDR will make recommendations regarding how such exemptions are to be implemented, in terms of safety and radiation protection, involvement of the public and transparency.

ASN will shortly be issuing its opinion on the report submitted by EDF and Orano on their study of a solution for reprocessing and reusing large homogeneous batches of very low level metallic materials resulting from decommissioning. At the same time, Andra examined the possibilities for increasing its very low level waste disposal capacity (see § 5.7.3.3).

4.4. Decommissioning of the gas cooled reactors and management of the waste produced

ASN considers that the new scenario proposed by EDF for decommissioning in air, with construction of an industrial demonstrator, is acceptable. After reviewing the justifications presented by the licensee, ASN issued two decisions in 2020 to regulate the next steps in the decommissioning of these reactors, notably with regard to the schedule (see § 5.2.3.1).

4.5. Monitoring the overall consistency of the industrial choices made concerning fuel management which could have an impact on safety beyond 2030, taking account of several energy mix scenarios.

At ASN's request, EDF periodically submits a file drafted together with the other fuel cycle operators, presenting the consequences of the strategic choices at each step in the cycle. This monitoring aims to anticipate any strategic change in the functioning of the fuel cycle by at least ten years so that it can be designed and carried out under controlled conditions of safety and radiation protection. Several possible energy mix scenarios are considered. In 2018, ASN issued its opinion on the file covering the period 2016-2030 (see § 5.2.3.2, § 6.2).

In addition, the above-mentioned decision of 21 February 2020 underlines the need to strengthen the interaction between the PNGMDR and the major energy policy orientations, through a clearer explanation of its interactions with energy policy and with the final shutdown and decommissioning strategies for the nuclear facilities.

5| THE MAIN CHANGES SINCE THE 6TH REPORT

5.1. The national framework and the regulations

A new Multi-year energy Programme (PPE) was adopted by the Government in 2019, with the aim at conducting a successful transition to a more efficient, lower consumption, more diversified and thus more resilient energy system. It sets public authorities' action priorities for the next ten years, aiming for a trajectory to achieve carbon neutrality in 2050 and determining goals for all the energy sectors which could be the complementary parts of the future French energy mix.

For the nuclear sector, the main measures adopted in the PPE are as follows:

- The Government sets itself the goal of achieving a 50% nuclear share of the electricity mix by the 2035 time-frame.
- Achieving this goal will imply the closure of fourteen 900 MW nuclear reactors, including the two Fessenheim reactors.
- The nuclear power plant closure schedule shall comply with the deadlines of the 5th ten-yearly outage of the reactors concerned, with the exception of 2 reactors which will close in the second period of the PPE in 2027 and 2028, provided that the security of energy supply criterion is satisfied.
- If certain conditions concerning the price of electricity and the development of the European electricity market are met, a further two reactors could be closed by 2025-2026, on the basis of a decision to be taken in 2023.
- The Government will identify the priority sites for closure, based on a programme transmitted by EDF. Barring exceptions, the contraction of the NPP fleet should not lead to the complete shutdown of any nuclear site.
- The nuclear fuel reprocessing-recycling strategy shall be maintained over the period of the PPE and beyond, until the 2040 time-frame. To this end, a number of 1300 MW reactors shall be made MOX-compatible and studies shall be carried out with a view to deploying multi-recycling of fuels in the current reactor fleet.

In terms of the regulation of safety and radiation protection, few major changes have been made to the management of radioactive waste since the publication of the sixth report.

Mention must however be made of Decree 2019-190 of 14 March 2019, modifying and codifying the provisions applicable to Basic Nuclear Installations (BNI), the transport of radioactive substances and transparency in nuclear matters, which stipulates that the waste management study is no longer required by the regulations as a specific document, but must now be incorporated into the impact assessment and the general operating rules of the BNIs.

The general provisions applicable to all nuclear activities, with regard to radiation protection, were revised by Decree 2018-434 of 4 June 2018 constituting various nuclear provisions and transposing Council Directive 2013/59/Euratom of 5 December 2013 setting basic safety standards for health protection against the dangers arising from exposure to ionising radiation. This decree sets a new framework for the management of long-term exposure situations resulting from contamination by radioactive substances including contaminated sites and soils (articles R. 1333-90 to R. 1333-103 of the Public Health Code).

5.2. The licensees' decommissioning and radioactive materials and waste management strategy

To deal with the challengesas regards the decommissioning of facilities and the management of radioactive materials and waste, the licensees are developing overall strategies incorporating safety issues covering decommissioning and radioactive materials and waste management, regardless of the operating phase of their facilities.

5.2.1. CEA's decommissioning and materials and waste management strategy

ASN and the Defence nuclear safety regulator (ASND) asked CEA to carry out an overall reassessment of its strategy for decommissioning and the management of its radioactive materials and wastes, for all the civil or defence facilities under its responsibility.

ASN and the ASND issued a joint position statement on 27 May 2019 concerning the strategy proposed by CEA. They consider that CEA's decommissioning and waste and materials management strategy is the result of an in-depth work and that staggering of the decommissioning operations as scheduled by CEA on the basis of the potential hazards from the various facilities is acceptable, in the light of the resources allocated by the State and the large number of facilities concerned.

However, even if the projects experience no unforeseen incidents and delays, risk reduction will not be effective before a decade or so at best, because many waste retrieval and conditioning (RCD) projects require the creation or prior renovation of the retrieval, conditioning and storage means for radioactive materials and waste, along with the corresponding transport means. ASN and the ASND therefore have concerns regarding the robustness of the CEA action plan and the human and financial resources available for dealing with all the situations involving the most important safety issues, as early as possible, and thus made a number of requests for it to consolidate its strategy.

ASN and the ASND ask that CEA implement specific measures to monitor the progress of the decommissioning and waste management projects, regularly report on their progress and communicate regularly with the public.

The ASN and ASND review of the CEA decommissioning and radioactive waste management strategy was thus able to identify the particular challenges facing CEA and determine the strengthes and weaknesses of the proposed strategy.

5.2.2. Orano's decommissioning and materials and waste management strategy

Decommissioning of the old installations and waste retrieval and conditioning (RCD) are major challenges for Orano, which has to manage several large-scale decommissioning projects (UP2-400 facility at La Hague, Eurodif Production plant, individual facilities of the DBNI at Pierrelatte, etc.). Implementation of decommissioning is closely linked to the radioactive waste management strategy, given the quantity and the non-standard nature of the waste, that is sometimes hard to characterise, resulting from the decommissioning operations. The authorities do however note that for numerous decommissioning, RCD and waste management projects, the deadlines set are not met, sometimes repeatedly.

In June 2014, ASN and the ASND thus asked Areva (which has now become Orano) to send them its national decommissioning and waste management strategy. The dossier was submitted and is currently under review by ASN and the ASND, which should issue their opinion in 2020.

5.2.3. EDF's decommissioning and waste and spent fuels management strategy

EDF's decommissioning and waste management strategy

In 2014, ASN conducted its review of EDF's revised waste management policy. In March 2016, EDF informed ASN of a complete change in its strategy for its six gas-cooled reactors (GCR), owing to technical difficulties, delaying their decommissioning for several decades. EDF then transmitted several files justifying the steps taken with respect to the safety requirements and compliance with the requirements for decommissioning as rapidly as possible.

ASN duly noted the difficulties encountered and considers that the new scenario proposed by EDF for decommissioning in air, with construction of an industrial demonstrator, is acceptable. After examining the justifications presented by the licensee, ASN issued two decisions in 2020 to regulate the next steps in the decommissioning of these reactors, notably with regard to the overall reactor decommissioning schedule.

EDF's spent fuel management strategy

EDF must ensure the overall consistency of its industrial choices for fuel management, together with Orano Cycle and Andra, and it does this with the "Cycle impact" dossier, updated every ten years. EDF thus submitted the "Cycle impact 2016" dossier, for the period 2016-2030, considering several possible energy mix scenarios.

ASN issued its opinion on this dossier on 18 October 2018. It noted that the consequences of the various potential nuclear fuel cycle scenarios for facilities, transport and waste had been studied satisfactorily, but that the consequences of contingencies that could affect the operation of the cycle needed to be studied more in depth.

ASN underlined the need to anticipate any strategic change in the functioning of the fuel cycle by at least ten years so that it can be designed and carried out under controlled conditions of safety and radiation protection. For the coming decade in particular, in order to avoid reaching the capacity limit of existing storage facilities too quickly (spent fuel pools of nuclear reactors and at La Hague facilities), any reduction in production by reactors using MOX fuel must be accompanied by a reduction in production by reactors using enriched natural uranium (ENU) fuel. In the longer term, it will be necessary either to have new storage capacities that are very significantly greater than the current and projected capacities, or to be able to use MOX fuel in reactors other than the 900 MWe reactors, which are the oldest. ASN therefore asked the industrial players to examine these two options.

The Government has also published the multi-year energy programme (PPE), which is updated every five years. ASN asked the industrial players to study the consequences, in terms of safety and radiation protection, of the PPE on the nuclear fuel cycle and its consistency.

This periodic review of fuel cycle consistency, which involves several interdependent industrial facilities, is thus a forward-looking exercise identifying any possible future difficulties, as early as possible, with definition of recommendations for remedying them.

5.3. The National Radioactive Materials and Waste Management Plan

Further to a decision by the National Public Debate Committee (CNDP), a national public debate prior to the drafting of the fifth edition of the PNGMDR was held between April and September 2019, on the basis of a project management report produced jointly by the Ministry responsible for energy and ASN.

The conclusions published in November 2019 underlined the point that the debate served to clarify the various options, as well as the issues associated with each of the topics identified, and highlighted the following needs:

- clarification of the prospects for recycling radioactive materials;
- the need for new storage capacity for spent fuel by 2030 and the pertinence of underwater storage in the French context;
- for the management of very low level waste (VLLW): appropriate traceability processes, effective and independent checks and involvement of civil society in any change to current procedures and methods;
- the use of additional technical expertise before defining management solutions suited to the heterogeneity of the low level and long-lived waste (LLW-LL);
- clarification of the challenges inherent in the implementation of the Cigéo project, taking account the long time-frames involved in managing high level waste (HLW) and intermediate level, long-lived waste (ILW-LL), plus the prospects for research into alternative management solutions.

Some questions addressed cross-cutting aspects of radioactive materials and waste management, such as local or environmental issues, management of particular categories of waste and governance of the plan.

Following these conclusions, the Ministry responsible for energy and the ASN Chairman issued a joint decision on 21 February 2020, as a result of the public debate in preparation for the fifth edition of the National Radioactive Materials and Waste Management Plan. The main orientations adopted for the production of the fifth PNGMDR are as follows:

- closer coordination with energy policy;
- reinforced governance of radioactive waste management;
- reinforced oversight of the reusable nature of radioactive materials;
- the implementation of new centralised storage capacity for spent fuel, as well as the study of the conditions and situations in which dry storage could be useful;
- whenever pertinent and by means of targeted exemptions, the possibility of reusing some very low level metal waste;
- continued definition of the conditions for implementation of the Cigeo project (involving the public in the fundamental stages of the project, R&D on alternative management solutions);
- reinforced assessment of impacts of the management choices both locally and on the economic, health and environmental issues (impact of transports, harmfulness of wastes, etc.).

This national public debate prior to the drafting of the fifth edition of the PNGMDR served to clarify the main issues linked to the management of radioactive materials and waste and to involve the public in forthcoming decisions on this subject, which concerns society as a whole.

5.4. The adoption of an approach for oversight of decommissioning and waste management projects

Legacy waste retrieval and conditioning operations (RCD) within the UP2-400 plant on the La Hague site, are characterised by major issues given the potential source terms and the environmental risks. They are thus regulated by ASN decision 2014-DC-0472 of 9 December 2014. Faced with the recurring delays, ASN developed an approach for assessing the licensee's ability to implement its decommissioning or RCD projects within the specified time, and for monitoring the progress of the projects. This approach also aims to evaluate the project management organisation put into place, along with deadlines, scope and cost management.

In 2019, ASN conducted an exploratory in-depth inspection of a complex RCD project. This inspection was conducted jointly with the General Directorate for Energy and Climate (DGEC) of the Ministry responsible for energy. The inspection identified strategic areas for organisational progress, notably in terms of evaluating project maturity, the role of the project owner and lead contractor, as well as the working of project governance.

ASN intends to reuse this in-depth oversight approach for complex RCD or decommissioning projects with other licensees, if the projects have significant radiological implications (significant source terms and storage in facilities where the safety levels are incapable of complying with current requirements). This approach would thus target certain facilities undergoing decommissioning, in particular the former reprocessing plants (UP1 and the storage facilities on the CEA's Marcoule DBNI site, Orano Cycle's UP2 400 plant on the Hague site), former CEA fuel or waste storage facilities (BNI 72 at Saclay and BNI 56 at Cadarache), along with the EDF graphite silos (Saint-Laurent) and the GCR reactors.

5.5. Review of the licensees' safety management systems

Pursuant to the Environment Code, the licensee of a basic nuclear installation is responsible for controlling the potential risks and detrimental effects of its facility in terms of public health and safety and protection of nature and the environment. It gives priority to protection of the abovementioned interests and its constant improvement, 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.

It must have the technical, financial and human resources, which it describes in a manual and must implement the means needed in order to exercise that responsibility. It must put in place and formalise an integrated management system that takes into account the requirements relative to the protection of the abovementioned interests in the management of the installation.

With regard to subcontracting, the Environment Code contains specific provisions for nuclear facilities, notably the ban on the licensee delegating monitoring of outside contractor personnel performing a "protection important activity" (AIP) or limited use of contractors or subcontractors for the performance of certain activities.

ASN oversight of the safety management systems is part of the inspections and examinations for which the opinion of the Advisory Committees of experts may be required. In 2015, the Advisory Committee for reactors was asked for its opinion concerning the management of EDF's subcontracting of the maintenance work carried out in the NPPs.

Since 2016, under the procedures currently in force, ASN has examined the safety management systems linked to the reorganisation of the Areva Group, leading to the division of the Group into several legal entities. This division of the Areva group led to the creation of the Framatome company (which took over the Romans-sur-Isère and Maubeuge sites), which became an EDF subsidiary on 1 January 2018, and of the Orano company (which took over the other French BNIs of the Areva Group).

In 2019, CEA sent ASN its five-year report on the management of safety and radiation protection, covering the period 2012-2017. This report is currently being reviewed by ASN, which is awaiting additional data in 2020.

5.6. Decommissioning of nuclear installations

5.6.1. Issues and adaptations of the regulatory framework

At the end of 2019, about thirty BNIs had been decommissioned and delicensed and thirty-five BNIs are shutdown or undergoing decommissioning. As these facilities vary widely in nature (nuclear power reactors, research reactors, fuel cycle facilities, support facilities, etc.), the decommissioning challenges can also vary significantly from one facility to another (quantity of waste to be managed during decommissioning, safety and radiation protection challenges linked to legacy waste, specific waste, etc.).

Act 2015-992 of 17 August 2015 relating to energy transition for green growth (TECV Act) and Decree 2016-846 of 28 June 2016 relating to the modification, final shutdown and decommissioning of BNIs, enables the principle of dismantling as rapidly as possible to be enshrined in the legislation and incorporated into the ASN decommissioning guides, as well as revising the procedures governing the final shutdown and decommissioning of BNIs.

5.6.2. Ongoing decommissioning work

The ongoing decommissioning work is taking place in conditions of safety that are on the whole satisfactory, but most of it is behind schedule, sometimes significantly.

Decommissioning of power generating reactors

The first PWR reactor decommissioning site in France is that of the Chooz A prototype reactor (BNI 163). Final shutdown of the two reactors at the Fessenheim NPP took place in the first semester of 2020, marking the first shutdown of PWR reactors of the type making up the fleet currently in operation in France.

The nuclear power reactors other than PWRs are the EL4-D heavy water reactor on the Brennilis site and the sodium-cooled fast neutron reactors, Phénix and Superphénix. The GCRs have the particularity of being extremely massive and large-sized reactors, requiring innovative cutting and access techniques under highly irradiating conditions. The final disposal route for some of this waste is in the process of being determined, such as the graphite bricks, for which subsurface disposal is envisaged. Decommissioning of the EL4-D reactor was slowed down, notably owing to the lack of operating experience feedback concerning the decommissioning techniques to be used.

The decommissioning of the sodium-cooled reactors has met with no major technological obstacles. The specific challenges lie chiefly in the control of the fire risk due to the presence of sodium and the safety of the treatment processes.

Decommissioning of research laboratories

Four laboratories initially devoted to research to support the nuclear power industry are currently being prepared for or undergoing decommissioning. These are the high activity laboratory (LHA) in Saclay (BNI 49), the chemical purification laboratory (LPC) in Cadarache (BNI 54), the irradiated material facility (AMI) in Chinon (BNI 94) and the “Process” laboratory in Fontenay-aux-Roses (BNI 165). These ageing facilities, which were commissioned in the 1960s, are also faced with the problem of managing “legacy” waste, stored on-site at a time when the disposal solutions were not yet in place. Moreover, incidents occurred during their operation, contributing to the emission of radioactive substances inside and outside the containment enclosures and to varying levels of contamination of the structures and soils, making the decommissioning operations long and difficult.

Decommissioning of research reactors

Nine experimental reactors have been definitively shut down: RAPSODIE (sodium-cooled fast neutron reactor), MASURCA (critical mock-up), PHEBUS (test reactor), OSIRIS, ORPHEE (“pool” type reactors), ÉOLE and MINERVE (critical mock-ups), ULYSSE and ISIS (teaching reactors). All of them are in the decommissioning preparation phase, except for ULYSSE for which decommissioning was completed in August 2019. These reactors benefit from a significant amount of experience feedback from the decommissioning of numerous similar installations in France and abroad.

Decommissioning of fuel cycle front-end facilities

Two fuel cycle front-end facilities are currently undergoing decommissioning. They are located on the Tricastin site, one specialising in uranium enrichment by gaseous diffusion (BNI 93 - Eurodif, George-Besse I plant), the other in uranium conversion (BNI 105, ex-Comurhex). These facilities are ageing and their operating history is sometimes incomplete. Determining the initial state, particularly the potential pollution present in the soils beneath the structures, therefore remains an important issue. In addition, the industrial processes employed involved the use of large quantities of toxic chemicals. The containment of these chemical substances thus represents a challenge on these facilities.

Decommissioning of fuel cycle back-end facilities

The back-end facilities of the nuclear fuel cycle are the spent fuel storage pools, the spent fuel reprocessing plants and the facilities for storing waste from the treatment process. These facilities are operated by Orano Cycle and situated on the La Hague site. Most of the waste produced by the first reprocessing plant has been stored without treatment or conditioning and remains highly irradiating. The retrieval operations require remotely operated pick-up means, conveyor systems, sorting systems, sludge pumping and waste conditioning systems. The development of these means and performance of the operations under conditions ensuring a satisfactory level of safety and radiation protection represent a major challenge for the licensee. At present about ten projects of this type are underway in the former facilities. They will span several decades and are a prerequisite to the complete decommissioning of these facilities.

Many support facilities (storage, processing of effluents and waste), most of which were commissioned in the 1960's and whose standard of safety does not comply with current best practices, have been shut down. As these storage facilities are ageing, they were not initially designed to allow the removal of the waste, and in some cases they were even seen as being the definitive waste disposal site. We could for example mention the silos at Saint-Laurent-des-Eaux (BNI 74), the silos of the Orano Cycle plant at La Hague (silos 115 and 130 in BNI 38, the HAO silo in BNI 80), the pits and trenches of BNI 56, shafts of BNI 72 and BNI 166. Waste retrieval on these sites is complex and will take several decades. It requires the construction of new conditioning and storage facilities. With regard to the effluent treatment stations (STE), the ageing of these facilities or the closure of the effluent-producing facilities led to the shutdown of these STEs. We could for example mention the STED in Fontenay-aux-Roses, BNI 37- B in Cadarache, STE2 in the La Hague plant and the Brennilis STE. The difficulties encountered during the decommissioning of the STEs are closely dependent on their shutdown conditions, particularly the emptying and rinsing of the tanks.

Oversight of decommissioning progress

Generally speaking, ASN and the DGEC ensure that in their specific fields of competence the licensees continue to devote the resources needed for rapid dismantling of their facilities and ensuring that a final state in which the entirety of the potential source term (dangerous substances, including those that are radioactive) has been removed.

To check the progress of the most complex projects with the greatest safety implications, ASN is continuing to develop innovative inspection methods, with the support of the DGEC concerning the financial aspects relating to the long-term costs. In 2019, ASN and the DGEC thus carried out an in-depth inspection of a complex RCD project on the Orano La Hague site, during an exploratory approach concerning project management. ASN considers that much can be learned from the initial results of this approach and aims to continue it with other licensees (CEA, EDF) (see § 5.4).

5.7. Radioactive waste and materials

A long-term management solution now exists for nearly 90% of the volume of radioactive waste. The other waste is stored pending the availability of final management solutions. The majority of the waste is in packages. Some of the radioactive waste is still in bulk or packaged in such a way as to render it incompatible with acceptance in the disposal routes for which it is intended. This mainly concerns legacy waste. This waste must be retrieved and conditioned.

5.7.1. A management framework defined by an Act and a national plan revised every three years

The National Radioactive Materials and Waste Management Plan, enshrined in the "'Waste" Act of 28 June 2006, is a central component of national policy oversight, implemented in 2006. Building on this experience, France worked actively at European level on drafting the European directive of 19 July 2011 establishing a Community framework for the responsible and safe management of spent fuel and radioactive waste, more specifically concerning the production of radioactive waste management plans in each Member State.

The drafting of the PNGMDR is based on the *national inventory of radioactive materials and waste*, the first edition of which dates from 2004 and which is revised every three years. All these data are published on France's open public data platform (www.data.gouv.fr) and on the website of the National Inventory (www.inventaire.andra.fr). The last version of the inventory was published in 2018.

For the first time in 2019, a national public debate was held prior to the drafting of the fifth edition of the National Radioactive Materials and Waste Management Plan (see § 5.3). The conclusions were returned at the end of 2019 and the Ministry responsible for energy and the ASN Chairman issued a joint decision on 21 February 2020 in preparation for the fifth edition of the National Radioactive Materials and Waste Management Plan.

5.7.2. Management of radioactive materials and reutilisation prospects

The status of the research, the data acquired, the progress achieved and the studies still to be carried out on the reutilisation of radioactive materials are described in the PNGMDR.

In addition, CEA coordinates research into separation-transmutation, together with other research organisations, notably the French national centre for scientific research (CNRS).

ASN opinion 2016-AV-0256 of 9 February 2016 on the studies submitted at the end of 2014 by Orano, CEA, EDF and Solvay highlighted the difficulties linked to the industrial implementation of the techniques associated with the reutilisation of certain radioactive materials.

The PNGMDR 2016-2018 thus recommended pursuing the studies on this subject – in particular in the Astrid fast neutron reactor prototype – while ensuring that the inventories or environmental impact assessments take account of potential future situations in which materials would need to be considered as waste (notably with regard to disposal conditions).

The strategy of one-time recycling of enriched natural uranium based spent fuel currently used in France was confirmed by the Government in the Multi-Year Energy Programme for the period 2019-2028; this is part of the long-term prospect for complete closure of the "fuel cycle", with the implementation of multi-recycling of spent fuels in the generation IV, fast neutron reactors (FNR). Research into generation IV reactors is now incorporated into an R&D programme designed to guarantee that fundamental expertise is maintained, so that it would be possible to create a demonstrator in the second half of the 21st century.

Following the public debate held in 2019, the Ministry responsible for energy and ASN decided on the following orientations for reusable materials:

- closer verification of the reusable nature of the radioactive materials, notably given the prospects envisaged and the volumes involved, by defining action plans comprising milestones binding on the industrial players, which will be periodically reassessed;
- continued studies into the feasibility of the disposal of radioactive substances for which subsequent use is not certain (notably the case of depleted uranium, reprocessed uranium and thorium-bearing substances).

ASN's opinion on the studies submitted within the framework of the PNGMDR 2016-2018 on the management of radioactive materials and the evaluation of their reusable nature, should be issued in 2020.

5.7.3. Improving existing management modes

5.7.3.1. Legacy waste

Certain legacy waste is not packaged or has been packaged in a manner today considered to be inadequate (deterioration of the containers for example) and not compatible with the requirements applicable to safety and radiation protection. In addition, the Environment Code states that the owners of intermediate level, long-lived waste produced before 2015 must package it no later than 2030.

Nonetheless, the uncertainty surrounding the data on some legacy waste, its heterogeneous nature and the complexity of the operations are such that retrieval and conditioning of legacy waste (RCD) can be technically complex, leading to delays and cost overruns. The RCD operations and compliance with the corresponding 2030 deadline represent challenges of different natures for each of the three main licensees.

For EDF, the main challenge is the management of the graphite sleeves from the old GCR reactors. They are currently stored, primarily in the silos of Saint-Laurent-des-Eaux, which are scheduled to be decommissioned (see A 3.5). EDF submitted a report presenting its management strategy for this waste and the technical safety options of the preliminary design study at the beginning of 2020. In it, EDF stated that it has performed an overall study of the decommissioning of the silos and the creation of a storage facility for the resulting waste. The implementation of the new storage facility and the beginning of the operations for removal of storage from the Saint-Laurent-des-Eaux silos are scheduled for 2029. These points are currently being investigated by ASN.

For CEA, the main challenges are, on the one hand, to implement new legacy waste treatment and storage facilities within a time-frame compatible with the shutdown and decommissioning programme for the old facilities where the level of safety no longer meets current requirements and, on the other, to run projects to remove legacy waste from storage.

For Orano, the RCD operations entailed a major commitment on the part of the licensee, within the framework of the ministryial authorisations for start-up of the spent fuel reprocessing plants in the 1990s. The calendar for these operations having drifted, ASN issued a decision to regulate the RCD operations and carries out inspections to verify the steps taken.

The PNGMDR 2016-2018 regulates the continuation of ILW-LL waste packaging studies and requires that the licensees present a progress report on this work to the Ministry responsible for energy and to ASN, before each update of the PNGMDR. This progress report is thus expected in 2020.

5.7.3.2. Mining residues and waste rock

The work done by the public authorities since the 1990s on the long-term health and environmental impact of uranium mining residue repositories is continuing, notably within the framework of the successive PNGMDRs. Several studies are submitted by Orano Mining on the occasion of each PNGMDR covering three topics:

- the mining processing residues disposal sites;

- management of the water from the redeveloped former uranium mining sites;
- management of mining waste rock.

The studies submitted by Orano Mining for the PNGMDR 2016-2018 aim to improve knowledge of the management of the mining processing residues and mining waste rock and the environmental and health impact of the former mining sites in France. The survey of the mining waste rock is now complete. Two PNGMDR working sub-groups were set up, by expanding the stakeholder consultations: the first concerns the treatment of water from the former uranium mining sites using a multi-criteria method; the second concerns the evaluation of the ability of the structures surrounding the mining treatment residue repositories to continue to perform their function and the definition of a study methodology.

A third working group should shortly be set up to assess the long-term impact of the residue repositories, in particular to study cover deterioration scenarios, taking account of experience feedback from radioactive waste disposal sites.

5.7.3.3. Management of very low level waste (VLLW)

The VLL waste disposal centre (Cires), which has been operational since 2003, was not sized to receive all the waste produced by the decommissioning of the nuclear facilities. At the end of 2019, the volume of waste disposed of in the Cires was about 396,000 m^3, or 61% of its authorised capacity. The latest production estimates for VLL waste confirm that Cires will become saturated by 2030 and that additional disposal capacity will need to be created.

The PNGMDR 2016-2018 asked the licensees and Andra to thoroughly explore possibilities for the reuse of certain materials and to study the conditions for increasing the Cires disposal capacity, for the same ground footprint and for creating new disposal capacity (new disposal centre, decentralised solutions). In this context, EDF and Orano submitted a study describing the solution for reprocessing and reusing large homogeneous batches of VLL metallic materials resulting from the decommissioning of the George-Besse I enrichment plant and the steam generators from EDF nuclear power plants.

Following the public debate held in 2019, in preparation for the fifth edition of the PNGMDR, the Ministry responsible for energy and ASN decided on the following orientations for the management of VLL waste:

- continued work to look for additional disposal capacity by identifying a second disposal centre and comparison of the advantages and drawbacks of the decentralised disposal facilities close to the production sites, in terms of the protection of human health and safety and of the environment;
- changes to the regulatory framework applicable to the management of very low level waste, in order to introduce a new possibility of targeted exemptions allowing the case-by-case reuse of very low level radioactive metallic waste, after melting and decontamination;

The PNGMDR will make recommendations regarding the implementation of such exemptions, in terms of safety and radiation protection, citizen associations, transparency, inspection and traceability, taking into consideration the work of the French High Committee for Transparency and Information on Nuclear Safety (HCTISN) on the subject.

ASN’s opinion on the studies submitted within the framework of the PNGMDR 2016-2018 on the management of VLL waste, should be issued in 2020.

5.7.4. The management routes to be implemented

Management of high level waste and intermediate level, long-lived waste

The management of high level waste (HLW) and intermediate level, long-lived waste (ILW-LL) is studied from the three complementary viewpoints identified in the Act of 30 December 1991 and then taken up in the Waste

Act of 28 June 2006: reversible deep geological disposal, conditioning and long-term storage, and separation and transmutation of long-lived radionuclides. Research is also being carried out into the processing and conditioning of these wastes.

The Waste Act adopts the following guideline *"After storage, ultimate radioactive waste which, for nuclear safety or radiation protection reasons, cannot be disposed of on the surface or at shallow depth, shall require deep* geological *disposal"*.

This disposal project, called the industrial centre for geological disposal (French acronym Cigéo), provides for underground installations in a layer of clay situated at a depth of about 500 metres and about one hundred metres thick, in the Meuse/Haute-Marne *départements*. The research carried out by Andra in the Bure laboratory is contributing more specifically to the study of the feasibility and safety of such a repository.

In 2016, Andra sent ASN a safety options report (DOS) on the Cigéo project, ahead of the facility's creation authorisation application. The review of the file, which began in the spring of 2016, underwent an international peer review under IAEA supervision in November 2016. The ASN opinion of 11 January 2018 concerning the Cigéo DOS is based on the recommendations of the Advisory committee for waste and on the report by the experts of this mission. While underlining the satisfactory technological maturity achieved at the DOS stage, the ASN opinion makes a number of recommendations, which concern the inventory of radioactive waste concerned, the disposal of bituminous waste packages and certain subjects which could lead to design changes (justification of the repository architecture, designing the installation against hazards, installation monitoring and post-accident situations).

More specifically with regard to the disposal of bituminous waste packages, owing to the corresponding specific risks, the Ministry responsible for energy and ASN stated that they wished to see an independent, international assessment to evaluate:

- scientific knowledge relating to the characterisation and behaviour of bituminous waste;
- the pertinence of ongoing research into the neutralisation of the chemical reactivity of these bituminous waste packages;
- the pertinence of Andra's studies aimed at modifying the design of Cigéo in order to preclude the risk of runaway exothermal reactions.

The review report on the management of bituminous waste was submitted to the authorities on 28 June 2019 and then presented to the radioactive waste producers, Andra, the IRSN and the PNGMDR Working Group in September 2019.

The joint decision by the Ministry responsible for energy and the ASN Chairman further to the public debate in preparation for the fifth edition of the National Radioactive Materials and Waste Management Plan emphasised the following aspects of the management of high level waste and intermediate level, long-lived waste:

- the need to specify the conditions for the implementation of disposal reversibility, in particular with regard to the retrieval of packages, the decision-making milestones of the Cigeo project as well as the governance to be adopted, so that the choices made could be re-examined;
- the need to define the objectives and criteria for the success of the pilot industrial phase, the means of informing the public between two successive updates of the operations master plan and the means for involving the public in the fundamental steps in the development of the Cigéo project;
- the organisation of public support for research into processing solutions, leading to the identification of avenues for work, by pooling the expertise of various research organisations (CEA, CNRS, IRSN, other research organisations) and specifying the means of public information on the subject;

- updating of the Cigéo project costs evaluation, which will be made public during the Cigéo creation authorisation process.

ASN will take account of the conclusions of the review and the above guidelines in its opinion on the management of HLW and ILW-LL, which should be issued in 2020.

Management of low level, long-lived waste

Low level, long-lived waste (LLW-LL) requires specific management, appropriate to its long lifetime, which rules out disposal in the existing industrial facilities. Within the framework of the 2013-2015 PNGMDR, Andra supplied an interim report on the creation of a disposal facility, selecting a 10 km² area for its geological investigations. However, ASN felt that this area would not be able to accommodate all the anticipated LLW-LL waste.

The PNGMDR 2016-2018 therefore asked Andra to continue its investigations on this site and evaluate the inventory of LLW-LL waste liable to be emplaced in it, while looking for alternative management solutions for waste which it will not be possible to dispose of there. An overall industrial system for management of all the LLW-LL radioactive waste is also expected before the end of 2020.

The joint decision by the Ministry responsible for energy and the ASN Chairman further to the public date in preparation for the fifth edition of the National Radioactive Materials and Waste Management Plan emphasised the following aspects of the management of low level, long-lived waste:

- continuation of the work following on from the current PNGMDR, with definition of a management strategy taking account of the diversity of low level, long-lived waste;
- incorporation of the characterisation of the safety issues, but also the environmental and local issues of the various management solutions;
- the possible role of the area of interest previously studied and the definition of a final management solution for the waste, legacy waste in particular, from the Orano Malvési facility.

ASN's opinion on the LLW-LL waste management solution should be issued in 2020.

5.7.5. Contaminated sites and soils

The management of contaminated sites and soils is the responsibility of the licensee of the activity causing the contamination or, if the party responsible defaults, of the State.

In France, most contaminated sites are connected to the former radium industry and have been the subject of continuous efforts on the part of the public authorities for several years.

As part of its general interest duties, Andra takes lasting measures to protect the population and reduce their exposure to a level as low as reasonably achievable, mainly through the decontamination of the plots of land concerned and the creation of active institutional controls, financed via the CNAR (national funding commission for radioactive matters).

Clean-out and remediation actions are continuing on these sites, in particular those of Isotopchim at Ganagobie (Alpes de Haute Provence *département*) and the Bayard plants at Saint Nicolas d'Aliermont (Seine Maritime *département*). A certain number of clean-out operations have been completed, for example on the former laboratories of the *Société nouvelle du radium* at Gif-sur-Yvette (Essonne *département*).

The State's representative in the *département* may adopt active institutional controls in order to mitigate the contamination-related risks.

Since 2014, on the basis of the information at its disposal, the State may draw up soil information sectors (SIS) which include land on which the ground contamination identified justifies the performance of soil studies and contamination management measures, notably in the event of a change in usage, such as to preserve public health and safety and the environment. The Regional Directorates for the Environment, Land Planning and Housing (DREAL) coordinate the SIS definition approach, under the authority of the representatives of the State. The ASN divisions make their contribution by proposing sites contaminated by radioactive substances of which they are aware.

5.7.6. Sealed radioactive sources

The general rules for the management of sealed radioactive sources are given in the Public Health Code. They deal with the license to hold sources, traceability, notification of loss or theft and the procedures for recovery of sources withdrawn from service.

Overview of the conditions for disposal of used sealed sources

Used sealed sources are among the categories of radioactive waste which, because of their properties, require special management routes.

At present, the CSA and the Cires have acceptance specifications allowing the disposal of radioactive waste packages containing used sealed sources.

Within the framework of the PNGMDR 2013-2015, a working group jointly chaired by the representatives of the Ministry responsible for energy and the Ministry responsible for the environment continued its analysis for the creation of a disposal route for used sealed sources which do not meet the current acceptance criteria for the CSA and the Cires.

On the basis of a report presenting the conclusions of this working group, the PNGMDR 2016-2018 recommended that Andra examine the reassessment of the CSA and Cires acceptance criteria, draw up acceptance criteria for used sealed sources for its LLW-LL waste disposal project currently being designed and include the case of used sealed sources in the drafting of the preliminary acceptance specifications for the Cigéo project.

In July 2018, Andra thus submitted a study verifying the implementation of these recommendations, proposing changes to the CSA technical specifications, while maintaining the existing protection objectives. ASN is currently examining this study.

Retrieval of disused sealed sources

The Public Health Code requires that all users must have the sealed radioactive sources that are delivered to them collected by any authorised supplier or, as a last resort, by Andra, as soon as they are no longer needed and no later than ten years following the date of first registration as it appears in the supply form.

5.8. Financing of long-term nuclear costs

Under the control of the State, radioactive materials and waste management is financed by nuclear licensees, in accordance with the polluter-pays principle. Arrangements to secure the financing of long-term nuclear costs were created by the “Waste” Act. The nuclear licensees are required to assess their long-term costs, including the cost of decommissioning and the costs linked to management of the spent fuels and radioactive waste. They are required to secure future financing of these costs by immediately creating a portfolio of dedicated assets.

Compliance with these regulatory obligations is verified by the Ministries responsible for the economy and for energy. Pursuant to the Environment Code, the licensees send them a report every three years describing the evaluation of the long-term nuclear costs, the corresponding methods and the choices made regarding the composition and management of the assets set up to cover them. Every year, they also send the Ministry responsible for energy a note updating this report and must inform it immediately of any significant change liable to modify the content. They also send it a quarterly inventory of the dedicated assets.

Every year, the ASN and the Defence Nuclear Safety and Radiation Protection Delegate (DSND) analyse the reports and the update notes transmitted, in order to issue an opinion on the consistency of the hypotheses and the data used by the licensees with their strategy for decommissioning and spent fuel and radioactive waste management.

ASN's opinion on the 2019 triennial reports will be published in 2020.

5.9. Peer reviews

In October 2017[1] ASN hosted the follow-up mission to the IRRS mission conducted in 2014[2] on all of its activities. The delegation of international experts concluded that France had significantly reinforced the framework of its oversight of nuclear safety and radiation protection.

In addition, an ARTEMIS peer review mission, run under the aegis of IAEA and concerning waste, spent fuel, decommissioning and post-operational clean-out management, was held in France from 15 to 24 January 2018[3]. The experts found that the French national programme is complete and coherent in promoting safety through a range of laws, regulations and decrees, and that it is effectively implemented by the waste management organisations. Good practices, such as the production and monitoring of the national management plan, its scope, its legally binding nature, as well as the creation of assets dedicated to waste management and decommissioning were also highlighted in the mission report. The team made no recommendations. The proposed suggestions will be taken into account in the production of the fifth edition of the PNGMDR.

ASN also regularly takes part in peer reviews performed abroad with other nuclear safety regulators.

5.10. International activities

In order to promote a high level of safety and to reinforce safety and radiation protection culture worldwide, France continues to be closely involved in international work, maintaining its active participation in the IAEA working groups, more specifically on the five IAEA safety standards committees (NUSSC, RASSC, TRANSCC, WASSC and EPReSC), in ENSREG, WENRA and the NEA. It advocates its vision of strict nuclear safety and radiation protection standards, notably with regard to the long-term management of radioactive waste and the importance of involving stakeholders .

It also attaches importance to incorporating the WENRA reference levels regarding waste disposal and conditioning activities in its regulatory framework. Since 2020, France has also chaired the WENRA club.

Bilateral relations between ASN and its foreign counterparts are an important component of international cooperation. They allow exchanges on important issues, visits on both sides and the implementation of cooperation arrangements. A transboundary seminar was thus organised by France at the end of 2019 with Germany, Switzerland, Belgium and Luxembourg.

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[1] https://www.asn.fr/Informer/Actualites/Mission-d-audit-international-IRRS-conclusions-de-la-mission-de-suivi

[2] https://www.asn.fr/Informer/Actualites/Rapport-international-IRRS-de-l-AIEA-en-ligne

[3] https://www.ecologique-solidaire.gouv.fr/sites/default/files/Rapport%20mission%20ARTEMIS%20version%20francaise.pdf

6| STRONG POINTS AND SIGNIFICANT ADVANCES

Below we will present the strong points and most significant advances in the safe management of spent fuel, of radioactive waste and the decommissioning of the nuclear facilities in France, since the drafting of the sixth report.

6.1. The public debate on the National Radioactive Materials and Waste Management Plan

A public debate, organised by the National Public Debates Commission, was held in 2019 to prepare the fifth edition of the National Radioactive Materials and Waste Management Plan (PNGMDR). The conclusions and lessons learned from this debate, enabled the Government to identify orientations for the drafting of the next edition of the Plan. As this is a long-term subject, which concerns society as a whole, as well as future generations, public involvement and transparency are fundamental values of the French plan for the management of radioactive materials and waste.

A large number of recommendations were made during the public debate, addressed by the Ministry responsible for energy and the ASN Chairman in their joint decision of 21 February 2020. The next PNGMDR will be drafted on the basis of all these points.

6.2. Checks on the overall consistency of fuel cycle management regarding safety

ASN checks the overall consistency of the industrial choices made concerning fuel management which could have consequences for safety. EDF periodically submits a file drafted together with the other fuel cycle operators, presenting the consequences of its strategy for each step in the cycle. This oversight aims to anticipate any strategic change in the functioning of the fuel cycle by at least ten years so that it can be designed and carried out under controlled conditions of safety and radiation protection. The context of an ageing fleet of reactors and the State's political goal of reducing the nuclear share in the electricity production mix, as well as the inclusion of contingencies, means that several scenarios must be considered.

In 2018, ASN issued its opinion on this file, covering the period 2016-2030, emphasising the need for an overall view of the issues and for anticipation.

6.3. Implementation of periodic evaluation of strategies to prioritise decommissioning projects based on safety issues

ASN and the Defence nuclear safety regulator (ASND) asked CEA to present them with an overall reassessment of its strategy for decommissioning and the management of its radioactive materials and waste, for all the civil or defence facilities under its responsibility (see § 5.2.1). The safety regulators' evaluation of the proposed strategy, based on prioritisation of the decommissioning projects according to the safety issues, served to validate the implementation of a graded approach, giving priority to decommissioning projects offering the greatest reduction in the potential danger and thus undeniably constituting a significant step forwards. A similar approach is currently being initiated with Orano Cycle.

6.4. Implementation of a new approach to the oversight of decommissioning projects

Faced with the recurring delays in the decommissioning and legacy waste retrieval projects, a new project management evaluation approach was experimented by ASN in 2019, in association with the Ministry responsible for energy, for the projects of Orano Cycle, notably concerning La Hague installations. The purpose of this approach, which is liable to be applied to all the nuclear licensees, is to encourage them to increase their control of the various phases of their projects, to ensure better compliance with the deadlines set in the light of the legislative goal of achieving dismantling as rapidly as possible, as well as more accurate evaluation of the long-term costs to be financed, given the risks and uncertainties of the projects (see § 5.4).

7| CONCLUSION

The French radioactive waste and spent fuel management programme has a clear roadmap for managing all types of waste with existing or identified solutions, or a precise action plan with milestones. It reflects the continuous and long-standing engagement by the Government and Parliament. It establishes a high standard in terms of safety and radiation protection, to ensure protection of humans and the environment, for the long and very long terms. It is also characterised by significant stakeholder and public involvement in the decision-making process. Finally, with a view to ensuring continuous improvement, France makes extensive use of international peer review tools, in particular those put into place by the IAEA.

SECTION A | INTRODUCTION

1| GENERAL INTRODUCTION

1.1. Purpose of the report

The Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management, hereinafter referred to as the "Joint Convention", is the result of international discussions held following the adoption of the Convention on Nuclear Safety in 1994. France signed the Joint Convention on 29 September 1997, the first day on which it was opened for signatures during the general conference of the International Atomic Energy Agency (IAEA). France approved it on 22 February 2000 and submitted the corresponding instruments to the IAEA on 2 April 2000. The Joint Convention entered into force on 18 June 2001.

For many years, France has been active in international actions to reinforce nuclear safety and it considers the Joint Convention to be an important step in this direction, covering fields with significant implications for nuclear safety and radiation protection in France.

This seventh report is published in accordance with Article 32 of the Joint Convention and presents the measures taken by France to fulfil each of the obligations of the Convention.

1.2. Installations concerned

The installations and the radioactive substances covered by this Convention are of widely differing natures and are under the control of different regulatory authorities in France (see section E of this report).

Above a certain level of radioactive content, an installation is subject to the "basic nuclear installations" (BNI) system and placed under the control of the French nuclear safety regulator (ASN). Below this level, if an installation is subject to the regulations covering installations classified for protection of the environment (ICPE), it is placed under the control of the Ministry for the Environment.

Installations containing only small quantities of radioactive materials or not meeting the criteria mentioned above are not subject to this type of regulatory control.

1.3. Report authors

This report was produced and coordinated by ASN, with contributions on the one hand from the General Directorate for Energy and Climate (DGEC) of the Ministry for Ecological and Solidarity-based Transition (MTES), the Nuclear safety and Radiation Protection Delegation (MSNR) of the MTES, the Institute for Radiation Protection and Nuclear Safety (IRSN) and the National Radioactive Waste Management Agency (Andra), and, on the other, from the main licensees of the nuclear installations, Électricité de France (EDF), Orano Cycle and Framatome (formerly AREVA), the Alternative Energies and Atomic Energy Commission

(CEA), the ITER Organisation and the Institut Laue-Langevin (ILL). The drafting of the final version was completed in September 2020 after consultation with the French stakeholders concerned.

1.4. Structure of the report

For this seventh report, France took account of the experience acquired through its participation in the previous meetings of the Joint Convention and the Convention on Nuclear Safety: the report aims to be stand-alone, produced from existing documents and reflecting the viewpoints of different actors (regulatory authorities and licensees). Hence, for every chapter in which the regulatory authority is not the only entity to express its views, a three-fold structure was adopted:

- a description of the regulations by the regulatory authority;
- a presentation by the licensees of the steps taken to comply with the regulations;
- an analysis by the regulatory authority of the steps taken by the licensees.

This report is structured according to the "guidelines concerning the national reports" for this Convention, that is with an "article by article" presentation, each of which is the subject of a separate chapter, with the text corresponding to the article of the Convention concerned being recalled at the beginning of the chapter. After this introduction (section A), the various sections will deal with the following topics in turn:

- section B: policy and practices in the field of the Convention (article 32-1) ;
- section C: scope of application (article 3);
- section D: the inventories of spent fuel and radioactive waste and the list of installations concerned (article 32-2);
- section E: the legislative and regulatory system in force (articles 18 to 20);
- section F: the other general safety provisions (articles 21 to 26);
- section G: the safety of spent fuel management (articles 4 to 10);
- section H: the safety of radioactive waste management (articles 11 to 17);
- section I: transboundary movements (article 27);
- section J: sealed sources withdrawn from service (article 28);
- section K: steps taken to improve safety.

The report is supplemented by appendices (section L).

It should be noted that the regulatory provisions common to the safety of spent fuel management facilities and the safety of radioactive waste management facilities were placed in section E in order to avoid duplication between sections G and H, as is recommended in the guidelines for the drafting of the national reports.

1.5. Publication of the report

The Joint Convention comprises no obligation of public communication of the report as set out in Article 32. As part of its duty of information of the public and in order to ensure transparency with regard to the activities covered, ASN will make it available on its website in both French and English (www.asn.fr).

2| MAIN CHANGES SINCE FRANCE'S PREVIOUS REPORT

2.1. Changes to the oversight of nuclear safety

2.1.1. Changes to the regulations and overhaul of the general technical regulations

Most of the provisions applicable to nuclear safety are contained in the Environment Code. Recent changes were made by the energy transition for green growth Act 2015-992 of 17 August 2015 (known as the TECV Act), notably for the provisions applicable to decommissioning, and by Decree 2019-190 of 14 March 2019. This decree codified the decrees concerning basic nuclear installations and transparency on nuclear matters in the Environment Code. It also implemented the legislative provisions resulting from Ordinance 2016-128 of 10 February 2016 containing various nuclear provisions, from Article 123 of the TECV Act and from Act 2017-55 of 20 January 2017 constituting the general status of independent administrative authorities and independent public authorities (methods for renewal of the ASN Commission in particular). It supplemented the provisions concerning the local information committees, in order to include members from foreign States if the site is situated in a border *département* and clarifies the system applicable to facilities located in basic nuclear installations and subject to the Industrial Emissions Directive or the Seveso 3 Directive.

The Order of 7 February 2012 (known as the "BNI order") and about fifteen ASN regulations clarify the regulatory framework. Work has been undertaken to learn lessons from application of the order and should lead to it being revised shortly.

With regard to the management of radioactive waste, the following ASN regulations in particular were issued:

- regulation 2015-DC-0508 of 21 April 2015 concerning the study of waste management and the inventory of waste produced in the BNIs;
- regulation 2015-DC-0532 of 17 November 2015 relative to the safety analysis report for basic nuclear installations;
- regulation 2016-DC-0569 of 29 September 2016 modifying regulation 2013-DC-0360 of 16 July 2013 relative to the control of detrimental effects and the impact of basic nuclear installations on health and the environment;
- regulation 2017-DC-0587 of 23 March 2017, relative to the conditioning of radioactive waste and the conditions of acceptance of radioactive waste packages in the disposal BNIs.

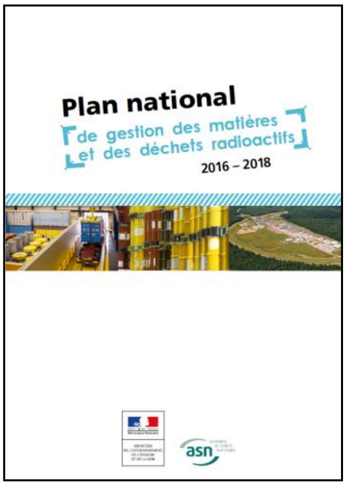
The regulatory texts are supplemented by ASN guides, which are not legally binding, but which give recommended best practices: Guide n° 6 concerning final shutdown, decommissioning and delicensing of BNIs, Guide n° 7 concerning the transport of radioactive substances on the public highway, Guide n° 14 concerning the clean-out of structures in BNIs, Guide n° 15 concerning the management of activities in the vicinity of BNIs, Guide n° 23 concerning the establishing and modification of the BNI waste zoning plan, Guide n° 24 concerning the management of soils polluted by BNI activities, Guide n° 25 concerning the drafting of an ASN regulation or Guide (methods for consultation with the stakeholders and the public) and Guide n° 27 concerning the stowage of radioactive packages, materials or objects for transport. The complete list of ASN Guides is presented in appendix L.5.2.

2.2. Changes to radioactive materials and waste management policy

2.2.1. Publication of the National Radioactive Materials and Waste Management Plan

The Environment Code requires that the Government draft a National Radioactive Materials and Waste Management Plan (PNGMDR), every three years. It is then transmitted to Parliament, which refers it to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) for evaluation, and it is made public.

Following each edition of the Plan, the Government publishes a Decree and an Order establishing the prescriptions and ensuring implementation of the PNGMDR. It checks execution thereof and requests opinions, more specifically from ASN, concerning the proposals and studies from the organisations concerned by said prescriptions.



According to Article L.542-1-2 of the Environment Code, the PNGMDR *"reviews the existing methods of radioactive materials and waste management and the technical solutions adopted, lists the foreseeable needs for storage or disposal facilities and specifies their required capacities and the storage durations. It sets the general targets, the main time-frames and the schedules enabling these time-frames to be met while taking into account the priorities it defines. It determines the targets to be achieved for radioactive waste for which there is as yet no final management solution. It organises the implementation of research and studies into the management of radioactive materials and waste. It determines the persons responsible for its implementation and the indicators for monitoring the progress of its implementation."*

The Environment Code sets the orientations to be followed by the Plan (see section B.1.3). For the first time, pursuant to the provisions of Ordinance 2016-1060 of 5 August 2016 and the decision of the National Public Debates Commission (CNDP), the drafting of the plan was the subject of a public debate (https://pngmdr.debatpublic.fr/), on the basis of a project management report drafted jointly by the Ministry responsible for Energy and ASN. The conclusions published in November 2019 underlined the point that the debate served to clarify the various options, as well as the issues associated with each of the topics identified, and highlighted the following needs:

- clarification of the prospects for recycling radioactive materials;
- new storage capacity for spent fuels by 2030 and the pertinence of underwater storage in the French context;
- for the management of very low level waste (VLLW): appropriate traceability processes, effective and independent checks and involvement of civil society in any change to current procedures and methods;
- the use of additional technical expertise before defining management solutions suited to the heterogeneity of the low level and long-lived waste (LLW-LL);
- clarification of the challenges inherent in the implementation of the Cigéo project, taking account of the long time-frames involved in managing high level waste (HLW) and intermediate level, long-lived waste (ILW-LL), plus the prospects for research into alternative management solutions.

Some questions concerned the cross-cutting aspects of radioactive materials and waste management, such as local or environmental issues, management of particular categories of waste and governance of the plan.

On 21 February 2020, the Ministry in charge of Energy and the ASN Chairman announced the main orientations of the new edition of the Plan, to be adopted following the public debate:

(https://www.asn.fr/Informer/Actualites/Orientations-du-prochain-Plan-national-de-gestion-des-matieres-et-des-dechets-radioactifs-PNGMDR)

- improve coordination between energy policy and waste management policy: the frequency of the PNGMDR will be brought into line with multi-year energy programming, and the coordination with final shutdown and decommissioning strategies proposed by industry will be more clearly explained;
- reinforce the governance of radioactive waste management: the PNGMDR drafting and oversight body will be expanded to include national elected representatives, civil society and representatives of local authorities, in addition to participation by environmental protection associations;
- reinforce oversight of the reusable nature of radioactive materials: for materials which are not currently reused, industry will make a commitment to interim targets in the action plans, which will be periodically reassessed;
- address the need for new spent fuel storage capacity: the PNGMDR will make provision for new centralised underwater storage capacity, taking account of the time needed to build it. It will study the conditions and situations in which dry storage could be of use;
- whenever pertinent and by means of targeted exemptions, allow the reuse of certain very low level metal waste and define the conditions for such reuse;
- continue with defining the conditions for implementation of the Cigéo project, notably the methods for involving the public in the fundamental stages of the project, as well as R&D on alternative management solutions;
- reinforce the assessment of local impacts of the management choices and the resulting economic, health and environmental issues (impact of transports, harmfulness of wastes, etc.): the public debate revealed particular sensitivity to these aspects.

The fifth edition of the PNGMDR will be produced during the course of 2020, with a view to public consultation and publication in the first half of 2021.

2.2.2. Changes to management solutions under development

2.2.2.1. High-level and intermediate-level, long-lived waste

The most recent texts published are the 25 July 2016 Act on the procedures for creating a deep reversible disposal facility and the ministryial Order of 15 January 2016 which set the cost of the project at 25 billion euros (in the economic conditions of 31 December 2011).

The disposal project is being examined by ASN in several stages: in 2014 on the safety data for the closure structures and the expected content of the facility's safety options file; in 2015 on the control of operational risks and the cost of the project; in 2016, on the file entitled "Components development plan".

These preliminary studies, entrusted to an industrial lead contractor, are based on a range of requirements established by Andra (safety, reversibility, operation, integration). These studies were able to consolidate the scientific and technical results acquired, as well as the recommendations of the evaluators following examination of the various dossiers submitted by Andra. In 2016, Andra submitted the "Cigéo 2015 dossier" to ASN, presenting Cigéo's safety options. ASN issued its opinion on this in January 2018, notably specifying the technical data to be provided for the purposes of the creation authorisation application.

Following this letter, Andra consolidated its study programme and set up a programme concerning the scientific and technical activities aimed at consolidating what had already been achieved and enhancing the justification of the choices made for the DAC dossier, notably in terms of design and sizing. Changes to the configuration of the Cigéo project also enabled optimisations to be made, both in terms of implementation (standardisation, construction site safety) and from the economic standpoint.

Andra also undertook work to demonstrate the possibility of emplacing bituminous waste packages through changes to the design of the vaults and management of the corresponding risks, tailored to the identified accident scenarios. It thus submitted an interim report at the end of 2019, on which ASN should issue a position statement during the course of 2020.

Andra also carried out adaptability studies at each of the major steps in the project. These studies were regularly updated, with the latest update being examined by ASN in 2016 as part of the review of the Cigéo project's safety options dossier. These studies are continuing and will be incorporated into the dossier submitted in support of the Cigéo creation authorisation decree (DAC), which should be forwarded to the Ministry in charge of nuclear safety in mid-2021.

The Andra teams are actively working on preparing the creation authorisation application file and are also preparing for the disposal facility construction phase. If creation of the Cigeo installation is authorised, the work to be done will imply the need for new skills. As of today, Andra must therefore anticipate its future needs by planning for the deployment of a new organisation around the project, by identifying the human resources needed and by preparing to place the future construction contracts.

The submission of the declaration of public utility (DUP) file for Cigéo is being envisaged by Andra during the course of 2020. The DUP will reaffirm the public utility of Cigéo and will also allow for land management on the site of the Cigéo project.

Finally, the Cigéo project has entered a consultation phase, with the aim of involving civil society and broadening the consultation measures taken since the public debate in 2013, in order to improve the quality of the decisions still to be taken.

To organise local socio-economic development, the Government asked the office of the Prefect of the Meuse *département* to draw up a regional development project (PDT), in which Andra played an active role. This document, signed on 4 October 2019, aims to create an environment around Cigéo that is favourable to the success of the project, the vitality of the region and the standard of living of its inhabitants.

2.2.2.2. Low-level long-lived waste

For low level, long-lived waste (LLW-LL), Andra at the end of 2012 presented the various management scenarios studied according to the nature of this waste and geological investigations were initiated in 2013 in the Soulaines municipality close to Andra's existing disposal centres. As requested by local government officials, a consultation committee was set up under the aegis of the State, to define the steps associated with project development. A geological analysis on the other BNI sites in France is also being carried out together with CEA, EDF and Orano.

Examination of the studies carried out until 2016 led to the ASN opinion of 29 March 2016, more specifically indicating "that it will be difficult to demonstrate the feasibility, in the investigated area, of a disposal facility for all the LLW-LL waste identified by Andra". The National Radioactive Materials and Waste Management Plan 2016 - 2018 thus asked Andra to submit an overall industrial project, before the end of 2019, for management of all LLW-LL waste and incorporating the new data available (ASN opinion on the 2015 report, inclusion of new waste in the project inventory, changes in decommissioning and post-operational clean-out strategies). The PNGMDR 2016-2018 thus recommended continued work to characterise the waste, R&D on reprocessing and the feasibility of the envisaged management scenarios.

3| INTEGRATION OF EXPERIENCE FEEDBACK FROM THE FUKUSHIMA ACCIDENT

Following the nuclear accident in Fukushima, ASN asked the licensees to carry out stress tests on all the French civil nuclear facilities in the light of the lessons learned from this accident. This process first of all concerned the facilities said to be a priority owing to their safety implications (NPPs, all fuel cycle plants operated by Orano and certain CEA facilities), and was then extended to the other facilities with lesser safety implications (see the list of facilities in Appendix L.4).

In September 2011, the licensees of the priority facilities presented ASN with the stress tests of their facilities in extreme situations, accompanied by proposed modifications to be implemented in the short and medium terms.

Following this process, ASN submitted its conclusions to the Prime Ministry in early 2012 (ASN opinion 2012-AV-0139 of 3 January 2012 and the ASN report available in English on the ASN website). It considered that the facilities examined offered a sufficient level of safety such that, on the one hand, immediate shutdown was not necessary for any of them but that, on the other hand, their robustness to extreme situations needed to be increased without delay and beyond the existing margins.

In resolutions of 26 June 2012, ASN set additional requirements binding on the licensees, notably to implement a "hardened safety core" of robust material and organisational provisions designed to prevent a severe accident or limit its spread, mitigate large-scale releases and enable the licensee to fulfil its emergency management duties.

3.1. NPP spent fuel pools

The pools of EDF's NPP reactors were included in the stress tests (see section G.2.2.3), with the aim of guaranteeing cooling of the fuel.

ASN made requests and set additional requirements for the EDF NPPs. Generally speaking, these requests are part of a continuous safety improvement process. They are issued in application of the defence-in-depth approach and as such concern measures to prevent and mitigate the consequences of an accident, based on both additional fixed means and external mobile means planned for all the installations on a site beyond their initial design basis.

EDF completed the deployment of the provisions in response to the recommendations resulting from the European peer review of the stress tests conducted as of April 2012. France will be submitting a closing report on this exercise by the end of 2020.

3.2. The fuel cycle plants

The Orano Cycle group submitted stress test reports in September 2011 for all its facilities within the scope covered by the Joint Convention.

The additional specifications of the regulations of 26 January 2012 required that the Orano group propose a "hardened safety core" of material and organisational measures to prevent the identified severe accident situations. The proposals made by Orano to define the hardened safety core were reviewed by ASN and its technical support organisation and were presented to the Advisory Committees (GPE) in April 2013. Following this review, the ASN resolutions of 8 January 2015 prescribed the hazard levels, the requirements associated with the "hardened safety core" and the corresponding deployment deadlines which, for all the cycle facilities, concern the following:

1. the implementation of material and organisational measures to mitigate the following in the La Hague plant:
    - the risks of uncovering of the spent fuel stored in the pool;

- for the silos, feasibility studies with a view to setting up technical arrangements, such as geotechnical containment or equivalent effect, with the aim of protecting the underground and surface water in the event of a severe accident;
- the risks of loss of cooling in the tanks storing concentrated fission product solutions;
- the risks of loss of condenser cooling for the fission products evaporators;
- the risks of loss of the unclogging function for the pendulum-type centrifugal decanters (DPC);
- the risks of loss of the air supply diluting the radiolysis hydrogen produced in the tanks of concentrated fines and alkali rinsing solutions;
- the risks of loss of cooling of the PuO2 storage facilities;
- the risks of loss of confinement of radioactive substances contained in the facilities' legacy waste storage silos;
- the risks of a fire in the equipment belonging to PuO2 dry processing;
- the risks of a fire in the legacy magnesium waste storage silos.

2. the implementation of material and organisational measures in the Melox MOX fuels fabrication plant, aiming to:
    - restore then maintain the cooling function within a time compatible with the temperature rise in the rods storage unit and other fissile materials storage units;
    - protect against the loss or deterioration of the high negative-pressure extraction network for the main fuel fabrication building and its extension.
3. The implementation of measures concerning emergency management, in particular the construction of robust emergency situation management premises, and social, organisational and human factors.

For the la Hague site, the work done further to the stress tests was finalised at the end of the second half of 2019 and underwent satisfactory completion and good operating checks by ASN.

For the Melox site, the implementation of the provisions resulting from the stress tests consisted in the 2017 commissioning of remediation means for cooling the material storage units and providing the licensee with a site emergency management building, for which the construction work, which started in 2018, is nearing completion.

ASN is monitoring the implementation of the additional safety measures required concerning the definition of systems, structures and components robust to extreme hazards, the management of emergency situations and compliance with the new requirements.

At the same time, ASN has issued a position statement on the reference hazards to be considered for the "hardened safety core" (in particular earthquakes). The reference hazard to be considered for the tornado risk is still being worked on and could lead to new requirements.

3.3. CEA facilities

Three CEA experimental reactors (OSIRIS, MASURCA and RJH) were among the priority facilities for which requirements were set by the ASN resolutions of 26 June 2012, for controlling the fundamental safety functions in extreme situations.

PHENIX and the plutonium technology facility (ATPu) undergoing decommissioning are also among the priority facilities and are dealt with specifically in § A.3.5.

22 CEA facilities are among the lower priority installations, including research facilities and the emergency management resources on the Cadarache and Marcoule sites. For the facilities with lower safety implications, the additional safety evaluation will be transmitted as part of the periodic safety review.

In resolutions dated 8 January 2015, ASN set requirements for CEA associated with the equipment and provisions of the "hardened safety core" in the facilities and centres which so require. With regard to the Cadarache centre, ASN agreed to the request for postponement of construction of the emergency centre buildings to 2023, given that the main risk considered for the site is associated with the RJH reactor, for which commissioning has been delayed. For the Saclay centre, ASN served CEA with formal notice on 6 September 2019 to send it the file justifying the design and sizing of the future emergency management buildings. This file was received in December 2019. Construction should begin in 2021. With regard to the Marcoule centre, ASN is still waiting for additional data on the strength of the emergency management building (containment, accessibility, operability, habitability, etc.).

3.4. Facilities undergoing decommissioning

ASN also asked the licensees of BNIs being decommissioned to conduct stress tests.

The reports on the EDF BNIs undergoing decommissioning (Chinon A1, A2 and A3, Saint-Laurent-des-Eaux A1 and A2, Bugey 1, Chooz A, Superphenix and Brennilis) and the fuel storage facility (APEC, in Creys-Malville) were transmitted on 15 September 2012. ASN returned its conclusions on 10 October 2014. It considered that the approach followed was in conformity with the specifications and requested additional information concerning the seismic risk in the APEC and in the GCR reactors, along with the risk of flooding of these latter. EDF has committed itself to taking several of these requests into account.

On 6 June 2014, EDF also transmitted the report on the irradiated material facility (AMI) operated in Chinon. On 10 July 2015, ASN considered that the provisions adopted by EDF to mitigate the consequences of an extreme accident situation were satisfactory, provided that the radioactive waste and spent fuel present in the facility were removed in the short-term.

The stress test reports for the facility comprising the storage silos for the graphite sleeves used in the operation of the Saint-Laurent-des-Eaux reactors A1 and A2 was transmitted on 15 December 2015 and will be examined during the course of the periodic safety review, the conclusions of which were transmitted in December 2019.

For the CEA facilities, the resolutions of 26 January 2012 set additional requirements for the ATPu laboratory in Cadarache and for the PHENIX reactor currently being decommissioned. The ASN resolution of 8 January 2015 also sets additional prescriptions specifying the requirements applicable to the “hardened safety core” of the PHENIX reactor.

With regard to the RAPSODIE reactor in Cadarache, CEA submitted studies at the end of 2014 with the aim of re-examining the sodium-water reaction scenario induced by rainfall occurring further to an extreme earthquake causing severe structural failure of the BNI buildings. This study did not lead to any additional requirements given that the sodium tanks still present in the facility were removed at the end of 2016 to BNI 71 Phenix in Marcoule for processing.

The lessons learned from the Fukushima Daichii accident for the CEA facilities of lesser importance will be implemented later on, on the occasion of the next periodic safety reviews for the PROCEDE and SUPPORT BNIs (Fontenay-aux-Roses).

No stress test was required on facilities for which decommissioning is sufficiently well-advanced, or those for which the potential source term is very low and for which delicensing is very close, given the limited consequences following an extreme situation.

3.5. Other facilities

Waste disposal facilities:

In resolution 2013-DC-0386 of 17 December 2013, ASN required that Andra conduct stress tests for its waste disposal facilities [Manche repository (CSM BNI 66) and Aube repository (CSA BNI 149)] on the occasion of their next periodic safety review.

These stress tests were transmitted in August 2016 and April 2019 respectively and are currently being reviewed.

CENTRACO facility:

The stress tests on the low-level radioactive waste processing and conditioning centre (CENTRACO - Cyclife France) were carried out and the measures in place were considered to be satisfactory.

SECTION B | POLICIES AND PRACTICES (ART. 32-§1)

In accordance with the provisions of Article 30, each contracting Party presents a national report at each review meeting of the contracting Parties. This report covers the steps taken to meet each of the obligations set out in the Convention. For each contracting Party, the report also covers:

- *i) its spent fuel management policy;*
- *ii) its spent fuel management practices;*
- *iii) its radioactive waste management policy;*
- *iv) its radioactive waste management practices;*
- *v) the criteria it applies to defining and classifying radioactive waste.*

1| GENERAL POLICY

The radioactive materials and waste management policy falls mainly within the legal framework consisting of two Acts, the 30 December 1991 Act and the 28 June 2006 Waste Act, along with their implementing texts. It is more specifically implemented through the National Radioactive Materials and Waste Management Plan (PNGMDR), notably drafted on the basis of the National Inventory of radioactive materials and waste (see section A.2.2.1).

Implementation of these principles is built around a management framework consisting of three pillars:

- a specific legislative and regulatory framework;
- a public agency devoted to the management of radioactive waste, called Andra (French national radioactive waste management agency);
- a National Radioactive Materials and Waste Management Plan (PNGMDR), updated every three years.

1.1. 28 June 2006 Waste Act on the sustainable management of radioactive materials and waste

The 30 December 1991 Act set the management principles and the main orientations for research on the management of high level, long-lived radioactive waste (HLW-LL).

The 28 June 2006 Act covers all radioactive materials and waste. It sets the orientations and goals for research and development on management solutions for radioactive waste with no operational management solution and specifies how decommissioning and waste management is to be financed. It recalls the ban on the disposal of foreign waste in France, as well as the responsibility of the producers of spent fuels and radioactive waste.

The Act also establishes tools for dialogue with the public. It was supplemented by the Ordinance of 10 February 2016, notably with the assessment of the legal and organisational arrangements for the management of radioactive materials and waste, and the organisation of ten-yearly peer reviews of radioactive materials and waste management. The Act also stipulates that the Government is vigilant about improving the legal and organisational arrangements with regard to the management of radioactive materials and waste, taking account of experience feedback, the results of the assessments and technical and scientific developments.

	Subject of the decree	Article of the Act	Date of publication
National radioactive materials and waste management policy	Requirements of the National Radioactive Materials and Waste Management Plan 2016-2018	**Art. 6**	23 February 2017
	Management of foreign waste and processing contracts	**Art. 8**	3 March 2008
	Nomination of members of the National Review Board (CNE)	**Art. 9**	5 April 2007
	Nature of information to be transmitted for the National Inventory	**Art. 22**	29 August 2008
Assistance with research conducted in the Meuse/Haute Marne underground laboratory	Local Information and Monitoring Committee (CLIS)	**Art. 18**	7 May 2007
	Public interest grouping (GIP) – Generic decree	**Art. 13**	14 December 2006
	Definition of the proximity area - GIP Meuse and Haute-Marne	**Art. 13**	5 February 2007
	“Support” tax: fraction paid by the GIPs to the municipalities within the 10 km area	**Art. 21**	7 May 2007
	Coefficient of the “support” and “technological dissemination” taxes	**Art. 21**	26 December 2007
	Consultation area when creating a repository	**Art. 12**	To be published
Financing provisions	Coefficient of additional “research” tax	**Art. 21**	26 December 2007
	Secure financing of nuclear costs	**Art. 20**	23 February 2007
	Creation of the national review board for financing the cost of decommissioning of basic nuclear installations and the management of spent fuels and radioactive waste (CNEF).	**Art. 20**	20 June 2008

Table 2: List of decrees issued with respect to the waste Act as at 31 December 2019

The first peer review concerning the French radioactive waste management system was held in France from 15 to 24 January 2018, by a delegation comprising 10 international experts. This international review was carried out within the framework of an ARTEMIS mission organised by the IAEA department responsible for the topics of radioactive waste and spent fuel management, decommissioning and post-operational clean-out. The conclusions underlined the fact that France has established a radioactive waste management framework covering all the issues, with numerous strong points, notably in terms of skills and the continuous progress approach. The auditors also made suggestions and spotlighted best practices.

1.2. A management policy covering all radioactive substances

1.2.1. Definitions

The following definitions are used in France, in accordance with the Environment Code.

A radioactive substance is a substance containing natural or artificial radionuclides, the activity or concentration of which justifies radiation protection monitoring.

A radioactive material is defined as being a radioactive substance for which subsequent use is planned or envisaged, if necessary after processing.

A nuclear fuel is regarded as a spent fuel when, after being irradiated in the core of a reactor, it is removed once and for all.

Radioactive wastes are radioactive substances for which no subsequent use is planned or envisaged.

Ultimate radioactive waste is radioactive waste which can no longer be reprocessed in current technical and economic conditions, in particular by extracting its reusable part or by reducing its polluting or hazardous nature.

The storage of radioactive materials or waste consists in placing these substances for a temporary period in an above-ground or near-surface storage facility specially fitted out for the purpose, pending their retrieval.

The disposal of radioactive waste consists in placing these substances in a facility specially designed to house them, potentially definitively.

Deep geological disposal of radioactive waste consists in emplacing the radioactive waste in an underground facility specially designed for this purpose, complying with the principle of reversibility.

Lastly, nuclear activities (article L. 1333-1 of the Public Health Code) are "*activities involving a risk of persons being exposed to ionising radiation (...) originating either from an artificial source (...) or from a natural source when the natural radionuclides are treated or have been treated on account of their radioactive, fissile or fertile properties (...)"*.

1.2.2. Radioactive materials

These materials primarily consist of the depleted uranium from the enrichment plants, spent fuels unloaded from the nuclear reactors and fissile materials extracted from irradiated fuel (uranium and plutonium) after reprocessing of the spent fuels.

They are currently partially reused in the existing routes:

- The plutonium from spent fuel reprocessing is used to fabricate MOX fuel that can be used by 24 nuclear power reactors operated by EDF.
- The depleted uranium from the enrichment of natural uranium is very little used (only in the fabrication of MOX) and is stored.
- The uranium from the reprocessing of spent fuels will be re-enriched and will be used to fabricate fuels for the reactors authorised to use it (in particular the four reactors of the Cruas NPP by 2023 and then possibly the 1300 MW reactors).

In its 15 March 2005 report, the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) indicated that the scope of the plan should be broadened to include reusable substances so that radioactive waste management would be completely transparent. This recommendation led to the PNGMDR and the scope covered by the National Inventory of radioactive waste produced by Andra being brought into line with each other to ensure consistency.

1.2.3. The National Inventory of radioactive materials and waste

Produced by Andra in accordance with the provisions of the Environment Code, the National Inventory of radioactive materials and waste aims to meet the following three objectives:

- List the radioactive materials and waste present on French territory as at 31 December of each year, on the basis of the information provided by the holders of the materials and waste.
- Establish forecasts of future radioactive materials and waste production at dates defined by ministerial order and, for the waste, at the end of operation of the waste producing facilities, based on information provided every three years by the holders of the radioactive materials and waste.
- Outline the broad trends for the production of radioactive materials and waste according to several possible scenarios.

With a view to ensuring transparency, Andra set up a pluralistic steering committee to oversee the preparation of the National Inventory. This committee is chaired by the CEO of Andra and comprises representatives from the institutional players (Ministries, ASN, High Committee for Transparency and Information on Nuclear Security, National Review Board, etc.), from civil society, from environmental protection associations and from the waste producers.

Every three years, Andra publishes the National Inventory which makes public the information on the stocks of radioactive materials and waste and presents the projected quantities of radioactive waste at predefined dates (2030 and 2040 in the 2018 issue) and at the end of life of the nuclear facilities.

The National Inventory also presents an estimation of the quantities of materials and waste according to several possible scenarios based on assumptions of the continuation or non-renewal of nuclear power production.

In addition to this, Andra makes the assessment of the radioactive materials and waste stocks available to the public each year.

Since the end of 2016, all these data have been published on France's open public data platform (www.data.gouv.fr) and on the website of the National Inventory (www.inventaire.andra.fr).

1.3. The National Radioactive Materials and Waste Management Plan (PNGMDR)

The PNGMDR is a core oversight element of the national management policy implemented by France.

The first Plan, transmitted to Parliament in March 2006, was the result of work that had been initiated by the Minister for Ecology and Sustainable Development on 4 June 2003 and carried out by a pluralistic working group placed under the aegis of ASN and the Ministry responsible for energy and raw materials (DGEMP), bringing together representatives of the administration, the radioactive waste producers, Andra, the IRSN and representatives of environmental protection associations, as well as a member of the National Review Board (CNE).

Drawing on this work, the Waste Act ratified the principle of this national management plan. It also made provision for a decree to set out its requirements. The decree associated with the first plan thus appeared on 16 April 2008. The decree setting out the requirements of the plan currently in force dates from 23 February 2017 and incorporates the PNGMDR's permanent provisions into the regulatory part of the Environment Code (Articles D.542-74 to D.542-96). The particular requirements are stipulated in an Order dated 23 February 2017.

The PNGMDR is based on the knowledge of the different types of waste, notably the National Inventory (see § B.1.2.3). The national plan must be drawn up and updated by the Government every three years, published and transmitted to Parliament, which forwards it to the Parliamentary Office for the Evaluation of Scientific and Technological Choices, for evaluation (see section E.3.4.1). The National Review Board (see section E.3.4.2.1) is also tasked with making an annual evaluation of the progress of research and studies concerning radioactive materials and waste management.

1.3.1. The legal framework underpinning the PNGMDR

1.3.1.1. The guiding principles of the PNGMDR

The guiding principles of the PNGMDR are set out in Article L.542-1-2 of the Environment Code:

- To reduce the quantity and harmfulness of radioactive waste, in particular by reprocessing spent fuels and treating and packaging radioactive waste.
- Radioactive materials awaiting treatment and ultimate radioactive waste pending disposal are stored in specifically designed facilities.

- After storage, ultimate radioactive waste which, for nuclear safety or radiation protection reasons, cannot be disposed of in above-ground or sub-surface facilities, shall require deep geological disposal.

The PNGMDR is also built around the following principles:

- compliance with the principles of protection against ionising radiation (justification, optimisation, limitation), protection of the environment (precautionary principles), and responsibility of waste producers (polluter-pays principle, etc.);
- the principle of an integrated approach from production to disposal;
- the definition of long-term management solutions appropriate to the characteristics of the various wastes, in particular with regard to the storage of waste for which there is as yet no long-term management solution, or society taking charge of "orphan" waste, usually from activities in the past;
- the traceability of radioactive waste management;
- information of and active involvement by the general public.

1.3.1.2. The objectives of the PNGMDR

The main objectives of the PNGMDR are set out in article D.542-75 of the Environment Code:

- The management strategies must be tailored to the heterogeneity and risks from the waste considered and proportionate to the technical, economic and safety issues.
- The use of radioactive waste disposal facilities must be optimised.
- The radioactive waste management routes must take account of the volumes of waste transported and the distances to be covered.

The PNGMDR focuses notably on the following areas:

- the search for long-term solutions for each category of radioactive waste produced;
- continuous improvement of existing solutions and their optimisation;
- analysis of the long-term management solutions implemented, in order to achieve management which is constantly more rigorous and safe;
- retrieval and conditioning of packaging of legacy radioactive waste;
- overall consistency of the radioactive waste management system, regardless of the level of radioactivity or origin;
- consideration of the concerns and the expectations of the public with regard to the fate of the radioactive waste.

To achieve this objective, a comprehensive, national process of reflection is being organised to define the broad outlines of a policy to ensure management of all radioactive waste, notably by defining long-term management routes for the radioactive waste currently with no solution, as well as their financing.

1.3.2. Scope covered by the PNGMDR

The PNGMDR concerns all radioactive waste, that is:

- “waste from nuclear activities” (activities regulated owing to the radioactivity they use);
- “waste from activities handling radioactivity, but exempted under the terms of the regulations”, which comprises significant concentrations of radioactivity or which represents particularly large numbers, requiring that specific measures to be taken (case of smoke detectors for example);

- “radioactive substances of natural origin”, the radioactivity of which may be concentrated by a human activity not necessarily using the materials for their radioactive properties, for which the radioactivity concentration is such that it cannot be ignored from the radiation protection standpoint;
- residues from the processing of uranium ore disposed of in the ICPEs and mining waste rock.

The PNGMDR also covers radioactive materials (see § B.1.2.2).

1.3.3. The PNGMDR 2016-2018

The PNGMDR 2016-2018 follows on from the previous version, putting greater emphasis on the management route approach, particularly by the constitution or updating of associated overall industrial systems. It moreover demands that the new management capacities and equipment necessary for the smooth functioning of the management routes be inventoried in order to set time frames for their deployment. It finally places particular emphasis on the need to consolidate the forecasts for the production of very low level (VLL) waste and to reinforce the explanation of the possibilities of reusing certain radioactive materials.

This fourth edition of the PNGMDR underwent an environmental assessment and a public consultation which enabled greater importance to be attached to the environmental themes while also reiterating the virtuous end-purpose of the plan. It also presents indicators for evaluating the progress of implementation of the plan in application of Council Directive 2011/70/EURATOM establishing a community framework for the responsible and safe management of spent fuel and radioactive waste, adopted on 19 July 2011.

The PNGMDR 2016-2018 proposes the following measures in particular:

Consolidation of the prospects for the reuse of radioactive materials

The PNGMDR 2016-2018 addresses the issue of radioactive materials whose long-term use depends on maintaining nuclear energy production in France or abroad: depleted or reprocessed uranium and thorium in particular. The plan required (1) a comparative analysis of the environmental impacts of a strategy for reprocessing spent fuel and those of a strategy without reprocessing, (2) consolidation of the prospects for reuse according to scenarios compatible with the Energy Transition for Green Growth Act, (3) continuation of the studies on the disposal concepts that could accommodate these substances if they were requalified in the future as radioactive waste and (4) the development of a programme of studies to be carried out in the ASTRID demonstrator in order to demonstrate the reuse capabilities of the proposed technologies on a representative scale. (see § B.2.4.1).

Optimisation of the very low level waste management route

The PNGMDR 2016-2018 addresses this subject from several aspects:

- it prescribes work on reducing the volumes of waste produced and on recycling;
- disposal solutions providing alternatives to a centralised VLLW disposal facility must be examined;
- in 2020 Andra must update the overall industrial system it developed in 2015 for the management of the very low level waste, which includes the creation of a new disposal facility for VLL waste;
- the environmental impact of transport operations must be assessed and reduced.

Working in collaboration with the waste producers, Andra must submit a revised overall industrial system for the management of VLL waste before the end of 2020.

New directions for low-level long-lived waste

The PNGMDR requires:

- the continuation of more detailed geological investigations on the Soulaines site;

- more detailed studies relative to the processing of graphite waste which would enable the radiological inventory disposed of on the site to be reduced;
- inclusion of some of the LLW-LL waste in the “reserve inventory”1 of Cigéo, enabling uncertainties to be addressed;
- the search for a second LLW-LL waste disposal site to provide a management solution for all the waste of this type in this medium term.

An overall industrial system for the management of all LLW-LL radioactive waste was to be submitted before the end of 2019. It is now announced by Andra for the end of 2020.

Continuation of the work on high-level and intermediate-level long-lived waste

The PNGMDR 2016-2018 requires the continuation of the Cigéo project by Andra and the producers of high-level and intermediate-level long-lived waste (HLW/ILW-LL). When Andra makes the creation authorisation application for Cigéo, it will have to detail the quantity and nature of packages needed so that the pilot industrial phase planned before definitive commissioning can on the one hand consolidate the safety case, and on the other demonstrate that the facility is capable of gradually ramping up to handle industrial disposal volumes. The PNGMDR 2016-2018 also requires that Andra and the radioactive waste producers take account of this industrial pilot phase when preparing delivery schedules for packages intended for deep geological disposal.

A better estimation of storage requirements

Drawing up the inventory of foreseeable waste storage facility needs is one of the roles of the PNGMDR. In this respect this edition of the plan asks the licensees to give details on the occupancy levels of the existing storage facilities for spent fuel (capacities needed for the continued production of nuclear electricity), uranium (depleted and reprocessed), waste, and the future storage capacity needs.

1.3.4. The fifth edition of the PNGMDR

1.3.4.1. The public debate in preparation for the fifth edition

With regard to how public participation would be organised for the production of the fifth edition of the National Radioactive Materials and Waste Management Plan, the Ministry responsible for Energy (General Directorate for energy and the Climate - DGEC) and ASN referred the matter to the National Public Debates Commission. The CNDP decided to organise a public debate and appointed a Special Public Debate Committee (CPDP).

ASN and the DGEC drew up a “project management file” (DMO), to present the main aspects of the PNGMDR and the main issues with respect to the drafting of the next plan. Ahead of the debate, the CPDP produced a “clarifying the controversies” dossier, which aims to provide the non-specialist public with the various viewpoints put forward by the experts and institutional organisations concerning questions arising from the plan.

The debate was held from 17 April to 25 September 2019, using a variety of procedures:

- general subject meetings in large cities;
- thematic meetings in the regions concerned;
- discussion sessions debating an ethical approach to the management of radioactive materials and waste;

[1] Article D.542-90 of the Environment Code states that “the inventory to be adopted by Andra for the studies and research carried out for the design of the repository comprises a reference inventory and a reserve inventory.
The reserve inventory shall take into account the uncertainties associated more specifically with putting in place new waste management routes or changes in energy policy.
The repository shall be designed to accommodate the waste of the reference inventory.

- a round-table on the question of trust and mistrust felt by the public with respect to the decisions taken or envisaged;
- information and debate stands in several towns around France;
- an on-line participative platform enabling people to express an opinion, submit comments on those opinions already expressed, submit questions to the prime contractor and, for artificial persons, submit an individual stakeholder's presentation and contributions document.

In parallel with these participation methods open to all, the CPDP set up some innovative systems:

- a "mirror group" comprising 14 randomly selected citizens, which produced a joint contribution on the topic "What did we inherit and what will be leave to our children?";
- a "tomorrow's specialists workshop" brought together students from different backgrounds to explore how radioactive waste management can be informed by different disciplines.

The CNDP and the CPDP presented the conclusions they drew from this debate in a report and summary transmitted on 25 November 2019 (https://pngmdr.debatpublic.fr/). The CPDP concluded that the debate had served to clarify the various options and the corresponding issues with regard to the main topics identified. Other subjects were also raised during the public debate, such as the management of special waste categories, transport or local impacts. Moreover, the duration of the plan, set by law at three years, was felt to be too short and inconsistent with the nature of the issues relating to the subjects to be dealt with today, as well as with the time-frames of the other plans linked to it, notably the multi-year energy programme.

1.3.4.2. Drafting of the fifth edition of the PNGMDR

On 21 February 2020, the Minister responsible for Energy and the ASN Chairman presented the orientations envisaged for the next plan, further to the debate:

- improve coordination between energy policy and waste management policy: the frequency of the PNGMDR will be brought into line with multi-year energy programming, and the coordination with final shutdown and decommissioning strategies proposed by industry will be more clearly explained;
- reinforce the governance of radioactive waste management: the PNGMDR drafting and oversight body will be expanded to include national elected representatives, civil society and representatives of local authorities, in addition to participation by environmental protection associations;
- reinforce oversight of the reusable nature of radioactive materials: for materials which are not currently reused, industry will make a commitment to interim targets in the action plans, which will be periodically reassessed;
- address the need for new spent fuel storage capacity: the PNGMDR will make provision for new centralised underwater storage capacity, taking account of the time needed to build it. It will study the conditions and situations in which dry storage could be of use;
- whenever pertinent and by means of targeted exemptions, allow the reuse of certain very low level metallic waste and define the conditions for such reuse;
- continue with defining the conditions for implementation of the Cigéo project, notably the methods for involving the public in the fundamental stages of the project, as well as R&D on alternative management solutions;
- reinforce the assessment of local impacts of the management choices and the resulting economic, health and environmental issues (impact of transports, harmfulness of wastes, etc.): the public debate revealed particular sensitivity to these aspects. ASN opinions on radioactive materials and waste management solutions will be issued on the basis of these orientations.

Changes to the governance of the plan are also currently being considered.

The drafting of the 5th plan and its strategic environmental assessment and public consultation will take place in 2020 and early 2021. The plan will then be transmitted to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) and made public.

1.4. Ban on the disposal of radioactive waste from abroad

The Environment Code states that the disposal in France of radioactive waste from abroad, as well as of radioactive waste resulting from the reprocessing of spent fuels and radioactive waste from abroad, is prohibited.

The law also requires that intergovernmental agreements must be concluded, setting a limit date for return of ultimate waste to its country of origin, before radioactive waste or spent fuel can be brought into the country for treatment or reprocessing. Each intergovernmental agreement also specifies the anticipated periods in which these substances will be received and processed and, as applicable, the prospects for the subsequent use of radioactive materials separated during processing.

The licensees reprocessing spent fuels or radioactive waste from abroad must implement a system for allocation of the waste resulting from the reprocessing operations, approved by Ministerial Order. The law requires that these licensees produce an annual report showing the stocks and traffic of foreign radioactive substances, including anticipated future volumes. This report is made public.

This legislative system is supplemented by a system of administrative controls and criminal penalties.

1.5. A management policy based on research and development

1.5.1. High-level and intermediate-level, long-lived waste

For high level and intermediate level, long-lived waste, three complementary areas of research are defined in the “Waste” Act:

Separation and transmutation of long-lived radioactive elements

At the end of 2018, CEA submitted a report on “*the anticipated inventory between 2016 and 2100 of radioactive materials and waste produced by the French fleet according to various development scenarios”* in response to the request made in the PNGMDR 2016-2018. This report presented the results of the technical characterisation studies of possible future scenarios involving different fuel cycle and uranium and plutonium management options: open-cycle, single-recycling cycle, PWR then FNR dual-recycling cycle, closed cycle with FNR (100% or FNR/PWR hybrids), also considering other options such as multi-recycling in PWRs. In terms of hypotheses and time-lines, these scenarios are identical to the anticipated scenarios of the 2018 edition of the National Inventory of radioactive materials and waste.

Following the conclusions of the multi-year energy programme (PPE), CEA announced that the FNR system was to be mothballed, specifying that the prospect for industrial development of the generation IV reactors is no longer envisaged before the second half of this century. At this stage, the construction of the Astrid prototype reactor is not scheduled for either the short or medium term.

Prospects for the reuse of materials currently without any identified use

The FNR programme offered a prospect for the reuse of materials currently with no identified use, that is those present in the fuels recycled in water reactors (MOX and URE). Following the postponement of this reactor type, a new intermediate plant series could be envisaged, consisting in recycling the materials several times (in the future third-generation EPR type reactors). If confirmed by the feasibility studies, the technologies needed for this would be similar to those used today (case of reactors) and would require adjustments in the fuel cycle plants. All irradiated spent fuels are recovered and their materials recycled, the plutonium inventory is controlled and could be stabilised at an appropriate level according to the future prospects, thus leading to savings in terms of additional uranium mining resources.

In accordance with the French nuclear sector Strategic Contract 2019-2022, EDF, Orano, Framatome and CEA came together to produce an R&D programme to study the benefits of multi-recycling in PWRs (MRREP) of materials (Pu and U) in terms of competitiveness and management of materials and waste, as well as its feasibility and its performance in the reactors (safety and operation) and in the fuel cycle (processing, fabrication, transport, storage). This programme will assess the question of the sustainability of the technological solutions identified before resorting to any generation IV reactors, and the compatibility of these same solutions with the objectives of the PPE. By the 2025-2028 time-frame, it will include experimental burn-up of a test fuel assembly in a reactor, which will aim to demonstrate the recyclable nature of the MOX fuels irradiated with current reactor and cycle technologies, adapted if need be.

The programme of work will comprise intermediate project reviews validating whether or not to launch subsequent R&D phases (based on the evaluation of technical and economic criteria).

Particular emphasis will also be placed in integrating the needs of the related major pre-industrial projects: refurbishment of the Orano plants, changes to current MOX products, deployment of MOX on the 1300 MWe plant series, France New Nuclear programme.

Reversible deep geological disposal of waste

This line of research corresponds to the following objective set by the Waste Act: *"after storage, the ultimate radioactive waste which for reasons of nuclear safety or radiation protection cannot be disposed of in an above-ground or near-surface disposal facility shall be disposed of in a deep geological facility"*.

Studies and research are under way with a view to producing the file that will accompany the facility creation authorisation application. The conditions of reversibility are defined by the 25 July 2016 Act specifying the procedures for the creation of a reversible deep geological disposal facility for high and intermediate level, long-lived radioactive waste. The studies and research carried out by Andra are based on experimental results obtained in the underground laboratory in the Meuse/Haute-Marne *départements*. This laboratory allows in-situ study of the geological environment (characteristics in the broad sense, including the behaviour of the radionuclides), the behaviour of the materials interacting with the host rock, the effects (thermal, hydraulic, mechanical, chemical) of the disposal facility on the host rock and the development and testing of processes for excavating, observing, monitoring and closing the disposal facility. The studies in the underground laboratory were deployed progressively to meet the various milestones of the disposal facility project; after focusing primarily on the characterisation of the geological environment and the constructability of the disposal facility in 2005 to satisfy the repository principle feasibility file, following the act of 2006, these studies focused on the materials and technological aspects of the disposal facility in order to provide the elements necessary for the Cigéo creation authorisation application.

The reversibility of disposal, required by the Waste Act of 2006, is a significant change with respect to the Act of 30 December 1991. Act 2016-1015 of 25 July 2016 provides a definition of reversibility applicable to Cigéo and specifies its implementation conditions.

When the creation authorisation application is examined, the safety of the deep geological disposal facility will be assessed in the light of the different stages in the incremental development of the facility, including its definitive closure. Only an Act (law) will be able to authorise definitive closure of the facility. A specific act defining the reversibility conditions will set the minimum period for which, as a precaution, the reversibility of disposal shall be guaranteed, this period not being less than one hundred years.

The deep geological disposal project is detailed in the rest of the report (more specifically see sections D and H.3).

Storage

The corresponding studies and research are carried out with a view to creating new facilities or modifying existing facilities in order to meet the needs identified by the National Radioactive Materials and Waste Management Plan.

Unlike disposal, storage is a temporary situation, offering an interim solution for placing the waste in a safe place pending commissioning of the disposal facility. The studies and research explored the different aspects of the complementarity between storage and reversible disposal. Storage is necessary but it cannot be considered a final solution for the management of high-level and intermediate-level, long-lived waste.

In 2012, Andra submitted the summary of the studies and research it had carried out on storage, in accordance with the Waste Act. The report details the various principles, criteria and technical options for storage, thus completing a process of several years of studies.

It was supplemented in 2014 by recommendations for the design of storage facilities as a complement to disposal. It was drawn up in collaboration with Orano, CEA and EDF. It addresses provisions that are favourable to the durability and monitoring of the facilities, and design aspects relating to disposal reversibility.

Finally, within the framework of the PNGMDR 2016-2018, Andra submitted a study in 2018 presenting the technical aspects on the basis of which it rules out the design of near-surface storage facilities.

Research into deep disposal and into storage is being carried out by Andra. Its method of financing is detailed in section F.2.2.1.1. Research into separation/transmutation is for its part financed by the subsidy to CEA.

1.5.2. Low-level long-lived waste

Large quantities of LLW-LL waste cannot be disposed of on the surface in Andra's industrial centres in the Aube *département* owing to their long lifetime, but nor does their harmfulness justify systematic disposal at 500 metres depth in Cigéo. An appropriate disposal solution proportionate to the safety issues represented by this waste must therefore be developed. This solution must address several issues: technical (choice of site, understanding of the waste, disposal concept), consistency with the strategy envisaged by the waste producers for the decommissioning of their facilities and the storage of their waste, as well as ethical and societal questions specific to this waste, which represents a minor hazard but one that persists over long time-scales.

The 28 June 2006 Act requires the development of disposal solutions for low level, long-lived waste, in particular for radium-bearing waste and graphite waste. In 2012, Andra submitted a report on the possible management scenarios for LLW-LL waste, depending on its nature.

The definition of the long-term management scenarios for this waste is notably based on the characterisation of the waste and its behaviour in a disposal situation.

In July 2013 the Municipal Federation of Soulaines gave its consent to geological investigations being conducted over a 50 km^2 sector to study the feasibility of a near-surface disposal facility for low-level long-lived waste (LLW-LL). The disposal concept studied on this site was the installation of disposal vaults in a clay formation at a minimum depth of about twenty metres, considering two design options: earthworks from the surface down to the disposal facility installation depth (and closure of the disposal facility by a reworked clay cover) and underground excavation of the vaults.

Preliminary reconnaissance works from 2013 to 2015 gave an initial representation on the one hand of the geological environment, notably the presence of a clay formation across most of the sector, with a thickness of up to 80 m and, on the other, flows through the clay formation to the underlying Albien aquifer.

Alongside this, studies were carried out on (1) waste, with regard to the waste inventory (graphites and bituminised sludge), waste treatment (graphite) and its behaviour in the disposal situation, particularly for graphites (kinetics of release of the radionuclides contained in the waste), and (2) the behaviour of certain radionuclides (chlorine-36 and carbon-14 in particular) in the cementitious materials and in the envisaged clay formation).

Thus, with regard to this waste, the characterisation work carried out by CEA and EDF on the graphite waste and bituminous sludges, in response to the requirements of the PNGMDR 2016-2018, concluded that there was a significant reduction in the radiological inventory of chlorine-36 and iodine-129 respectively. With regard to the radionuclides, the retention of chlorine-36 and carbon-14 in the concretes was consolidated and that of "inorganic" carbon-14 in the teguline clay was established.

With regard to the processing of graphite waste, in accordance with a requirement of the PNGMDR, CEA and EDF submitted their conclusions at the end of 2017 concerning the possibility of processing graphite waste, which concluded that given current technical know-how and after several years of R&D, the scenario of processing before disposal would no longer seem to be an alternative to the reference scenario based on direct, near-surface disposal of graphite waste. However, CEA and EDF are maintaining an international technological watch on the thermal processing of graphite, more particularly via IAEA's GRAPA project. Within this project, several countries presented graphite processing tests, but were unable to demonstrate industrial feasibility.

On the strength of the knowledge thus acquired (geological environment, waste and radionuclides), preliminary safety studies were carried out to evaluate the safety performance of the disposal facility.

The results as a whole were summarised in the interim report submitted to the government in July 2015. This first reconnaissance phase identified a zone of about 10 km^2 for the rest of the studies, displaying the most favourable geological characteristics on which to focus continuation of the study of a near-surface disposal facility for LLW-LL waste. This interim report was the subject of exchanges in 2015 and 2016 between Andra on the one hand and ASN and IRSN on the other. ASN issued an opinion on the report, stating *"that it will be difficult to demonstrate the feasibility - in the investigated area - of a disposal facility for all the LLW-LL waste identified by Andra"*.

To follow up the report submitted in 2015, the National Radioactive Materials and Waste Management Plan 2016-2018 (see § B 1.3.2.2) requires that before the end of 2019, Andra must submit an overall industrial system for the management of all LLW-LL radioactive waste. This system must in particular incorporate new input data that have become available since 2015: ASN opinion on the 2015 interim report, request to take account of new waste in the project inventory, changes in the decommissioning and clean-out strategies adopted by the producers, more specifically the announced postponement of the schedules.

In order to produce this industrial system, the Agency carried out additional geological investigations between 2017 and 2018 in the area of interest proposed in 2015. With the waste producers, it is also continuing to conduct studies of the radiological inventory of the waste and its behaviour in a disposal situation. At the same time, Andra also gave thought to the possible creation of a disposal area for very low level (VLL) waste in the future centre dedicated to LLW-LL waste. Given the predicted volumes of VLL waste to be produced by future decommissioning operations, plans must be made immediately for new disposal capacity and synergy could be created with the existing Andra centres in the Aube *département*. This overall industrial system for management of LLW-LL waste is now expected to be ready in 2020.

1.5.3. Other waste covered by research programmes

The PNGMDR keeps track of the waste for which a management route is not yet defined. "Management route" means the method of management (processing, packaging, etc.) of the waste enabling it to be accepted in a repository appropriate to its characteristics (radiological, etc.) and harmfulness.

The PNGMDR 2016-2018 thus identifies the following types of waste:

- waste containing asbestos for which the conditions of disposal at Cires are being discussed with the main producer concerned;
- mercurial waste waiting for final qualification of the treatment process;
- activated waste from small producers (coming from irradiators) waiting for radiological characterisation of the activated metals;
- tritiated or gaseous waste from small producers.

These types of waste, which have their own specific problems, nevertheless represent limited quantities, apart from waste contaminated by asbestos (several thousand cubic metres). Nonetheless, with regard to this latter, the studies carried out during the period 2013-2015 caused Andra to modify the Cires acceptance specifications applicable to this waste and to define maximum acceptable asbestos capacity. On these bases, the asbestos waste can now be disposed of in the CSA and Cires if it meets the acceptance criteria and if the authorised asbestos disposal capacity is not exceeded.

Work is also carried out on themes relative to particular types of waste to clarify, or possibly adapt, the specifications for acceptance in the disposal facilities in operation. This is for example the case with metals that react with hydraulic binders.

Within the framework of the Investments for the Future programme[1], Andra supports and participates in some thirty R&D projects on the characterisation, treatment or conditioning of radioactive waste. Andra has thus been involved since 2014 in the PIVIC project, in collaboration with CEA and Orano, on the treatment of ILW-LL alpha waste with a high organic content. It has also put out a call for proposals with a budget of €45 M on the theme of optimising the management of radioactive decommissioning waste. This call for proposals concerned 4 R&D themes:

- characterisation of the sites to be decommissioned and of the waste produced;
- sorting and treatment of the waste;
- new materials for disposal;
- Innovation and society (Social Sciences and Humanities theme).

Nearly 90 projects have been submitted, with a high level of participation by small and medium-sized enterprises and the involvement of actors from outside the nuclear sector. 29 projects have been selected.

On this decommissioning theme, which will be responsible for the majority of the future waste traffic, Andra is also mobilising its resources:

- to accept waste in its industrial facilities, adapting procedures where necessary with the aim of achieving overall optimisation, that is to say by considering all the waste management phases, from production through to disposal, and taking into account criteria such as the radiological exposure of operators, the rate at which disposal capacities are used up, costs, etc.
- to look for alternative management solutions to disposal on its sites and the services to licensees in order to become involved earlier on in the choice of decommissioning strategies with respect to waste management.

Andra assists the authorities in defining the policy guidelines to be adopted for the management of decommissioning waste. Lastly, Andra is involved in various dossiers and/or studies, especially the prospective

[1] The Investments for the Future Programme (PIA), run by the General Secretariat for investments (SGPI), was created by the State to finance innovative and promising investments around the country, to enable France to boost its growth and jobs potential.

characterisation studies for the disposal of waste from future nuclear power reactor fleets, notably including the generation IV fast-neutron reactors.

1.6. A management policy founded on transparency and democracy

The second pillar of the radioactive materials and waste management policy consists in ensuring there is a democratic dialogue at all levels:

- locally and continuously, through the setting up of Local Information Committees (CLI) for the treatment and disposal facilities;
- with the general public: the PNGMDR is a key factor in transparency (see § B.1.3);
- at Parliamentary level: the authorisation of a deep geological disposal facility is regulated by law (article L. 542-1-10 of the Environment Code, modified by the 25 July 2016 Act). The main change introduced by this Act concerns the creation of a pilot industrial phase ahead of operation, in order to confirm the facility's reversibility and its safety case, notably by means of an in-situ test programme. The results of this industrial pilot phase shall give rise to a report from Andra, an opinion from the national commission tasked with the annual assessment of progress in research and studies relating to the management of radioactive materials and waste, an opinion from ASN and the opinions of the neighbouring regional authorities.

Finally, in accordance with the Environment Code, any party responsible for nuclear activities and any enterprise mentioned in article L. 1333-10 of the Public Health Code is required to produce and update the information needed for the purposes of oversight and make it available to the administrative authority. The law makes provision for penalties for any failure to comply on the part of the licensee.

Decree 2008-875 of 29 August 2008 specifies the scope and nature of this information, in order to allow the production of the National Inventory of radioactive materials and waste.

1.7. Financing of radioactive materials and waste management policy

In the light of the issues involved in radioactive waste management, the public authorities expressed a desire for guarantees that the financing of research and of management itself was secure, as was the financing of BNI decommissioning.

1.7.1. Secure financing of the costs of managing radioactive waste and spent fuel and decommissioning of nuclear facilities

The system set up by France for financing the decommissioning of BNIs and managing the spent fuel and radioactive waste produced by these installations, is based on the entire financial responsibility of the licensees.

The BNI licensees must make a prudent evaluation of the cost of decommissioning their installations and managing the spent fuels and radioactive waste they produce and must create provisions accordingly in their accounts.

These provisions must be covered by financial assets. The realisable value of these covering assets must be at least equal to the amount of these provisions, except for those linked to the operating cycle.

The provisions linked to the operating cycle correspond to the provisions for the management of spent fuels considered to be recyclable in industrial facilities either already built or under construction. This mainly concerns provisions for the reprocessing of spent UOX fuels. These provisions are excluded from the base of the provisions to be secured by the creation of covering assets because they will be directly financed by operating revenue from the facilities benefiting from the use of reprocessed plutonium and uranium separated during the reprocessing of these spent fuels. However, the provisions for the long-term management (storage and disposal) of radioactive waste packages resulting from the reprocessing of these spent fuels are included in the base of the provisions to be secured by the creation of covering assets.

The covering assets are included in the licensee's balance sheet and managed by it (internal funds), but are legally separate from the rest of the balance sheet (legal separation): they may only be used to settle long-term nuclear costs, even if the licensee experiences financial difficulties. Article L. 594-3 of the Environment Code thus states that with the exception of the State under its policing powers in this respect, nobody may exercise any right over these assets, including on the basis of book VI of the Code of Commerce.

Furthermore, the covering assets must be sufficient in terms of security, diversity and liquidity. To this end, the regulations set out rules of prudence applicable to the management of the covering assets: nature of the allowable assets, rules of distribution between asset categories, dispersion rules, etc. This decree also stipulates requirements for governance, periodic financial risk assessments, etc.

The obligation to create provisions and allocate covering assets exists:

- as of the commissioning of the facilities, with regard to the decommissioning costs and the corresponding radioactive waste management costs;
- as of the introduction of fuel into the reactor core for the cost of managing the spent fuel and the corresponding radioactive waste;
- as of its production for the cost of managing other radioactive waste.

The law makes provision for oversight by the State, along with the power to issue binding requirements and penalties, up to and including seizure of the funds (see section F.2.3.1).

1.7.2. Financing of R&D and design studies for the deep geological disposal repository

R&D and design studies on the deep geological disposal repository conducted by Andra are financed from taxes and contributions levied on the radioactive waste producers. The "research" tax and the "design" special contribution are described in greater detail in section F.2.2.1.1. They are used to secure Andra's sources of financing.

The amounts of this tax and this contribution are calculated as being the product of flat-rate taxation multiplied by a coefficient. On the basis of the current BNIs, Andra receives about € 215 M/year.

2| FRANCE'S SPENT FUEL MANAGEMENT POLICY

2.1. General reprocessing-recycling policy

With its fleet of 56 nuclear power reactors operated by EDF, France produces about 400 TWhe of nuclear generated electricity every year (393 TWhe in 2018 and 379.5 TWhe in 2019), which leads to the production of an average of about 1150 t of spent fuel per year.

For these spent nuclear fuels, in the same way as other countries, France has opted for a spent fuel reprocessing-recycling strategy. This reprocessing-recycling choice was confirmed by the Waste Act, which requires that the PNGMDR must comply with the following goal: "to reduce the quantity and harmfulness of the waste, in particular by reprocessing spent fuels and processing and packaging radioactive waste".

The management strategy for the spent fuel produced in research reactors is developed according to the characteristics of the fuels and, depending on the case, may involve reprocessing-recycling, or direct disposal (see section G.7).

2.2. Justification of the choice of reprocessing-recycling

France considers that this reprocessing-recycling strategy offers a certain number of energy and environment advantages.

Recycling of nuclear materials makes a strategic contribution to the security of supply. On the one hand, it allows better use of existing energy resources, by reusing the uranium and plutonium still present (nearly 96% of it) in the spent fuel, which would not be the case in an open-cycle, or once-through system. On the other, with today's reactors, this recycling could help bring down the consumption of natural uranium by up to 25% if all the nuclear materials were to be recycled. Half of this saving can be achieved through MOX fuel and half through re-enrichment of the uranium derived from the reprocessing of spent fuels. This strategy serves to improve the security of supply and helps with the diversification of supply, which is of particular importance for a country such as France, which has few resources within its own borders. Finally, this strategy provides energetic materials usable for the potential deployment of future fast neutron reactors.

The reprocessing of spent fuels has benefits when it comes to the long-term disposal of radioactive waste. On the one hand, the waste resulting from reprocessing is packaged durably, facilitating handling, storage and disposal. On the other, the reduced volume and thermal load of the waste packages facilitates long-term disposal, because the footprint and volume of the management facilities is reduced accordingly, thus bringing down the cost of disposal and also mitigating the impact of uncertainties of this disposal cost. Conditioning by vitrification of the fission solutions resulting from the reprocessing of spent fuels offers good containment of the radionuclides. Moreover, with a strategy of recycling materials in fast neutron reactors, plutonium in particular, this brings down the long-term radiotoxicity of the ultimate waste.

From a political viewpoint, this strategy is consistent with the desire to limit the burden on future generations, by resorting to the best existing technologies, making the best possible use of energy resources and leaving all options open for the future (with or without fast neutron reactors).

Finally, using plutonium in the MOX fuels, which enables about one-third of the plutonium to be consumed, while significantly degrading the isotopic composition of the remaining plutonium, means that this technology is non-proliferating. In addition, France adapts the rate of its reprocessing-recycling operations to the MOX fuel consumption needs, in order to minimise the stock of separated plutonium. The use of reprocessing-recycling technologies in a small number of centres around the world, subject to international guarantees, helps reduce the risks of proliferation worldwide: the use of reprocessing-recycling services avoids the build-up of spent fuels in numerous storage centres around the world, thus leading to final waste that does not need to comply with the IAEA requirements.

With this strategy, the spent fuel is a reusable energetic material for which there is an intended future use. This strategy enables the option of recycling of materials as an energy resource for future reactors to be kept open. This point is also mentioned in the following §.

2.3. Implementation of this policy

This reprocessing – recycling strategy is implemented in France by means of:

- a fuel reprocessing plant (La Hague plant) and a MOX fuel fabrication plant (Orano Melox plant in Marcoule);
- an NPP fleet in which 22 of the 56 reactors are currently authorised to work with a MOX fuel (up to one third of the fuel assemblies), along with 4 other reactors authorised to operate entirely with re-enriched reprocessed uranium based assemblies.

Given the "moxable" fleet and the units authorised to receive uranium from the reprocessing of spent fuel, France can thus save up to about 17% natural uranium in its fuel consumption.

To avoid creating unused stocks of separated plutonium, the fuel must be reprocessed as and when outlets appear for the plutonium extracted ("flow matching" principle).

Pending reprocessing, the spent fuels are stored in the pools of the la Hague plant after interim storage in the fuel cooling pools in the NPPs.

2.4. Outlook

2.4.1. Generation IV prospects

For the spent MOX, which contains a high concentration of plutonium with a high energy potential, as well as for the spent UO_2 fabricated from the uranium derived from reprocessed spent fuels, the current strategy is to store them and, as applicable, reprocess them subsequently in order to use the plutonium in fast neutron reactors (FNR). Therefore, whether or not new generations of reactors are developed will be decisive in determining the duration of storage of these fuels, their future and their final destination. Experimental campaigns to process MOX (65 tHMi of MOX so far reprocessed) have already been carried out at La Hague, demonstrating the feasibility of this operation by dissolution then mixing with solutions from the reprocessing of spent UO_2 fuels.

Developing such generation IV FNR reactors could further optimise the use of the energy resources. For a given quantity of natural uranium, the recoverable energy could be up to 100 times greater than with today's reactors.

However, given that natural uranium resources are abundant and available at low cost, at least up until the second half of the 21st century, the need for a demonstration FNR reactor, followed by FNR deployment, would not appear to be useful before this time-frame. This is why, in the short-term, R&D efforts will be focused on the feasibility of multi-recycling in PWRs. With regard to the generation IV reactors, France is continuing its long-term efforts around a programme aiming to reinforce its digital simulation capability and maintain the skills acquired on these reactors of the future (ASTRID prototype), a technology that is key to the sustainable use of the nuclear systems. The content of this R&D programme will need to be defined in detail in the coming months.

In 2014, the Advisory Committee for Nuclear Reactors (GPR) informed ASN that: *"In the light of the report produced, the GPR considers that, to date, of the various nuclear systems envisaged by the GIF [Generation IV Forum], only the SFR sodium-cooled fast neutron reactor system [RNR-NA] is at present mature enough for the construction of a 4th-generation industrial reactor prototype to be conceivable in the first half of the 21st century. However, in the light of what was presented to it, the Advisory Committee cannot give any clear opinion - with regard to the industrial deployment of this technology - on the ability to achieve a level of safety significantly higher than that which is targeted for the EPR type pressurised water reactors, owing in particular to design differences and the current state of studies and research".*

2.4.2. Multi-recycling in PWRs

The eventual goal is plutonium multi-recycling in a fleet of fast neutron reactors. However, this does not need to be implemented on a large scale, either today or indeed before the last part of the 21st century, given that natural uranium resources are abundant and available at an acceptable price, at least up until that time-frame.

As recalled in the Strategic Contract for the French nuclear industry, "this recycling strategy may be reinforced and prepared by exploring solutions for multi-recycling in PWRs which could minimise the plutonium stocks in the cycle, while making technical progress on subjects common to PWR and FNR multi-recycling".

This approach is based on the MOX2 fuels concepts that is fuels containing both rods recycling Pu and rods with enriched uranium (Corail) or rods containing both (MIX).

The use of this type of fuel requires an in-depth R&D programme and reactor safety engineering studies, possible changes in operating conditions, fabrication in the plants, transport logistics, etc. An initial objective is the introduction of a test assembly into a reactor by the 2025 time-frame.

2.4.3. Precautions taken for the future, supplementing this long-term strategy

The Environment Code creates arrangements to secure the financing of long-term nuclear costs (see § B.1.7), which, it should be remembered, exclude costs "linked to the operating cycle". On the other hand, spent fuels which are not recyclable in existing installations (spent MOX and spent URE) must be covered by accounting provisions on the basis of a direct disposal scenario, as well as being financially covered by the dedicated funds described in § B.1.7.

The PNGMDR 2016-2018 also requires that the holders of reusable substances and Andra conduct interim studies on the possible disposal solutions if these materials were in the future to be qualified as waste (see § B.1.2.2 and B.4.1.2).

3| SPENT FUEL MANAGEMENT PRACTICES

3.1. EDF's management of spent fuels from NPP reactors

EDF is responsible for the fate and the reprocessing of its spent fuels and the corresponding waste with no possible transfer nor time limit.

At present, the strategy adopted by EDF is to reprocess the spent fuels and optimise the energy efficiency of its fuels. After a cooling period in the nuclear reactor fuel building pools, the spent fuel assemblies are transported to the Orano Cycle plant at La Hague. After a few years, the spent fuels are then treated by dissolution, to separate the high-level waste, which is vitrified, from the materials that can still be reused. The plutonium is recycled in the MOS fuels; the uranium obtained from reprocessing will again be recycled in the URE fuels, after re-enrichment, as of 2023 in the 900 MW reactors at Cruas and then, in the longer term, in the 1300 MW reactors. With the current recycling of plutonium and the future recycling of reprocessed uranium, savings of up to 25% could be made in terms of natural uranium.

To check the overall consistency of the fuel cycle, EDF – together with the fuel cycle industry – periodically provides a forward-looking file analysing the compatibility between changes in the characteristics of new or spent fuels, and changes in the installations of the transport, storage, reprocessing and recycling installations (known as the "cycle impact" file).

ASN completed its review of the most recent version of this file in 2018 (see section G.1.3).

3.2. CEA's management of spent fuels from research reactors

CEA's reference strategy is to transport irradiated fuels to the "back-end" plants of the fuel cycle for reprocessing, as rapidly as possible.

Most of the CEA spent fuels are sent to the La Hague processing plant (Orano).

Until such time as they are accepted by the La Hague plant, CEA stores its spent fuels in two facilities on the Cadarache site, in accordance with specific safety rules. These facilities include dry storage, CASCAD (spent fuel elements dry storage bunker, with shaft cooling by natural convection), which takes most of the fuels from the CEA's civil activities, plus underwater storage in the CARES pool.

There are still storage facilities at Saclay and Marcoule: the fuels they contain are gradually being removed. Those still present in the pools of BNI 22 (PEGASE) at Cadarache will be removed by 2030 while those in BNI 72, including the EPOC waste bins from Saclay, will be removed by 2035.

The solutions currently envisaged include phased processing in the La Hague plant, with possible prior storage in the CASCAD or CARES facilities.

3.3. Management of spent fuels by Orano

Orano provides the French and foreign licensees with the products and services needed to implement their spent fuel management policy.

The spent fuels are sent for reprocessing to the La Hague site and are stored there in pools, for an appropriate cooling period. The materials derived from reprocessing are managed for recycling either immediately, or later on, depending on market conditions. The waste is packaged for return to its owner, pursuant to Article L. 542-2 of the Environment Code.

The reusable materials and the various wastes are separated and packaged in the La Hague plants. The plutonium is recycled in the form of MOX fuels fabricated in the Melox plant at Marcoule, which has an authorised annual capacity of 195 t of heavy metal (tHM).

More than 36,000 tHM of fuels have been reprocessed at La Hague (as at end of 2019), primarily enriched natural uranium fuels (UNE). The feasibility of the recycling of the MOX, FNR and URE fuels was demonstrated by specific industrial campaigns covering about a hundred tonnes of fuels in the La Hague plants, UP2-400, UP2-800 and UP3-A.

4| THE CRITERIA APPLIED FOR DEFINING AND CLASSIFYING RADIOACTIVE WASTE

4.1. Definition of “radioactive waste”

The definitions of a “radioactive substance”, a “radioactive waste” and a “radioactive material” as defined by law are given in § B.1.2.1.

Two aspects deserve particular consideration:

- on the basis of what criteria should a substance be considered as radioactive?
- how to assess whether a radioactive substance is reusable or waste?

4.1.1. Radioactive nature of substances

4.1.1.1. Exemption

Further to the transposition of European Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for the protection of health against the hazards arising from exposure to ionising radiation, some of the exemption thresholds in the Directive were introduced in tables 1 and 2 of Appendix 13-8 of the Public Health Code.

Case of naturally occurring radioactive substances not used for their radioactive, fissile or fertile properties:

Most materials are naturally radioactive. Their radioactivity comes primarily from potassium 40 and the radionuclides of the uranium and thorium families. The exemption value defined in table 1 is 1 kBq/kg for the uranium and thorium series and 10 kBq/kg for potassium 40. Waste containing substances with an activity level below these thresholds is sent to conventional waste management routes. If the quantities exceed one tonne, these activity levels must be declared for installations classified for protection of the environment (ICPE) under heading 1716.

Case of other radionuclides or radioactive substance:

Article R. 1333-106 of the Public Health Code states that the possession, fabrication, utilisation, distribution, import and export of radioactive sources and products or devices containing them are exempt from licensing, registration or notification to ASN, if the weighted activity and the weighted specific activity of the radionuclides of each homogeneous assembly are below the exemption limit values set in Appendix 13-8 of the Public Health Code.

Moreover, sealed radioactive sources and radioactive substances for which the activity at the time of their fabrication or first entry into circulation, does not exceed the exemption limit values set in the second and third columns of table 2 of appendix 13-8, are not subject to the obligation of recovery and disposal by the supplier or by Andra.

Article R. 1333-161 of the Public Health Code specifies that any holder of expired or end-of-life sealed radioactive sources is required to have them recovered, regardless of their condition, by an approved supplier or, as a last resort, by Andra. This obligation does not apply to holders of sealed radioactive sources, the activity of which does not exceed the exemption limit values set out in Appendix 13-8 of the Public Health Code. On the other hand, the supplier of sealed radioactive sources, products or devices containing them, is still obliged to recover any sealed radioactive source that it has distributed.

4.1.1.2. Clearance

Pursuant to European Directive 96/29/Euratom of 13 May 1996 setting basic safety standards relating to the health protection of the population and workers against the hazards arising from ionising radiation and the associated technical recommendations, some countries established unconditional clearance thresholds below which waste produced by a nuclear activity can be considered to be conventional waste.

The French regulatory framework defines a different approach: any substance liable to be contaminated or activated is specifically managed in facilities licensed accordingly. This waste is defined using a "zoning" approach (see § B.5.2.1). France has a specific disposal facility for long-term management of very low level (VLL) waste, the industrial centre for collection, storage and disposal (Cires), located in the Aube *département*.

With regard to the possibility of recycling, the materials from a nuclear activity can be recycled provided that a waiver to the Public Health Code (article R. 1333-4) can be obtained. To date, materials, even if only slightly radioactive, are recycled or reused in the nuclear sector (nuclear facilities, waste containers, biological shielding in waste packages, etc.).

The PNGMDR 2016-2018 requires that Orano and EDF present technical and safety options for a facility to melt-reuse large homogeneous batches of VLL metallic materials, along with the corresponding management routes, to be situated as a priority within the nuclear sector. In June 2018, Orano and EDF submitted a study on the processing of the George-Besse I plant diffusers and the steam generators from the NPPs.

The public debate organised in 2019 showed that the public was extremely sensitive to the partial or generalised introduction of clearance thresholds: in the debate, the answers to the questions regarding traceability processes, the effectiveness of checks and the independence of those responsible for them, as well as the means of involving civil society, appeared as pre-requisites to any changes.

The 21 February 2020 decision by the Minister responsible for energy and the ASN Chairman states that the Government will make changes to the regulatory framework applicable to the management of very low level waste, in order to introduce a new possibility of targeted exemptions allowing the case-by-case reuse of very low level radioactive metallic waste, after melting and decontamination. The PNGMDR will make recommendations regarding the implementation of such exemptions, in terms of safety and radiation protection, involvement by the general public, transparency, inspection and traceability, taking into consideration the work of the French High Committee for Transparency and Information on Nuclear Safety (HCTISN) on the subject.

4.1.2. Analysis of prospects for future use of nuclear materials assuming they are not qualified as waste

Those radioactive substances for which future use is planned or envisaged are qualified as materials rather than radioactive waste. The status of radioactive material depends primarily on the reasonably reusable nature of the substance, taking account of the industrial strategy of the owner and of energy policy. The conditions for the reuse of radioactive materials thus need to be periodically reviewed, more specifically to keep pace with changes in energy policy or technical advances.

To that end, Article L. 542-13-2 of the Environment Code states:

- that at each update of the PNGMDR, "the owners of radioactive materials, with the exception of nuclear materials necessary for defence, inform the Ministers responsible for energy and nuclear safety of the reuse processes they envisage, or, if they have already submitted this information, the envisaged changes";
- that after obtaining the opinion of ASN, the administrative authority (i.e. the Minister responsible for energy) "can requalify radioactive materials as radioactive waste if the prospects for reusing these materials are not sufficiently well established. It can also cancel this reclassification in the same manner." The PNGMDR takes account of these materials and their future utilisation prospects (see § B.1.2.2).

4.1.2.1. Spent fuels

According to French policy, most spent fuels are considered to be reusable substances. More specifically, the reuse of civil spent fuels is an operation already used industrially for MOX fuels. For MOX and URE fuels, the feasibility of processing has been proven. Similarly, except for limited quantities of certain spent fuels from research reactors, the feasibility of reprocessing fuels from research and naval nuclear propulsion reactors is also possible.

4.1.2.2. Uranium and plutonium

Depleted uranium has potential for reuse. It may be:

- enriched in the same way as natural uranium;
- used in MOX fuels;
- used in future fast neutron generation IV reactors (if France were to decide to actually build such reactors). These technologies will make the most of the energy potential of uranium.

The fact that the first two reuse solutions are already effective means that depleted uranium is a reusable material given that its use is planned or envisaged.

If the generation IV fast neutron reactors could not be developed, these materials would become waste once their uranium 235 content is no longer reusable. They would then have to be managed as long-term waste. This long-term strategy falls within the framework set by the Environment Code.

With regard to plutonium, the recycling prospects in the short term are based on its reuse in reactors that are authorised to use MOX fuel, and in the longer term on the introduction of fast-neutron reactors which will enable the inventory to be stabilised through the multirecycling of this material in a mixed fleet of fast-neutron and thermal neutron reactors.

4.1.2.3. Residue from the processing of effluents produced by rare earth extraction

The SOLVAY company is in possession of materials resulting from the neutralisation treatment of the chemical effluents produced in the La Rochelle plant, which contain rare earth oxides, as well as traces of thorium and uranium as a result of the former activity to extract rare earths from monazite. The stock declared in Andra's

National Inventory is 5 tHM. The rare earths from these materials have been reused since 2000. A project currently being studied aims to reprocess all the radioactive substances stored on the site (crude thorium hydroxides, general solid residues, suspended solids). However, for the radioactive suspended solids, the prospects for reusing the thorium content are highly uncertain (use for the production of energy and the production of anti-cancer treatments). The reusable nature of these radioactive materials has thus not been established.

4.1.2.4. Thorium

Orano and Solvay are envisaging several reuse solutions for thorium-bearing materials. No route in the energy sector is at present fully operational on an industrial scale. First of all, Orano and Solvay explored reuse as energy in the nuclear industry, but considerable uncertainties still remain with regard to the short or medium term development of this type of reuse in reactors using thorium as a fuel. The successful development of processes and design of the various types of reactors using thorium will require a considerable R&D effort. Solvay is thus actively continuing to explore this solution. For its part, Orano has for the past 10 years also been developing a reuse route in the medical sector, for anti-cancer treatments using alpha therapy. This solution is better suited to the Orano inventory, which is chemically very pure and thus ideal for this application, which is progressing rapidly in order to deal with a significant rise in demand. Partnerships, clinical trials and industrial equipment are being developed both in France and the United States. The public authorities are supporting this reuse, through the General Investment Commission and the Public Investment Bank. At present, 8% of the Orano inventory has been contractually committed to this reuse and an optional reservation of the entire inventory has also been formally set out. As this inventory is closed (no new production), Orano is paying particularly close attention to the conditions of its storage, in order to preserve its quality over the medium term.

4.1.2.5. The ASN opinion within the framework of the PNGMDR 2013-2015

ASN submitted to the Ministers concerned its Opinion 2016-AV-0256 of 9 February 2016 on the studies submitted by CEA, EDF, Orano and Solvay at the end of 2014. In this opinion ASN states its position for each type of reusable material.

For natural, enriched, depleted and reprocessed uranium, ASN considers that the technical feasibility of reuse has been demonstrated but nevertheless asks that the reuse prospects be considered with respect to the available volumes. ASN also recommends that Andra carry out disposal feasibility studies for these materials in the eventuality of all or part of them being requalified as waste.

With regard to plutonium, ASN considers reuse to be credible but asks CEA to substantiate the reusable nature of all the physical-chemical forms held, and asks the owners to check that the volumes held are consistent with the prospects for reuse.

Concerning spent fuels, ASN considers it necessary for their reusability to be periodically reassessed and the prospects of recycling at an industrial reprocessing scale to be consolidated. With regard to spent fuel from research reactors and naval propulsion, ASN considers in particular that the information provided by the producers is insufficient to prove effective reusability and asks that the reuse prospects for all the separated materials be presented in greater detail.

In view of the preliminary stage of the studies relative to the use of thorium in fuels for electricity production reactors and the abundant availability of this resource in the world, the reuse of thorium is awaiting the results of the studies currently being carried out by Orano for the development of innovative cancer treatments. Pending these results, ASN considers:

- that it is vital to ring-fence funding for the long-term management of thorium-bearing substances;

- that, if the forthcoming clinical studies relative to the use of lead-212 for targeted alpha internal radiotherapy were to prove conclusive, AREVA should justify the quantity of thorium-bearing substances which would be needed for the production of the radiopharmaceutical, with the remainder in any event being requalified as radioactive waste;
- that all the thorium must be requalified as radioactive waste if these clinical studies do not prove conclusive.

ASN also recommended that Andra should study the conditions of disposal of the radioactive materials assuming that they were to be requalified as waste. This request is important because it is necessary to anticipate the impact of potential requalification of radioactive materials as waste, in particular to guarantee that the design and operation of the facilities intended for the disposal of this waste can be adapted accordingly.

4.1.2.6. The recommendations of the PNGMDR 2016-2018

The Decree of 23 February 2016 establishing the prescriptions of the PNGMDR 2016-2018 set out the following requirements:

- information on the reuse of radioactive materials is provided when the PNGMDR is updated. It includes an analysis of the compatibility of the reuse prospects and the quantities held presently and in the future, and a presentation of the materials in homogenous batches with respect to the envisaged methods of reuse, excluding nuclear materials necessary for defence;
- in relation with the owners of radioactive materials, excluding those necessary for defence, Andra conducts studies on the feasibility of disposal of radioactive materials that could be requalified as waste. These studies include an assessment of the cost of these methods of management based on a detailed radiological and chemical inventory of the substances in question.

4.1.2.7. The orientations of the fifth PNGMDR

Following the national public debate held in 2019 prior to the drafting of the fifth edition of the PNGMDR, the 21 February 2020 decision by the Minister responsible for energy and the ASN Chairman states that the checks on the reusable nature of radioactive materials will be reinforced, notably in the light of the envisaged prospects and the volumes involved, by defining action plans comprising milestones binding on the industrial players and which will be periodically reassessed. The studies into the feasibility of the disposal of radioactive substances for which subsequent use is not certain will be continued.

In 2020, ASN will be sending the Ministers concerned an opinion on the studies submitted within the framework of the PNGMDR 2016-2018 concerning the management of radioactive materials.

4.2. Classification of radioactive waste

4.2.1. Criteria and categories

The usual French classification of radioactive waste is based on two parameters which are important when defining the appropriate management method: the activity level of the radionuclides it contains and their radioactive half-life.

With regard to the radioactive half-life, a difference is made between very short-lived waste, with a half-life of less than 100 days, short-lived waste, in which the radioactivity comes primarily from radionuclides with a half-life of 31 years or less and long-lived waste, which contains a large quantity of radionuclides with a half-life of longer than 31 years.

Depending on the radioactive half-life and taking account of the activity level, six main waste categories have been defined:

- high-level waste (HLW), mainly consisting of vitrified waste packages from spent fuels after reprocessing. These waste packages contain most of the radioactivity from all of the waste produced in France, whether fission products or minor actinides. The activity level of the vitrified waste is about several billion (Bq) per gram. Owing to its high level of radioactivity, this waste gives off heat;
- intermediate level, long-lived waste (ILW-LL), mainly comes from spent fuels after reprocessing and activities involved in the operation and maintenance of fuel reprocessing plants. This notably consists of nuclear fuel structural waste, that is the hulls (sections of cladding) and end-pieces, packaged in cemented or compacted waste packages, along with technological waste (used tools, equipment, etc.) or waste resulting from the treatment of effluents such as certain sludges. The activity level of this waste is about one million to one billion Bq per gram. The heat given off is slight or negligible;
- low level, long-lived waste (LLW-LL), mainly graphite waste and radium-bearing waste. Graphite waste comes primarily from the old gas-cooled reactor technology (GCR). Graphite waste (graphite sleeves of stored fuels and stacks still in place) primarily contains long-lived beta radionuclides such as carbon-14 and chlorine-36. Their activity level is about ten thousand to a hundred thousand Bq per gram. Radium-bearing waste, mostly from non-nuclear power generating activities (such as the treatment of ores containing rare earths), mainly contains long-lived alpha emitting radionuclides and their activity level is between a few tens of Bq per gram and a few thousand Bq per gram. This waste category also comprises other types of waste, such as certain legacy bitumen packages, uranium conversion treatment residues from the Orano plant in Malvési, and so on;
- low level and intermediate level, short-lived waste (LLW/ILW-SL), mainly from the operation, maintenance and decommissioning of nuclear power plants, fuel cycle facilities, research centres and, to a far lesser extent, from medical research activities. The level of this waste is between a few hundred Bq per gram and a million Bq per gram;
- very low level (VLL) waste mainly comes from the decommissioning of the NPPs, the fuel cycle facilities and research centres and, to a lesser extent, from the operation and maintenance of this type of nuclear installations. The activity level of this waste is generally less than 100 Bq per gram;
- very short lived waste comes mainly from the medical and the non-nuclear power generating research sectors.

In practice, the following acronyms are often used:

French acronym	Meaning	English acronym
HA	High level	HL
MA-VL	Intermediate level – long-lived	IL-LL
FA-VL	Low level – long-lived	LL-LL
FMA-VC	Low level / Intermediate level – short-lived	LIL-SL
TFA	Very low level	VLL

Table 3: Acronyms used for the various waste categories

Note: There is currently no acronym for very short lived waste.

This classification enables each waste category to be schematically associated with one or more long-term management routes, either in existence or being studied. They are summarised in the following table.

4.2.2. Absence of a simple and unique criterion in the classification

There is no single classification criterion for determining the category of a waste. The radioactivity of the various radionuclides present in the waste must first be studied in order to classify it in a particular category. However, given the lack of any single criterion, it is possible to give the approximate specific activity that is generally that of each waste category. This is what is described in the previous section.

A waste may appear to fall into one of the categories defined above in terms of radioactivity but is not accepted in the corresponding management route owing to other characteristics (chemical composition, possible attractiveness). This is notably the case of waste containing significant quantities of tritium, a radionuclide that is hard to contain, or sealed sources, which may offer a certain attractiveness in long-term recovery scenarios, or even waste in which the radioactive content exceeds the capacity of the management route.

Numerous criteria are therefore needed to determine the acceptability of a particular waste in a given route. The licensees of disposal facilities define acceptance specifications to determine the acceptable waste packages. C'est la conformité aux spécifications qui finalement définit, en général, la catégorie d'un déchet.The compliance with these specifications generally ultimately determines the category of a given waste.

Classification of radioactive waste

<table>
<tr><th></th><th></th><th>VERY SHORT LIVED WASTE CONTAINING RADIONUCLIDES WITH A HALF-LIFE OF < 100 DAYS</th><th>SHORT LIVED WASTE IN WHICH THE RADIOACTIVITY COMES MAINLY FROM RADIONUCLIDES WITH A HALF-LIFE ≤ 31 YEARS</th><th>LONG LIVED WASTE CONTAINING MAINLY RADIONUCLIDES WITH A HALF-LIFE > 31 YEARS</th></tr>
<tr><td>HUNDREDS Bq/g</td><td>Very low-level (VLL)</td><td rowspan="3">Management by radioactive decay on production site then disposal via disposal routes dedicated to conventional waste</td><td colspan="2">Recycling or dedicated surface disposal (disposal facility of the industrial centre for collection, storage and disposal (Cires) in the Aube département)</td></tr>
<tr><td>MILLIONS Bq/g</td><td>Low-level (LL)</td><td rowspan="2">Surface disposal (Aube waste disposal repository)</td><td>Near-surface disposal (being studied pursuant to the Act of 28 June 2006)</td></tr>
<tr><td></td><td>Intermediate-level (IL)</td><td></td></tr>
<tr><td>BILLIONS Bq/g</td><td>High-level (HL)</td><td>Not applicable(1)</td><td colspan="2">Deep geological disposal (planned pursuant to the Act of 28 June 2006)</td></tr>
</table>

(1) There is no such thing as high level, very short-lived waste.

Table 4: Radioactive waste classification principles

5| RADIOACTIVE WASTE MANAGEMENT POLICY

5.1. General framework

Act 75-633 of 15 July 1975 (article L.541-1 of the Environment Code), supplemented by the 13 July 1992 Act and its implementing decrees, relative to the disposal of waste and the recovery of materials, defines the framework applicable to the management of all types of waste.

Radioactive materials and waste management policy falls under the more precise legal framework of the Waste Act (see section A.2 and § B.1).

5.2. Conventional waste, radioactive waste

5.2.1. Conventional and radioactive waste in BNIs

The management of radioactive waste from BNIs is subject to strict regulations, defined by the Environment Code, the BNI Order of 7 February and the ASN resolution of 21 April 2015 concerning the study of waste management and the inventory of waste produced in the BNIs. Since 1 April 2019, further to a modification of the requirements of the procedures decree, codified in the Environment Code, the regulations no longer require the waste management study as a specific document. All the requirements concerning waste management are now incorporated into the impact assessment or the general operating rules of BNIs. These documents must notably include a description of the operations leading to the production of the waste:

- the characteristics of the waste produced or to be produced;
- an estimation of the waste production streams;
- the waste zoning plan stipulated in article 6.3 of the order of 7 February 2012 which justifies the methodological principles relative to:
    - the demarcation of potential nuclear waste production zones (ZppDN), that is to say in which the waste produced is contaminated, activated or likely to be so, and conventional waste zones (ZDC), enabling a reference waste zoning map to be drawn up,
    - the procedures implemented for the temporary or definitive waste zoning declassification or reclassification measures,
    - the traceability and conservation of the historical record of the zones in which the structures and soils could have been contaminated or activated.
- the provisions adopted for the management of waste already produced or to be produced, particularly the organisation in place and the envisaged developments. These include provisions for preventing and reducing the production and the harmfulness of the waste, the waste management choices, the list and characteristics of the storage facilities, the coherence of the measures taken for the waste and effluents, and traceability measures.

Lastly, more specifically to establish an annual waste management assessment, the licensee is obliged under article 6.5 of the Order of 7 February 2012, to ensure the traceability of management of the waste produced in its facility and to keep a precise and up-to-date inventory of the waste produced and stored in the facility, indicating the nature, the characteristics, the location, the waste producer, the identified disposal routes and the quantities present and removed.

In September 2016 ASN published a guide (Guide No. 23) for application of its Resolution 2015-DC-0508 with regard to drawing up and making modifications to the BNI "waste" zoning plan. This guide notably sets out the methods of establishing "waste" zoning based on the distinction between the potential nuclear waste production zones and conventional waste zones and proposes that the licensees define zone sub-categories allowing the implementation of radiological controls that are proportionate to the risks presented by each of these zone sub-categories and to anticipate the problems associated with the facility decommissioning phase.

The guide also details the methods of implementing waste zoning declassifications or reclassifications.

With regard to the waste zoning plan, the absence of a clearance level implies that the waste coming from ZppDN must be managed in nuclear routes.

5.2.2. Naturally occurring radioactive material (NORM)

5.2.2.1. Nature of NORM

Naturally occurring radioactive materials (NORM) are substances produced by the transformation of raw materials naturally containing radionuclides and which are not used for their radioactive, fissile or fertile properties. Their radioactivity is due to the presence of natural radionuclides: potassium 40, radionuclides of the uranium 238 or thorium 232 family. These radionuclides may be concentrated in the waste by transformation processes.

There are two categories of NORM:

- very low level, long-lived waste (for example, legacy deposits of phosphogypsum from the production of fertilisers, coal ash from thermal power plants and residues from the production of alumina, foundry sand waste, waste from zirconium-based refractory materials, notably used in the glass-making industry, etc.);
- low level, long-lived waste (for example, certain waste from the processing of monazite, certain waste from the production of zirconium sponges, certain waste from the decommissioning of industrial facilities, either already produced or yet to be produced, for example from facilities producing phosphoric acid, processing titanium dioxide, processing zircon flour, former monazite processing activities, etc.).

5.2.2.2. Legal framework for activities using materials containing naturally occurring radioactive substances

Further to the transposition of European Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for the protection of health against the hazards arising from exposure to ionising radiation, the activities using naturally occurring radioactive materials, called NORM, which exceed the exemption thresholds presented in section 4.4.1, are now considered to be nuclear activities. If the quantities exceed one tonne, these activities must be declared under the system of installations classified for protection of the environment (ICPE) under heading 1716.

Furthermore, new provisions introduce a list of activities into Article D.515-111 of the Environment Code, for which the radiological characterisation of the substances by accredited organisations is required. This list of activities also stems from European Directive 2013/59/Euratom:

- extraction of rare earths from monazite, processing of rare earths and the production of pigments containing them;
- production of compounds of thorium, manufacture of products containing thorium and the mechanical working of these products;
- processing of niobium/tantalum and aluminium ore;
- oil and gas production, except for exploratory drilling;
- production of geothermal energy, except if carried out on a small scale;
- production of titanium dioxide pigments;
- thermal production of phosphorus;
- zircon and zirconium industry, including the refractory ceramics industry;
- production of phosphated fertilisers;
- production of cement, including maintenance of clinker furnaces;
- coal-fired power plants, including boiler maintenance;
- production of phosphoric acid;
- production of primary iron;
- tin, lead, or copper foundry work;
- treatment by filtration of groundwater circulating through igneous rocks;
- extraction of natural materials of igneous origin such as granitoids, porphyries, tuff, pozzolan and lava, when intended for use as construction products;

Moreover, the competent authority in possession of data showing that another professional activity is liable to use NORM may ask the party responsible for the activity for a radiological characterisation of the materials, products, residues or waste, under Article R. 1333-37 of the Public Health Code.

5.2.2.3. Management of NORM

NORM for which no use is planned or envisaged constitutes radioactive waste as defined in Article L. 542-1-1 of the Environment Code:

NORM management is facilitated by the radiological characterisation of waste stipulated in the Ministerial Order of 3 July 2019. Thus the characterisation required for activities notified under the system for installations classified for protection of the environment (heading 1716) and the activities included in the list mentioned in Article D. 515-111 of the Environment Code, allow management of this waste according to the radiological characterisations.

There are several methods for managing waste containing naturally occurring radioactive materials:

- if the activity of the radionuclides exceeds 20 Bq/g, this waste is disposed of in dedicated radioactive waste disposal facilities, more specifically facilities licensed under heading 2797 of the ICPE – there is only one such facility in France, the Cires operated by Andra;
- if the activity of the natural radionuclides is below 20 Bq/g, this waste can be disposed of in conventional waste disposal facilities specifically licensed for this purpose.

Very low level NORM which cannot be accepted in conventional waste disposal facilities is placed in the Morvilliers industrial centre for collection, storage and disposal (Cires). The 2018 edition of the National Inventory identifies 1,400 m^3 of waste in this category at the end of 2016, excluding the waste generated by spas, paper-mills and biomass combustion.

Low level, long-lived technologically enhanced naturally occurring radioactive materials (TENORM) waste is incorporated into the low level, long-lived waste management industrial systems being studied by Andra. The 2018 edition of the National Inventory identifies 21,000 m^3 of naturally occurring radioactive materials waste in this category (excluding the waste generated by spas, paper-mills and biomass combustion. Pending the arrival of such a repository, this waste is stored on certain production sites.

5.2.3. Radioactive waste disposed of in the conventional disposal centres

In the past, waste containing radioactive substances was disposed of in landfill sites (CET). Most of these sites have been closed or redeveloped. This primarily consists of sludges, earth, industrial residues, rubble and scrap metal from certain historical conventional industrial activities or, in certain cases, from the civil or military nuclear industry.

A distinction is generally made between two types of facilities used for the disposal of such waste:

- hazardous waste disposal centres, previously referred to as “class 1 landfills”;
- non-hazardous waste disposal centres referred to as “class 2 disposal sites”.

The Order of 30 December 2002 on the disposal of hazardous waste and the Order of 15 February 2016 on the disposal of non-hazardous waste place a ban on the disposal of radioactive waste of artificial origin in these centres. Radioactivity detection procedures at the entrance of the disposal sites must be put into place to prevent radioactive waste from entering these facilities and, as applicable, to send it to the authorised routes.

The National Inventory published by Andra lists 11 disposal sites which have in the past received waste containing radioactive substances.

For example there is the Vif landfill (Isère *département*) which received residues from the manufacturing process in the Orano plant (formerly the Areva NP Cézus plant), the phosphates transformation residues disposed of in the Menneville landfill (Pas-de-Calais *département*) and the landfills at Pontailler-sur-Saône (Côte-d'Or *département*) and Monteux (Vaucluse *département*) which received waste from purification sludges of the Valduc research centre and from the manufacture of zirconium oxide, respectively.

These former disposal sites are subject to the surveillance measures specified for classified installations (mainly chemical pollution measures, check on the absence of settling and, as applicable, the implementation of land use restrictions). For the sites listed in the Andra inventory which received the largest amount of radioactivity, monitoring and surveillance, which is more or less extensive depending on the site, includes the radiological monitoring of the groundwater (case of the Vif, Solérieux and Monteux landfills).

5.3. The case of radioactive sources not liable to activate the materials

The use of radioactive sources not liable to activate the materials produces no waste other than the source itself. There are regulatory mechanisms described in section E.2.1 and the prospects (disposal, lifetime extension, justification for the use of radioactive sources) are covered in section J. The management of radioactive sources is handled within the framework of the PNGMDR.

5.4. The case of unsealed sources, radioactive waste from the ICPEs and mining processing residues

The radioactive waste from ICPEs or sites regulated by the Public Health Code must be disposed of in the same routes as those defined for basic nuclear installations.

The installations receiving conventional waste may not accept radioactive waste (certain TENORM waste may be accepted in the conditions explained in § B.5.2.2.4).

After use, unsealed sources are considered to be radioactive waste and are normally entrusted to Andra. For example, if the acceptance criteria so allow, they are shipped to the CENTRACO facility for processing.

The waste containing radionuclides with a half-life of less than 100 days may nonetheless be managed by radioactivity decay.

At present, no mining processing residues are produced on French territory. Legacy mining processing residues are disposed of in-situ on certain former mining sites.

5.5. The responsibilities of the players

Article L. 542-1 of the Environment Code states that "the producers of spent fuel and radioactive waste are responsible for these substances, without prejudice to the liability of those who hold these substances in their role as persons or entities responsible for nuclear activities". However, various players are also involved in waste management: the companies tasked with transport, the processing contractors, the managers of storage or disposal centres, the organisations in charge of R&D aiming to optimise this management.

The responsibility of the radioactive waste producer does not exonerate the other players mentioned above from their own responsibility for the safety of their activities. The scope of responsibility of the waste producer includes its financial liability. The fact that a radioactive waste producer has transferred its waste to a storage or disposal facility does not mean that it is no longer financially liable for it (also see section F.1.2.2).

In accordance with the PNGMDR orientations, the waste producers must continue to aim to limit the volume and activity of their waste, upstream in the design and operation of the facilities and downstream in the management of the waste. Compliance with this goal is ensured both by ASN, through the process to approve the BNI waste studies, and by the cost involved in dealing with this waste, which necessarily encourages the producers to attempt to minimise the quantities. This subject of volume reduction is covered in § B.6.1.1 and section H.1.2.3 for LLW/ILW-SL waste and in § B.6.1.3.5 for HLW and ILW-LL waste (Orano): these sections show the progress made in this field over the past two decades. The quality of packaging of the waste must also be guaranteed given the long-term radiation protection and safety implications following disposal.

The work done by research organisations plays a role in the technical optimisation of radioactive waste management, in terms of both production and the development of methods for processing, packaging and characterisation of the packaged waste. Good coordination of these research programmes is needed in order to improve the overall safety of this management.

5.6. The role of Andra

Andra, the National radioactive waste management agency, is an industrial and commercial institution (EPIC) tasked with finding, deploying and guaranteeing safe management solutions for all French radioactive waste in order to protect present and future generations against the risks this waste presents.

Its role has been defined by three successive acts:

- the Act of 30 December 1991 relative to research in the management of high-level long-lived radioactive waste (this Act created the Agency as a government-funded institution, entrusting it with research into deep geological disposal of high-level and intermediate-level long-lived radioactive waste);
- the Planning Act of 28 June 2006 relative to the sustainable management of radioactive materials and waste (this Act extends and reinforces the role of the Agency and its areas of activity);
- the Act of 25 July 2016, which details the conditions for creating a reversible deep geological repository for high-level and intermediate-level long-lived waste.

Placed under the authority of the Ministries responsible for energy, the environment and research, the Agency is independent of the radioactive waste producers. In accordance with Article L. 542-12-1 of the Environment Code, Andra receives a State subsidy to help fund its assigned missions of general interest. It is the State operator for the implementation of the public policy for radioactive waste management. Its role comprises several activities:

- operate two above-ground disposal facilities in the Aube *département*, namely the CSA (Aube waste repository) dedicated to low-level and intermediate-level short-lived waste (LLW/ILW-SL), and Cires (Industrial centre for collection, storage and disposal) dedicated to very low level (VLL) waste;
- manage the closure of the CSM (Manche waste repository), the first French above-ground disposal facility for low-level and intermediate-level radioactive waste;
- study and devise disposal solutions for the types of waste which do not yet have one, namely low-level long-lived waste (LLW-LL) and high-level and intermediate-level long-lived waste (HLW/ILW-LL): the Cigéo project;
- look for and study solutions to optimise radioactive waste management in order to preserve the radioactive waste disposal facilities, which are a rare resource;
- ensure a public service mission for:
    - the collection of old radioactive objects held by individuals (old luminescent watches and clocks, objects containing radium for medical uses, certain minerals, etc.),
    - the clean-out of sites contaminated by radioactivity,

    - the drafting every three years of the National Inventory of radioactive materials and waste on French soil (last edition published in 2018 - https://inventaire.andra.fr/).

- informing and communicating with all audiences;
- preserving the memory of its disposal facilities;
- sharing and capitalising on its know-how internationally.

5.7. ASN policy

Created by the 13 June 2006 Act on nuclear transparency and security, ASN is an independent administrative authority tasked with the regulation and oversight of civil nuclear activities in France.

On behalf of the State, ASN performs oversight of nuclear safety and radiation protection to protect people and the environment. It informs the public and contributes to enlightened societal choices.

ASN decides and acts with rigour and discernment: its aim is to exercise regulation and oversight recognised by the citizens and seen as a benchmark internationally. It exercises its duties in compliance with four fundamental values: competence, independence, rigour and transparency.

In 2017, when it developed its strategic plan 2018-2020, ASN laid down the guidelines of its oversight actions. These guidelines constitute the foundation of a shared culture and collective know-how.

The multi-year strategic plan (https://www.asn.fr/L-ASN/Presentation-de-l-ASN/La-strategie) guides the actions of the departments for a period of 3 years. It defines a common project and constitutes a reference document for ASN's control actions. This document, which is used by the staff, presents five broad lines of collective action:

- reinforce the implementation of a graded approach;
- improve the running of technical investigations;
- reinforce the efficiency of our actions in the field;
- consolidate the way we work;
- consolidate the French and European approach through international action.

ASN's policy is to achieve progress in the safe, consistent and structured management of radioactive materials and waste. To do this, it puts this into practice in its various roles (regulation, authorisation/licensing, oversight, information, monitoring of research). It considers that the methods of drafting the PNGMDR and its recommendations are essential to the implementation of this policy of improvement and is thus fully committed to this. One of the priorities is the existence of safe management routes for each category of radioactive materials and waste, whatever their activity, lifetime, origin, giving preference to definitive management solutions. This implies identifying the foreseeable needs for storage and disposal facilities, ensuring compliance with the requirements of the Environment code and implementing a stepped approach to management methods (reduction at source, recycling, reuse, incineration, disposal).

For ASN, this policy must be accompanied by rigorous oversight of all the activities concerned by radioactive waste management. It more particularly considers the safety of each of the radioactive waste management steps to be important (production, processing, packaging, storage, transport and disposal of the waste).

The aim is to ensure that the BNI licensees and the waste producers assume their radioactive waste management responsibilities. To do this, ASN draws up rules and guides, monitors the safety checks and periodic safety reviews carried out by the BNI licensees involved in the management of radioactive waste, conducts inspections at the licensees – in the facilities or in the head office departments – promotes and takes part in project progress meetings in order to identify any difficulties liable to be encountered as early as possible, regularly revises the waste management strategies of the main nuclear licensees. Checks are also carried out on the general organisation put into place by Andra for the design and operation of the disposal centres, as well as for the acceptance of waste in the corresponding facilities from the producers. These actions lead to resolutions, opinions, or follow-up letters, all of which are made public.

As was indicated earlier in this section, the management of VLL waste is based on the use of “waste” zoning and the absence of a clearance threshold.

ASN provides information through the Report on the state of nuclear safety and radiation protection in France, presented to Parliament every year, through various publications and information on its website and at press conferences.

ASN has also published a guide (n° 25) detailing the ways in which the licensees and industry players concerned, the public and the associations contribute to the preparation of draft ASN regulations or guides concerning the BNIs. With this guide ASN propose more specifically to:

- improve the involvement of the stakeholders, as of the beginning of the preparation process;
- reinforce the initial framework for the preparation of a draft regulatory text or guide and communicate on the orientations and related objectives from the start of the process;
- develop an analysis of the impacts of the draft texts;
- accompany and monitor the implementation of the regulatory texts through the development of guides for the licensees and industry players concerned and by gathering experience feedback after a few years of application,

Finally, under Article L. 592-31-1 of the Environment Code, ASN keeps track of national and international research and development work on nuclear safety and radiation protection. It can formulate all types of proposals and recommendations on research needs for nuclear safety and radiation protection and communicate them to the Ministers and to the public organisations exercising the research duties concerned so that they can be taken into account in the orientations and the definition of the research and development programmes of interest for nuclear safety or radiation protection.

6| RADIOACTIVE WASTE MANAGEMENT PRACTICES

6.1. Radioactive waste from the BNIs

6.1.1. EDF management of waste from the nuclear power reactors

The waste resulting from the operation of PWRs is essentially very low, low or intermediate level short-lived waste. This waste contains beta and gamma emitters, and very few alpha emitters. It can be classified in two categories:

- process waste that comes from the purification of systems and treatment of the liquid or gaseous effluents to reduce their activity before being discharged; This comprises ion exchange resins, water filters, evaporator concentrates, pumpable sludges, pre-filters, absolute filters and iodine traps;
- technological waste that comes from maintenance operations. This can be solid (cloths, paper, cardboard, plastic sheets or bags, metallic parts, rubble, gloves, working clothes, etc.) or liquid (oils, solvents, decontamination effluents).

The following tables show the breakdown of operating waste from EDF's nuclear reactors for one year, in terms of the waste packages for 2018 intended on the one hand for Cires and on the other for the CSA, directly or after processing at CENTRACO. These volumes of packages represent the production in 2018; most of the packages were shipped but some were still present on the sites at the end of the year.

Very-low-level waste to be disposed of in Cires

2018 results 58 PWR considered	Disposal route	Volume of waste to be disposed of (m³)	Activity (TBq)
Process waste	Cires	**1000**	0.0035
Technological waste	Cires	**2250**	0.0031
TOTAL		**3250**	**0.0066**

Table 5: Volume and activity of EDF NPP reactor operating waste produced in 2018 and to be disposed of in Cires

Note: the difference between the above values and those presented in B.6.4 is primarily linked to the offset between the production time-line and the removal time-line

The very low level waste is packaged in metal containers or big-bags depending on its nature, prior to shipment to Cires.

Low or intermediate level waste to be disposed of in the CSA

2015 result 58 PWR considered	Disposal route	Gross volume before packaging (m³)	Volume of packages to be disposed of in the CSA (m³)	Activity (TBq)
Process waste	CSA/CTO(*)	**1 0550**	**43650**	**260**
Technological waste	CSA/CTO	**9690**	**2850**	**11**
TOTAL		**10 740**	**6 500**	**271**

(*) CTO (CENTRACO): Processing and Packaging Centre operated by Cyclife France (EDF subsidiary).

Table 6: Volume and activity of EDF NPP reactor operating waste produced in 2018 and to be disposed of in the CSA

Note: the difference between the above values and those presented in B.6.4 is primarily linked to the offset between the production time-line and the removal time-line.

Of the low and intermediate level, short-lived waste, the technological waste, which accounts for most of the traffic, is:

- either, after pre-compacting on-site in 200-litre metal drums, shipped directly to the CSA press for further compaction and then definitive disposal after concreting in 450-litre metal drums. Certain non-compactable technological waste is packaged in metal containers of 5 m3 or 10 m3. The most highly radioactive is packaged on site in concrete containers and disposed of directly in the CSA;
- or, when incinerable and of low activity, shipped in plastic drums to the CENTRACO incineration unit, while the low-contamination metal scrap is sent to the fusion unit of the same plant in metal containers. The waste resulting from processing in CENTRACO is dealt with as follows:
  - the residual ash and clinkers from incineration are conditioned in 450-litre metal drums and definitively disposed of in the CSA repository;
  - the 200-litre ingots resulting from fusion are disposed of definitively in the CSA or Cires, depending on their level of activity. Similarly, depending on their specific activity, the ventilation filters for treatment of the gases and fumes, the slag and the furnace refractory materials produced during the maintenance operations are disposed of in the CSA or Cires.

Presentation of the CENTRACO facility

The purpose of CENTRACO, situated in the municipality of Codolet close to the Marcoule site in the Gard *département*, operated by the Cyclife France company, is to process low level or very low level waste, either by fusion of metallic waste, or by incineration of combustible waste or liquid waste (oils, solvents, evaporation concentrates, chemical washing effluents, etc.).

With this facility, some of the low or very low level metallic waste can be recycled in the form of biological shielding in the packaging of other higher level waste in concrete overpacks.

The process waste is all packaged in concrete containers, except for the evaporator concentrates, a part of which is shipped in tankers to CENTRACO for incineration. With the exception of ion exchange resins, this waste is encapsulated in a hydraulic binder in fixed installations (in the nuclear auxiliaries building (BAN), or the effluent treatment building (BTE) in the NPPs).

For the final conditioning of the ion exchange resins, EDF uses the Mercure process (coating in an epoxide matrix), implemented using two identical mobile machines.

The packages produced by these two machines are intended for the CSA. They are equipped with a leaktight steel liner and biological shielding inserted into the containers, which can be made of slightly contaminated steel recycled in the CENTRACO facility.

On the one hand, NPP maintenance may require the replacement of certain extremely voluminous components such as the reactor vessel closure heads, steam generators, racks (fuel storage modules in the pool). This particular waste is stored either on the site, or in the Tricastin operational hot unit (BCOT) then disposed of either in the CSA, or in Cires.

Over the past 25 years, considerable progress has been made concerning the quantities of low and intermediate level short-lived waste resulting from nuclear reactor operations. The volume of packaged waste (that is in ultimate disposal at the CSA) has significantly fallen, from about 360 m^3/plant unit in 1985 to an average of 110 m^3/plant unit in recent years.

The decisive factors contributing to the drop recorded over the decade 1985-1995 are mainly organisational in nature - reduction of waste at source, shared operating experience feedback, “best practices”, and technical - implementation of changes to the liquid effluents treatment process, densification of packaging of certain waste by grouping and/or pre-compacting. These improvements were effective for waste produced directly by operation of the reactors and that from their maintenance.

It is important to underline that this reduction in the production of solid waste was not offset by an increase in liquid discharges. Over this same period, the average activity (excluding tritium) of the liquid effluents discharged into the environment by the NPPs was divided by 50.

Improvement measures are continuing, notably with regard to:

- “waste zoning” (see § B.5.2.1);
- limiting the production of waste at source (this concerns ion exchange resins, water filters and technological waste, etc.);
- waste sorting, in order to send it to the best possible route.

It should be underlined that the results of these actions are used in assessing the environmental performance of each of the 19 EDF sites in operation.

6.1.2. CEA management of waste from nuclear research facilities

CEA’s radioactive waste management strategy involves the following orientations:

- absorb the stocks of legacy waste as soon as possible, by taking steps to retrieve and characterise it, setting up appropriate treatment and packaging solutions and giving priority to safety issues;
- limit the volumes of waste at the production stage;

- no longer produce waste with no defined management solution;
- sort the waste at the level of the primary producers, according to the defined management solutions, notably to avoid over-classification of waste or subsequent retrieval operations;
- remove the waste to the existing routes (definitive Andra repositories or, failing which, CEA's long-duration storage facilities), ensuring that the removal rate is equivalent to that of production: to avoid congestion in the producer installations or waste treatment and packaging facilities, which are not designed to store large quantities of waste over long periods;
- as soon as Andra has defined the acceptance specifications for LLW-LL and ILW-LL packages, directly place in disposal packages the primary packages of LLW-LL waste and, to a far lesser extent, the ILW-LL primary packages, then ship all the LLW-LL and ILW-LL packages to the future repositories;
- carry out these steps in the best conditions of safety and radiation protection, but also in the best technical / economic conditions.

At the end of 2016, CEA sent a file specifying these aspects and answering the July 2015 request from the nuclear safety regulators to review the overall decommissioning strategy, and to review the radioactive materials and waste management strategy (see section F.6.2.1).

6.1.2.1. Waste from the treatment of radioactive liquid effluents

The main function of the treatment stations for radioactive liquid effluents is to treat them (notably by filtration, neutralisation, decontamination or concentration) and discharge them into the environment in accordance with the discharge licenses for each of the sites. Their function is also to package the residues from this treatment.

The management strategy for CEA's radioactive aqueous effluents from most of the CEA facilities is focused primarily around the Marcoule liquid effluent treatment station (STEL). Some centres (Cadarache, Saclay) can pre-process their effluents before shipping them to the Marcoule STEL.

In Marcoule, the STEL facility receives radioactive aqueous effluents and then processes them by neutralisation of the low-level effluents or chemical co-precipitation and filtration of the intermediate level and high level effluents. The sludges obtained are bituminised in 214-litre drums or cemented in 380-litre drums, while the compatible effluents are discharged into the Rhône river. The corresponding packages are intended for disposal in the CSA for the LLW/ILW-SL waste, or for storage pending the availability of a future repository for the LLW-LL and ILW-LL waste.

In Cadarache, the Agate facility was commissioned in 2014. This facility is dedicated to processing by evaporation of beta-gamma emitting effluents. The concentrates are transferred to Marcoule for processing and conditioning in the liquid effluents treatment station (STEL) along with the other alpha and beta-gamma emitter effluents received at the STEL.

In Saclay, a facility called Stella only processes legacy beta-gamma effluents from BNI 35 by evaporation, and the concentrates are encapsulated in a cement matrix for future disposal in the CSA. The effluents from the other Saclay facilities are sent to the Marcoule STEL.

6.1.2.2. Solid radioactive waste

Since the end of 2003, VLL (very low level) waste from CEA has been shipped to Cires. Since 2003, CEA has sent about 195,000 m^3 (as at 31/12/2018), with annual transfers of between 11,000 and 17,000 m^3.

The solid LLW/ILW-SL waste is:

- either processed in the CEA facilities before shipment to the CSA;
- or pre-conditioned and then transported without treatment to the CSA, where it undergoes definitive packaging;

- or incinerated in the CENTRACO plant.

The solid waste currently compacted at the CEA is encapsulated or blocked in a cement matrix.

CEA has about 25 approvals for acceptance of these waste packages at the CSA, enabling an annual volume of about 2,000 to 3,000 m^3/year to be disposed of.

For the types of radioactive waste not acceptable in existing management routes, CEA has storage facilities the capacity and design of which, notably with regard to safety, are compatible with its production forecasts and the announced lead-times for the creation of repositories to be put into place by Andra.

CEA's LLW-LL waste comprises:

- graphite waste from the R&D and subsequent operation of GCR and heavy water reactors. (Most of this waste, consisting of stacks of graphite from the reactors, is kept in-situ in the shutdown reactors);
- radium-bearing waste;
- packages of bituminous waste stored on the Marcoule site.

It will be retrieved once the dedicated repository is commissioned by Andra.

For the low and medium activity ILW-LL waste intended for geological disposal, the packaging and storage facility (CEDRA, BNI 164) replaced the existing dedicated storage facility (BNI 56) which was of an old design. This facility, which was commissioned in April 2006, should allow the storage of this waste until such time as the Cigéo repository opens.

In addition, for the high activity waste, CEA intends to commission a storage facility called DIADEM on the Marcoule site in 2022.

On the Marcoule site, the Multi-purpose Interim Storage facility (EIP) is used to store packages of LLW-LL and ILW-LL bituminous waste from the processing of the site's effluents in the STEL, notably that from the operation and then clean-out of the site.

The delays attributable to:

- the uncertainties surrounding the date of commissioning of Cigéo;
- the postponed opening of the future disposal facility for LLW-LL waste;
- the postponement and extension of the time-lines for the removal of certain types of waste to the disposal routes;
- CEA's prioritisations in a constrained budgetary context;

will lead to the construction of new storage facilities.

The scenario for the retrieval of bituminous waste packages from Marcoule is already dependent on the industrial commissioning of the EIP 3-4 extension in 2022, the construction of which is currently being finalised.

The other categories of waste produced by CEA (specific waste) also form the subject of studies or retrieval measures with a view to treatment and/or packaging.

This primarily concerns:

- Tritiated waste: it has been decided to study a storage facility for the decay of tritiated waste following treatment and packaging by the producers, on the Cadarache site. This facility will be named Intermed. A storage duration of 50 years will reduce the tritium inventory by a factor of 16 due to its natural decay, which should facilitate the acceptance of this waste in a disposal facility that should take over from the CSA.

- Sodium waste from R&D on fast neutron reactors and the operation of experimental reactors or prototypes of this plant series. This waste will be treated using the equipment designed for the decommissioning of the Phénix power plant; after treatment and stabilisation, it will be possible to dispose of this waste in Andra's CSA or Cires.
- Contaminated metallic waste and mercury, for which decontamination processes exist. The outlet is disposal by Andra (after physico-chemical stabilisation of the mercury). The suitability of recycling is undergoing technical-economic analyses and is being developed within the framework of the PNGMDR.

Achieving the technical-economic optimum in waste management is one of CEA's primary concerns. With this in mind, its policy is to opt for packagings appropriate to storage on its sites and directly acceptable by Andra. CEA therefore plays an active role in the discussions concerning Andra's various projects. Moreover, this goal implies a coherent fleet of service, packaging and storage facilities, and transport packagings, and ensuring that they are kept in good condition.

6.1.3. Orano management of nuclear fuel cycle facility waste

The waste produced by the operation of Orano's facilities is essentially managed on a just-in-time basis and taken away directly to Andra's disposal sites, in order to minimise the quantity of waste being stored. As at the end of 2019, the volumes of VLL and LLW/ILW-SL waste from operation of the Orano facilities and shipped stood at 4900 m^3 and 1200 m^3 respectively.The general management policy for all Orano waste notably aims to:

- reduce waste production at source;
- reduce the volume of waste produced, for example in the following way:
  - use of presses for metallic waste on the Malvési site,
  - use of compacting for technological waste on the la Hague site,
  - optimised filling of the waste racks on all the Orano sites.

Waste which does not yet have an operational disposal route is stored.

With regard to high level waste or intermediate level, long-lived waste (HLW and ILW-LL), the management of which is being studied as part of the Cigéo disposal project, the Orano share represents a small fraction of the National Inventory. This waste consists mainly of "legacy" waste, corresponding to the operation of the previous generation of treatment plants from the 1960s to the 1980s. It is stored at Marcoule and La Hague. Virtually all the high level waste from the beginning of the French nuclear programme is today packaged in the form of standard vitrified waste packages (CSD-V).

Among the high level legacy waste stored at La Hague, the fission products molybdenum solutions from the reprocessing of "Umo" spent fuels (consisting of uranium and molybdenum alloy), used in the gas-cooled reactors (GCR) required the development of a technologically innovative conditioning process called "cold crucible". The retrieval and vitrification operations for the "Umo" fission product solutions in a "cold crucible" in the R7 unit were started in January 2013 and should be completed in 2020.

However, most of the intermediate level legacy waste has still to be retrieved and conditioned (see section H.2.2.3). The retrieval and conditioning of this waste (RCD) are the subject of major programmes owing to the significant safety and radiation protection implications and represent a significant commitment on the part of Orano. In addition, the intermediate level, long-lived waste from decommissioning will, after packaging, represent several thousand m^3.

Pursuant to the Environment Code, the waste from spent fuels after reprocessing and belonging to foreign customers is returned to them as soon as the technical time constraints allow. Most of the activity of the waste packaged under the “SA-UP3” contracts, which underpinned the construction and early operation of the La Hague plant, has been shipped onwards. With regard to the design and sizing of the repositories currently being planned, the Orano share is estimated on the basis of current stocks and the forecasts made by its French customers. These forecasts are used as the basis for their financing.

Finally, it is important to note the low variability in the volumes of Orano waste. Orano’s HLW waste is primarily legacy waste. The volume of packages of ILW-LL waste from Orano, CEA and EDF is relatively well known and forecasts are relatively reliable. The changes in packaging methods for the waste still to be packaged, the La Hague operating scenario, the future commercial agreements and the volumes of decommissioning waste are taken into consideration when establishing volume forecasts. Variations could occur according to any new technical scenarios, but they should remain relatively minor by comparison with the total inventory at completion.

6.1.3.1. Fission products

Fission product solutions (high level waste) are concentrated by evaporation before being stored in stainless steel tanks, fitted with cooling and permanent mixing systems along with a system for continuous sweeping of the hydrogen produced by radiolysis. After a decay period, the fission product solutions are calcined then vitrified using a process developed by CEA. The resulting molten glass, into which the fission products are integrated, is poured into stainless steel containers. After solidification of the glass, these standard vitrified waste packages (CSD-V) are transferred to a storage facility where they are air-cooled.

6.1.3.2. Structural waste

Since the end of 2001, the hulls compaction facility (ACC) at La Hague processes intermediate level, long-lived structural waste (hulls and end-pieces from spent fuels). This compaction leads to the production of standard compacted waste packages (CSD-C) which are replacing the cemented packages previously produced by Cogema, with a significant saving in volume. This process also enables certain categories of technological waste to be packaged.

6.1.3.3. Waste from the treatment of radioactive effluents

Orano Cycle La Hague

Most of the activity and volume of the liquid effluents produced by Orano comes from the Orano Cycle La Hague installations. Orano is therefore committed to improving the management of effluents from this site.

The La Hague site initially had two radioactive effluent treatment stations (STE2 and STE3). The effluents were treated by co-precipitation and the resulting sludges were encapsulated in bitumen and then poured into stainless steel drums in the most recent of the facilities (STE3). These drums are stored on the site. Output from these two facilities has fallen to practically zero over the last decade, because most of the acid effluents are now evaporated in the various spent fuel treatment units and the concentrates are vitrified (see section F.4.2.3.2).

The studies needed for the retrieval and conditioning of “legacy” sludges are in progress, notably those of the seven STE2 silos.

In accordance with the particular contractual provisions, for foreign fuels received before Act 2006-739 of 28 June 2006 entered into force, packages of cold crucible vitrified intermediate level effluents (CSD-B) have been and will continue to be shipped to certain customers. On the La Hague site, Orano also has a facility for pyrolysis mineralisation of organic effluents in the MDS/B unit. This facility produces cemented packages that can be disposed of in an above-ground facility.

Finally, the water from the fuel unloading and storage pools is continuously purified by means of ion exchange resins. Once used, these resins constitute process waste, which is encapsulated by cementation in the resins conditioning facility (ACR). When placed in CBF-C2 these cemented resins are intended for disposal in the CSA.

Orano Cycle Tricastin

The Tricastin site also implements management measures and operates facilities aiming to reduce the quantity of radioactive materials and chemical compounds in order to reduce the environmental impact. The facilities on the Tricastin site are shared by the entire platform (chemistry, conversion, enrichment).

Orano Cycle Malvési

The Orano site in Malvési dedicated to the conversion of natural uranium is continuing to invest heavily in the refurbishment of its industrial tool and in reducing its environmental footprint. A number of major projects are being conducted in parallel, including:

- the Nitrates Treatment Project (TDN): designed to deal with the legacy of liquid effluents stored in the site's evaporation ponds, by using a thermal denitration process;
- the solid residues management improvement projects: the ECRIN project to install a bituminous cover over the site's B1-B2 ponds, which are classified as a BNI, in order to improve containment;
- the PERLE and CERS Projects to build leaktight storage vaults in which the solid residues will be desiccated by means of Géotubes©. A factor 2 reduction in the volumes of solids from the B5/B6 ponds is expected;
- new Aqueous Effluents Treatment (TEA) unit which will be used to achieve:
    - densification of the process solid residues,
    - a very significant reduction in their volume (approximately factor 4) before storage,
    - elimination of diffuse ammonia emissions.

Framatome's Maubeuge site (ex-SOMANU)

This site calls on other industrial installations (CEA Saclay and Orano Cycle La Hague) for the treatment and management of its liquid effluents. This installation has no longer held BNI status since 2018.

6.1.3.4. Solid technological and structural waste

Orano Cycle La Hague

The solid technological waste is sorted, compacted and then encapsulated or blocked in cement in the AD2 facility before being sent to the CSA. When it fails to meet Andra's technical specifications for above-ground disposal, it is stored pending the commissioning of Cigéo.

Orano Cycle Melox

Depending on the radioactive waste categories, the current disposal routes are:

- for radioactive waste "suitable for above-ground disposal (SSS)": the CEA Marcoule centre which has approved facilities for compacting and conditioning packages for the Andra above-ground disposal centres in the Aube *département*;
- for radioactive waste "not suitable for above-ground disposal (NSSS)", this waste is sent to the Orano la Hague site for treatment and packaging prior to final disposal.

Orano Cycle Tricastin

Waste from all industrial firms is processed and packaged in the STD and SOCATRI facilities. The purpose of the "Trident" project is to construct a shared facility to be installed on the SOCATRI site. The preparatory work for installation of this new unit has started. Commissioning is planned for 2020. The waste concerned is primarily VLL.

Orano Cycle Malvési

The compactable waste is packaged in-situ prior to shipment to Andra's Cires (VLL), or is shipped to the Tricastin site and managed in exactly the same way as that from the rest of the platform. Packaging waste (drums) and equipment used for routing raw materials to the site is pre-treated on the site before shipment to a disposal site.

6.1.3.5. Recent progress and reduction in volume of HLW and ILW-LL waste

In the field of waste, significant results have been obtained in the following fields:

- progress in the packaging of waste from past activities: legacy waste, shutdown of old facilities, etc., and reduction in volumes;
- optimisation of treatment of spent fuels, ahead of packaging (recycling, etc.).

In the field of high level and intermediate level, long-lived waste, all these measures now mean that the waste generated directly by the spent fuels processed at La Hague is packaged:

- in standard CSD-V containers for the vitrified fission products and minor actinides;
- in standard CSD-C containers for the compacted metallic structures.

Over and above the reduction of volumes in HLW and ILW-LL resulting from reprocessing/recycling, Orano's efforts are focused on reducing the volumes of technological waste. The improvement measures based notably on zoning of the facilities, sorting at source, recycling and characterisation, have helped achieve a very significant reduction in the volumes of technological waste. Overall, therefore, the annual volume of high level and intermediate level, long-lived waste has been reduced by a factor of more than 5 when compared with the design parameters of the processing plants.

6.2. Radioactive waste from industrial, research and medical activities

This chapter concerns the nuclear activities defined by Article L. 1333-1 of the Public Health Code, that is nuclear activities authorised or notified in accordance with the Public Health Code, including nuclear activities intended for medicine, human biology and biomedical research. The following are not concerned:

- the basic nuclear installation licensees mentioned in article L. 593-2 of the environmental code;
- the nuclear installations and nuclear activities concerning defence mentioned in Article L. 1333-15 of the Defence Code
- the nuclear activities contained in the list of installations classified for protection of the environment, pursuant to Articles L. 511-1 to L. 517-2 of the Environment Code (ICPE);
- installations subject to authorisation pursuant to Article L.162-1 of the Mining Code.

These activities are regulated and authorised by ASN. The medical, veterinary, research and industrial sectors are the main activities using radionuclides and requiring this regulation.

These fields of activity produce small quantities of radioactive waste when compared with the nuclear power industry. However, the waste produced varies and some, notably in the field of biological research, may have particular characteristics (putrescible waste, chemical hazards, biological hazards).

The medical sector comprises all the public or private establishments using radionuclides for analysis or health care in the field of medicine. It primarily comprises three fields:

- biological analyses, carried out in vitro on biological samples, for diagnostic purposes;
- medical imaging techniques used for diagnostic purposes;
- therapeutic applications, carried out in vitro or in vivo.

These establishments use unsealed sources, in other words radionuclides (mainly very short lived) contained in liquid solutions. They also use sealed sources for radiotherapy, brachytherapy and equipment calibration.

Liquid waste is managed in two different ways according to the lifetime of the radionuclides it contains (by decay or treatment in CENTRACO then disposal of the incineration residues in the repositories operated by Andra (see § B.6.2.2.2).

Apart from sealed radioactive sources, solid waste is managed by decay or placed in a repository according to the methods defined in § B.6.2.2.1.

In the field of medical and biological research, the radionuclides most frequently used are very short lived, or short lived (tritium and cobalt-57) or long lived (carbon-14). They often take the form of unsealed sources (small samples of liquid).

Some research laboratories are situated inside hospitals: the waste they produce is often managed by the hospital's services, together with the waste generated by the health care activities.

Physics laboratories are of varying sizes and have a variety of equipment up to and including particle accelerators. The type of waste can concern any radionuclide (including activation products). However, there is no waste which, together with the radiological hazard, comprises a major biological or chemical hazard. The management of waste, radioactive materials and sources is the responsibility of the laboratories. The waste produced is primarily LLW/ILW-SL and VLL waste.

In the field of university research, no data is available on the management of radioactive waste nationally. This sector comprises highly specific aspects (personnel rotation, different practices dispersed among the facilities, few resources, etc.). The waste produced by the universities is similar to that produced by biological and medical research. It can comprise biological or chemical hazards.

The waste from industrial activities outside the nuclear field comes:

- from the past or present use of radioactive sources (sealed or unsealed). There are no more sealed source manufacturers in France, except for the Laboratoire d'Etalons d'Activités (LEA), a subsidiary of Orano which manufactures sealed calibration sources. There are however a very large number of users in the nuclear and non-nuclear industries (measurement, inspection, molecular detection, industrial irradiation). The management of sealed sources no longer in use is dealt with in section J of this report;
- non-nuclear industries linked to chemistry, metallurgy or energy production, which handle mineral raw materials containing natural radioactivity, even though there is no intention to use this radioactivity (see § B.5.2.2).

6.2.1. Provisions applicable to the nuclear activities defined in article L. 1333-1 of the Public Health Code

The Public Health Code states that *"effluents and waste contaminated or liable to be contaminated by radionuclides or activated by a nuclear activity are collected and managed while taking account of the characteristics and quantities of these radionuclides, the risk of exposure and the disposal routes identified. The means of collecting, managing and disposing of effluents and waste are written up by the person* *responsible for a nuclear activity in an effluents and waste management plan held at the disposal of the competent authority"*.

ASN resolution 2008-DC-0095 of 29 January 2008, approved by the Order of 23 July 2008, defines requirements for the management of contaminated waste and effluents for these nuclear activities defined in Article L. 1333-1 of the Public Health Code. In addition, ASN published a guide indicating the methods of application of the abovementioned resolution (Guide No. 18 on the elimination of effluents and waste contaminated by radionuclides produced in facilities authorised under the Public Health Code).

All the methods of managing the contaminated solid and liquid waste from an establishment must be described in a contaminated waste and effluents management plan (see § B.6.2.3) drawn up by the person responsible for a notified or licensed activity covered by Article L. 1333-1 of the Public Health Code if that activity generates radioactive waste or effluents.

Under Article 14 of the above-mentioned resolution, an annual report indicating the quantity of contaminated waste produced and of contaminated effluents discharged is transmitted to Andra each year.

6.2.2. The management and elimination of solid and liquid radioactive waste produced by the nuclear activities defined in Article L. 1333-1 of the Public Health Code (in particular biomedical research and nuclear medicine activities)

6.2.2.1. Management of solid waste

Solid waste containing radionuclides with a half-life of less than 100 days

Waste containing only radionuclides with a half-life of less than 100 days (called very short lived waste) may be managed by decay in-situ, prior to disposal in conventional waste routes.

It is obtained by sorting waste according to the half-life and level of radioactivity, is packaged as far upstream as possible in specific containers and is stored in a storage area.

To check that there is no contamination of the waste intended for non-radioactive waste management routes, detection systems such as monitors or detection portals shall be put into place at the exits from establishments with a nuclear medicine department.

Solid waste containing radionuclides with a half-life of more than 100 days

Waste containing radionuclides with a half-life of longer than 100 days must be eliminated in radioactive waste management solutions. This waste is then collected and managed by Andra. The management routes are notably incineration in CENTRACO, with the residues produced by this operation being disposed of in Andra's repositories. Some solid waste may be disposed of in Cires if its characteristics are compatible with the acceptance specifications set by Andra (VLL).

Solid waste containing tritium from small producers will be stored in storage facilities provided for the tritiated waste that is to be produced by ITER, the Intermed project, for which the creation authorisation application will be filed by the CEA (see § B.6.2.4). Within the framework of the PNGMDR 2016-2018, Andra and CEA studied the strategy envisaged for its management pending the commissioning of this facility, now put back to 2035, in line with the ITER schedule. Andra and CEA have set up a management solution: this waste will be accepted in the DBNI installations and will be transferred to Intermed once the installation is up and running.

6.2.2.2. Management of contaminated liquid waste

Liquid waste containing radionuclides with a half-life of less than 100 days

Liquid waste containing radionuclides with a half-life of shorter than 100 days may be managed by decay and then discharged, after monitoring, into the sewerage networks, in conditions identical to those for non-radioactive liquid waste.

To ensure their radioactive decay, this liquid waste is routed either to a system of tanks or storage containers or to a system avoiding direct discharge into the sewerage network. In practice, some establishments with a nuclear medicine department encounter technical difficulties with setting up this type of arrangement owing to the large volumes to be handled.

Liquid waste containing radionuclides with a half-life of more than 100 days

Liquid waste containing radionuclides with a half-life of longer than 100 days is collected by Andra and mainly incinerated in the CENTRACO facility.

In some cases, a licence for the discharge of liquid effluents containing radionuclides with a radioactive half-life of more than 100 days into the sewerage network may be granted by ASN under certain conditions (see section E.2.1). In this case, discharge limits are set.

With regard to liquid waste containing tritium, the Order issued pursuant to the PNGMDR 2016-2018 requires that Andra continue research into appropriate solutions for this waste. At the beginning of 2020, Andra transmitted the results of this work. The standard management solution consists in incineration in CENTRACO, if necessary after grouping in the collection-sorting-treatment building of Cires. Some batches of tritiated gaseous and liquid waste are treated in a laboratory at CEA Saclay. Specific work still needs to be done for a very small minority of batches.

6.2.3. The contaminated waste and effluent management plan

The content of the contaminated waste and effluent management plan (see § B.6.2.2) is defined in article 11 of ASN resolution 2008-DC-0095. It should notably present the methods for sorting, packaging, storage, inspection and elimination of solid and liquid waste produced by the facility.

This plan is drawn up either for a nuclear medicine unit, or for the establishment when several units producing contaminated waste or effluents and using common resources are concerned.

This management plan is enclosed with any authorisation application specified in Article L. 1333-8 of the Public Health Code. It must be updated regularly to integrate any changes within the establishment (waste zoning, etc.).

It is also recommended for the management plan to describe:

- the measures to heighten personnel awareness regarding radioactive waste and effluent management;
- the action to be taken in the event of contamination or triggering of the fixed detection system, where applicable;
- the conditions for transporting the waste between the place of production and the various storage sites;
- the means for verification of correct functioning of the liquid detector installed in the retention system (frequency to be defined and justified).

6.2.4. ITER activities

ITER (BNI 174) is an experimental facility situated at Cadarache which is designed to scientifically and technically demonstrate control of thermonuclear fusion energy obtained by magnetic confinement of a deuterium-tritium plasma during long-duration experiments with significant power (500 MWe for 400 s). This project enjoys financial support from China, South Korea, India, Japan, Russia, the European Union and the United States. The ITER organisation was restructured in 2019 to adapt to the transition from design and manufacturing activities to construction work.

ITER-Organization, the nuclear licensee of the ITER facility, is responsible for managing the waste that will be produced by this facility. The ITER-France Agency created within CEA is tasked with setting up the disposal route, particularly for the tritiated waste that will be produced.

CEA is thus tasked with providing a service to ITER, on behalf of the host country, for the management and storage of the radioactive waste resulting from the operation of ITER and from the decommissioning phase.

Radioactive waste

The radioactive waste produced at ITER will contain tritium. The estimated quantities of waste were presented in the Preliminary Safety Report. The waste in question will comprise very low level (VLL) waste, low level/intermediate level short-lived (VLL/IL-SL) waste, purely tritiated waste and tritiated ILW-LL (intermediate level, long-lived) tritiated waste produced during the operations phase (1200 tonnes) and during the final shutdown and decommissioning phase (34,000 tonnes).

Owing to the very mobile nature of tritium, the solution chosen in France is to store the tritiated waste packages for about fifty years to allow the tritium activity to decay before considering their transfer to a disposal facility.

The plan is for the ITER operating waste to be stored in Intermed, a decay storage facility to be built by the host country. This waste includes very low level (VLL) solid tritiated waste and low and intermediate level short-lived (LLW/ILW-SL) tritiated waste. The purely tritiated and ILW-LL waste will be stored in the ITER hot cells until decommissioning takes place. With regard to the decommissioning waste, the favoured solution is storage on the ITER site. Implementation of the storage solutions must be authorised in the ITER final shutdown and decommissioning decree, after about 20 years of operation.

The Intermed tritiated waste storage facility

The safety options file for Intermed was submitted to ASN in 2014. The delay in the ITER project schedule has repercussions on the intermed project schedule and on the strategy for the management of tritiated waste from small producers. In early 2020, CEA announced a delay in the commissioning of this facility to 2035.

Pending the commissioning of Intermed, the management strategy adopted by Andra and CEA is storage of the waste from the small producers in the DBNIs (see §. B.6.2.2.1).

6.3. Management of mining processing residues

The public authorities have given constant attention to the management of the former uranium mines since their closure. After these sites were made safe, their management continued with refurbishment, remediation and surveillance measures. Rehabilitation of the residue disposal sites consisted in placing a solid cover over the residues, to provide a geomechanical and radiological protection barrier designed to mitigate the risks of intrusion, erosion, dispersion of products in place and the risks related to external and internal (radon) exposure of the surrounding populations. Public access to these sites is nonetheless prohibited. The uranium mining processing residues disposal sites are authorised by the system of installations classified for protection of the environment, under heading 1735.

In the specific case of the former uranium mines and in order to reinforce the actions of Orano Mining, which is responsible for these sites, and of the public authorities, the Minister responsible for the environment and the ASN Chairman, decided, through the circulars of 22 July 2009, 8 August 2013 and 4 April 2014, to implement an action plan built around the following:

- monitor the former mining sites (check on the steps taken by Orano by the regional directorates responsible for the environment, together with ASN), and reinforce intruder prevention on these sites and then define any resulting improvement measures;
- improve the understanding of the environmental and health impact of the former uranium mines and their monitoring, consolidate the environmental inventory of these sites;

- manage the waste rock by improving the understanding of its use and, if necessary, by reducing its environmental and health impact;
- conduct more detailed investigations into the impact of the use of radioactive materials in the construction of residential buildings owing to radon emissions;
- strengthen information and consultation (more specifically at the local level).

The work done by the public authorities since the 1990s on the long-term impact of uranium mining residue repositories is continuing, notably within the framework of the successive PNGMDRs. The studies submitted by Orano within the framework of the various editions of the PNGMDR led to improved understanding of the environmental and health impact of these former sites, with regard to:

- the dosimetric impact of the mining residue repositories on man and the environment, in particular through the comparison of data obtained from monitoring and the results of modelling;
- the evaluation of the long-term dosimetric impact of the mining waste rock piles and the mining waste rock in the public domain, in conjunction with the results obtained within the context of the Circular of 22 July 2009;
- the strategy to be chosen for changes to the treatment of water collected from former mining sites;
- the relationship between the discharged flows and the accumulation of contaminated sediments in rivers and lakes;
- the assessment of the long-term integrity of the embankments surrounding residues disposal sites;
- the phenomena of uranium transport from the mining waste rock piles to the environment;
- the mechanisms governing the mobility of uranium and radium within uranium-bearing mining processing residues.

The studies supplied by Orano through the successive PNGMDRs constitute a major step forward in guaranteeing the safety of these disposal sites. ASN issued an opinion on these studies for each PNGMDR and made recommendations in several areas (changes in the long-term physico-chemical characteristics of the ore processing residues and modelling of the strength of the embankments, needs concerning reinforcement of the residues repository covers, evaluation of the impact of mining waste rock, including that of radon, treatment of waters and impact of discharges, etc.). The steps to be taken as a result were extensively incorporated in the successive PNGMDRs and will also be included in the 5th version of the PNGMDR.

The studies submitted by Orano Mining for the PNGMDR 2016-2018 constitute a step forward in understanding the long-term evolution of the uranium processing residues repositories, notably in terms of the evolution of the long-term physico-chemical characterisations of the residues and the production of geotechnical files on certain embankments surrounding these repositories.

Moreover, the MIMAUSA programme (Memory and Impact of Uranium Mines: Summary and Archives) launched in 2003, and carried out by IRSN jointly with the DGPR and ASN, traces the history of all the French uranium mining sites, as well as the radiological monitoring and surveillance systems put in place. It constitutes a working tool for the State's service responsible for defining rehabilitation and monitoring/surveillance programmes, as well as a public information tool. Since the end of 2008, this database has been available on the internet (http://mimausabdd.irsn.fr/), with the latest update of the data carried out in March 2017, collating information about the 250 uranium mining sites in metropolitan France. MIMAUSA thus gives access to the environmental summaries submitted by Orano Mining, to the second level inspections performed by IRSN on these summaries, and to a list of the waste rock piles.

In addition, the pluralistic experts group committee (GEP) on the uranium mines in the Limousin region was set up in November 2005 at the initiative of the Ministers in charge of the environment, industry and health. The duties assigned to the GEP were on the one hand to assess the current impacts of the operations of the former uranium mines on a few sites, and on the other, to make a critical review of the monitoring and surveillance of the former uranium mining sites in the Limousin region, in order to inform the administration and the licensee about the management prospects for varying future time-scales.

The GEP Limousin submitted its final report and its recommendations on the former uranium mining sites in France to the Minister for ecology and sustainable development and to the ASN Chairman, on 15 September 2010. ASN and the Minister in charge of the environment are engaged in an action plan dedicated to implementing these recommendations and entrusted the president of the GEP with the tasks of presenting its conclusions and recommendations to the local and national consultation bodies and assessing the actual implementation of its recommendations.

In November 2013 the GEP submitted its report presenting the conclusions of this latter assignment to ASN and the DGPR of the Ministry responsible for the environment. The GEP considers its involvement to have brought positive results and notes that its recommendations remain fully relevant. In order to conserve the GEP's pluralistic approach to the question of the management of the former uranium mining sites, ASN and the DGPR proposed the creation of a network of experts from the site monitoring commissions who would be assigned appraisal missions on questions of both local and national reach where justified by the societal aspect.

6.4. Waste management by Andra

Andra operates three industrial facilities. Two facilities are dedicated to low-level and intermediate-level short-lived waste (LLW/ILW-SL):

- the CSM, which is a disposal facility "undergoing decommissioning", insofar as Andra is still scheduling improvement work on the repository cover (see section D.3.2.2.1);
- the CSA, which is a disposal facility in operation and also comprises waste packaging facilities (drum compacting, injection of metal containment structures) (see section D.3.2.2.2).

These two facilities come under the system governing basic nuclear installations.

Andra also operates the Cires (Industrial centre for collection, storage and disposal) which comprises:

- treatment and packaging facilities for very low level (VLL) waste;
- a disposal facility for VLL waste which is described in section D.3.2.2.3;
- a collection building for transit before transfer to the treatment facilities for the waste collected by Andra, particularly waste from the medical sector and institutional research ("small producers" waste);
- a treatment building for the waste from the "small producers" in which operations such as the grinding of the tritiated scintillation bottles, separation of the solid part from the liquid part, or preparation by assembly of liquid containers can be carried out. This building was commissioned in 2016 and now enables Andra itself to treat waste for which it previously subcontracted the packaging operations;
- storage facilities for the waste collected by Andra which does not yet have an operational disposal route.

Andra effectively collects the waste produced by the small and medium-sized industries, research laboratories (apart from those of CEA), universities, hospitals, etc. A collection guide sets out the conditions for acceptance of the waste for which Andra has treatment solutions for its elimination or disposal. With regard to waste for which disposal routes are not yet available, the producers address their collection requests to Andra, which examines them on a case-by-case basis.

This activity concerns 850 Andra customers of whom 200 each year make collection requests in application of the removal guide. 2,492 packages were collected in this way in 2019, corresponding to a volume of 212 m^3.

A portion of this waste, after passing via the collection building - and possibly via the sorting and treatment building as well - is transferred to the CENTRACO plant for incineration prior to disposal at the CSA.

The Cires centre is used to store sealed sources, radioactive lightning conductors and radium-bearing waste from the clean-out of sites with legacy contamination (radium industry).

As at the end of 2019, the quantity of waste of this type was 868 m^3 for a total storage capacity of 4,500 m^3.

SECTION C | SCOPE (ART. 3)

i) This Convention applies to the safe management of spent fuel when this is the result of civil nuclear reactor operation. The spent fuel held in the spent fuel reprocessing facilities and which is reprocessed, does not fall within the scope of this Convention unless the Contracting Party declares that the reprocessing of the spent fuels is part of the spent fuel management process.

ii) This Convention also applies to the safe management of radioactive waste when it is the result of civil applications. However, it does not apply to waste which only contains naturally occurring radioactive materials and which does not come from the nuclear fuel cycle, unless it constitutes a sealed source removed from service or is notified as radioactive waste by the Contracting Party for the purposes of this Convention.

iii) This Convention does not apply to the safe management of spent fuel or radioactive waste originating from military or defence programmes, unless it has been notified as spent fuel or radioactive waste by the Contracting Party for the purposes of this Convention. However, this Convention applies to the safe management of spent fuel and radioactive waste from military or defence programmes if and when these materials are definitively transferred to exclusively civil programmes and managed within the framework of these programmes.

iv) This Convention also applies to effluent discharges in accordance with the provisions of Articles 4, 7, 11, 14, 24 and 26.

1| THE PLACE OF SPENT FUEL REPROCESSING IN SPENT FUEL MANAGEMENT

On the occasion of the diplomatic conference to adopt this Convention, held from 1 to 5 September 1997 at IAEA headquarters, France, Japan and the United Kingdom made the following declaration (Final Act §12 – Analytical report on the fourth plenary session § 93-95-GC(41)/INF 12/Ann. 2):

"The United Kingdom, Japan and France regret that no consensus could be reached on the inclusion of reprocessing in the scope of the Convention.
They declare that they shall report, within the context of the Convention, on reprocessing as part of spent fuel management.
The United Kingdom, Japan and France invite all other countries that undertake reprocessing to do the same."

Through this report, and in accordance with its commitments, France reports on the steps taken to ensure the safety of the spent fuel reprocessing facilities.

2| RADIOACTIVE WASTE

All the radioactive waste resulting from civil applications is covered by this report. It includes waste from the nuclear fuel cycle as well as that from other activities, in particular the medical, industrial and research fields.

3| OTHER SPENT FUEL AND RADIOACTIVE WASTE PROCESSED BY CIVIL PROGRAMMES

Once transferred to civil programmes, spent fuel and radioactive waste from military or defence programmes is included in the inventories and processed in the facilities presented in this report.

All disposal facilities are civil. Andra may thus take all necessary steps to check the quality of the waste packages intended for its facilities, even if this waste comes from military or defence-related installations. ASN conducts a second-level check on Andra, notably to verify the procedures put into place with the waste producers and in the disposal centres, to guarantee the quality of the packages received, as this plays a key role in the safety of the disposal centres. Inspections are carried out by ASN and, if necessary, jointly with ASND (defence nuclear safety regulator).

Any transfer of radioactive materials or waste between civil and military installations must be duly approved by the two regulatory authorities in order to guarantee transparency and verify their acceptability in the receiving installation.

4| EFFLUENT DISCHARGES

Effluent discharges are dealt with in this report (more specifically see section F.4.).

SECTION D | INVENTORIES AND LISTS (ART. 32-§2)

The report also includes:

i) a list of the spent fuel management facilities to which this Convention applies, indicating their location, their main purpose and their key characteristics;

ii) an inventory of the spent fuel to which this Convention applies and which is in interim storage or definitive disposal. This inventory includes a description of the materials and, if available, information about the mass and total activity of these materials;

iii) a list of the radioactive waste management facilities to which this Convention applies, indicating their location, their main purpose and their key characteristics;

iv) an inventory of the radioactive waste to which this Convention applies and which:

a) is stored in the radioactive waste management facilities and in the nuclear fuel cycle facilities;

b) has been sent for definitive disposal; or

c) is the result of past practices.

This inventory comprises a description of the materials and other available relevant information, such as information about volume or mass, the activity and certain radionuclides; a list of the nuclear facilities undergoing delicensing, indicating the progress of the delicensing activities in these facilities.

v) The map showing the location of the main facilities concerned is given at the beginning of section L, containing the Appendices to the report.

1| SPENT FUEL MANAGEMENT FACILITIES

1.1. Facilities producing spent fuel

Most of the spent fuel produced in France comes from the 56 PWR nuclear generating reactors, with an electrical power of between 900 MWe and 1450 MWe, commissioned between 1977 and 1999 and distributed around 19 EDF centres.

The fuel used in these reactors is either based on uranium oxide slightly enriched with uranium 235 (UOX), or a mixture of depleted natural uranium oxide and plutonium separated out during the reprocessing of spent fuels (MOX), or, as of 2023, comprising enriched reprocessed uranium (URE).

The other spent fuels come from 9 research reactors of various types, either in service or shutdown, with a thermal power of between 100 kW and 350 MW and commissioned between 1964 and 1978. Eight of them are located in the CEA Centres at Cadarache, Marcoule and Saclay, while the ninth is in the Institut Laue-Langevin (ILL) near the CEA Centre in Grenoble.

The inventory of these facilities is given in the appendix (see Appendix L.1.1).

1.2. Spent fuel storage or reprocessing facilities

Some BNIs take part in spent fuel management. These are the spent fuel experimentation laboratories, the spent fuel storage facilities and the spent fuel reprocessing facilities. The inventory of these facilities, operated by CEA, EDF or Orano, is given in the appendix (see Appendix L.1.2).

1.2.1. The Orano Cycle facilities

1.2.1.1. General

The Orano spent fuel management facilities in service are located in the La Hague facility, situated on the north-western tip of the Cotentin peninsula, 20 km west of Cherbourg.

Via three Decrees of 12 May 1981, the Compagnie générale des matières nucléaires (COGEMA) (today Orano Cycle) was authorised to create plants UP3-A and UP2-800 to reprocess fuels from the light water reactors, and STE3, designed to treat the effluents from the two plants.

The various units of the UP3-A, UP2-800 and STE3 plants were commissioned from 1986 (reception and storage of spent fuels) to 1992 (R7 vitrification unit), with the actual start-up of most of the process units in 1989/90, ending with the commissioning of the ACC (hulls and end-pieces compaction facility) and R4 (of the plutonium line in the UP2-800 plant) in 2001.

The main line in these facilities comprises units for spent fuel reception and storage, shearing and dissolution, chemical separation of the fission products, final purification of the uranium and plutonium and treatment of the effluents.

Via the Decrees of 10 January 2003, the reprocessing capacity of the spent fuels in each of the two plants was increased to 1,000 t initial heavy metal (tIHM) contained in the substances per year, with the site's capacity being limited by administrative order to 1,700 t per year.

The recycling of the materials obtained from reprocessing of the spent fuels enables the current generation of reactors to make raw material savings of up to 25% natural uranium in mono-recycling. This figure could increase to 30% with multi-recycling of the spent fuels in pressurised water reactors. An R&D programme incorporating studies and experiments has been started by Orano, with other players in the sector, in accordance with the orientations of the Multi-year Energy Programme 2019-2028. Introduction of a test assembly into a reactor is planned for about 2025-2028.

The quantities of fuel reprocessed are tailored to the amount of plutonium needed to fabricate MOX fuels for Orano's customers.

The German, Belgian, Japanese, Dutch, Swiss and French (EDF) customers of Orano have used or currently use recycling of the uranium obtained from the reprocessing of spent fuels. The use of URE fuel (enriched reprocessed uranium) in the Cruas reactors was halted in 2013, but EDF intends to resume this in 2023.

1.2.1.2. Storage of spent fuel

The spent fuel awaiting reprocessing is stored in two stages: first of all in the cooling pools in the fuel buildings (BK) adjacent to the reactor buildings in the NPPs, and then in the Orano La Hague pools until reprocessing.

The authorised capacity of the La Hague pools corresponds to a total of 17,600 tonnes broken down as follows:

Plant	Pool	Capacity (t)
UP2-800	NPH	2,000
	Pool C	4,800
UP3-A	Pool D	4,600
	Pool E	6,200

Table 7: Authorised storage capacity in the Orano pools at La Hague

1.2.2. The other storage facilities

The fuel evacuation facility (APEC) for the Superphénix fast neutron reactor (sodium cooled industrial prototype with a thermal power of 3000 MW finally shut down in 1997) consists mainly of a storage pool on EDF's Creys-

Malville site, commissioned on 25 July 2000. The irradiated assemblies from Superphénix were extracted from the reactor between 1999 and 2002, washed and stored in the APEC pool.

The fuels from CEA's civil programmes that are surplus to requirements are stored pending a final solution (reprocessing or disposal), either dry (in shafts) in the CASCAD facility, or under water (in a pool) in the PÉGASE facility on the Cadarache Centre. Storage clearance from this facility began in 2006 and is ongoing. CEA spent fuels are also stored in BNI 72 at Saclay and their removal to CASCAD has started.

2| INVENTORY OF STORED SPENT FUEL

Most of the spent fuel stored in France comes from the PWRs or BWRs (boiling water reactors) and are uranium oxide or MOX based, as well as from research reactors. They are stored in the various facilities mentioned in the previous sections.

Location	Mass of French spent fuel stored (tHM)
La Hague	**10,017**
EDF NPP sites	**4,096**
CEA centres	**55**

Table 8: Mass of French spent fuel stored in France as at 31 December 2018

Origin	France	Italy	Netherlands	Belgium	Australia
Mass (t)	10,017	9.29	6.73	0.024	0.554

Table 9: Origin of spent fuel stored on the La Hague site as at 31 December 2018

3| INSTALLATIONS PRODUCING RADIOACTIVE WASTE AND RADIOACTIVE WASTE MANAGEMENT FACILITIES

3.1. Installations producing radioactive waste

3.1.1. Basic nuclear installations (BNI) in operation

The BNIs in operation produce radioactive waste. The installations producing or managing spent fuel are listed in Appendix L.1. The installations producing or managing radioactive waste, except for the BNIs undergoing decommissioning, are listed in Appendix L.2.

3.1.2. BNIs being decommissioned

Radioactive waste is also produced in the BNIs being decommissioned (reactors, laboratories and plants), which are given in the list in Appendix L.3 (it should be noted that the list in Appendix 3 contains delicensed facilities which no longer produce radioactive waste). Some of these facilities also contain legacy waste which has been neither processed nor conditioned during the operation of these facilities. This waste is stored in pits or in older units not specifically designed for this purposes. The retrieval and conditioning of this waste (RCD) is usually a major and complex step in the decommissioning of these facilities. This waste also represents a significant potential source term (HLW, ILW, or LLW-LL).

3.1.3. Installations Classified for Protection of the Environment

In France, there are about 800 installations classified for protection of the environment (ICPE) subject to licensing owing to the radioactive substances they hold and use. Most of these installations hold sealed sources and do not therefore produce any radioactive waste. They are located all around the country. They are normally analysis and research laboratories or industrial facilities (manufacturers of radioactive sources, plants using naturally radioactive ores, irradiators).

3.1.4. Polluted sites

Case of BNIs:

In accordance with Article 4.2.1. of the Order of 7 February 2012, the licensee of a BNI shall periodically analyse the chemical and radiological state of the environment of the installation and its neighbourhood, as appropriate for the activity and the potential consequences. It focuses at least on the parameters measured to produce the environmental status report required in the initial impact assessment of the installation and its successive updates. The analysis more particularly concerns all the substances that could be incorporated into the biological cycles.

If the soil status results reveal the presence of radioactive or chemical substances at an unexpected level, the licensee shall propose and implement management measures appropriate to the issues involved and implement them following ASN approval.

The management of sites potentially contaminated by radioactive substances is covered by a methodological guide published jointly by the Ministry responsible for the environment, ASN and IRSN in 2011.
In 2012, ASN established its doctrine regarding the management of sites polluted by radioactive substances (https://www.asn.fr/Informer/Dossiers-pedagogiques/Les-sites-et-sols-pollues-par-des-substances-radioactives). It is based on four main principles applicable to all situations, which define the approach to be implemented:

- the justification and traceability of the ASN position statements;
- involvement of the stakeholders and the public concerned as early as possible in the process;
- application of the polluter-pays principle to the solvent party responsible for the pollution;
- optimisation in terms of radiation protection.

Pursuant to the Public Health Code, the exposure of individuals to ionising radiation during and after operations to manage sites contaminated by radioactive substances must be kept as low as reasonably achievable in the light of current technology and of economic and social factors. Thus, from an operational standpoint, in ASN's opinion, the reference procedure to be adopted when technically possible is to completely clean out sites contaminated with radioactivity, even if the human exposure induced by the radioactive contamination appears to be limited. If, based on the characteristics of the site, this procedure would be difficult to apply, it is in any case necessary to go as far as reasonably possible in the clean-out process and to provide data, whether technical or economic, proving that the clean-out operations cannot be taken further and are compatible with the actual or planned use of the site. On the assumption that complete clean-out has not been achieved, appropriate measures must be implemented. Excavated contaminated earth is managed in the same way as radioactive waste and sent to the dedicated routes.

Case of ICPEs:

For ICPEs that have reached the end of their service life, Articles R. 512-39-1 et seq. of the Environment Code set out site rehabilitation obligations.

The rehabilitation of such sites may lead to the production of radioactive waste as a result of decontamination and earth excavation work.

The waste resulting from rehabilitation works is generally of low specific activity. Some radionuclides are long-lived. As management routes are not yet available, this waste must be stored, pending the availability of a disposal solution for LLW-LL waste.

Two databases, which are accessible on the Géorisques geographical information system, list polluted sites in France, including those contaminated by radioactivity:

- Basias (georisques.gouv.fr/dossiers/inventaire-historique-des-sites-industriels-et-activites-de-service-basias) lists all industrial sites that are abandoned or unlikely to generate environmental pollution;
- Basol (basol.developpement-durable.gouv.fr) lists polluted (or potentially polluted) sites requiring preventive or remedial action by the public authorities.

In order to improve public knowledge and retain a record of these sites, Soil Hazard Information Sectors (SIS) have been created. These SIS comprise plots of land where the identified pollution, particularly if there is to be a change in usage, justifies the performance of soil studies and the determination of management measures to preserve public and environmental health and safety.

The SIS will be incorporated into the local risk assessment, in order to ensure that any buyers and tenants are well informed, and in the town planning documents. This tool supplements the memory conservation measures already available to the State services to ensure that the future use of a contaminated site remains compatible with the management procedures decided on and implemented. The SIS may also be consulted on Géorisques.

3.2. Radioactive waste management facilities

Apart from the installations which produce radioactive waste and perform the first steps in its management, the treatment and/or storage facilities and the disposal facilities are given in Appendix L.2.2 and are shown on the following map. Most of these installations are BNIs. The very low level (VLL) waste disposal facility, Cires, is however an ICPE.

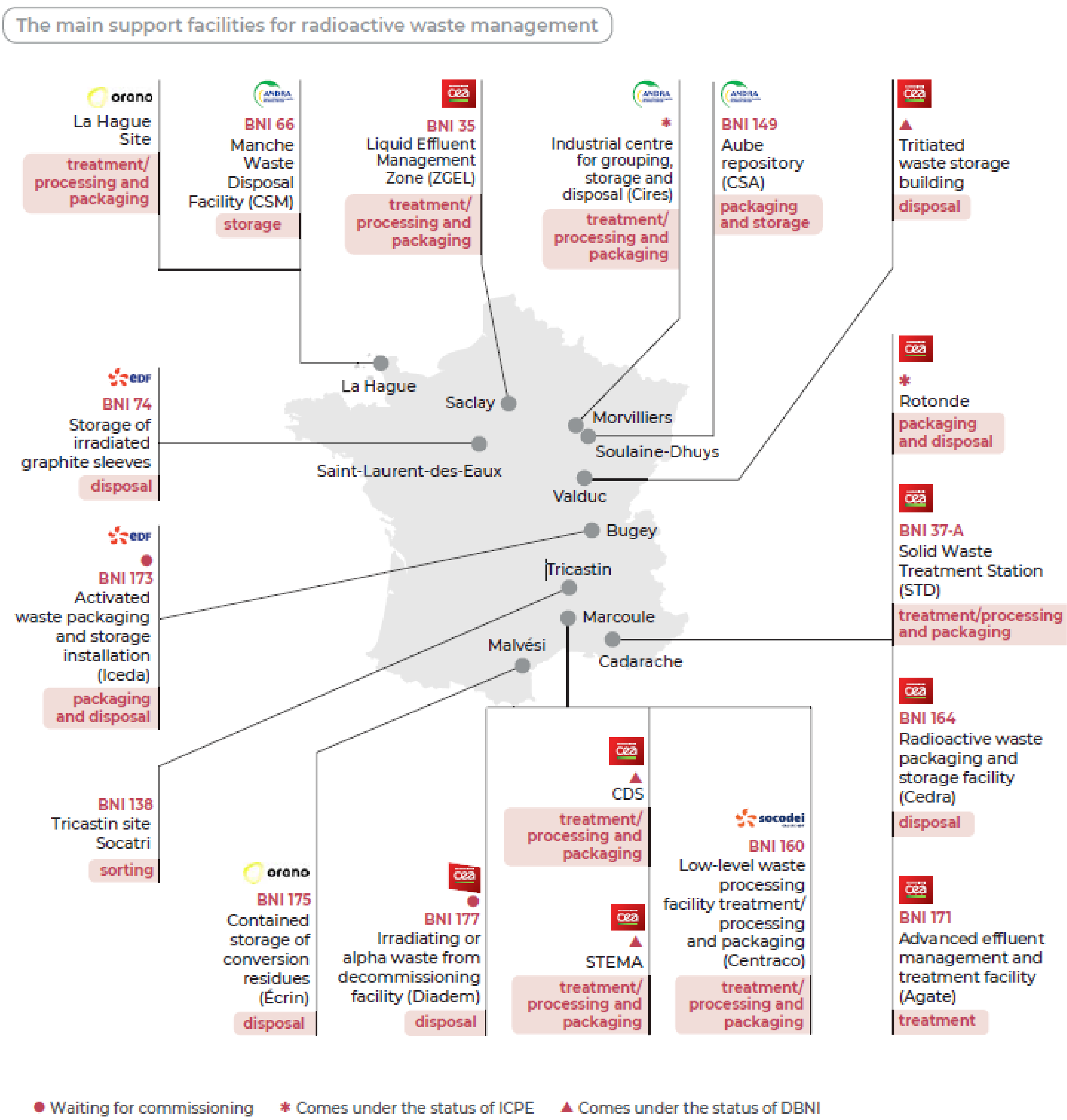


Figure 1: Radioactive waste management facilities (excluding national defence facilities)

3.2.1. Storage facilities

3.2.1.1. Storage of HLW vitrified waste packages on the La Hague site

The vitrified waste packages (standard vitrified waste packages - CSD-V) are stored in three facilities: the two production units, “R7” and “T7”, which have appropriate halls, and the modular “E/EV” facility (operational storage units: E/EV-SE and E/EV-LH; extension planned E/EV-LH2).
Storage capacity is as follows:

- UP2-800: R7 storage unit: 4,500 vitrified waste packages;
- UP3-A: T7 storage unit: 3,600 vitrified waste packages;

- UP3-A: E/EV-SE storage unit 4,320 vitrified waste packages; E/EV-LH 8,411 vitrified waste packages (planned extension; E/EV-LH2 with a capacity of 8,424 packages (4,212 packages planned as of June 2022 then a further 4,212 packages planned as of December 2026).

All of the extensions will represent a vitrified fission products storage capacity corresponding to about 40,000 tonnes of spent fuel.

		Current capacity
Capacity (Number of CSD-V)		8,100 R7 + T7
	+	4,320 E/EV-SE
	+	8,411 E/EV-LH
Total	=	20,831

Table 10: Storage capacity for vitrified waste packages on the Orano La Hague site as at 31 December 2018

As at 31 December 2018, 16,836 packages of HLW vitrified waste were present in the facilities on the La Hague site. From 1 January 1995 to 31 December 2018, the number of HLW vitrified waste packages returned to foreign customers stands at 5,319, or a return rate of higher than 98%.

3.2.1.2. Intermediate level, long-lived (ILW-LL) waste on the La Hague site

In the “ILW-LL” long-lived waste category, most of the packages currently produced come from compacting of the metal structures from the reprocessed assemblies, the CSD-C (standard compacted waste containers). However, most of the ILW-LL waste, either not conditioned or pre-conditioned, already produced and stored, comes from the activity of the old plants which operated from the 1960s to the 1980s. This waste, currently stored in pools and silos, is being handled through retrieval and conditioning programmes (RCD). The conditioning methods adopted are primarily compacting, drying, bituminisation and cementation.

Standard compacted waste containers “CSD-C”

The maximum capacity of the “Hulls and end-pieces storage unit” (ECC) is 23,432 places and allows the storage of the packages to be produced over the next six years, on the basis of the programmes of the plants. An extension with a capacity of 5,928 is scheduled for commissioning by about 2024.

Bituminous waste packages

The production of bitumen drums is today very small at La Hague following implementation of the “New Effluents Management” (NGE) which enables the concentration then vitrification of radioactive effluents (see section B.6.1.3.2).

Existing capacity allows the storage of all the bitumen drums already produced and to be produced (11,843 drums stored as at end 2018 for a total capacity of 15,756).

Cemented waste packages

The production of “Asbestos Cement Containers” (CAC) has been halted since 1994. They number a total of 753 packages, only 306 of which constitute intermediate level, long-lived waste. The other packages are to be disposed of in the CSA.

The production of “cemented fibre concrete packages” (CBFC’2) started in 1994, to replace the CAC. CBFC’2 production will slow down significantly in line with the gradual increase in the rate of incorporation of the flow of technological waste into the compacting unit (ACC, commissioned in 2002).

3.2.1.3. Other storage facilities

There are a number of storage facilities outside those mentioned above for Orano Cycle.

EDF storage facilities

EDF stored graphite waste (LLW-LL waste) from the old GCR plant series, in particular in the silos at Saint-Laurent A. EDF intends to create a new storage facility to take graphite waste once it is removed from these silos. This facility should be commissioned in 2029.

EDF also stored ILW-LL waste on its NPP sites in operation (notably rod cluster control assemblies and burnable poison rod assemblies). This waste will be packaged and stored in the ICEDA facility, for which the commissioning application has been reviewed and the commissioning authorization was issued in July 2020..

Production of ILW-LL waste from the decommissioning of certain shut-down NPPs has now started. Its packaging and storage in the ICEDA facility should begin in 2020.

CEA storage facilities

The ILW-LL and HLW radioactive waste from CEA is the result of industrial and research activities carried out in CEA's nuclear facilities, plus the waste generated by their decommissioning and the legacy waste retrieval and conditioning programmes (RCD). CEA's HLW and ILW-LL waste storage facilities are located on the Cadarache and Marcoule sites.

In Cadarache, BNI 56 was used to store waste until 2006. A storage facility called CEDRA was commissioned in 2006 and took over from BNI 56. CEA is currently carrying out RCD operations (old trenches and pits) and is removing packages stored in BNI 56 to the CEDRA facility. At Saclay, BNI 72 also stores legacy waste. CEA has submitted the decommissioning files for these two facilities to the Minister responsible for nuclear safety. Waste should be removed from storage in these BNIs and sent for storage or disposal in more recent facilities or existing routes.

At Marcoule, the HLW vitrified waste packages (AVM glass containers) are stored in the glass disposal facility (SVM) of the AVM (Marcoule vitrification unit). As at 31 December 2017, 3,159 HLW vitrified waste packages were present in this facility, along with 147 containers of ILW-LL vitrified waste (rinsing glasses) and 167 containers of ILW-LL technological vitrification waste.

CEA is at present building the DIADEM storage facility in Marcoule for irradiating beta and gamma, or alpha-emitter rich waste, for commissioning in about 2022. The DIADEM facility will complement the CEDRA facility.

CEA is studying the design of future interim storage facilities to make up for the delay in the scheduled commissioning of the LLW-LL and ILW-LL waste disposal facilities and to ensure the reconditioning of legacy waste: the main projects are the creation of new EIP (multi-purpose interim storage) cells for bituminous waste and the creation of an EIP for non-bituminous waste (EIP HB renamed EDEN: French acronym for decladding extension dedicated to storage), for the other LLW-LL and ILW-LL waste.

Storage of radioactive substances of natural origin

This primarily concerns radium-bearing waste (LLW-LL) stored in Rochelle (from the rare earths extraction industry) and Jarrie (from the manufacture of zirconium sponges).

Storage on CEA sites or waste not produced by CEA

For historical reasons and because of their skills, the CEA centres – mainly Saclay and Cadarache – accept various wastes not produced by themselves, for storage. This is waste that is to be sent on for disposal in centres currently at the planning stage (radium-bearing waste and used sealed sources).

Andra storage facilities

In 2012, Andra commissioned a storage facility in its industrial centre for collection, storage and disposal (Cires) notably dedicated to low level, long-lived waste, in particular that from the Agency's public service duties (see section B.6.4).

3.2.2. Radioactive waste disposal facilities

3.2.2.1. The Manche repository

The Manche repository (CSM), managed by Andra, was commissioned in 1969. It is located in the municipality of Digulleville on the Cotentin peninsula, in the immediate vicinity of the La Hague spent fuel reprocessing plant (Orano). About 527,000 m^3 of waste packages were emplaced there, until operations ceased on 30 June 1994.

The general design principle was to dispose of the packages on or in structures and to collect any water liable to have been in contact with the packages and monitor it separately from other rainwater. The structures, the design of which has evolved over the years, consisted of concrete slabs on which the packages were stacked directly, or disposed of in concrete chambers built on these slabs. The structures were loaded in the open air. The rainwater which fell on the slabs was collected on the periphery of the structure and routed to outlets by a network of pipes in underground galleries. This water was treated in the neighbouring Orano plant. The choice of disposal by direct stacking of packages or by disposal in concrete chambers was determined by the radiological activity of the packages or the package longevity criterion.

The centre, which covers about fifteen hectares, has since 1997 been covered by a bituminous membrane inserted into a system of layers of draining or impermeable materials, all of which are designed to prevent water from infiltrating. The cover is planted with grass to promote the evapotranspiration of rainwater and avoid erosion of the upper surface of the cover.

Since January 2003 (Decree 2003-30 of 10 January 2003 modified by Decree 2016-846), the CSM has been in what the new terminology applicable to BNIs refers to as the decommissioning phase (preparatory phase that formally prefigures closure and the start of monitoring and surveillance, which will take place once all the cover redevelopment work has been completed). An ASN resolution will set the minimum duration of the monitoring and surveillance phase, as well as the time-frame within which Andra will be required to close this facility.

This decommissioning phase was started in 1997 after the end of the covering work. The transition from the operating phase to this phase involved the same type of process as that applied for the creation of a BNI, including a public consultation. The activities carried out on the CSM since 1997 concern the following points:

- verification of the correct working of the disposal system:
  - stability of the cover,
  - impermeability of the cover,
  - estimation of water infiltration into the cover and at the base of the structures.
- detection of any abnormal situation or evolution:
  - radiological and chemical monitoring of the groundwater,
  - irradiation checks at the boundary fence,
  - atmospheric contamination checks.
- monitoring of the radiological and physico-chemical impact of the facility.

The assessment of the centre's impact is written up in annual reports that are made public and can be consulted on the Andra website (www.andra.fr).

The safety reassessments are carried out every ten years, in accordance with the BNI general regulations. The centre's latest safety assessment was carried out in December 2009. ASN notified its conclusions regarding the files in a letter sent out on 15 February 2010. In accordance with the strategy it proposed concerning the evolution of the cover, Andra performed work to consolidate the embankments around the edge of the cover in three sectors where land movements had been observed. The decision was made at the time to evaluate the effectiveness over approximately a decade before moving onto the subsequent modification stages in the other sectors. The modifications were to reduce the slopes of the cover down to the natural land level, with the drainage chambers then to be found under the more gently sloping cover. With a sequence of work and observation periods, this phase should extend to 2060.

Since then, Andra submitted a complementary file to ASN in 2015 to detail the different aspects concerning the evolution of the CSM over the long term, and the associated conditions (drainage, embankments, cover, monitoring). In this file, Andra provides information aiming to demonstrate that the bituminous membrane would be capable of protecting the disposal facility over a time frame of several hundred years, with the performance of sealing nevertheless being monitored, notably by taking periodic samples of the membrane. Observations will need to be made to demonstrate the ability of the rainwater and cover drainage networks to evacuate rainfall of rare intensity, given the high volumes to be anticipated.

2018 was marked by completion of the studies initiated in 2017 for drafting the CSM's periodic safety review report. This report, along with its support studies and supplementary files, were sent to ASN on 9 April 2019. Several studies were finalised with regard to the hydrogeological model, the lightning, electromagnetic, flooding, and earthquake hazards and an inventory of the fauna and flora.

The studies conducted to ensure the longevity of the existing cover, presented in the review file, will undergo in-depth examination in the light of the long-term objectives (beyond the monitoring and surveillance phase).

Moreover, in accordance with the technical requirements for the CSM monitoring and surveillance phase, documents must be securely archived in appropriate conservation conditions, with two copies kept in two separate locations. A first set was sent to the National Documentation Archives in order to guarantee a permanent record.

This documentation comprises a "summary historical record" (DSM) which, in about 170 pages, describes the history and main characteristics of the installation, and a "detailed historical record" (DDM) concerning technical documents regarding the construction, operation and closure of the CSM and documents relating to its safety. The DDM, more specifically its composition, conservation and transmission during and after the monitoring and surveillance phase, will be a key factor in the ongoing review process.

The CSM's local information committee (CLI) examined the CSM's "summary historical record" in 2011 and 2012. Following information search exercises in 2012 across the entire historical record (two exercises within Andra and an international exercise involving the CLI), the classification of the documents recorded was modified.

3.2.2.2. The Aube repository

The Aube repository (CSA) operated by Andra is located at Soulaines-Dhuys, in the Aube *département* in eastern France. It was commissioned in January 1992. Maximum activity levels are set by the creation decree for each radionuclide. The CSA, which benefited from the lessons learned with the CSM, is authorised for disposal of a volume of 1 million cubic metres of waste packages. The site covers an area of 95 hectares, 30 of which are for actual disposal.

This centre also carries out waste conditioning operations: this involves either injecting cement mortar into 5 or 10 m^3 metal containers, or compaction of 200-litre drums, which are then placed in 450-litre drums and blocked with mortar.

The principle of the disposal facilities operated by Andra consists in protecting the waste from any form of aggression (circulation of water, human intrusion) until the radioactivity has decayed sufficiently for there no longer to be any significant radiological risk, even in the event of loss of all trace of the existence of the disposal sites. The disposal structures form chambers in which the packages are placed. Filling takes place protected from rainwater. Metal envelope packages are concreted into the structures, while durable concrete envelope packages are stabilised in the structures using gravel. Once the structure is filled and the packages immobilised, a closure slab is poured and then covered by a temporary sealing coating, pending final covering of the repository, which will include an impermeable layer of clay. The basemat of the structures, made of reinforced concrete covered with a polymer seal, comprises an orifice for collecting any water infiltration.

As at 31 December 2019:

- the volume disposed of was about 375,000 m^3;
- 148 structures had been closed out of a planned total of about 400.

Given the rate of deliveries, of about 15,000 m^3 per year, whereas the centre was designed for annual traffic of 30,000 m^3, its operation could last beyond 2060. The National Inventory figures show that the CSA should be capable of absorbing the low and intermediate level, short-lived waste produced by the operation and decommissioning of nuclear facilities today authorised.

With regard to radiological protection, the Public Health Code (book III, title III, chapter III) states that the impact of all the nuclear activities (except medical) on the public should not lead to a dose higher than 1 mSv/year. For its part, Andra accepted a maximum impact value of 0.25 mSv/year, both during operation and after closure of the repository, in normal situations. For the other situations (altered scenarios), this value could be exceeded. The criteria used to assess whether the calculated impact is acceptable are primarily the mode and duration of exposure, as well as the worst-case aspect of the hypotheses used in the calculation (see section H.5.1).

The criteria for accepting packages in the centre are defined from operational and long-term safety studies.

Radiological capacities were defined for a certain number of radionuclides in the creation authorisation decree of 4 September 1989, as amended.

Radionuclides	Tritium	Cobalt 60	Strontium 90	Caesium 137	Nickel 63	300-year alpha emitters
Maximum radiological capacity (TBq)	**4,000**	**400,000**	**40,000**	**200,000**	**40,000**	**750**

Table 11: Radiological capacity defined for a certain number of radionuclides

(CSA creation authorisation decree of 4 September 1989)

Other limits were set by the centre's technical specifications. More specifically, the technical specifications revised in 1999, now incorporated into the centre's general operating rules, notably set a radiological capacity for chlorine-36, niobium-94, technetium-99, silver-108m and iodine-129.

For all the radionuclides, except for chlorine-36, the radiological capacity consumption fraction is below the authorised volume capacity fraction. The chlorine-36 capacity was set by ASN, after examining the repository's long-term safety conditions, to allow the acceptance of some graphite waste with radiation protection problems on its storage location. For this radionuclide, the share of capacity consumed is nearly 90% as compared with 32% consumption of the total capacity volume. Consequently, the specific activity of chlorine-36 in the waste acceptable in the repository is very low (5 Bq/g) and is being closely monitored.

In addition to the hazards linked to radioactivity, the hazards linked to certain toxic chemicals were taken into account (Pb, Ni, Cr VI, Cr III, As, Cd, Hg, Be, U, B, Sb), differentiating between the two modes of exposure in humans (ingestion and inhalation).

The centre's creation authorisation decree was modified on 10 August 2006 in order to explicitly introduce discharges from the centre, the limits of which are officially set in the Ministerial Order of 21 August 2006.

The discharge order also stipulates a quarterly assessment of the gaseous discharges from the disposal structures.

The flexibility of the CSA's disposal conditions meant that it could accept non-standard waste packages such as large sized waste packages, enabling the waste producers to limit the doses received during the cutting work. Consequently, 55 EDF pressurized water reactor closure heads have been delivered to the CSA. Special packages of lateral neutron shielding from the Creys-Malville NPP (breeder reactor) have also been accepted. Disposal of such waste is currently subject to ASN authorisation on a case-by-case basis. This option makes it possible to optimise the management of decommissioning waste.

In 2006, Andra was authorised by ASN to dispose of sealed sources with a half-life no longer than that of caesium 137. The authorisation sets the allowable activity limits per source for the radionuclides concerned.

As part of the examination of the second periodic safety review, Andra made 58 undertakings on 22 February 2018. The conclusions of this review are satisfactory. However, the continued operation of the CSA is subject to steps being taken, as will be stipulated in a forthcoming ASN resolution.

On 13 March 2019, ASN authorised Andra to operate the package inspection facility (ICC). This new facility, built in a hall of the waste conditioning unit, allows more in-depth on-site inspection of certain packages, in parallel with the systematic checks performed on all the waste packages when they arrive at the CSA. These inspections may be either destructive (opening of the package to produce an inventory of the waste present, or core sampling of the various components of the package) or non-destructive (measurement of dimensions, weighing, visual inspection, surface and radiological checks, tritium and carbon-14 degassing rate checks, verification of package quality and the absence of any prohibited waste by X-ray scanner). These more in-depth investigations were previously carried out in facilities off the site, not belonging to Andra. The fact of being able to conduct them on-site means greater reactivity, avoiding the to-and-fro between external inspection laboratories and CSA, thus increasing the number of inspections.

3.2.2.3. The VLL waste repository

The VLL waste repository (Cires), commissioned in August 2003, has a regulation capacity of 650,000 m^3. It is located a few kilometres from the CSA, in the municipality of Morvilliers (Aube *département*). It covers an area of 45 hectares. At the end of 2019, about 396,000 m^3 of waste had been emplaced in it. Given the total radiological activity it will contain, the repository is not subject to the regulations applicable to BNIs, but to that applicable to ICPEs.

The design of the centre adopts the principles applicable to hazardous waste disposal facilities.

The waste must be solid and inert. Hazardous waste is stabilised according to the same rules as for non-radioactive waste. Given its activity level, its packaging aims simply to prevent all dispersion of radioactive materials during its transport and disposal. It is protected from the rain by a mobile roof and placed in cells excavated in the clay. At the bottom of the cell, a membrane reinforces the leaktightness of the system. The cell is then filled with sand and covered by a membrane and a layer of clay. An inspection shaft is used to inspect the cell and more specifically detect any water infiltration.

As for the CSA, Andra accepts a maximum impact value of 0.25 mSv/year for Cires, both during operation and after closure of the repository, in normal situations. As an example, the impact of Cires on the public is estimated at 3.10^{-5} mSv/year in normal operation after 200 years. For the other post-surveillance scenarios, such as building a road, or a children's play area, the doses estimated are 0.02 to 0.05 mSv/year.

As for the CSA, the hazards related to the toxic chemicals were taken into account.

Cires was designed before experience feedback was available on the application of French regulations regarding waste management inside BNIs (creation of waste zoning, absence of clearance threshold).

The waste traffic as currently anticipated could lead to early saturation of the regulation capacity of Cires, the planned service life of which was thirty years. Studies have therefore been initiated to improve the density of the waste emplaced, to optimise the use of the disposal space available and to evaluate the feasibility of a very low level metallic waste recycling solution. This work is being monitored under the terms of the PNGMDR. More specifically thanks to optimised use of the disposal space available, the capacity of Cires would now appear to be about 40% greater than its regulation capacity which, provided that changes are made to the regulations, would enable its saturation to be postponed to at least 2030, without modifying the perimeter of the facility.

Moreover, in mid-2015 Andra proposed an overall industrial system that meets the needs for new disposal capacities for very low level radioactive waste. In addition to the recycling options, this system envisages the possibility of creating disposal facilities of simpler design than Cires in the vicinity of certain decommissioning sites for the less radioactive waste should disposal capacity needs increase. Between a third and half of the waste so far received at Cires, in application of the waste zoning requirement, does not present a radiation protection risk.

As for the CSA, the search for overall optimisation of waste management led to the development of solutions enabling large components to be accepted, without having to cut them up for packaging in standard packages. These solutions should be deployed taking account of the issues, notably safety, technical, economic, and calendar, of all the phases in waste management. In this way, four steam generators from the Chooz NPP were emplaced in Cires after advanced decontamination on the NPP site, enabling them to be downgraded from LLW/ILW-SL to VLL status. This solution cannot necessarily be applied generally to all the steam generators of the reactor fleet in service. However, the inventory of outsized waste led Andra to design a special disposal cell for this type of package, which entered service in December 2017. This cell is 265 m long and 23 m wide and will allow the disposal of very heavy or voluminous waste resulting notably from the decommissioning of the French nuclear installations. It is built using the same concept as the other cells at Cires, but has the particularity of being equipped with a gantry with a lifting capacity of 130 tonnes.

3.2.3. Disposal facilities for uranium ore processing residues

Depending on economic criteria, the ores with the lowest uranium content were sent to static treatment, otherwise to dynamic treatment. Depending on the nature of the ores, treatment was acid or basic. On most French sites, uranium leaching used sulphuric acid and, if necessary, with sodium chlorate acting as an oxidiser.

These processes left virtually all the components of the ore intact following dissolution of the uranium. The uranium remaining in the residues represents about 0.1 kg/t, which it is impossible to recover, owing to its low solubility form or its inaccessibility in the dissolution conditions. However, all the highly insoluble radium remained in the solid residue.

The uranium extraction industry, which has now ceased operation in France, generated 50 million tonnes of mining treatment residues. These residues are currently distributed around 17 repositories on the former operations sites (see table § D.4.2). These repositories are installations classified for protection of the environment and are subject to the licensing system stipulated by the regulations for classified installations (heading n°1735).

The layout of the mining treatment residues repositories consisted in placing a solid cover over the residues to provide a geomechanical and radiological protection barrier. The licensees also created installations to treat overflow water from the hydraulic basins created by the operations sites or the tunnels. These stations help reduce the uranium and radium concentrations of the waters before they are discharged into the environment.

After rehabilitation of the sites, it could be necessary to carry out maintenance on the installations treating the mine water and or water from drying of the residues on some of them. Studies are being conducted into the long-term future of these sites, notably within the framework of the PNGMDR (see section B.6.3).

4| THE UNDERGROUND LABORATORY IN THE MEUSE/HAUTE-MARNE CENTRE

Following the decision taken by the Government in 1998 to select the Meuse/Haute-Marne site for an underground research laboratory, the first development work was carried out in 2000 and drilling work on the laboratory access shaft began in 2001.

Since 2002, Andra has carried out a range of experiments in the Meuse / Haute-Marne underground laboratory, in particular at the main level 500m down, designed to evaluate in-situ the thermal, hydraulic, mechanical and chemical properties of the clay host rock, to understand its behaviour in response to various repository loadings (mechanical, hydric/hydraulic, thermal or chemical) and to reproduce the expected interactions between the materials liable to be used in the repository and the host rock. At the same time, Andra is conducting in-situ tests and using technological demonstrators to examine techniques for building various components of the repository architectures (drifts, disposal vaults, and closure structures – seals) as well as their actual behaviour in-situ.

More than 1,600 m of drifts have currently been excavated and made available for the scientific and demonstration programme. Nearly 14,000 measurement points are installed in the underground laboratory and continuously transmit data on the behaviour of the rock and the structures built.

The following R&D orientations, selected as priorities for the period 2011-2016, are particularly noteworthy:

- with regard to scientific knowledge:
  - continuation of long-duration tests on the behaviour of the repository materials (concrete, glass, steel),
  - evaluation of the thermo-hydro-mechanical behaviour of the clay host rock under the effect of thermal loading (overpressure, expansion, etc.),
  - characterisation of the evolution of the hydromechanical and hydraulic properties of the near-field host rock area damaged by excavation of the works, following stress or strain paths, in particular its hydraulic healing and its compressibility,
  - evaluation of the effect of the humidity in the ventilation air on the hydric status of the damaged area and its hydromechanical behaviour,
  - characterisation of the development of the loads on the supports and coatings for various coating/support methods (compressible shims, thick projected concrete, poured concrete, voussoirs),
  - characterisation of the damaged area associated with the various coating/support methods (flexible and rigid coatings, voussoirs) and various drift sizes.
- with regard to technological knowledge:
  - excavation of HLW vaults,
  - excavation of large diameter drifts,
  - installation of voussoirs as the coating/support method,
  - installation of a seal.

All of this work carried out in the underground laboratory will contribute to the production of scientific and technical data to support the preparation of the creation authorisation application for the deep geological repository (see section H.3.2.1).

5| INVENTORY OF RADIOACTIVE WASTE

5.1. Annual production of radioactive waste

The annual production of radioactive waste in 2018 according to the classification defined in § B.4.2, as well as its origin, is summarised in the following table.

Type of waste	Volume in m³	Fuel cycle and electricity production (%)	Nuclear research (%)	Others(%)
Very low level	**20,000**	**68**	**28**	**4**
Low and intermediate level, short-lived	**6,000**	**~80**	**~20**	**Low**
Low level, long-lived	**100**	**25**	**0**	**75**
Intermediate level, long-lived	**200**	**80**	**20**	**0**
High level	**140**	**100**	**0**	**0**

Table 12: Annual production of radioactive waste in France in 2018

The ILW-LL and HLW shares here comprise all the waste packaged by reprocessing of the spent fuels produced in France.

The percentages were calculated on the basis of the waste conditioned in the form of packages. Stored spent fuels were not taken into account. The "others" category includes waste from the clean-out of contaminated sites (LLW-LL), the nuclear industry other than power generation and the medical sector (VLL, LLW/ILW-SL).

5.2. Waste present in the storage facilities

5.2.1. Radioactive waste from spent fuels after reprocessing (French share)

The ultimate waste contained in the spent fuels reprocessed in the La Hague installations falls into two categories: fission products and structural waste.

The fission products are packaged in CSD-V packages (standard vitrified waste containers) and structural waste in CSD-C packages (standard compacted waste containers). As at 31 December 2018, and as presented in the following table, the vast majority of the CSD-V were French, given that most (98.7%) of the activity of the reprocessed foreign fuels had been shipped. As at 31 December 2018, the share of CSD-C packages still to be shipped was greater than for the vitrified packages, given that Orano gave priority to shipping those packages with the highest activity.

	Total number of packages stored as at 31.12.18	Estimation of the share belonging to the French owners of spent fuel reprocessed before 31.12.18 (%)
CSD-V	**16,836**	99.1
CSD-C	**16,216**	67.9

Table 13: HLW Vitrified and compacted waste packages present on the Orano la hague site as at 31 December 2018 (French share)

5.2.2. Radioactive waste from spent fuels after reprocessing (foreign share)

In accordance with the Order of 2 October 2008 approving the system of inventorying and shipping waste after reprocessing of spent fuels from abroad in the BNIs at La Hague, the CSD-V and CSD-C packages are shipped on the basis of the activity and the mass of the imported spent fuels, respectively.

	Germany	Belgium	Spain	Italy	Japan	Netherlands	Total
CSD-V	0	<0.1	0.4	0.4	0	0.1	0.9
CSD-C	21.2	0	0.1	1.2	9.6	<0.1	32.1

Table 14: Vitrified and compacted HLW waste packages present on the Orano La Hague site as at 31 December 2018 (the quantities "< 0.1" are not counted in the total)

5.2.3. Other stored waste (in packaged equivalent volume, as at end 2018)

As at the end of 2018, the other stored waste (in packaged equivalent volume) is as follows:

- intermediate level long-lived waste other than that from spent fuels after reprocessing: 46,300 m^3;
- low-level long-lived waste: 87,200 m3;
- low and intermediate level waste, not yet disposed of in the CSA: 67,000 m^3;
- very-low-level waste, not yet disposed of in Cires: 154,000 m^3;
- tritiated waste: 5,500 m^3;
- for certain categories of very low and low level waste which have remained without a disposal route for a long time (oils, resins, scrap, etc.), EDF has set up special, regulated areas (VLL areas) where this waste is stored, pending disposal;
- used sealed radioactive sources: 1,700,000;
- mining residues: 50 million tonnes (see following table) for which there is a specific disposal solution.

Region	Disposal site	Share of total disposed of (%)	Residues disposed of: Tonnage (thousands of tonnes)
Alsace	Teufelsloch	0.01 %	**4**
Auvergne	Rophin	0.06 %	**30**
	Saint-Pierre	1.2 %	**605**
Bourgogne	Bauzot	0.03 %	**16**
	Gueugnon	0.4 %	**226**
Languedoc	Le Cellier	12.0 %	**5,821**
	Le Bosc (Lodève)	10.0 %	**5,446**
Limousin	Bellezane	3.1 %	**1,653**
	Le Bernardan (Jouac)	3.7 %	**1,870**
	Brugeaud	25.3 %	**12,564**
	Lavaugrasse	15.1 %	**7,489**
	Montmassacrot	1.5 %	**737**
	La Ribière	0.4 %	**197**
Midi-Pyrénées	Bertholène	0.9 %	**476**
Pays-de-Loire	La Commanderie	0.5 %	**250**
	L'Ecarpière	22.9 %	**11,350**
Rhône-Alpes	Bois-Noirs Limouzat	2.6 %	**1,387**
		100 %	**~50 000**

Table 15: Disposal sites for uranium ore processing residues in France

5.3. Waste disposed of VLL-LL-IL

The total volume of very low level (VLL), low level (LL) or intermediate level (IL) short-lived radioactive waste disposed of as at the end of 2018 amounts to about 1,238,000 m^3 and can be broken down as follows.

	Volume (m³)
Immersion of 14,300 t (1967 and 1969)	9,900
Manche repository	527,000
Aube repository (CSA)	335,000
Cires repository	396,000

Table 16: Volumes of VLL and LL/IL waste disposed of as at 31 December 2018

At present, there is no disposal route in France for intermediate level, long-lived waste (ILW-LL) and high-level radioactive waste (HLW).

6| BNIS UNDERGOING DECOMMISSIONING

As at the end of 2019, 35 BNIs of all types (power and research reactors, laboratories, fuel reprocessing plants, waste treatment facilities, etc.) had been shutdown or were undergoing decommissioning in France (see Appendix L.3.1 and L.3.2). This corresponds to about one third of the BNIs in operation, other than the power reactors in service.

This more specifically concerns:

- 9 old reactors and an old EDF support unit;
- 20 CEA facilities;
- 6 Orano facilities.

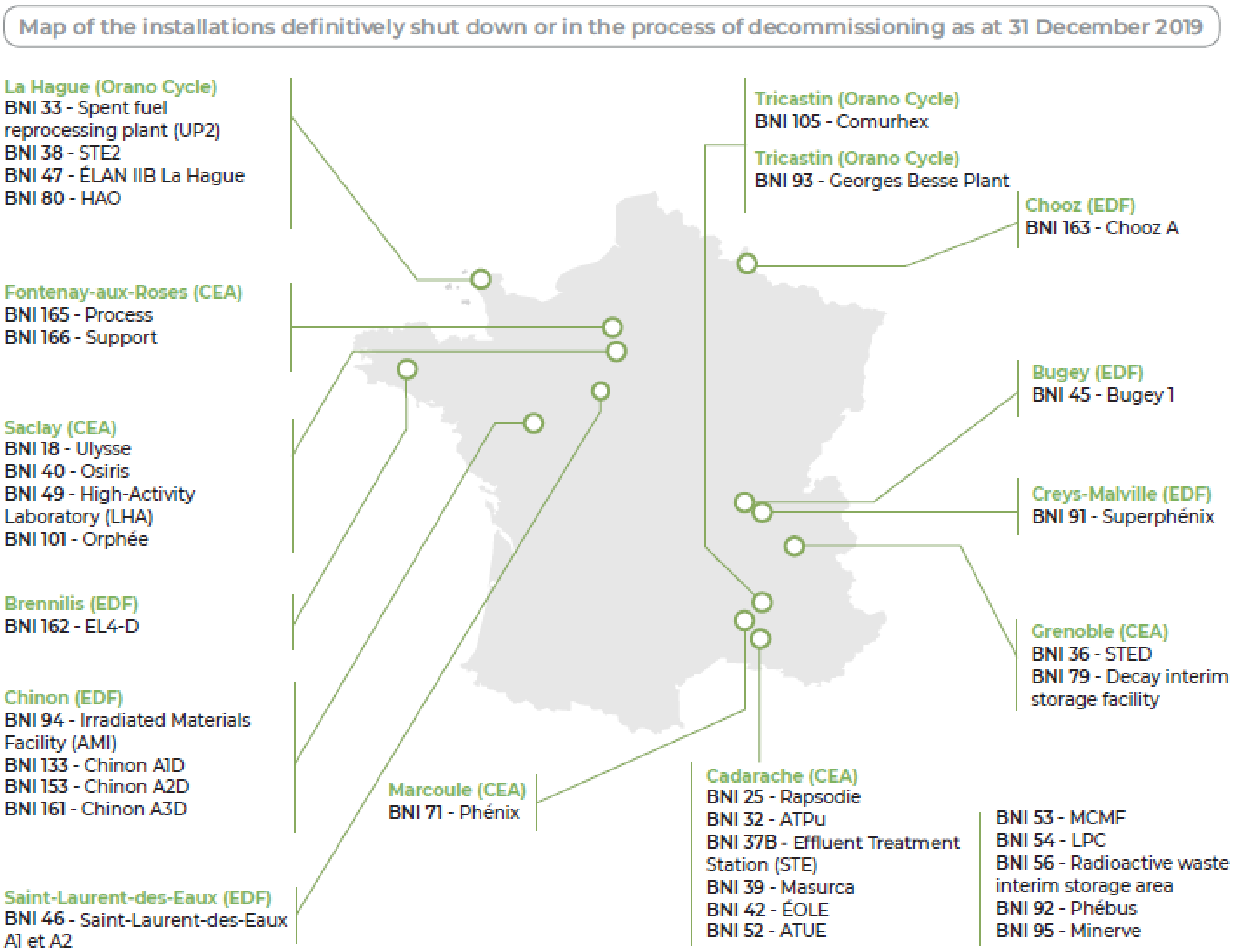


Figure 2: BNIs definitively shut down or undergoing decommissioning in France as at 31 December 2019

SECTION E | LEGISLATIVE AND REGULATORY SYSTEM (ART. 18 TO 20)

1| THE GENERAL FRAMEWORK (ARTICLE 18)

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

1.1. The general legal framework for nuclear activities

The safe management of nuclear activities comprises two inseparable aspects: radiation protection and nuclear safety.

With regard to radiation protection, the regulations in France are set by the Public Health Code and the Labour Code.

With regard to nuclear safety, the radioactive installations and substances covered by this Convention differ widely in nature and are covered by different regulatory frameworks in France.

Above a certain threshold, in terms of activity and specific activity, set by Articles R. 593-1 et seq. of the Environment Code and its appendix, an installation is a basic nuclear installation (BNI) and placed under the control of ASN.

This category more particularly includes all the installations producing, storing or processing spent fuel (reactors, storage facilities, spent fuel reprocessing plants, etc.), installations “whose main purpose is to manage radioactive waste" as defined in this Convention (except for Cires which is an installation classified for protection of the environment - ICPE) and a large number of installations containing radioactive waste, even though its management is not the main objective: as at 31 December 2019, there were 124 BNIs.

Below this threshold, an installation containing radioactive substances may be an ICPE placed under the control of the Ministry responsible for the environment. There are about 800 installations of this type.

It should be noted that installations concerning national defence are subject to the same activity classification system. The authorities responsible report to the Ministry in charge of industry and/or defence. However, the radioactive waste produced by these installations is sent to civil waste disposal facilities and the long-term management of this waste in these facilities is therefore subject to ASN oversight. ASN coordinates with the ASND (defence nuclear safety regulator).

Finally, radioactive sources are subject to specific regulations and, since April 2002, have been subject to ASN oversight. Sealed sources are regulated once they exceed an exemption threshold defined, per radionuclide, by the Public Health Code. This threshold is set at a very low level.

The consistency of safety oversight is guaranteed by regular interaction between the regulatory authorities, which hold frequent high-level meetings.

The French organisation with regard to nuclear safety and radiation protection is more specifically based on the principle of the prime responsibility of the licensees or parties responsible for the nuclear activity (BNI licensee - CEA, Orano, Framatome, EDF - consignor of radioactive materials, source user, etc.). The regulations applicable to BNIs are mainly based on the Environment Code and its implementing texts (decrees, orders and resolutions).

Several legislative and regulatory provisions relative to the BNIs stem from or take up international conventions and standards, notably those of the IAEA.

Several European community texts apply to BNIs. The most important ones are the Euratom Treaty and the two Directives establishing a community framework for the nuclear safety of nuclear facilities (Directive 2009/71/Euratom modified by Directive 2014/87/Euratom) and for the responsible and safe management of spent fuel and radioactive waste (Directive 2011/70/Euratom).

1.2. National texts

The legal system applicable to BNIs was revised in depth by Act 2006-686 of 13 June 2006 on transparency and security in the nuclear field (TSN act), and its implementing decrees, and in particular decree 2007-1557 of 2 November relative to basic nuclear installations and oversight of the transport of radioactive substances from the nuclear safety aspect ("procedures" decree), the requirements of which were modified and codified by Decree 2019-190 of 14 March 2019 codifying the provisions applicable to BNIs, to the transport of radioactive substances and transparency in the nuclear field. Since 6 January 2012, the provisions of the three main Acts specifically concerning BNIs – the TSN Act, Programme Act 2006-739 of 28 June 2006 on the sustainable management of radioactive materials and waste (“Waste” Act) and Act 68-943 of 30 October 1968 on civil liability in the nuclear energy field (“RCN” Act) – are codified in the Environment Code.

Moreover, in 2015 and in 2016, the TECV Act, the ordinance of 10 February 2016 and Decree 2016-846 of 28 June 2016 concerning the modification, final shutdown and decommissioning of basic nuclear installations and subcontracting, represented new milestones in BNI regulation. These texts contain a number of advances concerning:

- enhanced transparency and information of the citizens;
- changes to the BNI authorisation system, more particularly with regard to decommissioning;
- oversight of the use of contractors and subcontractors;
- changes to the BNI final shutdown and decommissioning system;
- reinforcement of ASN’s means of inspection and powers of sanction;
- clarification of the organisation of the oversight of nuclear safety and radiation protection;
- enhanced monitoring of former nuclear sites.

In 2016, two regulatory texts also further reinforced the management of the deep geological disposal project. Act 2016-1015 of 25 July 2016 supplemented Article L. 542-10-1 of the Environment Code, clarifying the notion of reversibility. The Order of 15 January 2016 concerning the cost relating to the implementation of long-term management solutions for high level and intermediate level, long-lived radioactive waste, set the cost of the project at 25 billion euros in the economic conditions of 31 December 2011.

For the management of used sealed sources, Decrees 2015-231 of 27 February 2015 and 2018-434 of 5 June 2018 modified and renumbered Articles R.1333-52 (which became article R. 1333-161) and R.1337-14 of the Public Health Code so that holders of used sealed sources that had either expired or were no longer needed could have them recovered not only by their initial supplier, but also by any supplier of authorised radioactive sources or, as a last resort, by Andra.

The regulatory changes are part of a process of European-wide harmonisation of safety provisions (see following figure). Therefore the Ordinance of 10 February 2016 completed the transposition of directive 2011/70/Euratom of 19 July 2011 establishing a community framework for the responsible and safe management of spent fuel and radioactive waste. In addition, Council Directive 2013/59/Euratom of 5 December 2013 setting the basic standards for health protection against the dangers arising from exposure to ionising radiation and reinforcing oversight of TENORM waste has been transposed.

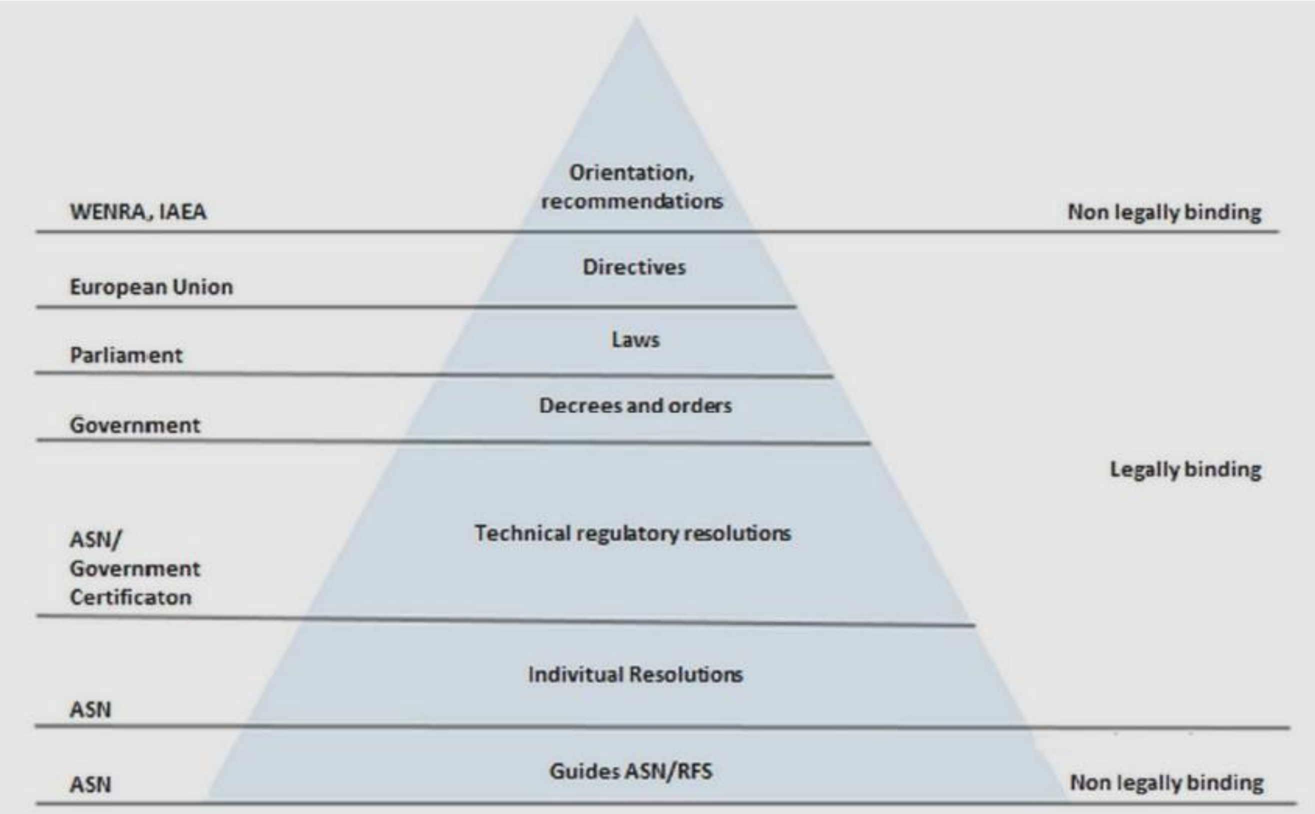


Figure 3: Different levels of regulation

1.2.1. The Environment Code

The provisions of chapters I, III, V and VI of title IX of book V of the Environment Code underpin the BNI licensing and regulation system. This BNI legal system is said to be "integrated", because it aims to prevent or control all risks and detrimental effects a BNI is liable to create for humans and the environment, whether or not these are radioactive. In addition, the provisions of chapter II of title IV of book V of the Environment Code (drawn in particular from the codification of the "Waste" Act) introduce a coherent and exhaustive legislative framework for the management of all radioactive waste.

1.2.1.1. Environment Code (title II of book 1 and title IX of book V)

The legislative base governing the safety of BNIs in France is title IX of book V of the Environment code, and more specifically its provisions taken from the TSN Act that created ASN as an independent administrative authority.

These provisions reiterate that the environmental protection principles apply to nuclear activities, particularly the polluter-pays principle and the principle of public participation. They reassert the three broad principles with regard to radiation protection: justification, optimisation and limitation. They set out the fundamental principle of the responsibility of the licensee with regard to the safety of its installation and require that the licensee produce an annual report.

The Local Information Committees (CLI), provided for by the Act, include representatives of the States, elected officials, members of associations and of the regional authorities, more particularly the departmental councils (elected assemblies at the head of the French *départements*). The Act gives them the possibility of creating an association and ensures their long-term funding. It provides for a federation of CLIs to give a foundation for the National association of CLIs.

The Environment Code recalls the principle of a 10-yearly assessment of the regulations governing nuclear safety and radiation protection with a view to ensuring their continuous improvement. Such international reviews must also be organised every ten years, in accordance with the Safety Directive, on a specific topic related to nuclear safety or radiation protection within BNIs.

The licensee's responsibility is expressly extended beyond the safety of the facility, to the control of all the risks and detrimental effects that its installation represents for the protected interests. The responsibility of the owner of the land has been clarified, and the possibility of ASN having “third-party assessments” conducted at the expense of the parties responsible for an activity that it oversees has been introduced.

The provisions of the Environment Code cover transparency and information around BNIs, relying in particular on the CLIs, which are open to representatives of neighbouring countries when sites are situated in a *département* sharing a border with these countries, and whose areas of competence are increased with, for example, the annual organisation of a public meeting open to all and the possibility of the CLI addressing any subject within its area of competence (Article L 125-17 et seq. of the Environment Code).

The management of subcontracting is also dealt with by the Environment Code and the arrangements for the final shutdown and decommissioning of BNIs has been overhauled, incorporating the principle of dismantling as rapidly as possible.

1.2.1.2. Environment Code (chapter II of title IV of book V)

The provisions of the Code concerning waste are detailed in B.1.1.

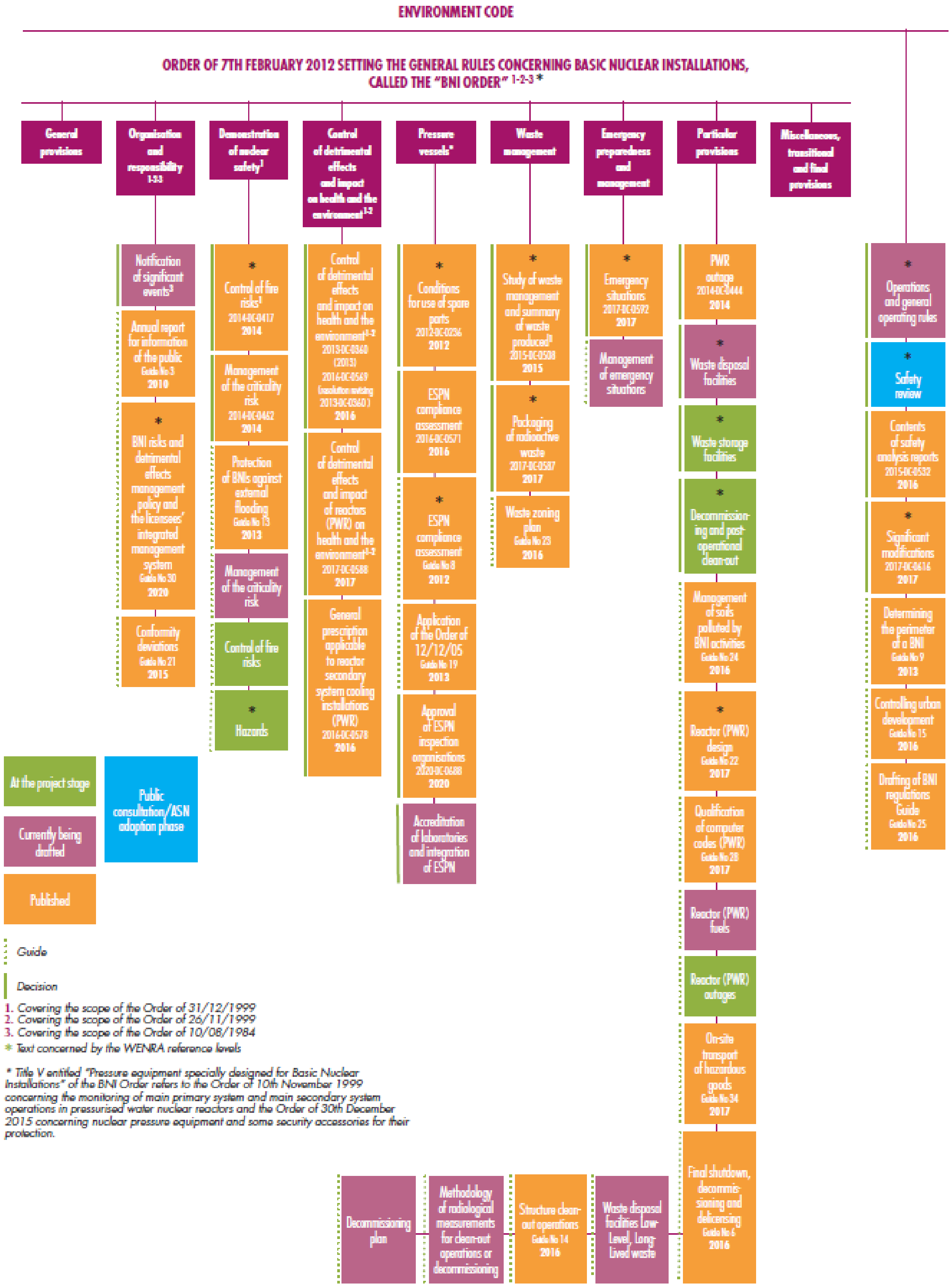


Figure 4: Status of progress of the overhaul of the general technical regulations applicable to BNIs (as at 1 July 2020)

1.2.2. Regulatory part of the Environment Code

Decree 2019-190 of 14 March 2019 modifying and codifying the provisions applicable to basic nuclear installations, the transport of radioactive substances and transparency in the nuclear field abrogated and codified the provisions of the Decree of 2 November 2007 in the regulatory part of the Environment Code.

Henceforth, the entire body of legal texts concerning BNIs and the regulation of the nuclear safety of the transport of radioactive materials is issued in application of the Environment Code. The regulatory part of the Code defines the conditions for application of the law with respect to authorisations for creation, commissioning, modification, final shutdown, decommissioning and delicensing of BNIs, and with regard to inspection and administrative or penal sanctions applicable to licensees. It also includes provisions relative to the binding requirements that ASN can set for the licensees.

1.2.3. Order of 7 February 2012 (known as the BNI Order)

Issued pursuant to Article L. 593-4 of the Environment Code, the BNI Order sets essential requirements applicable to BNIs, from design to delicensing.

Its section 6 in particular, concerning waste management, includes the WENRA reference levels (responsibilities, management principles, traceability, etc.) and comprises new requirements regarding waste conditioning and packaging:

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

These requirements are supplemented by title 8 which notably contains the provisions applicable to facilities for the storage of radioactive substances including waste and spent fuel (defining acceptability criteria, a storage duration, possibility of retrieving the substances at any time, etc.) and to radioactive waste disposal facilities.

Work to revise this Order began in 2019 and will continue in 2020 on the basis of the lessons learned from application of the Order since 2012.

1.3. Regulatory framework applicable to BNIs and to the obligations of the licensees

Article L. 593-7 of the Environment Code states that, when creating a BNI, *"the authorisation takes account of the technical and financial capacity of the licensee, which must enable it to carry out its project […], 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 monitoring and surveillance*" while protecting the interests mentioned in Article L. 593-1 of the Environment Code.

Act 2015-992 of 17August 2015 concerning energy transition for green growth (TECV Act), the Decree of 2 November 2017 modified by the Decree of 28 June 2016 and title II of the BNI Order set requirements concerning the licensee's technical capacity or its obligations for monitoring outside contractors (see section F.3.1).

With regard to the provisions for the cost of decommissioning, managing radioactive waste and spent fuel, the Environment Code defines the obligations incumbent upon the BNI licensees and organises oversight of compliance with these obligations (see sections B.1.6. and F.2.3.2).

1.4. The legal frameworks of ICPEs and mines

The legal framework for ICPEs is set by the Environment Code, notably its book V. In France, oversight of the prevention of pollution and industrial and agricultural hazards lies with the State, which drafts policy for controlling hazards and detrimental effects generated by industries. These texts comprise a general definition of the principles applicable to any facility which could represent a hazard or detrimental effect either such as to inconvenience the neighbours, or affecting public health and safety, or agriculture, or the protection of nature and the environment, or the preservation of sites and monuments.

The ICPE legislation introduces a very simple system. The industrial activities that come under this legislation are inventoried in a list that subjects them to a system of either licensing, registration or declaration, depending on the activity in question and the quantity of hazardous products involved.

The polluter-pays principle is a basic principle of environmental policy. It consists in having the polluter bear the cost of the damage it causes to the environment as a result of its activity, notably the impact of liquid and gaseous discharges, or even waste.

In France, common law states that "*ownership of the ground includes ownership of what is above and below it*". (Article 552 of the Civil Code). The Mining Code however nuances this rule by specifying that "mines" substances can be covered by a concession from the State. They are thus outside the law of ownership and the State attributes the use and sets the conditions of operation.

In mining law, there is a clear difference between:

- the rights to the substance granted by a mining title: an exclusive research permit for exploration, an operating license (until the end of 1994 except in geothermal applications or overseas) or a concession for operation. The mining title (concession in perpetuity or limited concession, depending on its date of institution, operating license or exclusive research license) is delivered by the Minister in charge of mines;
- the permit to begin research work or operations: granted by decision of the Prefect by virtue of the mining policing authority exercised by the Prefect without necessarily obtaining the consent of the owner of the land. This license relates to the valorisation of the substance (substantial research work and mining work) and sets the conditions for operating the mine in compliance with the various interests set by the Mining Code.

Pursuant to Article L155-3 of the Mining Code, the licensee remains responsible for any damage caused by its activity, with no time limit. When the operation of the site is completed, the licensee submits a mining works shutdown declaration file. This file is examined by the administration in charge of mines policing. An order of the Prefect, known as the “First acknowledgement or AP1” ratifies the declaration and, if necessary, proposes additional measures to protect the interests of Article L. 161-1 of the Mining Code. When the licensee has placed its site in a state guaranteeing the protection of the interests mentioned in Article L. 161-1 of the Mining Code (public health and safety in particular), the State issues a Prefectoral second acknowledgement, or AP2. This order puts an end to mining policing pursuant to Article L. 163-9 of the Mining Code.
This mining policy may persist, if significant risks are discovered, until expiry of the mining title and until transfer to the State of monitoring and surveillance and prevention of mining risks pursuant to Article L. 163-9 of the Mining Code.

1.5. The Public Health Code

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

Article L. 1333-2 of the Public Health Code defines the general radiation protection principles (justification, optimisation, limitation), established internationally (ICRP) and incorporated into the IAEA reference texts and Directive 2013/59/Euratom. These principles underpin the regulatory measures for which ASN has responsibility.

The Public Health Code also institutes the Radiation Protection Inspectorate, tasked with overseeing the application of its radiation protection provisions.

Lastly, the Code defines a system of administrative and criminal sanctions, by the creation of a complete system of monitoring, policing and administrative and criminal sanctions, carried out primarily by ASN and the radiation protection inspectors, with reference to the system mentioned in chapters I to III of title VII of book I of the Environment Code.

2| THE LEGISLATIVE AND REGULATORY FRAMEWORK (ARTICLE 19)

1. Each Contracting Party shall establish and maintain a legislative and regulatory framework to govern the safety of the management of spent fuel and radioactive waste.

2. This legislative framework provides for:

i) the drafting of pertinent national requirements and regulations with regard to radiological safety;

ii) a system for issue of licenses for spent fuel and radioactive waste management activities;

iii) a system prohibiting unauthorised operation of a spent fuel or radioactive waste management installation;

iv) a system of appropriate institutional oversight, regulation inspection, documentation and reports;

v) measures designed to ensure compliance with the applicable regulations and the licensing conditions;

VI) clear distribution of responsibilities among the organisations concerned by the various steps in spent fuel and radioactive waste management.

3. When they examine whether radioactive materials are to be subject to the regulations applicable to radioactive waste, the contracting Parties shall take due account of the objectives of this Convention.

This chapter describes the radiation protection regulations, then the regulations for the three categories of nuclear activities mentioned in § E.1.1 (BNI, ICPE with the special case of mines and sealed sources) in turn.

2.1. The general regulatory framework for radiation protection

The regulatory framework for radiation protection was updated with the transposition of Directives Euratom 96/29 and 97/43 and 2013/59.

2.1.1. The legislative bases of radiation protection

At a European level, the Euratom Treaty and more specifically its Articles 30 to 33, defines the procedures for drawing up community provisions concerning protection against ionising radiation and specifies the powers and obligations of the European Commission with regard to their implementation. The corresponding Euratom Directives are binding on the various countries, such as the new European Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for health protection against the hazards arising from exposure to ionising radiation. This Directive, published in the Official Journal of the European Union on 17 January 2014, revokes Euratom Directives 89/618, 90/641, 96/29, 97/43 and 2003/122.

The legal framework for nuclear activities in France, which had been extensively overhauled since 2000, has once again been updated.

Decree 2018-434 of 4 June 2018 containing various nuclear provisions, made a complete transposition of Council Directive 2013/59/Euratom of 5 December 2013 setting out the basic standards for health protection against the hazards arising from exposure to ionising radiation and abrogating Directives 89/618/Euratom, 90/641/Euratom, 96/29/Euratom, 97/43/Euratom and 2003/122/Euratom.

This Decree sets standards for health protection against the dangers arising from exposure to ionising radiation. It determines the administrative system applicable to nuclear activities and the transport of radioactive substances, built around the principles of justification, optimisation and limitation, and sets the conditions governing protection against exposure to natural sources of ionizing radiation, such as radon, or in a medical setting, or in the event of pollution. It also sets out conditions for the protection of sources of radiation against malicious acts and the conditions for monitoring and tracking sources, electrical appliances emitting ionising radiation and particle accelerators. Finally, the Decree updates the regulations concerning protection against ionising radiation in the mining industries.

BNIs are also subject to a particular system stipulated by the Environment Code (chapter III of title IX of book V). In accordance with this Code, it is the responsibility of ASN to authorise commissioning of a BNI and define the requirements concerning its design, construction and operation. It is in this respect that ASN defines the requirements concerning water intake and liquid and gaseous discharges of substances from the facility, whether or not radioactive.

2.1.1.1. The Public Health Code

The principles of radiation protection

The general principles of radiation protection applicable to all nuclear activities are given in chapter III of title III of book III of the first part of the Public Health Code. They were updated by the Ordinance of 10 February 2016 concerning nuclear activities.

Article L. 1333-1 of the Public Health Code defines nuclear activities as “activities comprising a risk of human exposure to ionising radiation related to the use either of an artificial source, whether substances or devices, or of a natural source, whether natural radioactive substances or materials containing natural radionuclides. They also include the steps taken to protect individuals from a risk following radioactive contamination of the environment or products from contaminated areas or manufactured from contaminated materials”.

Article L.1333-2 of the Public Health Code defines the general principles of radiation protection (justification, optimisation and limitation). These principles underpin the regulatory measures for which ASN has responsibility.

The scope of application of this chapter of the Public Health Code includes the measures necessary to prevent or mitigate the risks in various radiological exposure situations: in addition to steps taken to protect individuals from a risk following radioactive contamination of the environment or from products from contaminated areas or manufactured from contaminated materials, the steps taken in a radiological emergency situation or in the event of exposure to a natural source of ionising radiation, radon in particular, are also concerned. All of these steps must now meet the justification and optimisation principles.

The justification principle

The justification principle is defined as being the principle “whereby a nuclear activity may only be undertaken or exercised if justified by the individual or collective advantages it procures - particularly in health, social, economic or scientific terms – as compared with the risks inherent in the exposure to ionising radiation to which the individuals are likely to be subjected”. Assessment of the expected benefit of a nuclear activity and the corresponding health drawbacks may lead to prohibition of an activity for which the benefit does not seem to outweigh the risk.

The optimisation principle

The optimisation principle is defined as being the principle whereby “the level of exposure of individuals to ionising radiation as the result of a nuclear activity, the probability of occurrence of this exposure and the number of persons exposed must be kept as low as is reasonably achievable, given the current state of technical knowledge, economic and societal factors and, as applicable, the medical goal". This principle, referred to as the ALARA (as low as reasonably achievable) principle, leads for example to a reduction in the discharge licences of the quantities of radionuclides present in radioactive effluents discharged from BNIs or requires mandatory monitoring of exposure at workstations in order to keep it to the strict minimum.

In the context of the implementation of the principles of justification and optimisation, the assessment of the expected benefit of a nuclear activity and the corresponding health drawbacks may lead to the non-authorisation or the prohibition of an activity for which the benefit does not seem to outweigh the risk. This prohibition is either generic (for example: ban on the addition of radioactive substances in consumer goods), or a specific license required under radiation protection legislation will not be granted or renewed.

With regard to the ban on the addition of radionuclides in consumer goods (Articles R. 1333-2 and 3 of the Public Health Code), the trade in irradiated gemstones, accessories such as key-rings, hunting equipment (sighting devices), navigation equipment (compass), river fishing equipment (floats) containing sealed tritium sources, and lightning arresters, is therefore prohibited.

For the existing activities, the justification is reassessed if the state of knowledge and techniques so justifies. This is the case with smoke detection and various other activities that are tending to disappear on account of technical advances in particular.

In the case of smoke detection, where several types of radionuclides have been used (americium-241, plutonium-238, nickel-63, krypton-85), although this technique was justified a few years ago owing to the advantages it offered for human safety, this is no longer the case given that new detection techniques using optical technology have been developed and meet the fire detection requirements of the regulations and standards. Pursuant to the Public Health Code, this change makes it mandatory to organise the withdrawal of smoke detectors containing radionuclides. The Order of 18 November 2011 constituting a waiver to Article R. 1333-2 of the Public Health Code for ionisation chamber smoke detectors, sets out a regulatory framework for the gradual withdrawal from service of this type of detector, with the goal of completely phasing them out within 10 years. The widespread use of these detectors makes it necessary, ultimately, to have disposal facilities in order to dispose of them. Suggestions were made in this respect in the preparation of the PNGMDR.

The limitation principle

The limitation principle is defined as being the principle whereby exposure of an individual to ionising radiation resulting from one of these activities may not raise the sum of the doses received beyond limits set by the regulations, except when this person is exposed for medical purposes or certain research on humans. Strict limits are set for the exposure of the general population or workers as a result of nuclear activities. Thus, for a member of the public, the effective annual dose limit received as a result of nuclear activities is set at 1 mSv; the equivalent dose limits for the lens of the eye and for the skin are set at 15 mSv/year and 50 mSv/year respectively (average value for any 1 cm² area of skin). If these limits are exceeded, this can lead to administrative or criminal penalties.

2.1.1.2. The Labour Code

The Labour Code contains various specific provisions for the protection of workers, whether or not salaried, exposed to ionising radiation (title V of book IV of part IV) which supplement the general prevention principles. It establishes a link with the three radiation protection principles contained in the Public Health Code.

Decree 2018-437 of 4 June 2018 concerning the protection of workers against hazards due to ionising radiation modifies the rules for the prevention of health and safety hazards as a result of natural or artificial ionising radiation applicable to workers, to ensure the transposition into the regulations of the provisions concerning worker protection of Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for health protection against hazards resulting from exposure to ionising radiation, and for application of the provisions of

Ordinance 2016-128 of 10 February 2016 constituting various nuclear provisions. It enables the radiological hazard to be better incorporated into the general occupational hazard prevention approach, notably with regard to the organisation of radiation protection and the conditions surrounding technical checks on workplaces and working equipment. This overall approach, which aims to ensure improved control of hazards and the prevention of incidents and accidents, helps to optimise the resources implemented by the employer.

2.1.2. Regulatory aspects concerning protection of individuals against the hazards of ionising radiation resulting from nuclear activities

2.1.2.1. General protection of workers

Articles R. 4451-1 et seq. of the Labour Code create a single system of radiation protection for all workers (whether or not salaried) liable to be exposed to ionising radiation during the course of their professional activity. These provisions more particularly include:

- application of the optimisation principle and the prevention principle aiming to eliminate or, failing which, minimise the hazards arising from worker exposure to ionising radiation, through risk prevention measures at source and taking account of technical progress;
- dose limits, which are set at 20 mSv effective dose for 12 consecutive months, 500 mSv dose equivalent for the skin and extremities, and 20 mSv for the lens of the eye over 12 consecutive months;
- the dose limit for pregnant women, or more specifically for the unborn child (1 mSv for the period between the declaration of pregnancy and the actual birth).

The implementing orders provide the clarifications needed for these new provisions to be put into place.

Radiation protection zoning: Requirements concerning the demarcation of the monitored areas, controlled areas and regulated areas (special controlled areas) were specified, regardless of the activity sector, in the Order of 15 May 2006 and were updated through the transposition of Directive 2013/59/Euratom of 5 December 2013 by the Order of 28 January 2020.

2.1.2.2. General protection of the population

In addition to the particular radiation protection measures taken for the individual authorisations concerning nuclear activities, for the benefit of the general public and the workers, several more general measures incorporated into the Public Health Code help protect the public against the dangers of ionising radiation.

This is in particular the ban on the addition of natural or artificial radionuclides in all consumer goods, foodstuffs and animal feedstuffs, on top of those naturally present. Prohibitions are also in place for building materials. Waivers may however be granted by the Minister in charge of health, on the advice of the High Council for Public Health, except with regard to foodstuffs and materials in contact with them, cosmetic products, toys and jewellery, and animal feedstuffs. The use outside BNIs of materials or waste from a nuclear activity, when it is contaminated or liable to have been contaminated by radionuclides used or generated by this activity, is also prohibited.

This also concerns the annual effective dose limit received by a member of the public as a result of nuclear activities.

A national system for collection of environmental radioactivity measurements was set up in 2009. The data collected must be used to help estimate the doses received by the population. This network collates the various results of environmental assessments required by the regulations and those performed by the various State services and its public establishments, as well as by regional authorities and the associations which so request. These results have been held at the disposal of the public since 1 January 2010 (www.mesure-radioactivite.fr). Management of this monitoring network is entrusted to the IRSN, with its orientations being defined by ASN (ASN Resolution 2008-DC-0099 of 29 April 2008 as amended, organising the national environmental radioactivity monitoring network and setting the laboratory approval procedures). General information about environmental monitoring and radiological assessments in France are regularly published on the IRSN website:

https://www.irsn.fr/FR/connaissances/Environnement/Pages/Home.aspx.

To guarantee the quality of these measurements, the laboratories in the network must meet approval criteria which notably comprise inter-comparison tests. The list of approved organisations is available on the ASN website (www.asn.fr).

Management of waste and effluents from BNIs and ICPEs is subject to the provisions of the particular regulatory regimes concerning these facilities. The management of waste and effluents from other establishments licensed to use or possess radioactive materials under the Public Health Code, including hospitals, is described in section B.6.2.

It is recalled that, even though allowed by the Euratom Directive, French regulations do not include the notion of a generalised clearance threshold, that is a radioactivity level below which effluents and waste from a nuclear activity can be eliminated without controls (see section B.4.1.1.3). In practice, the elimination of waste and effluents is checked on a case by case basis when the activities which produce them are subject to an authorisation/licensing system (case of BNIs and ICPEs); otherwise these discharges are covered by technical requirements.

2.1.2.3. Licensing and notification of ionising radiation sources

The licensing or notification system, which extends to all sources of ionising radiation, is described in full in chapter II of title III of book III of the public Health Code. In the transposition of the Euratom Directive, these systems are supplemented by a new simplified intermediate licensing system: the registration system.

Licensing and registration applications and notifications are filed with the ASN regional divisions.

Medical, industrial and research applications are concerned by these provisions, provided that they are not exempted. More specifically, this concerns the manufacture, utilisation or possession, distribution, including import and export (from and to a country outside the European Union) of radioactive sources, products or devices containing them, or electrical devices emitting ionising radiation, including import and export.

It should be recalled that, in accordance with Article L. 1333-9 of the Public Health Code, the industries subject to the Mining Code, BNIs and ICPEs, as well as defence-related nuclear activities and installations, are governed by specific systems.

The procedures for filing licensing or notification applications are specified by ASN resolutions approved by Orders (ASN resolutions 2008-DC-108 and 109, ASN resolution 2009-DC-148 and ASN resolution 2010-DC-192).

2.1.2.4. Radioactive source management rules

The general rules for the management of radioactive sources are given in the Public Health Code. They were detailed in 2015 in ASN resolution 2015-DC-0521 of 8 September 2015 relative to the tracking and registration of radionuclides in the form of radioactive sources and products or devices containing them.

These general rules are as follows:

- no-one may acquire or relinquish sources without authorisation or without having made the required notification;
- prior registration with the IRSN is compulsory for the acquisition, distribution, import and export of radionuclides as sealed or unsealed sources, or of products or devices containing them. This prior registration is also used for monitoring by the customs services;

- each establishment is required to ensure the traceability of radionuclides in the form of sealed or unsealed sources and of products or devices that contain them, and a quarterly record of deliveries must be sent to IRSN by the suppliers;
- any loss or theft of radioactive sources must be notified.

The system for the elimination and recovery of expired or end-of-life sealed sources is as follows:

- all users of sealed sources are obliged to have expired, damaged or end-of-life sources recovered at their own expense;
- without condition and if simply requested by the user, the supplier is required to recover from it any source the user no longer needs or which is expired.

The source suppliers are required to provide financial guarantees. These guarantees may take the form of bonds deposited notably with Andra or with banks, or by joining an association set up by the source suppliers. The table of guarantees is drawn up and revised by Andra every year.

2.1.3. Radiation protection in the BNIs

“Nuclear activities” include those carried out in BNIs. They are given particular attention owing to the risks of exposure to ionising radiation.

Within the framework of the procedures defined by the Environment Code and the BNI procedures decree, the licensee of a BNI provides the justifications needed to demonstrate compliance with the principles of radiation protection as of the design and at each step in the life of its facility, authorised by ASN: creation, commissioning and decommissioning.

In addition, Article L. 593-42 of the Environment Code states that the BNI system covers worker collective radiation protection aspects (for example, sizing of biological shieldings, optimisation of radiation protection zoning, etc.). (see § E.2.2.6.3).

BNIs undergo periodic safety reviews, during which the licensee is required to demonstrate that it makes permanent progress in terms of safety and radiation protection.

In addition, radiation protection in the BNIs is inspected in the event of any modifications being made to the installations and having an impact on worker radiation protection.

Finally, inspections are also performed throughout the authorisation period.

2.1.4. Discharge licenses

2.1.4.1. BNI discharge licenses

The normal operation of BNIs produces radioactive effluents. In general, it also leads to water intake from and discharges of non-radioactive liquid and gaseous effluents into the environment. The license concerns water intake and effluent discharges, whether liquid or gaseous, radioactive or not.

The BNI legal system was overhauled by the TSN Act and its implemented decrees, now codified in the Environment Code (Articles L. 593-1 et seq., as well as Articles R. 593-1 et seq.).

The modification introduced by the TSN Act aims to better incorporate environmental considerations alongside questions regarding safety and radiation protection, via the installation’s creation (or decommissioning) authorisation application. The content of the application and the procedure are defined in the Environment Code. If the response to the application is favourable, it leads to the authorisation decree. Technical considerations relating to discharges (limit values, monitoring, information, etc.) are then defined in an ASN resolution which sets technical requirements (discharge limits and procedures, monitoring of discharges and the environment). More specifically with regard to discharge limits, the ASN Resolution must be approved by the Minister in charge of nuclear safety.

The first discharge limits were set on the basis of an impact below the health effects thresholds in force. The optimisation efforts urged by the authorities and implemented by the licensees led to emissions being considerably reduced.

The regulations applicable to BNIs (BNI Order of 7 February 2012, supplemented by ASN Resolution 2013-DC-0360 of 16 July 2013, as amended, concerning the control of BNI detrimental effects and the impact on health and the environment) specifies for all BNIs the requirements applying to water intake and effluent discharges, the monitoring of them and the environment, the prevention of pollution and detrimental effects and the conditions surrounding information of the authorities. The main provisions are:

- the use of the best available techniques within the meaning of the ICPE regulations. More specifically, the limit values for emissions must be set on the basis of the best available technologies in technically and economically acceptable conditions, taking into consideration the characteristics of the installation, its geographical location and the local environmental conditions;
- limiting discharges and noise emissions to the level of the thresholds in the general regulations applicable to ICPEs;
- a ban on the discharge of certain hazardous substances and discharge into the water table;
- setting up monitoring of emissions and of the environment;
- the general application to the equipment necessary for operation of BNIs, of a number of Ministerial Orders applicable to identical installations governed by the ICPE regulations;
- the production of an annual discharge forecast and an annual impact report by the licensee: this forecast - which is necessarily below the regulatory limit - is intended to help them achieve forward-looking discharge management that is as precise as is technically possible.

Moreover, in accordance with Article 37 of the Euratom Treaty, France provides the European Commission with general data on any radioactive effluent discharge project.

For environmental monitoring around the nuclear sites, specialised personnel regularly take samples and measurements in the various receiving environments (air, water, soil, fauna and flora). Monitoring of the environmental radioactivity around BNIs represents about 100,000 measurements and 40,000 samples annually in France. Every month, these data are sent to ASN and to the national environmental radioactivity monitoring network (RNM) for publication on the website www.mesure-radioactivite.fr. This website was entirely overhauled in October 2016 to make for easier access and improved legibility of the information for the public.

2.1.4.2. Licensing of ICPE and mines discharges

For ICPEs, the regulations stipulate an integrated approach to the hazards. Discharge licenses and conditions are stipulated in the installation's general authorisation (see §E.1.2). The general principles for setting discharge conditions and limits are identical to those followed in the BNIs, because they are based on the same laws (in particular Act 92-3 of 3 January 1992, as amended, on water, codified in book II of the Environment Code).

Mine discharges are also regulated by part two of the "ionising radiation" section of the mining industrial general regulations. The start of work authorisations given by Order of the Prefect specified these conditions. However, it should be noted that the installations associated with mines and for which the discharges are liable to have the greatest impacts (ore treatment plants, etc.) are generally classified as ICPEs. Consequently their discharges are regulated accordingly.

2.1.4.3. Discharge licenses for the other activities covered by the Public Health Code

The general provisions for the management of contaminated waste and effluents for the nuclear activities defined in Article L. 1333-1 of the Public Health Code[1] are set by ASN Resolution 2008-DC-0095 approved by the Order of 23 July 2008 (see section B.6.2.1).

The contaminated effluent management methods must be described in a framework document, the contaminated waste and effluent management plan.

According to the Public Health Code, a licence for the discharge into the sewerage network of effluents containing radionuclides with a radioactive half-life of more than 100 days may be granted by ASN. To allow licensing of discharges into the sewerage network of effluents containing radionuclides with a radioactive half-life of longer than 100 days, the contaminated waste and effluents management plan must include the justification for the discharges, taking account of technical and economic constraints, justification of the effectiveness of the steps taken to limit the activity discharged, an impact assessment presenting the effects of the discharges on the workers, the population and the environment and the procedures put into place to monitor the discharges and suspend them if certain criteria are not met.

Moreover, it should also be recalled that “any discharge of wastewater other than domestic into the public network must be authorised beforehand by the network manager”. These effluents must be the subject of a license which notably sets out the characteristics of the wastewater to be discharged and the discharge monitoring conditions; this license is issued pursuant to the Public Health Code.

2.2. The regulatory framework for BNI safety

Article L. 593-7 of the Environment Code states that, when creating a BNI, *“the authorisation takes account of the technical and financial capacity of the licensee, which must enable it to carry out its project […], 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 monitoring and surveillance”* while protecting the interests mentioned in Article L. 593-1 of the Environment Code.

Act 2015-992 of 17 August 2015 concerning energy transition for green growth (TECV Act), the Decree of 2 November 2017 modified by the Decree of 28 June 2016 and part II of the BNI Order set requirements concerning the licensee’s technical capacity or its obligations for monitoring outside contractors (see section F.3.1).

With regard to the provisions for the cost of decommissioning, and managing radioactive waste and spent fuel, the Environment Code defines the obligations incumbent upon the BNI licensees and organises oversight of compliance with these obligations (see sections B.1.6. and F.2.3.2).

Apart from the general regulations, for example those concerning labour law and the protection of nature, BNIs are subject to two types of particular regulation: authorisation procedures and technical requirements.

ASN oversight aims to check that the licensee of a BNI fully exercises its responsibility and its obligations with regard to safety. This external oversight does not relieve the licensee of its prime responsibility for organising its own checks on the activities it carries out, in particular for those activities contributing to safety.

[1] This concerns all authorised or notified nuclear activities except for those carried out in the following installations:
- basic nuclear installations;
- defence-related nuclear activities and installations;
- installations requiring licensing pursuant to Article 83 of the Mining Code.

2.2.1. The BNI authorisation and management procedures framework

French legislation and regulations prohibit the operation of a BNI without authorisation. BNIs are thus governed by chapters III, V and VI of title IX of book V of the Environment Code and by the above-mentioned "procedures" Decree which notably provides for a creation authorisation procedure followed by a series of authorisations or licenses issued during the main steps in the life of these installations: commissioning, any changes to the installation, final shutdown and decommissioning and, in the case of a repository, the post-closure surveillance and monitoring phase. Any licensee which operates a facility, either without the required authorisations or licenses, or in breach of these authorisations or licenses, may be subject to policing measures and administrative and criminal penalties. These are set out by the provisions of chapter VI of title IX of book V of the Environment Code, which themselves refer to the provisions concerning inspections and penalties in chapters I to III of title VII of book I of the Environment Code. Application of these various authorisation procedures runs from the siting choice and the design phase up to final decommissioning.

2.2.2. BNI siting procedures

Before applying for a BNI creation authorisation, the licensee must inform the administration of the site(s) on which it plans building this installation.

On the basis of this information, ASN notably analyses the safety-related characteristics of the sites: seismicity, hydrogeology, industrial environment, cold water sources (heatsinks), etc.

Pursuant to Articles L. 121-8 et seq. of the Environment Code, the creation of a BNI is subject to a public debate procedure when dealing with a new nuclear power generation site or a new site (other than for nuclear power generation) with an anticipated cost of more than €300 M and, in certain cases, a new nuclear power generation site, or a new site (other than for nuclear power generation) costing between €150 M and €300 M (Article R. 121-1 and R.121-2 of this same code). The public debate focuses on the appropriateness, the objectives and the characteristics of the project.

In addition, the construction of a BNI is subject to the issue of a building permit by the Prefect in accordance with the procedures specified in Articles R. 421-1 et seq. and Article R. 422-2 of the Town Planning Code.

Finally, neighbouring countries are informed by the French Government in accordance with the treaties in force, notably the Euratom treaty, and the 25 February 1991 Convention on the assessment of the environmental impact in a transboundary context (Espoo Convention).

2.2.3. Procedures concerning the design, construction and safety assessment of BNIs

2.2.3.1. Safety assessment

Safety options

According to the Environment Code, any person intending to operate a basic nuclear installation may, prior to initiating the creation authorisation procedure, ask ASN for its opinion on all or part of the options it has adopted to ensure the safety of this installation. In an opinion issued and published in the conditions determined by itself, ASN specifies to what extent the safety options presented by the applicant are such as to prevent or mitigate the risks […] in the light of the technical and economic conditions prevailing at the time. It may define the additional studies and justifications that will be required for a potential creation authorisation application.

The safety review and assessment during the BNI creation authorisation application

The list of documents to be provided for a BNI creation authorisation application is given in Articles R. 593-14 et seq. of the Environment Code. The future licensee must notably produce an impact assessment as defined in the Environment Code, as well as a preliminary version of the safety analysis report. This application may only be made once the siting process and preliminary studies are sufficiently well advanced. The safety review and evaluation methods for the installation are stated in § E.2.2.3.2.

Safety review and evaluation prior to BNI commissioning

When applying for commissioning of a BNI, the licensee must provide a safety analysis report comprising the update of the preliminary version of the safety analysis report. The safety review and evaluation methods for the installation are stated in § E.2.2.4.

The periodic safety reviews and reassessments

In accordance with Article L. 593-18 of the Environment Code, the licensees must periodically carry out a review of their facility, taking account of the best practices adopted internationally. This review is designed to allow an appraisal of the situation of the facility with respect to the rules applicable to it and to update the assessment of the risks or detrimental effects presented by the facility in terms of health, safety and the environment, notably taking into account the condition of the facility, acquired operating experience, changing knowledge and of the rules applicable to similar facilities. The licensee sends ASN and the Minister in charge of nuclear safety a report containing the conclusions of this review and, if necessary, the measures it plans taking to correct any anomalies observed or to improve the safety of its installation.

After analysis of the report, ASN may impose new technical requirements. It communicates its analysis of the report to the Minister in charge of nuclear safety.

These safety reviews are held every ten years. However, the authorisation decree may set a different frequency if so warranted by the particularities of the facility.

For the installations covered by Council Directive 2009/71/Euratom of 25 June 2009 establishing a community framework for the nuclear safety of nuclear installations, the frequency of the periodic safety reviews cannot be less than once every ten years.

In France, all basic nuclear installations are subject to a periodic safety review, regardless of their nature and their operating phase. Installations undergoing decommissioning are therefore subject to this requirement and the review is carried out in the light of the situation of the installation and the corresponding issues and implications.

2.2.3.2. The creation authorisations

Presentation of the creation authorisation application

The creation authorisation application for a BNI is filed with the Minister in charge of nuclear safety by the industrial concern which intends to operate the facility, which thus acquires the status of licensee. The application is accompanied by a file comprising a number of items, including the detailed plan of the facility, the impact assessment, the preliminary version of the safety analysis report, the risk management study and the decommissioning plan. In the case of a deep geological disposal facility, the specific aspects of the creation authorisation application are detailed in section H.3.1.

The coordination of the licensing procedure is led by the competent services under the authority of the Minister in charge of nuclear safety. They entrust ASN with a technical review of the application file.

Consultation of the public and the local authorities

The authorisation can only be granted after holding a public inquiry.

Prior to the public inquiry, the file presenting the project and comprising the impact assessment and the authorisation application is submitted for approval to the environmental authority (the environmental authority body within the General Council for the environment and sustainable development), as well as to the local authorities and their groups interested by the project.

The public inquiries system is harmonised and the procedure applicable to BNIs is a procedure incorporated into the general system. 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 decision.

The inquiry is conducted according to the provisions of the Environment Code. The Prefect opens the public inquiry at least in every commune which has any part of its territory located within a 5 km radius of the installation perimeter. This inquiry shall last at least one month and no more than a month and a half. The file submitted by the licensee to support its authorisation application is made available. However, as the preliminary version of the safety analysis report is a bulky document (containing the inventory of the risks the installation can present, the analysis of the measures taken to prevent these risks and a description of the measures designed to limit the probability of accidents and their effects) and could be difficult for non-specialists to understand, it is supplemented by a risk control study. The opinion of the Environmental Authority is also appended to the public inquiry file.

The principle of on-line information as part of a public inquiry is enshrined in the Environment Code. This gives the public the possibility not only of consulting the file via the Internet throughout the duration of the inquiry but also of submitting its comments by this means.

Consultation of technical organisations

To conduct the technical review of the file, and notably of the preliminary safety analysis report which accompanies the creation authorisation application, ASN calls on the expertise of the IRSN and its Advisory Committees of experts.

After conducting its review and noting the results of its consultations, ASN sends the Minister in charge of nuclear safety a proposed draft decree, authorising the creation of the installation.

The creation authorisation decree (DAC)

If all the conditions are met, the Minister in charge of nuclear safety sends the licensee a preliminary draft decree granting creation authorisation (DAC). The licensee has a period of two months in which to present its comments. The Minister then obtains the opinion of ASN. ASN Resolution 2010-DC-0179 of 13 April 2010 gives the licensees and the CLIs the possibility of being heard by the ASN Commission on the subject of this preliminary draft decree before it issues its opinion.

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

The DAC determines the perimeter and characteristics of the facility. It designates the essential components required for the protection of public health and safety, as well as of nature and the environment. It also sets a time-frame for commissioning. More generally, the authorisation for a BNI has no limited validity period.

The requirements defined by ASN for implementation of the authorisation decree.

For implementation of the authorisation decree, ASN issues a resolution defining requirements relative to BNI design, construction and operation that it deems necessary for protection of the above mentioned interests.

ASN defines requirements concerning BNI water intake and discharges. The specific requirements setting the BNI environmental discharge limits must be approved by the Minister in charge of nuclear safety.

In accordance with the provisions of Article L. 123-19-2 of the Environment Code, these decisions to set these requirements involve public participation when they have a direct and significant impact on the environment.

2.2.4. BNI operations procedures

2.2.4.1. Commissioning authorisations

As defined in Article R. 593-29 of the Environment Code, commissioning corresponds to the first use of radioactive substances in the facility or the first utilisation of a particle beam.

For commissioning and in accordance with Article R 539-30 of the Environment Code, the licensee sends ASN a file containing the safety analysis report comprising the updated preliminary safety analysis report, the general operating rules, the on-site emergency plan, an updated version of the decommissioning plan if necessary, information enabling the installation's compliance with the ASN requirements to be assessed, the updated impact assessment, as applicable, and the updated risk control study.

Further to a modification of the requirements applicable to basic nuclear installations, codified in 2019 in the Environment Code, the regulations no longer require the waste management study as a specific document. All the above-mentioned management procedures must, as of 1 April 2020, be carried over to the impact assessment and the general operating rules of the BNIs.

After checking that the installation complies with the objectives and rules specified in chapter III of title IX of book V of the Environment Code and its implementing texts, ASN authorises commissioning of the installation.

ASN's authorisation decision is mentioned in the Authority's Official Bulletin. ASN notifies the licensee of its decision and communicates it to the Minister in charge of nuclear safety and to the Prefect. It also sends it to the installation's CLI.

Before carrying out or completing the commissioning authorisation procedure, partial commissioning may be authorised by an ASN resolution, published in its Official Bulletin, for a limited period of time and in certain specific cases, more specifically if particular operating tests need to be run on the installation, requiring that radioactive substances be brought inside it.

ASN's commissioning resolution sets the time-frame within which the licensee must submit its end of start-up file, comprising a summary of the installation's start-up tests, a summary of the operating experience acquired and updated versions of the documents submitted for the commissioning application.

2.2.4.2. Substantial or noteworthy modification of the installation

During operation, the licensee informs either the Minister in charge of nuclear safety or ASN of any substantial or noteworthy modification relating to the installation.

Case of a substantial modification of the installation

A new authorisation - examined in the manner and following the procedure described earlier for a creation authorisation - must be obtained in the case of a "substantial" modification.

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

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

The other modifications necessitating a modification of the authorisation decree, changes of licensee or modifications of the perimeter are subject to a simplified procedure.

Case of a noteworthy modification of the installation

Modifications other than substantial and having an impact on the protected interests are said to be "noteworthy" modifications to the installation, its authorised operating procedures, aspects which led to its creation authorisation or its commissioning authorisation. Depending on their importance, they require either notification to ASN or authorisation by ASN, pursuant to the terms of Article L. 593-15 of the Environment Code. This same Article states that these modifications may be opened up for public consultation. ASN resolution 2017-DC-0616 of 30 November 2017 concerning noteworthy modifications of BNIs sets the list of noteworthy modifications requiring notification of ASN.

2.2.4.3. Incidents monitoring and follow-up

The Environment Code states that the licensee of a basic nuclear installation or the person responsible for the transport of radioactive substances is required to notify ASN and the administrative authority, without delay, of any accidents or incidents that occur on account of the operation of that installation or the transport activity and which could significantly prejudice public health and safety or the protection of nature and the environment. Operating experience feedback (OEF) encompasses events occurring in France and abroad, when it appears relevant to take them into account to reinforce nuclear safety, radiation protection and protection of the environment. OEF from French events more specifically concerns events referred to as "significant". In published guides, ASN defines the events notification criteria. These are notified by the licensee to ASN, which records them in a database. The notifying party assesses the urgency of notification in the light of the confirmed or potential seriousness of the event and the speed of reaction needed to avoid a worsening of the situation or to mitigate the consequences of the event. The person responsible for the activity transmits this notification as rapidly as possible on the basis of these factors. The ASN notification guides give a notification time of two working days. ASN systematically rates these events on the INES scale when it is applicable.

An event that would not be considered significant must nevertheless be taken into account by the licensee as an anomaly or deviation and recorded with a view to taking corrective action if necessary, or analysing trends. This information is made available to ASN, during inspections for example.

ASN is currently drafting a resolution concerning the notification methods and the codification of notification criteria for significant worker, patient, public or environment radiation protection events.

2.2.4.4. Final shutdown and decommissioning

The legislative and regulatory framework for final shutdown and decommissioning

The technical provisions applicable to an installation a licensee intends to definitively shut down and decommission must satisfy the general regulations concerning safety and radiation protection. These more particularly concern the measures taken with respect to the external or internal exposure of workers to ionising radiation, the criticality, the production of radioactive waste, discharges of effluents into the environment and measures to reduce the risks of accidents and mitigate their effects.

Nevertheless, decommissioning activities have particularities that must be taken into consideration (change in the nature of the risks, rapid changes in the status of the installations, duration of operations, etc.). A licensee planning to definitively shut down its installation must therefore notify the Minister in charge of nuclear safety and ASN of its intent, indicating in its notification the date on which shutdown is to take place. No later than two years after notification (unless this deadline is extended, for which there is no provision in the case of electricity production pressurised water reactors), the licensee must submit a file detailing the planned decommissioning operations. Decommissioning of the BNI is prescribed by a decree issued after obtaining the opinion of ASN and holding a public inquiry.

The decree, which modifies the creation authorisation decree, prescribes the decommissioning operations, defines the decommissioning stages, sets the decommissioning characteristics and time-frame and, if applicable, the operations incumbent upon the licensee after decommissioning. Decommissioning is performed with a view to delicensing the BNI. When the BNI has been completely decommissioned and no longer requires implementation of the provisions of the BNI system, ASN issues a delicensing resolution submitted to the Minister in charge of nuclear safety for approval.

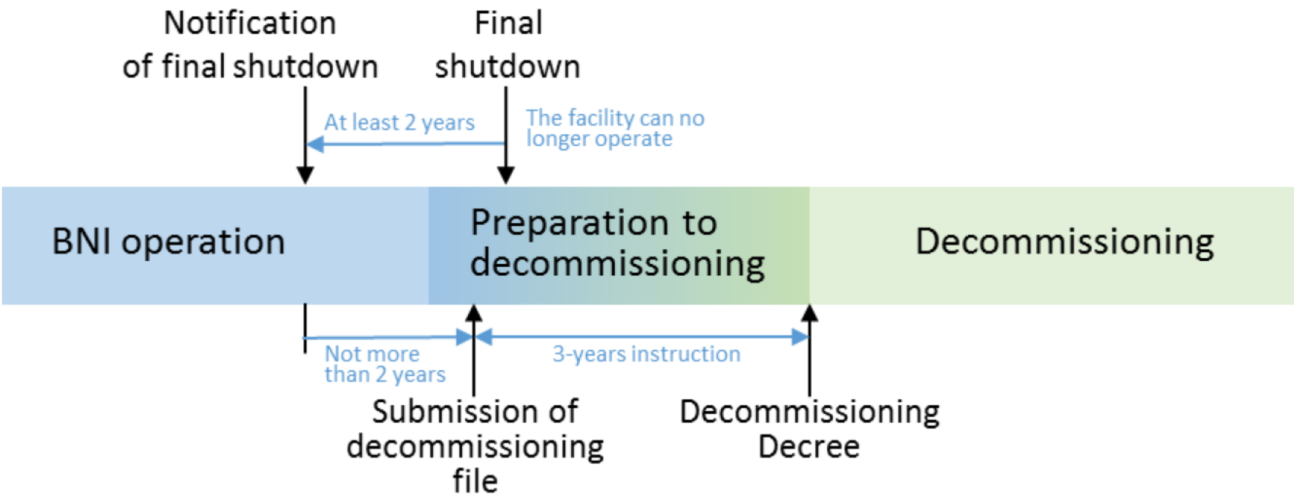


Figure 5: The final shutdown and decommissioning procedure

The contents of the decommissioning file the licensee is required to submit are defined in Articles R. 593-64 and R. 593-67 of the Environment Code.

As part of the decommissioning procedure, legislative provisions require consultation of the CLI and of the public, by means of a public inquiry.

For basic nuclear installations devoted to the disposal of radioactive waste, final shutdown is defined as being the definitive cessation of reception of new waste and decommissioning is taken as meaning all the operations in preparation for closure of the installation after final shutdown, and closure itself; the phase following closure of the installation is known as the surveillance and monitoring phase.

Special provisions for the closure of a deep geological disposal centre are set out in the Environment Code, more particularly that closure of this repository may only be authorised by means of an Act.

Performance of final shutdown and decommissioning operations

For facilities other than radioactive waste disposal centres, final shutdown and decommissioning operations comprise two consecutive work phases:

- final shutdown operations which mainly include the disassembly of equipment outside the nuclear island and not needed for maintaining its monitoring and safety, for maintaining or reinforcing the containment barriers and for performing radioactivity controls;
- dismantling work concerning the actual nuclear part; this can be started following the final shutdown operations, or can be put off (it being understood that the goal is dismantling as rapidly as possible) (see section F.6.1).

In certain cases, operations such as unloading and removal of nuclear substances, the elimination of fluids or decontamination and clean-out work may be carried out within the framework of the installation's creation decree, on the two-fold condition that they do not lead to any failure to comply with the rules previously set and that they are performed in compliance with the safety analysis report and the general operating rules (RGE) in force, although a few modifications may however be made. In all other cases, they are subject to the decommissioning decree.

2.2.4.5. Delicensing of BNIs and establishment of active institutional controls

The “delicensing” of a BNI is an administrative measure whereby the installation is removed from the BNI list. In accordance with the provisions of Article R. 593-73 of the Environment Code, delicensing of the installation is pronounced by ASN resolution, following approval by the Minister in charge of nuclear safety. As of the entry into force of this delicensing decision, the installation no longer falls under the BNI legal and administrative system.

The delicensing application file more particularly contains a presentation of the site status following decommissioning and clean-out, notably containing an analysis of the state of the soil and a description of any remaining installation constructions and their status.

The delicensing of a basic nuclear installation is only authorised after implementation of an optimisation approach to achieve clean-out within the BNI perimeter that is as exhaustive as possible in acceptable technical-economic conditions. To do this, the licensee submits a delicensing application file. However if, following clean-out of the site, residual radiological and chemical pollution remains in the soil and groundwater, the licensee may propose implementing active institutional controls around the site or on the actual land of the installation, in accordance with the provisions of Articles R. 593-81 to R. 593-83 of the Environment Code. The delicensing application file is reviewed in parallel with the review of the file applying for the above-mentioned active institutional controls. As part of these reviews and to optimise information of the stakeholders, a number of public consultation and information sessions are stipulated by the regulations.

Active institutional controls concerning the use of the ground and the performance of works subject to notification or administrative authorisation may also be adopted by virtue of Article L. 593-5 of the Environment Code on existing installations, including installations in service.

2.2.5. Technical rules concerning BNIs

A hierarchical series of texts sets out the technical rules and practices for nuclear safety. They are summarised in Appendix L.5.1 and L.5.2. The first of these texts, which has regulatory status, are relatively general and cover a broad range, while usually not going into too much technical detail. The last ones, however, deal with subjects in greater depth and detail. Their legal form is more flexible.

2.2.5.1. The general technical regulations

The general technical regulations currently deal with three major subjects: pressure equipment (a subject which is of only very limited relevance to the installations falling with the scope of the Convention), the quality organisation (see section F.3), external detrimental effects and hazards resulting from BNI operation (see § E.2.2.6.2).

Pursuant to Article L.592-20 of the Environment Code, ASN issues resolutions to supplement the implementing procedures for decrees and orders adopted in the areas of nuclear safety or radiation protection, except for those relating to occupational medicine.

They are subject to approval by the Minister in charge of nuclear safety, with respect to those relating to nuclear safety, the Minister in charge of energy, with respect to those concerning the means and measures for protecting sources of ionising radiation against malicious acts, and the Ministers in charge of radiation protection with respect to relevant resolutions in this field.

ASN’s resolutions, as well as the mandatory opinions it issues on draft decrees, are published in its Official Bulletin, which can be consulted on-line on its website (www.asn.fr).

2.2.5.2. Basic safety rules and ASN guides

On various technical subjects, concerning both power reactors and other BNIs, ASN previously issued basic safety rules (RFS), recommendations defining safety objectives and describing practices ASN considers to be satisfactory for achieving them.

They are not strictly speaking regulatory texts. A licensee may not follow the provisions of an RFS if the measures it proposes are able to attain the safety objectives set.

As part of the ongoing restructuring of the general technical regulations, the fundamental safety rules (RFS) are gradually being replaced by "ASN guides". In the form of recommendations, the purpose of these guides, intended for professionals concerned by the nuclear safety and radiation protection regulations (licensees, users or transporters of ionising radiation sources, general public , etc.), is: to explain a regulation and the rights and obligations of the persons concerned by the regulation; to explain the regulatory objectives and, as applicable, to explain practices considered by ASN to be satisfactory; to provide practical advice and useful information regarding nuclear safety and radiation protection.

The list of RFS and guides falling within the scope of the Convention is given in Appendix L.5.

2.2.6. The scope of BNI oversight

ASN oversight of nuclear activities aims to protect humans and the environment. It therefore consists in verifying that a party in charge of a nuclear activity fully assumes its responsibility and complies with the requirements of the regulations concerning nuclear safety and radiation protection. On the basis of these elements, ASN assesses the performance of or issues involved in a nuclear activity and the licensee’s rigorousness in terms of safety and radiation protection.

2.2.6.1. Oversight of nuclear safety

Within its scope of oversight, ASN looks at installation equipment, operators of this equipment, working methods and the organisation from the initial design phases up to decommissioning and then delicensing. It examines the steps taken regarding safety or monitoring and limitation of the doses received by those working in the facilities, as well as procedures for waste management, monitoring of effluent discharges and environmental protection.

2.2.6.2. Environmental protection

The prevention and mitigation of detrimental effects, and of the impact and risks from BNI operations are regulated by title IX of book V of the Environment Code (integrated system) and its implementing decrees, the BNI Order and ASN resolution 2013-DC-0360 of 16 July 2013, as amended, concerning management of the detrimental effects and the impact on health and the environment from basic nuclear installations.

As a general rule, ASN's environmental protection policy tends to fall into line with that applied to industrial activities involving conventional hazards. As an example, the BNI Order requires implementation of the best available techniques at an economically acceptable cost, taking account of the particular characteristics of the environment of the site.

This approach leads to specification of limits concerning the discharge of chemical substances, and to a reduction in the authorised limits for the discharge of radioactive and chemical substances. The requirements governing BNI discharges and water intake are periodically reviewed in the light of regulatory or technological changes, in order to assess the possibility of reducing discharges from the installations and improving the monitoring conditions. Following this review, the requirements are revised as necessary.

2.2.6.3. Working conditions in BNIs

As a general rule, monitoring the application of all the provisions regarding labour regulations (in particular the work contracts, working hours, personnel representation, health and safety, reconciliation of the parties in the event of a labour dispute, advice and information of the employers, employees and personnel representatives regarding their rights and obligations) is the responsibility of the personnel responsible for the labour inspectorate duties.

Under Article R. 8111-11 of the Labour Code, in NPPs comprising one or more BNIs as defined in Article L. 593-2 of the Environment Code, the labour inspectorate duties are carried out by ASN personnel duly authorised by ASN.

In the other BNIs, in which ASN does not have labour inspectorate duties, exchanges with conventional labour inspectors are a valuable source of information on the labour relations situation, in the context of a nuclear safety and radiation protection approach that is more attentive to the importance of people and organisations.

Article L. 593-42 of the Environment Code confirms that the BNI system covers worker collective radiation protection aspects (for example, sizing of biological protections, optimisation of radiation protection zoning, etc.).

Decree 2018-437 of 4 June 2018 concerning the protection of workers against hazards due to ionising radiation modifies the rules for the prevention of health and safety hazards as a result of natural or artificial ionising radiation applicable to workers, to ensure the transposition into the regulations of the provisions concerning worker protection of Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for health protection against hazards resulting from exposure to ionising radiation, and for application of the provisions of Ordinance 2016-128 of 10 February 2016 constituting various nuclear provisions. It enables the radiological hazard to be better incorporated into the general occupational hazards prevention approach, notably with regard to the organisation of radiation protection and the conditions surrounding technical checks on workplaces and working equipment. This overall approach, which aims to ensure improved control of hazards and the prevention of incidents and accidents, helps to optimise the resourecs implemented by the employer.

2.2.7. BNI oversight procedures

ASN employs many oversight methods. These mainly comprise:

- inspections on-site, or in the departments of the licensees or their contractors, for activities which could have a significant impact on safety, radiation protection, or the environment, worksite inspections during maintenance outages of facilities and technical meetings on the site with the BNI licensees or the manufacturers of the equipment used in the facilities;
- technical review of the substantiating files and documents supplied by the licensee.

2.2.7.1. Inspection

In order to address, on the one hand, the issues linked to the activities and how the person responsible for them guarantees operation in terms of safety and radiation protection and, on the other, the number of activities under its control, ASN periodically identifies the priority activities and topics on which it focuses its inspection resources and exercises direct oversight at a predetermined frequency. Management of waste and effluent is one of the topics considered to be a priority.

To ensure a good distribution of inspection resources according to the nuclear safety, radiation protection and environmental protection issues as relating to the various installations and activities, ASN draws up a programme of future inspections, every year. This programme identifies the targeted facilities, activities and the particular topic. Those responsible for the nuclear activities are not made aware of it.

To achieve its goals, ASN has inspectors chosen for their professional experience and their legal and technical expertise. These nuclear safety inspectors are ASN engineers, qualified following a training course appropriate to their functions and then appointed by an ASN resolution. They exercise their inspection activity under the authority of the ASN Director-General. They take an oath and are bound by professional secrecy.

The oversight activities in the field are carried out primarily by the ASN regional divisions, with coordination at the national level.

In 2019, 2,283 inspector.days were devoted to inspecting BNIs and PE, broken down into 755 inspections, about 21% of which were unannounced. This inspection work is broken down into 1,199 inspector.days in the NPPs (349 inspections), 820 inspector.days in the other BNIs (301 inspections), in other words mainly fuel cycle facilities, research facilities and installations being decommissioned, along with 264 for pressure equipment (105 inspections).

141 inspector.days were devoted by ASN to inspecting transport activities, distributed over 92 inspections, 41% of which were unannounced; their breakdown into topics is illustrated in figure 6.

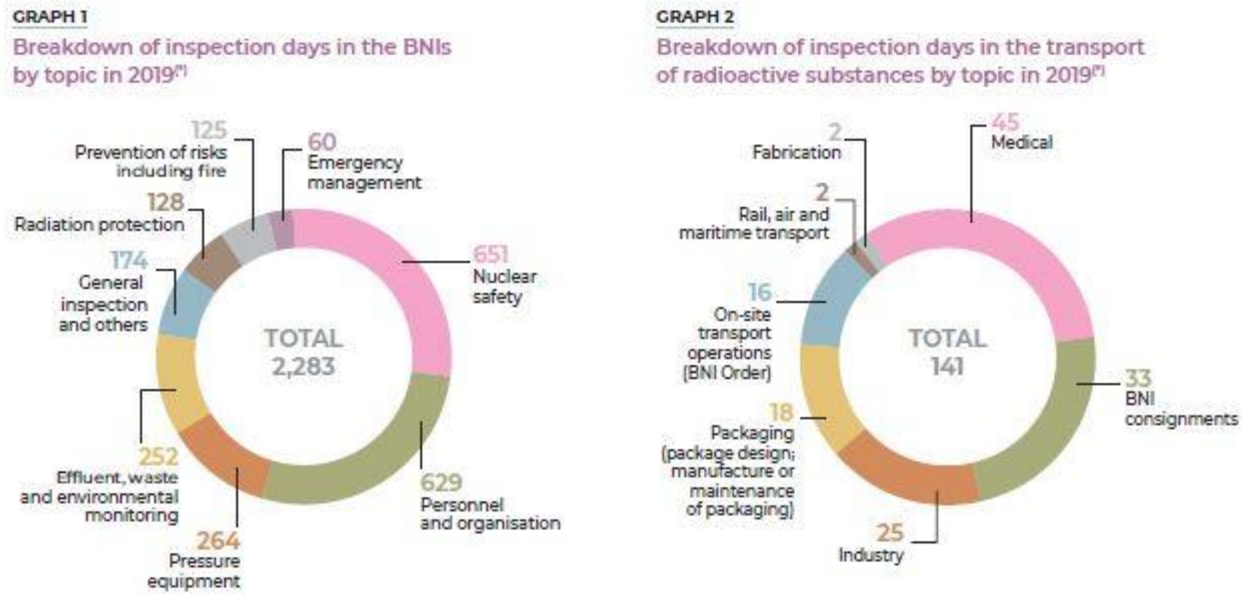


Figure 6: Breakdown of BNI, environmental protection and transport activities inspections carried out in 2019 per nature of activity

2.2.7.2. Technical review of files submitted by the licensee

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

Review of these files may lead ASN to accept or reject the licensee's proposals, or to ask for additional information or justification, studies or works to ensure conformity. ASN issues its regulatory requirements in the form of resolutions.

Review of the supporting documents produced by the licensees and the technical meetings organised with them are one form of ASN's regulatory oversight. Technical dialogue is a key component of this process.

Significant events:

Any "significant event" (see § E.2.2.4.3) affecting BNI safety, radiation protection of workers or the public, the environment, or the transport of radioactive materials, must be reported to ASN as rapidly as possible.

ASN checks that the licensee has suitably analysed the event, taken the appropriate measures to correct the situation and prevent it occurring again, and has circulated the lessons learned from it.

The analysis of a significant event covers compliance with the significant event detection and notification rules in force, the immediate technical measures taken by the licensee to maintain the facility in or bring it to a safe state and, finally, the pertinence of the significant event reports supplied by the licensee.

ASN and its technical support organisation, IRSN, conduct a subsequent review of the lessons learned from the events. The information from the regional divisions and analysis of the significant event reports and the periodic assessments submitted by the licensees form the basis of ASN's experience feedback organisation. The operating experience feedback may lead to requests for improvements to the condition of the facilities and the organisation adopted by the licensee, but also to changes to the regulations. It is taken into account in the drafting of the programme of inspections mentioned in § E.2.2.7.1.

The figure below shows information relative to significant events having occurred in the laboratories, plants, installations undergoing decommissioning, and waste processing, storage or disposal facilities.

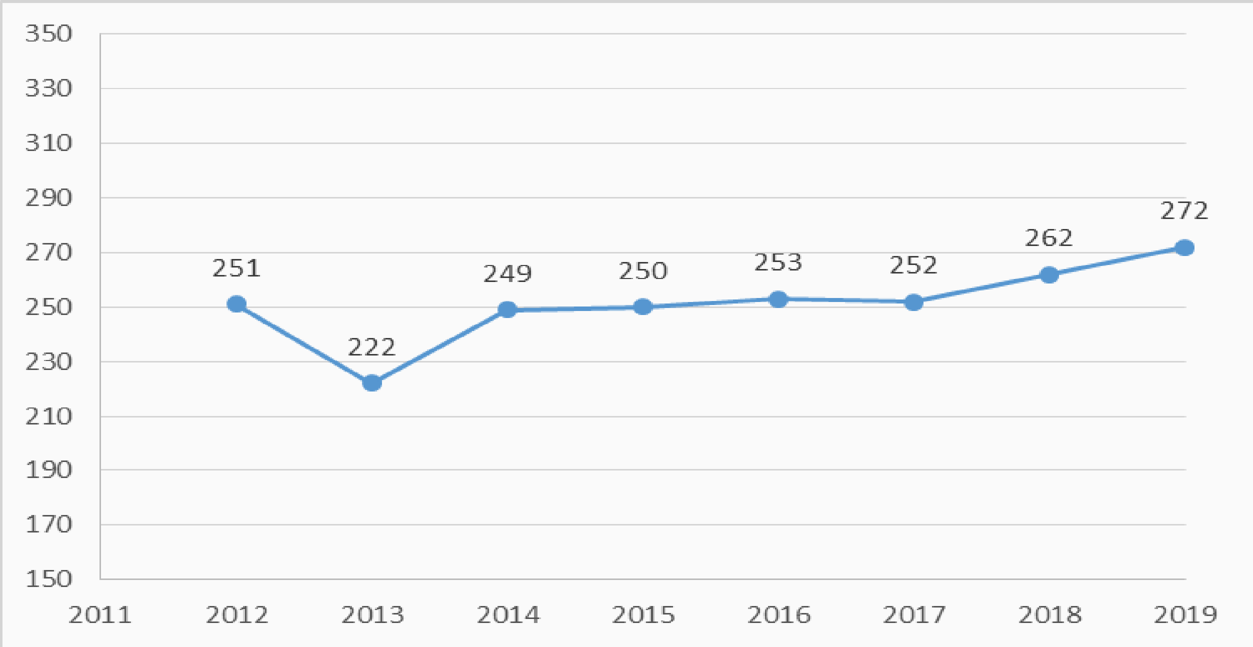


Figure 7: Trend in total numbers of significant events notified for facilities between 2012 and 2019

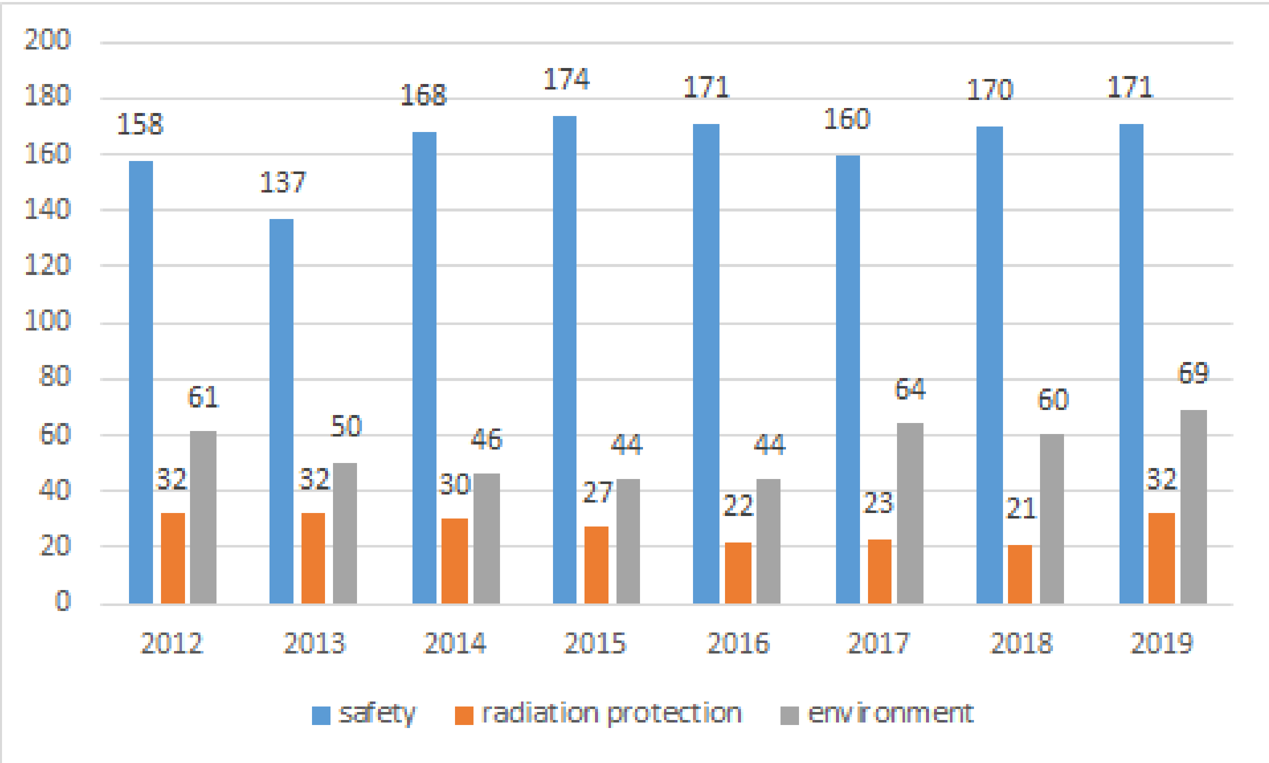


Figure 8: Notification fields used to report significant events (period 2012-2019)

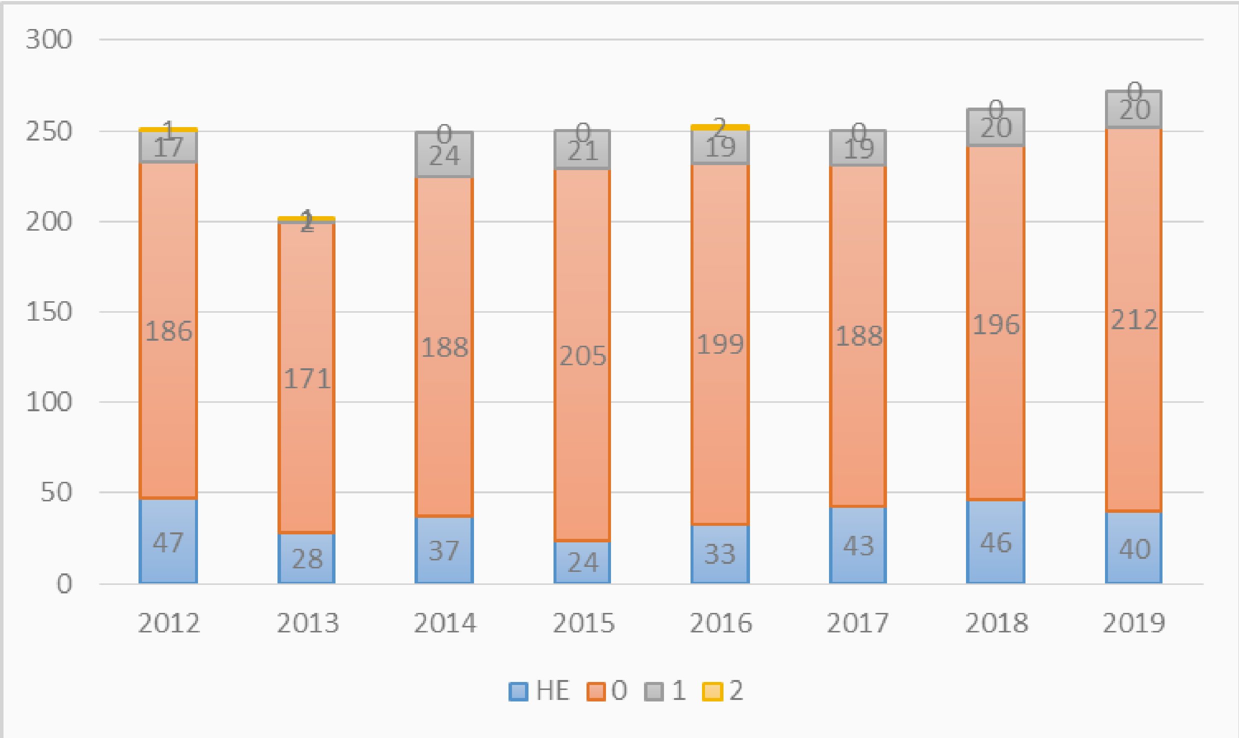


Figure 9: INES classification used for significant events affecting facilities other than NPP reactors (period 2012-2019)

Evaluation of the information provided

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

Depending on the subject, ASN may diversify its technical support bodies, calling in specialist organisations, from both France and abroad.

For most of the other subjects, the safety analyses are dealt with in opinions requested from IRSN directly by ASN. For the more important issues, ASN requests the opinion of the competent advisory committee of experts.

2.3. The regulatory frameworks of the ICPEs and mines

2.3.1. The regulatory framework of the ICPEs

The regulations on installations classified for protection of the environment (ICPE) are applied by the *département* Prefects, under the control of the General Directorate for the Prevention of Risks (DGPR) of the Ministry in charge of the environment. For each heading of the ICPE nomenclature, the inspectorate develops formal prescriptions for the licensees through Prefectoral orders. The latter take into consideration the particularities of the installations and their environment.

The general regulations are drawn up by the Ministry in charge of the environment, in accordance with European community directives and France's international commitments. The DGPR oversees the inspection and is responsible for national level technical, methodological, legal and regulatory control.

The ICPE regulations are based on an integrated approach, meaning that:

- a single authorisation is issued for an industrial site in terms of protection of the environment (rather than various authorisations, including one for liquid discharges, one for gaseous discharges, one for hazards, and so on). The integrated approach makes it possible to take account of all environmental impacts (air, water, soil, noise, vibrations) and the industrial accident hazard;
- a single authority is competent to apply this legislation. In France, the State is the only body competent to legislate on the ICPEs. It intervenes through the Prefect (State representative in each *département*) assisted by the ICPE inspectorate.

There are three classified installation regulatory systems:

- notification: a simple procedure for installations with low environmental impact; the notification must be made to the Prefect of the *département*, general requirements must be adhered to and the installation may be inspected;
- registration: prior authorisation from the Prefect of the *département* is necessary;
- authorisation: this is granted after a public and administrative inquiry, further to the report by the ICPE inspectors and the opinion of the Departmental Council for the Environment and for Health and Technological Risks (CODERST).

The authorisation concerns the activities presenting the highest risks. The authorisation procedure begins with the creation of an authorisation application file which, depending on the potential risks from the installation, comprises an impact assessment or an environmental impact assessment and a hazards study. The file undergoes a variety of consultations, notably consultation of the local authorities and a public inquiry. The procedure ends with the granting (or rejection) of authorisation in the form of an Order of the Prefect which contains the requirements.

Whereas the requirements concerning installations subject to notification and registration are standardised, the requirements on installations subject to authorisation are drawn up on a case by case basis, according to the characteristics of the installation. However, for certain installation categories, ministerial orders and general requirements set minimum provisions to be incorporated into the authorisation orders.

2.3.2. The regulatory framework for mines

The regulations governing mines is different from that for ICPEs, mainly for historical reasons, and also because the working of mines poses particular technical problems. The Prefect of the *département*, the local government representative, is the oversight Authority. However, the mining titles (concessions or operating permits) and the operating licenses are issued at national level after obtaining the opinion of the General Council for the Economy, Industry, Energy and Technologies (CGEIET).

The regulations governing mines cover the actual mining works and the legal dependencies of the mines; the majority of the ore processing and residue disposal facilities are currently classified as ICPEs (see § E.2.3.2).

For the mine operations, the discharge of radioactive substances into the environment is regulated by Decree 2006-649 of 2 June 2006 concerning mining works, underground disposal works and the mines and underground disposal facilities policing regulations (chapter VI “protection against ionising radiation”). Through the transposition of European Council Directive 2013/59/Euratom of 5 December 2013 setting basic standards for the protection of health against the hazards arising from exposure to ionising radiation, some of the provisions of Decree 90-222 are undergoing modification.

These regulations apply to the actual mining work and to the legal dependencies of these operations, that is the surface installations which are needed by them and the other essential installations, such as mechanical preparation of the ore with its chemical treatment, which is itself not covered by the Mining Code but by the Environment Code.

The end of operations or of a tranche of operations must be notified by the licensee, indicating the measures it envisages taking to protect the interests mentioned in Article L.161-1 of the Mining Code. The mining work cessation procedure concerns all the work and all the structures and facilities essential to operation, and which have never been duly declared abandoned or completely stopped with respect to the applicable regulations in effect at the time of industrial cessation of the works. This procedure is governed in particular by the Mining Code, by Decree 2006-649 of 2 June 2006 and specified in the circular of 27 May 2008. Stoppage of the works is the subject of a prior declaration to the competent authority.

The Ministerial Order of 8 September 2004 details the composition of the file for declaring final stoppage of the mining work and use of the mining facilities.

It is important to note that if the mining regulations become applicable as of the start of mine research or operation work, the procedure for stopping the mining work is not applicable if the mining title has given rise to no research or operating work necessitating a start of works procedure.

Since the 30 March 1999 Act, whenever major hazards are liable to compromise the safety of property or persons, the licensee must install and operate the equipment needed to monitor and prevent them. The end of validity of a mining title constitutes transfer of the monitoring of these hazards to the State, provided that the cessation of work procedure has been completed.

3| THE REGULATION AND OVERSIGHT ORGANISATIONS (ARTICLE 20)

1. Each Contracting Party creates or appoints a regulatory organisation responsible for implementing the legislative and regulatory provisions of Article 19 and given adequate powers, expertise and financial and human resources to enable it to assume the responsibilities assigned to it.

2. In accordance with its legislative and regulatory framework, each Contracting Party takes the appropriate measures to ensure effective independence of the regulatory function with respect to the other functions in the organisations dealing both with management of spent fuel or radioactive waste and the corresponding regulations.

Several Ministries are involved in defining, implementing and overseeing radioactive materials and wastes management policy. Within the Ministry for Ecological and Solidarity-based Transition (MTES), the General Directorate for Energy and the Climate (DGEC) draws up policy and implements Government decisions concerning the civil nuclear sector, while the Nuclear Safety and Radiation Protection Delegation (MSNR), under the joint authority of the MTES and the Minister in charge of health, drafts, coordinates and implements the Government's roles concerning civil nuclear safety and radiation protection.

3.1. The Nuclear Safety Authority

Created by Act 2006-686 of 13 June 2006 on nuclear transparency and security, known as the TSN Act, ASN is an independent administrative authority tasked with the regulation and oversight of civil nuclear activities in France.

On behalf of the State, ASN performs oversight of nuclear safety and radiation protection to protect people and the environment. It informs the public and contributes to enlightened societal choices. It also contributes to the management of radiological emergencies.

ASN decides and acts with rigour and discernment: its aim is to exercise regulation and oversight recognised by the citizens and seen as a benchmark internationally. It exercises its duties in compliance with four fundamental values: competence, independence, rigour and transparency.

ASN draws on the expertise provided primarily by IRSN and by the Advisory Committees of experts.

3.1.1. The independence of ASN, the regulatory authority

The Commission

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

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

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

The duration of the mandate of the members is six years. It is non-renewable. A member's functions may only be terminated in the event of incapacity or resignation as recorded by a majority vote of the Commission. The President of the French Republic may also put an end to the term of any commissioner in the event of severe dereliction of duty.

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

ASN opinions and resolutions

The TSN Act gives ASN competence to issue regulatory resolutions clarifying the decrees and orders relating to nuclear safety and radiation protection. These resolutions are subject to approval by the Minister in charge of nuclear safety or radiation protection. It also gives ASN the authority to impose binding requirements on the licensee throughout the lifetime of the facility, including during its decommissioning.

Pursuant to the TSN Act, the Commission submits its opinions to the Government and issues ASN's main resolutions. These are published on the ASN website www.asn.fr. The members of the Commission act with complete impartiality, receiving no instructions from either the Government or any other person or institution.

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

ASN reports on its activities to Parliament, notably by submitting its annual report on the state of nuclear safety and radiation protection in France[1] to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST).

3.1.2. Organisation

ASN, run by its Commission of five commissioners, consists of head office departments and regional divisions, placed under the authority of the Director General, assisted by three deputies, a chief inspector and a head of private office.

The TSN Act lists the various categories of regulatory or individual texts issued by ASN, for example:

- technical regulations to implement decrees or orders issued regarding nuclear safety and radiation protection;
- BNI commissioning authorisations;

[1] https://www.asn.fr/Informer/Publications/Rapports-de-l-ASN

- authorisations or approvals for the transport of radioactive substances or medical installations and equipment using ionising radiation.

Some of these resolutions must be approved by the Minister in charge of nuclear safety or radiation protection.

3.1.2.1. The ASN Commission

The Commission and its working methods are described in § E.3.1.1.

ASN draws up its internal regulations, made public, which set the rules regarding the organisation and working of ASN and its rules of ethics. The internal regulations set out the conditions and limits whereby the Commission of commissioners may delegate powers to its Chairman, as well as those in which the Chairman may delegate his or her powers of signature to the personnel of the ASN departments.

3.1.2.2. ASN head office departments

The ASN head office departments comprise eight departments, an office of administration and a legal affairs department.

The role of the departments is to manage the national affairs concerning the activities under their responsibility. They take part in determining the general regulations and in coordinating the actions of the ASN divisions. They also take part in international work.

The Regulation and Oversight Support Office (MSC) ensures that the inspections carried out by ASN are pertinent, harmonised, effective and in-line with ASN's values. It reports to the chief inspector and runs inspection strategies, drafts the inspection programme, handles operating experience feedback regarding events reported by those responsible for the nuclear activities and monitors all reported cases and irregularities.

The Management and Expertise Office (MEA) provides ASN with its high-level appraisal and assessment expertise. It ensures consistency in the action taken, through the ASN quality approach and by overseeing and coordinating the teams.

Since December 2017, an ethics coordinator has been appointed at ASN by the Chairman of the Authority, in accordance with the provisions of Act 2016-483 of 20 April 2016 concerning ethics and the rights and obligations of civil servants. They are tasked with providing the staff and commissioners with any advice they may need regarding compliance with the rules of ethics. They may thus be consulted by all staff working at ASN regarding the ethical obligations contained in the civil service general statutes, regarding potential conflict of interest situations in the performance of their duties and the measures to be taken to prevent them, regarding any combination of activities or a company start-up with a departure for the private sector.

The obligations and duties of the ethics coordinator are defined by the civil service general statutes and Decree 2017-519 of 10 April 2017 concerning the ethics coordinator in the civil service and are implemented in Articles 50 and 51 of the Ethics Charter for ASN commissioners and staff, which constitutes Appendix 1 to the ASN internal regulations (Resolution 2018-DC-0644 of 9 October 2018).

3.1.2.3. The ASN regional representatives and divisions

ASN's regional divisions operate under the authority of the regional representatives. The director or the DREAL[1] for the location of the division concerned assumes this delegated responsibility. They are made available to ASN and, for these functions, are not under the authority of the Prefect with regard to their nuclear safety and radiation protection duties. Delegation of signature from the Director General gives the regional representatives authority for local decisions.

[1] DREAL: Regional Directorate for the Environment, Planning and Housing

The divisions conduct most of the oversight in the field of BNIs, radioactive material transports and other small-scale nuclear activities.

In emergency situations, the divisions assist the Prefect of the *département* who is responsible for protection of the population, and oversee the operations to safeguard the facility on the site. To ensure preparedness for these situations, they help draw up the emergency plans established by the Prefects and take part in the periodic exercises.

The divisions contribute to ASN's public information duty, by holding press conferences in the regions. They also take part in CLI meetings. They maintain regular relations with the local media, elected officials, environmental protection associations, licensees and local administrative partners (Prefects, regional health agencies, etc.).

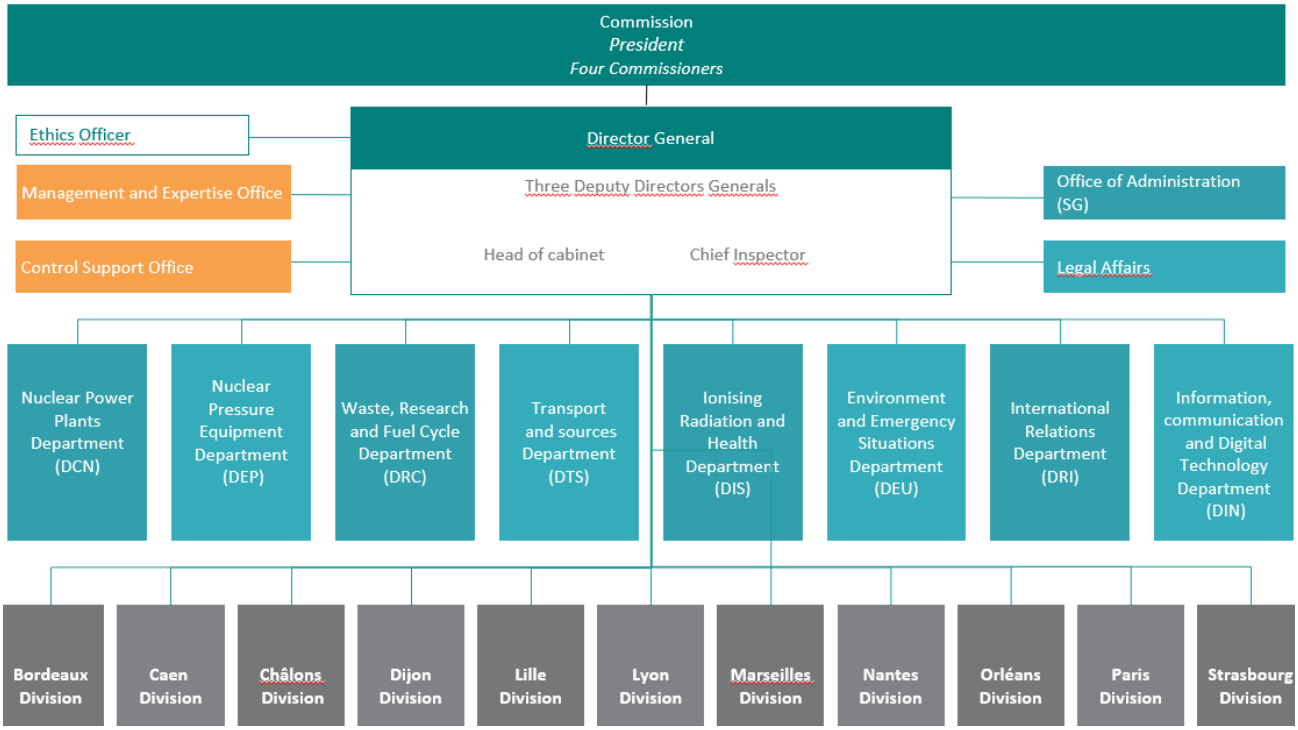


Figure 10: ASN organisation as at 1st September 2020

3.1.3. ASN human resources and their management

3.1.3.1. Resources

Human resources

The ASN overall workforce at 31 December 2019 stood at 521 staff including 321 inspectors.

This workforce can be broken down as follows:

- 437 tenured or contract staff;
- 84 staff members seconded by public establishments (Assistance publique – Hôpitaux de Paris, CEA, IRSN, Andra, SDIS[1]).

As at 31 December 2019, the average age of the ASN staff was 44 years and 4 months.

[1] Departmental Fire and Emergency Response Service

Head office departments	Regional Divisions	Total
288	230	521 (including 3 staff in international organisations)

Table 17: Breakdown of ASN workforce as at 31 December 2019

Financial resources

Since 2000, all the personnel and operating resources dedicated to the performance of the tasks entrusted to ASN have been covered by the State's general budget.

In 2019, the State's budget for transparency and the oversight of nuclear safety and radiation protection in France, amounted to €297.42 million.

BNI tax

The TSN Act stipulates that the ASN Chairman is responsible, on behalf of the State, for levying and collecting the BNI tax created by Article 43 of the 2000 Budget Act (Act 99-1172 of 30 December 1999). The revenue from this tax amounted to €574.79M in 2019. It is paid into the general budget of the State.

Additional radioactive waste taxes

For nuclear reactors and spent nuclear fuel reprocessing plants, the Waste Act creates three taxes in addition to the BNI tax, referred to as the "research", "support" and "technological dissemination" taxes respectively, allocated to financing economic development work on the one hand and to research into underground disposal and storage by Andra, on the other.

For 2019, revenue from these taxes amounted to €126.18 M. Lastly, Act 2009-1673 of 30 December 2009 instituted an additional tax on the disposal facilities financed by Andra and paid over to the municipalities and public establishments of intercommunal cooperation situated around the disposal facilities. For 2019, revenue from this tax amounted to €3.3 M.

Special contribution

Finally, the Supplementary Budget Act for 2013 created a special contribution that is payable until the date of creation of the deep geological disposal facility, as mentioned in 2° of article 3 of Planning Act 2006-739 of 28 June 2006 relative to the sustainable management of radioactive materials and waste;

The revenue from this contribution amounted to €148.66 M in 2019.

Licensee	Amount for 2019 (in million euros)			
	BNI Tax	Additional waste and disposal taxes	Andra special contribution	Contribution on behalf of IRSN
EDF	544.78	96.67	115.92	48.42
Orano-Framatome	16.66	6.20	7.44	6.29
CEA	4.78	18.34	25.30	6.92
Andra	5.41	3.30	-	0.40
Others	3.16	1.67	-	0.71
Total	574.79	126.18	148.66	62.74

Table 18: Breakdown of licensee's contributions for 2019

3.1.3.2. Human resources management

Employee training

Skills management:

A tutoring system, allied with initial and continuous training, whether general or relating to nuclear techniques, constitute essential aspects of the professionalism of ASN staff.

The management of ASN staff skills is based notably on a formalised series of technical training courses. This series of training courses is set, for each employee, according to a detailed and regularly updated training baseline. For example, an inspector must follow a series of predetermined training courses before being qualified to carry out inspections. These training courses cover technical, legal and communication aspects. In 2019, nearly 3,800 days of training were given to the ASN staff during the course of 230 sessions involving 133 different courses. The financial cost of the courses, carried out by organisations other than ASN, amounted in 2019 to €528.9 k.

The percentage of training costs with respect to the payroll also includes the payroll costs of the 4,545 "trainee days" (national and local training plans), the 162 internal instructor days and the payroll for the personnel responsible for training. In 2019, training costs totalled €2.8 M, that is to say 7.5% of the ASN payroll.

Inspector qualification:

In 1997, ASN initiated a qualification system for its inspectors based on recognition of their technical competence. An approvals committee was created in 1997 to advise the Director General with regard to the qualification system as a whole. It more specifically examines the training courses and the qualification baselines applicable to the various ASN departments, as well as conducting hearings for the inspectors as part of a confirmation process.

The qualification committee consists half of confirmed inspectors from ASN and half of persons with competence in inspection, appraisal and teaching in nuclear safety and ICPE oversight. Its competence was confirmed in 2009 for the radiation protection field.

As at 31 December 2019, ASN employed 321 nuclear safety or radiation protection inspectors holding at least one qualification, or nearly 61% of the 521 ASN staff.

Internal quality management

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

- an organisation manual containing organisational notes and procedures defining rules for the conduct of each of its missions;
- in-house and third-party audits to ensure rigorous application of the requirements of the system and regular questioning of the practices and the compatibility between the baseline requirements and the needs;
- listening to stakeholder feedback;
- activity and performance indicators for monitoring the effectiveness of the action;
- a periodic review of the system in the drive for continuous improvement.

With the goal of achieving continuous progress, ASN hosted an IRRS (*Integrated Regulatory Review Service*) mission in 2006 which focused on all areas of nuclear safety and radiation protection and led to a follow-up mission in 2009[1].

From 17 to 28 November 2014, ASN hosted another IRRS mission covering all of its activities, During the mission, twenty-nine experts from the nuclear safety and radiation protection authorities of nineteen countries and from the IAEA met the ASN teams and the other State services concerned.

[1] Link to the IRRS mission and follow-up mission reports https://www.asn.fr/Informer/Actualites/Rapport-international-IRRS-de-l-AIEA-en-ligne

This extremely detailed mission confirmed the robustness and rigorous management of the regulation and monitoring carried out in France by ASN. The conclusions of the mission also show that new means must be examined in order to guarantee that ASN has the human and financial resources it needs for effective oversight of nuclear safety and radiation protection in the future. The IAEA final report was transmitted to France in the first quarter of 2015 and posted on the ASN website.

From 1 to 9 October 2017, ASN received an IAEA delegation responsible for follow-up to the 2014 mission, which concerned all of the activities regulated by ASN. With 40 recommendations and suggestions applied, the delegation concluded that France had significantly reinforced the framework of its regulation and oversight of nuclear safety and radiation protection. IAEA did however point out that ASN needed to demonstrate vigilance with regard to the question of human resources, in the light of the safety issues facing nuclear facilities in France and continue to determine orientations for the methods to review and update safety texts. The mission also suggested that ASN promote internal dissemination of safety culture as extensively as possible and clarify the conditions for classification of emergency situations by the licensees.

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

3.1.4. ASN's technical support organisations

ASN benefits from the expertise of technical support organisations in preparing its resolutions and decisions. The main organisation is IRSN. For several years, ASN has been making efforts to diversify its national and international service providers.

3.1.4.1. French Institute for Radiation Protection and Nuclear Safety

The IRSN was created by Act 2001-398 of 9 May 2001 and instituted by Decree 2002-254 of 22 February 2002. This decree organised the separation between CEA and the old Institute for Protection and Nuclear Safety (IPSN), and the partial merger between this latter and the old Office for Protection against Ionising Radiation (OPRI), creating a nuclear safety and radiation protection research and expert analysis organisation, the IRSN.

Since Act 2015-992 of 17 August 2015 on energy transition for green growth, the legislative part of the Environment Code defines the roles of the Institute for Radiation Protection and Nuclear Safety (IRSN), the public risks expert, alongside those of the Nuclear Safety Authority (ASN) and the Local Information Committees (CLI). Decree 2016-283 of 10 March 2016 concerning IRSN, is a transcription of the law and places the establishment under the joint supervision of the Ministers in charge of ecology, research, energy, health and defence.

As a public expert in nuclear and radiological risks, the Institute deals with all scientific and technical questions associated with these risks, in France and internationally. Its activities therefore cover numerous fields: environmental monitoring, intervention in the event of a radiological risk, radiation protection of humans in normal and accident situations, prevention of major accidents, safety and security of nuclear reactors, plants, laboratories, transport and waste.

The conditions of IRSN technical support for ASN are governed by a convention. In addition, the technical support actions cover assessment of safety or radiation protection dossiers produced by the licensees, the performance of studies or work on scientific or technical subjects, field work for sampling, measurement and analysis, more specifically concerning ionising radiation, participation in inspections carried out by ASN, participation in the national emergency organisation and participation in and coordination of national/international working groups and meetings.

From among these actions, analysis of the safety cases for the installations subject to this Convention calls on more than a hundred experts which, in 2019, enabled the IRSN to issue 60 opinions, 4 of which were written up in a report presented to the Advisory Committees of experts (GPE) called on by ASN. The IRSN also issued 26 opinions concerning the safe transport of radioactive substances.

The research activities carried out by the IRSN with regard to radiation protection, radio-ecology and the safety of installations, primarily covers the main hazards encountered in the installations subject to this Convention (criticality, fire, dispersion, structural strength), as well as those linked to the safety of repositories after their closure. A growing share of this research work is done in collaboration with French and international entities.

3.1.4.2. The other technical support organisations

In order to diversify its expertise and benefit from other specific skills, ASN also has its own budget.

ASN has continued its collaboration with:

- the Building Industry Scientific and Technical Centre (CSTB) on subjects associated with the exposure of populations to radon in the home. In 2019, this collaboration led to the preparation of a collection of recommendations to protect new and existing buildings from radon;
- the French national institute for environment and risks (INERIS) on the subject of the environment and chemical hazards;
- the French Nuclear Protection Evaluation Centre (CEPN), to support post-accident work.

Since 2017, ASN has placed expert analysis contracts with other organisations, for example on targeted subjects such as the strategic environmental assessment of the PNGMDR or the performance of in-depth inspections on complex projects such as the decommissioning of power reactors and Cigéo.

3.1.4.3. Advisory Committees of experts

When preparing its more important resolutions, ASN draws on the opinions and recommendations of eight Advisory Committees of experts (GPE), with competence in the fields of waste (GPD), nuclear pressure equipment (GPESPN), radiation protection in a medical environment (GPMED), radiation protection in environments other than medical (GPRADE), reactors (GPR), transports (GPT), laboratories and plants (GPU) and decommissioning (GPDEM).

They may more specifically review the files submitted to ASN by an applicant, changes to the regulations, or draft guidelines. They may also be consulted on more general topics.

For each of the subjects dealt with, the GPE base their technical opinions on the reports produced by the IRSN, by a special working group or by one of the ASN departments. They issue an enlightened and independent opinion, plus recommendations as applicable.

The Advisory Committees comprise experts appointed for their technical competence. They come primarily from industrial or university backgrounds. In 2014, ASN defined new methods for selecting and appointing members, opening up these groups to experts from “civil society”.

Each member of the Advisory Committees therefore speaks in a personal capacity at meetings. The participation of experts from other countries can bring new approaches to subjects and the benefit of international experience.

As part of its approach to ensure transparency in nuclear safety and radiation protection, ASN has since 2009 made public the documents concerning the meetings and, as applicable, the ASN position statement regarding the file being reviewed.

The opinions expressed by the Advisory Committees are considered to be expert assessments. In order to reinforce the independence and robustness of the opinions expressed, additional guarantees are provided with regard to independence from the nuclear licensees, transparency in the selection of the members of the Advisory Committees and the technical quality of the opinions issued.

3.2. DSND and ASND

In 2001, a nuclear safety and radiation protection delegate for defence-related activities and facilities (DSND) was created at the Ministry of Defence.

The DSND is tasked with studying nuclear safety policy applicable to defence-related installations and activities and proposing it to the Ministry. They check that it is implemented. Taking account of the specific aspects of defence-related activities, they propose any adaptations to nuclear safety regulations they deem necessary.

For these same installations and activities, they draw up nuclear safety regulations and propose the technical provisions regarding protection against ionising radiation. In this field, they give their opinion on any adaptation of the regulations they deem necessary to take account of the specific aspects of defence-related activities.

The DSND monitors application of the regulations and reviews any authorisation application for creation, commissioning, modification, shutdown and decommissioning.

The DSND proposes safety measures to prevent accidents and mitigate their consequences.

The DSND takes part in public information in the fields within their scope of competence and on the activities and installations under their control, in compliance with national defence requirements and notably via information committees (CI).

In issuing their opinion, they draw on expert groups, including the IRSN and independent commissions.

The DSND is assisted by personnel placed at their disposal, within an entity called the Defence Nuclear Safety Authority (ASND) placed under their responsibility.

On a day-to-day basis, the ASND ensures that nuclear safety regulations are drawn up and implemented.

The ASND acts consistently with and in coordination with the ASN. In the same way as the ASN, the DSND is independent from the nuclear licensees.

3.3. The Nuclear Safety and Radiation Protection Mission

The Nuclear Safety and Radiation Protection Mission (MSNR) is the ministerial department, placed under the authority of the Minister for ecological and solidarity-based transition, and the Minister for health, which, on their behalf, deals with nuclear safety and radiation protection subjects within the competence of the Government, except for defence-related activities and installations and the protection of workers against ionising radiation. These missions are defined in Article 8.1.3 of the Order of 9 July 2008. The MSNR thus:

- coordinates and follows the files falling within the competence of the Ministers responsible for nuclear safety and radiation protection (coordination of BNI procedures, preparation of regulations in collaboration with ASN, etc.);
- participates in the development of the national emergency organisation (accidents affecting nuclear installations or radioactive material transports, radiological emergency situations, acts of terrorism, etc.) in collaboration with the services of the ministry responsible for civil protection;
- contributes to the preparation of the French positions in international and European Community discussions;
- coordinates the action of the DREALs with respect to the former uranium mines and the ICPEs containing radioactive substances;
- coordinates and monitors the management of sites and soils other than BNIs with radioactive contamination (jointly with the Bureau of Soils and Sub-Soils);

- proposes the State's intervention priorities in terms of rehabilitation of orphan radiation contaminated sites (CNAR) jointly with Andra and the DGEC;
- provides secretariat services for the High Committee for Transparency and Information on Nuclear Security (HCTISN) (see § E.3.4.2.4).

3.4. ICPE inspectorate and mines inspectorate

The ICPE inspectorate checks compliance with the technical requirements binding on the licensee. This means that its work focuses both on the equipment of the installations and the persons responsible for operating it, as well on the working methods and the organisation. It also intervenes in the event of complaints, accidents or incidents. If the inspectorate observes that the binding requirements are not appropriate, it can propose that the Prefect imposes additional requirements through an order. If the licensee does not comply with the compulsory measures, it could incur administrative penalties (compliance notice, deposition of sums, automatic enforcement, daily penalty payment, administrative fine, suspension of license, closure) and criminal penalties. The law provides for severe penalties in the event of any breach of these provisions.

The mines inspectorate duties are handled by the DREAL staff. This concerns operations, mineworker health and safety and any prejudice caused to the environment by the mine workings. As the former uranium mines are no longer in operation, the checks carried out mainly concern redevelopment work, safeguarding and monitoring of their impact on the environment.

3.5. The other stakeholders

3.5.1. The Parliamentary Office for the Evaluation of Scientific and Technological Choices

As a joint body of the National Assembly and the Senate, comprising eighteen members of Parliament and eighteen Senators, the role of the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) is to “inform Parliament of the consequences of scientific and technological choices, so that it can take informed decisions”. It thus provides Parliament with the expert assessments it needs to inform its long-term political choices.

The Office acts as an interface between the political and research worlds. It is assisted by a scientific council, the composition of which reflects the diversity of scientific and technological disciplines. This scientific council, consisting of twenty-four high-level personalities appointed for their competence, may be convened by the President of the Office whenever they so deem necessary.

The OPECST holds hearings for personalities on subjects of interest within its field of competence. Some hearings are required by law, such as the annual presentation of the activity reports from ASN (Act of 13 June 2006), the National Commission for the assessment of research and studies on radioactive materials and wastes (Act of 26 June 2006), the Biomedicine Agency (Act of 7 July 2011) or the Building Industries Scientific and Technical Centre (Act of 17 August 2015). Barring exceptions, these hearings are open to the press.

In addition to the studies it is instructed to perform, the OPECST carries out evaluations within the framework of procedures defined by various Acts, notably for the sustainable management of radioactive materials and waste. Some of these evaluations are recurrent, for example the three-yearly evaluation of the National Radioactive Materials and Waste Management Plan.

3.5.2. The consultative bodies

3.5.2.1. The National Assessment Commission

The National Assessment Commission (CNE), which comprises scientific personalities, was created in 1991 to assess the results of research on the management of high level and long-lived (HLW-LL) radioactive waste; it was more particularly required to produce an annual report on its assessment work and monitor international research on radioactive waste management. The Environment Code continues the action of the CNE: it thus continues to produce an annual assessment report, which now concerns research on all radioactive materials and waste, in the light of the objectives set by the National Radioactive Materials and Waste Management Plan.

The composition of the Commission is set by law (mandate renewable once, half of members renewed every three years). Rules of ethics are defined in order to guarantee completely impartial assessment. The powers of the Commission have also been reinforced, in that the law states that the research organisations assessed are required to provide it with any documents it may need to produce its annual report.

3.5.2.2. The French High Council for Technological Risk Prevention

The High Council for Technological Risk Prevention (CSPRT), created by Ordinance 2010-418 of 27 April 2010, comprises representatives of the State as well as licensees, qualified personalities and representatives of associations active in the environmental field. The scope of the CSPRT, which followed on from the High Council for Classified Installations, has been expanded to take in transport pipelines for gas, hydrocarbons and chemical products, as well as BNIs.

The CSPRT must be called on by the Government for an opinion on Ministerial Orders relating to BNIs. It may also be called on by ASN for BNI-related resolutions.

3.5.2.3. The High Public Health Council

The High Public Health Council (HCSP), created by Act 2004-806 of 9 August 2004 concerning public health policy, is a scientific and technical consultative body reporting to the Minister in charge of health.

The HCSP contributes to defining multi-year public health objectives, assesses the attainment of national public health targets and contributes to annual monitoring. Together with the health agencies, it provides the public authorities with the expertise needed to manage health risks and to design and evaluate health prevention and safety policies and strategies. It also provides prospective studies and advice on public health issues.

3.5.2.4. The High Committee for Transparency and Information on Nuclear Security

The TSN Act created the French High Committee for Transparency and Information on Nuclear Security (HCTISN) as an information, consultation and discussion body for the risks linked to nuclear activities and the impact of these activities on human health, the environment and nuclear safety.

This Committee can issue an opinion on all questions in these fields, as well as on the relevant controls and information. It may also examine all questions concerning the accessibility of information on nuclear safety and propose all measures such as to guarantee or improve nuclear transparency.

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 OPECST, by the chairmen of the local information committees or by the BNI licensees.

The High Committee comprises 40 members appointed for six years, including members of Parliament, CLI representatives, representatives of environmental protection associations and associations mentioned in Article L. 1114-1 of the Public Health Code, persons responsible for nuclear activities, representatives of employee trades unions, representatives of ASN, IRSN and the State's services concerned, as well as personalities chosen for their competence.

The High Committee held its first meeting on 18 June 2008 and holds four plenary meetings per year. It issues two to three reports or opinions every year on topical or fundamental issues. In 2010, it notably sent the Minister in charge of ecology a report on information and transparency associated with the management of radioactive materials and waste produced at all stages in the fuel cycle, and a report in 2013 prior to the public debate on the Cigéo radioactive waste deep disposal facility project. In 2010, it also published an opinion on transparency relating to the management of nuclear materials and waste produced at various stages in the fuel cycle, which it updated in 2018. Within a special working group, it also examined French prospects for changes to the management route for very low level waste (VLL) or waste that is liable to be VLL. Its report was published on 7 April 2020. Finally, a special working group was launched in early 2020, to make recommendations on the involvement of the public in the next steps in the development of the Cigéo project, in particular during the creation authorisation application review phase.

3.5.2.5. The Approvals Commission for environmental radioactivity monitoring laboratories

The environmental radioactivity monitoring measurements are to be made public. French regulations (Article R. 1333-25 of the Public Health Code) states that they are to be collated within a network – The National Environmental Radioactivity Monitoring Network (RNM) – for which the orientations are set by ASN and which is managed by the IRSN. This network more particularly collates the results of all the environmental monitoring analyses the licensees are required to carry out by the regulations, those performed by the various State services and its public establishments, as well as those carried out by associations, private laboratories or the local information committees of the nuclear installations. All of these measurement results are made available to the public on the website (www.mesure-radioactivite.fr). In order to guarantee that the results published come from measurements of sufficient quality, a laboratories approval process has been set up.

ASN Resolution 2008-DC-0099 of 29 April 2008, as amended, details the organisation of the national network and sets the provisions for the approval of environmental radioactivity measurement laboratories.

The approval procedure includes the presentation of an application file by the laboratory concerned after taking part in an inter-laboratory test (ILT), its examination by ASN and a review of the application files by a pluralistic approval commission.

The task of the approval commission is therefore to ascertain that the measurement laboratories have the organisational and technical skills needed to provide the network with high-quality measurement results. It is this commission that is responsible for proposing to ASN the granting, refusal, withdrawal or suspension of approval. It makes its decision on the basis of the application file presented by the candidate laboratory and its results in the inter-laboratory tests organised by IRSN.

Chaired by ASN, the commission comprises qualified persons and representatives from government departments, laboratories, standardisation bodies and IRSN. ASN Resolution 2013-CODEP[1]-DEU-2018-046580 of 26 September 2018, appointing the members of the approval commission for environmental radioactivity measurement laboratories, renewed the mandates of the Commission's members for a five year term.

The laboratories are approved by ASN resolution published in its Official Bulletin.

The above-mentioned ASN resolution 2008-DC-0099 was modified by ASN resolution 2018-DC-0648 of 16 October 2018, more specifically in order to introduce a new type of approval for measuring radon-222 in water. This revision aligns the procedures for the approvals issued by ASN for the RNM and by the Directorate

[1] ASN Chairman opinion CODEP-CLG-2017-022588 of 8 June 2017 concerning the reports submitted by the BNI licensees pursuant to Articles L. 594-1 to L. 594-13 of the Environment Code

General for Health (DGS) for the health checks on waters intended for human consumption, respectively, which are based on common technical requirements: to obtain approval from the DGS, these laboratories must now first have obtained approval from ASN.

3.5.3. The Health Safety Agencies

3.5.3.1. The National Public Health Agency

The National Public Health Agency (ANSP) is a public administrative establishment reporting to the Ministry for health, created by Ordinance 2016-462 of 14 April 2016. The ANSP takes over all the duties, competences and powers previously held by the French Health Monitoring Institute (InVS), by the National Institute for Prevention and Health Education (INPES) and by the Health Emergency Preparedness and Response Agency (EPRUS). The creation of the ANSP enables the roles of the three establishments to be merged, on behalf of the population and the health authorities, in order to more clearly understand, explain, preserve and protect the health of the population. The ANSP carries out epidemiological observation and monitoring so that it can improve its understanding of the state of health of the population in order to implement the health policies most appropriate for the needs and for the health issues and to deal with exceptional health situations (www.santepubliquefrance.fr).

3.5.3.2. French National Agency for the Safety of Medication and Health Products

The National Agency for the Safety of Medication and Health Products (ANSM) was created on 1 May 2012. The ANSM, a public institution reporting to the Ministry in charge of health, has taken up the functions of the French Health Products Safety Agency (AFSSAPS) alongside other new responsibilities. Its key roles are to guarantee the safety of health products throughout their lifecycle, from initial testing through to monitoring after receiving the marketing authorisation.

3.5.3.3. The French Agency for Food, Environment and Occupational Health and Safety

The French Agency for Food, Environment and Occupational Health and Safety (ANSES) is an administrative public institution reporting to the Ministries in charge of health, agriculture, the environment, labour and consumer affairs. It was created on 1 July 2010 by merging two French health agencies: AFSSA (French food health safety agency) and AFSSET (French agency for environmental and occupational health safety).

It duties are wide-ranging monitoring, assessment, research and referencing encompassing human health, animal health and wellbeing and plant health. It offers a cross-disciplinary perspective of health issues and obtains an overall understanding of the exposure to which humans can be subjected through their various lifestyles and consumption habits, or the characteristics of their environment, including their occupational environment.

Within the scope of its competence, the Agency’s role is risk assessment, to provide the competent authorities with all the information they need about these risks and the scientific and technical expertise and support needed to draw up legislation and regulations and to implement risk management measures.

SECTION F | OTHER GENERAL SAFETY PROVISIONS (ART. 21 TO 26)

1| RESPONSIBILITY OF A LICENCE HOLDER (ARTICLE 21)

1. Each Contracting Party shall do what is necessary to ensure that prime responsibility for the safe management of spent fuel or radioactive waste lies with the holder of the corresponding license and shall take appropriate steps to ensure that each holder of such a license assumes their responsibility.

2. If there is no licence holder or other responsible party, responsibility shall lie with the Contracting Party with jurisdiction over the spent fuel or the radioactive waste.

1.1. Spent fuel management

Spent fuel from civil nuclear activities is produced and stored in Basic Nuclear Installations (BNI). The fundamental principle underpinning the BNI nuclear safety organisation and regulation system is that of the prime responsibility of the licensee. For many years, this principle has been enshrined in law and in the regulatory texts. It has been reaffirmed in the Environment Code.

The BNI order of 7 February 2012 sets the essential requirements with which BNI licensees must comply.

On behalf of the State, ASN ensures that this responsibility is assumed in full. The interaction between the respective roles of ASN and the licensee is as follows:

- ASN defines the general safety objectives;
- the licensee proposes and substantiates the technical means of achieving them;
- ASN then verifies that these proposals comply with the objectives set;
- the licensee then implements the approved measures;
- by means of inspections, ASN checks correct implementation of these measures and draws the corresponding conclusions.

Furthermore, any BNI licensee assumes civil liability pursuant to the Convention on third-party liability in the field of nuclear energy (Paris Convention).

1.2. Radioactive waste management

The roles and responsibilities of the various players involved in the management of radioactive waste are described in section B.5. They are recalled below.

1.2.1. ASN and the BNI licensee with regard to radioactive waste management

The respective roles and responsibilities of ASN and the licensee of a BNI are identical to those presented in § F.1.1 regarding spent fuel management.

1.2.2. Licensee producing radioactive waste and licensee of a waste management facility (waste processing company, storage, Andra)

A producer of radioactive waste remains responsible for the management of its waste. Even if the producer sends the waste to a facility operated by another company for processing, storage or disposal, it remains responsible for it, without prejudice to the responsibilities of that other company as a nuclear installation licensee. Thus, the licensee of the facility in which the waste is stored or processed is responsible for the safety and radiation protection of its facility during its operation or its decommissioning. Similarly, for the disposal facilities, Andra is responsible for the safety and radiation protection of the facilities it operates.

The waste producer remains responsible for its waste, even after storage or disposal: ownership of the waste is not transferred to Andra. However, as mentioned above, this principle does not preclude Andra's liability as a BNI licensee and with respect to the Paris Convention.

The liability of the waste producer is above all financial. In this respect, the practice (contractual with Andra rather than regulatory) developed by France is based on the possibility, with no time limit, of turning back to the producers if necessary (for example in the event of consolidation works, or additional provisions made necessary by new legal or regulatory obligations).

There are a number of exceptions to this rule, which concerns only a very small share of the radioactive waste. This is the case of waste from "small producers", such as biological research laboratories and medical objects (radium needles, etc.) or radium products (salts, compasses, etc.) used in the past or resulting from the clean-out of polluted sites as part of Andra's public interest duties.

In addition, should the parties responsible default (compulsory liquidation of a company, actual or alleged insolvency of one of its managers, etc.), the State may take their place to ensure that the risks on the sites concerned are controlled. This is notably the case with a certain number of sites contaminated by radioactive substances used in the radium industry or in the clock and watchmaking industry (radium based paints) at the beginning of the 20th century. In accordance with 6°) of Article 542-12 of the Environment Code, Andra is tasked in particular with "collecting, transporting and dealing with radioactive waste and rehabilitating sites with radioactive contamination at the request of and expense of those responsible, or when requisitioned by the Government if those responsible for this waste or these sites have defaulted".

In accordance with Article L. 542-12-1 of the Environment Code, Andra receives a State subsidy to help fund its assigned missions of general interest. The French National Funding Commission for Radioactive Matters (CNAR), was set up within Andra to issue an opinion on the use of this subsidy. The State will initiate legal proceedings against those responsible whenever possible, in order to obtain reimbursement of the expenses incurred.

With regard to radioactive sources, the respective responsibilities of the users, suppliers and manufacturers, and the role of ASN, are described in § F.2.5 and section J.

2| HUMAN AND FINANCIAL RESOURCES (ARTICLE 22)

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

i) the necessary qualified personnel is available for safety-related activities throughout the service lifetime of the spent fuel and radioactive waste management facilities;

ii) sufficient financial resources are available to ensure the safety of the spent fuel and radioactive waste management facilities throughout their service lifetime and for delicensing;

iii) financial steps are taken to ensure the continuity of the institutional controls and appropriate surveillance and monitoring measures as long as is deemed necessary following closure of a final disposal facility.

2.1. Regulatory framework applicable to BNIs and to the obligations of the licensees

This framework is presented in section E.1.3.

2.2. Presentation by the BNI licensees of resources allocated to safety

2.2.1. Andra's human and financial resources

2.2.1.1. Andra's financial resources

Andra was created in 1979 as part of the CEA, and was transformed by Act 91-1381 of 30 December 1991 and the "Waste" Act of 28 June 2006 into an industrial and commercial public establishment (EPIC). This status gives it independence from the waste producers.

Its organisation was clarified by Decree 92-1391 of 30 December 1992, now repealed and incorporated into Articles R. 542-1 et seq. of the Environment Code, modified by Decree 2010-47 of 13 January 2010, which gives the Agency:

- a Board comprising a member of Parliament and a Senator, ten representatives of the Government, seven qualified personalities and eight staff representatives;
- a Director General appointed by decree;
- a Government commissioner, who is the Director General for Energy at the Ministry in charge of energy;
- a finance committee;
- a consultative contracts committee;
- a National Funding Commission for Radioactive Matters;
- a scientific council.

Andra's internal organisation is presented in the appendix (see Appendix L.6.1).

Since 1 January 2007, the Agency has been funded through:

- commercial contracts for the Agency's industrial activities[1] (operation and monitoring of radioactive waste disposal centres, particular studies, handling of waste or site rehabilitation);
- a subsidy for production of the National Inventory, the collection and handling of radioactive objects from private individuals and local authorities and the rehabilitation of sites contaminated by radioactive substances when the responsible party has defaulted (Article L. 542-12-1 of the Environment Code).

[1] By their very nature, commercial contracts are subject to traditional commercial contingencies. They may result in a profit but intrinsically carry a degree of risk.

- an allocated tax.

The main waste producers with whom the Agency has contracts are EDF, Orano and CEA. Pursuant to Article L.542-12-1 of the Environment Code, Andra manages an internal "Research fund" intended for financing research and studies on the storage and deep geological disposal of high-level and intermediate-level long-lived radioactive waste. The Research fund is financed by a tax that is additional to the "Research" tax that already exists for BNIs. This additional tax has been instituted in place of the commercial contract that bound Andra to the main producers in order to "guarantee the funding of research and the management of radioactive waste over the long term". The tax is collected from the waste producers by ASN in accordance with the "polluter pays" principle, on the basis of flat-rate sums set by the Environment Code and multiplying coefficients set by decree. The flat-rate sums vary according to the facilities (nuclear power plant, fuel reprocessing plant, etc.)

Moreover, since 1 January 2014, the Cigéo project design studies and any preliminary work have been financed by a "design" fund internal to the Agency (Article L.542-12-3 of the Environment Code), which is financed by contributions paid by the waste producers.

Finally, the “Waste” Act comprises a financial provision for the future: it stipulates that the construction, operation, final shutdown, upkeep and monitoring and surveillance of high level or intermediate level, long-lived waste storage or disposal facilities built or operated by the Agency shall be financed by means of an internal fund created within Andra’s accounts and into which the BNI licensee contributions defined by conventions are paid.

As indicated in section B.1.7, the BNI licensees are required to constitute provisions corresponding to the cost of managing their waste and spent fuel, along with the decommissioning costs, and to allocate the assets needed to cover these provisions. This represents a certain guarantee for the financing of Andra’s medium and long-term activities, more particularly as the system is closely overseen by the State.

Andra’s financial statements and annual management reports can be downloaded from its website.

2.2.1.2. Andra’s human resources

As at 31 December 2019, the Andra workforce stood at 650 staff, 69% of whom are engineers and management. About 120 staff are assigned to general management or transverse support functions: human resources, buying, management, accounts and finances, legal, information system and communication.

About 140 people contribute directly to the operational industrial activities (particularly operation or monitoring of above-ground disposal facilities) and provision of services, particularly with the aim of optimising the management of radioactive waste in France. This workforce includes the staff in charge of checking that the packages delivered are compliant with the safety rules in force in the centres. With regard to these personnel, the Agency maintains and develops a strong safety culture through training actions or through its daily operating methods, notably as related to its quality and environmental protection approach.

Formal definition of safety principles, assistance to the licensees to help with implementation and oversee correct application, the definition of safety analysis methods and operating experience feedback from the centres are carried out by the safety, environment and disposal routes strategies department, whose duties also cover building on know-how about packages and inventories, oversight of packages, quality and environmental management activities. This department comprises about 75 staff.

An R&D department with about a hundred staff supports all Andra activities in fields such as geology, hydro-geology, materials, the biosphere and modelling. This department thus contributes to the safety studies, both for the disposal centres in operation and those that are planned.

The engineering and Cigéo project departments, comprising about 85 staff, coordinate the design studies for the future waste management solutions, with priority given at all times to safety and security concerns, together with the safety, environment and disposal routes strategies department.

The Meuse/Haute Marne centre manages the underground research laboratory, comprising about a hundred staff. It is responsible for operation and maintenance of the laboratory, for conducting experiments, the reconnaissance work for the future disposal site and communication and dialogue with the stakeholders, in order to promote acceptance of the future Cigéo disposal centre.

2.2.2. CEA human and financial resources

2.2.2.1. CEA financial resources

The day-to-day functioning of CEA's operations concerning the management of spent fuel and radioactive waste is financed by the State subsidy paid to the organisation. For the operations concerning the retrieval and conditioning of waste resulting from the clean-out and decommissioning of "legacy" installations, including the waste produced and stored on the sites during the operation of these installations, the financing which until the end of 2015 came from dedicated funds, is today based on funding from the State budget, which is constant and amounts to €740M per year. The state guaranteed this amount until 2020. CEA must comply with the annual financial envelope allocated to it by the State. The effect of CEA’s compliance with the annual budget allocated to it by the State has the effect of smoothing out the multi-year project spending curves and postponing the lower priority operations so that the work considered to have priority is completed. At the same time, CEA takes steps to reduce operating costs and the overheads associated with installations that are shut down, with a specific action plan designed to increase the means necessary for performing clean-out and decommissioning and waste retrieval and conditioning (RCD) operations.

By their very nature, these funds present guarantees of availability to ensure the safety of the spent fuel and radioactive waste management facilities throughout their working life.

Furthermore, for these facilities, like all the nuclear installations it operates, CEA makes the necessary provisions for their decommissioning in accordance with the legislative and regulatory provisions in force.

2.2.2.2. CEA human resources

CEA is a public research organisation created in October 1945 to give France atomic expertise and be able to use it for energy, health and defence. CEA’s organisation is presented in the appendix (see Appendix L.6.2). As at 31 December 2018, CEA had 16,096 permanent staff. Female employees represented 33.5% of the staff. In addition, CEA hosted 1,181 doctoral students and 170 post-doctoral researchers. The employees assigned to CEA's civil programmes are divided among 5 centres situated in Paris-Saclay, comprising two sites at Fontenay-aux-Roses and Saclay, Cadarache, Marcoule and Grenoble.

The human resources allocated to nuclear safety, apart from the workforce assigned to radiation protection or safety, represent some 300 staff (engineers): installation heads, installation safety engineers, engineers and experts from the support units or safety expertise hubs, safety oversight engineers. The designation of persons for these functions is dependent on an examination - at the appropriate level - of their ability to carry them out, particularly with regard to their training and experience. The key players, such as the installation heads, can only be appointed further to a favourable opinion from the nuclear security and safety department.

Since 2009, CEA has adopted indicators more specific to safety management, focusing in particular on monitoring the workforce relating to safety, the quality of the files and compliance with the file deadlines. These indicators are monitored by the management of the centres, and overall reporting is carried out by the nuclear security and safety department. They provide a means of ensuring that on the whole the human resources allocated for safety are sufficient in quantity and quality.

2.2.3. Orano human and financial resources

2.2.3.1. Organisation of Orano

The State is a major shareholder in the Orano limited company, for which the shareholder breakdown as at the end of 2019 was as follows:

Shareholder	Share in %
State	50,0 [1]
AREVA	20,0
Caisse des Dépôts	10,0
NATIXIS	10,0
JNFL	5,0
MHI	5,0
CEA	0,0 [1]

(1) *+ 1 share*

Table 19: Orano shareholders

As at the end of 2019, the group employed 18,604 employees, virtually all of them (apart from support functions) in the nuclear sector. The units hierarchy is responsible for deciding on the allocation of competent personnel to the performance of the required tasks and thus assess their competence. It does this on the basis of their initial training and experience and identifies the need for additional training, qualification, or clearance for specific tasks. It receives support from the competent services of the human resources department and its functional extension within the establishments, which are responsible for providing training and keeping records.

2.2.3.2. Financial aspects

The 2019 turnover published by the Orano group is €3,787 M and group net income is €408 M. The electrical utilities remain owners of the waste from Orano's reprocessing of their spent fuels. Orano thus actually possesses very little waste. Orano assumes responsibility for it by permanently implementing solutions aiming to reduce its impact and, by means of dedicated assets, safeguarding the long-term financing of the related costs.

The provisions for the management of Orano waste are based on the volumes of waste, of all categories, not yet shipped.

They include the BNI decommissioning costs, the cost of retrieval and conditioning of legacy waste (RCD), the long-term management costs for radioactive waste packages and the costs involved in surveillance and monitoring after closure of the disposal facilities.

For Orano, the amount of the provisions[2] as at 31 December 2019 was €7.6 G in current day values, for all the group's BNIs concerned, in accordance with the Environment Code.

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[1] These provisions concern the following subsidiaries and sites: Orano Cycle La Hague, Marcoule, Pierrelatte and Cadarache, as well as the undertakings made for SICN, Orano Cycle Malvési and Marcoule (Melox), EURODIF-Pro and SOCATRI and SOMANU.

2.2.4. EDF human and financial resources

2.2.4.1. EDF human resources

At the end of 2019, the workforce of the EDF Nuclear Operation Division (DPN) in charge of operating the nuclear reactors, stood at about 22,684, spread around the 19 NPPs in service and the 2 national engineering units. The engineers and management account for 36% of the workforce (8,250 staff), supervisors 60% (13,400 staff) and operatives 4% (822).

To these 22,684 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 4,600 engineers and technicians from the New Nuclear Projects Engineering Division (DIPNN) and the Dismantling and Waste Projects Division (DP2D) broken down into management (79%) and supervisors (21%);
- about 1900 engineers and technicians in the Nuclear Fleet, Dismantling and Environment Division (DIPDE);
- nearly 230 engineers and technicians from the nuclear fuel division (DCN);
- nearly 2000 engineers and technicians in EDF's research and development division (EDF R&D).

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

If one considers only those whose role and duties exclusively concern nuclear safety, more than 480 persons are involved.

About 1150 people are devoted to safety and radiation protection activities.

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

The staffing levels have risen significantly in recent years, to deal with the skills renewal process currently under way and the projects for the NPPs in service and to reinforce skills with regard to severe accident management (for example with the creation of the FARN – the nuclear rapid intervention force). Large numbers of staff have been hired in recent years: in 5 years, nearly 3,614 new staff have joined the DPN (16% of the workforce).

Training volumes have also risen significantly since 2007 and reached 2.03 million hours in 2019. The initial training programme has been enhanced and adapted to this context, with the development of the "Nuclear common core academies", along with a revised programme for each specific trade. In addition, reactive training programmes are also deployed on the sites, based on experience feedback from other international licensees.

Similarly, with regard to engineering, the New Nuclear Projects Engineering Division (DIPNN) has since 2006 been running a "nuclear engineering key skills development plan" (PDCC), involving the units of the DIPNN and other divisions of the Nuclear and Thermal Fleet Department (DPNT) and R&D. This approach serves to ensure the satisfactory development of the skills of the engineering sectors and, through a cross-cutting, forward-looking approach, helps the other units prepare their choices for anticipatory management of jobs and skills.

The new engineers joining the DIPNN or the DIPDE follow a 5-week common core "design" engineer training course (operation, safety and quality culture, security and radiation protection, etc.).

2.2.4.2. EDF financial resources

With a net installed power of 122.3 GWe[1] around the world as at 31 December 2019, with production worldwide standing at of 557.6 TWh, the Group has one of the world's largest production fleets and, of the ten leading energy utilities on the planet, has the fleet emitting the least CO_2 per kWh[2] produced, thanks to the share of nuclear, hydraulic and other renewable energies in its production mix.

In 2019, net electricity production by EDF in France amounted to 422.7 TWh, including 379.5 TWh from nuclear production (with an installed power of 63.13 GWe), 33.4 TWh hydraulic and 9.8 TWh fossil, out of a total of 537 TWh from all the producers taken together.

In 2018 and 2019, global nuclear production was 457.8 and 437.7 TWh (for an identical installed power).

In 2019, the Group achieved consolidated sales of 71.3 billion euros, a gross operating surplus (EBITDA) of 16.7 billion euros and a net income of 3.9 billion euros.

The provisions created by EDF SA at the end of 2019 (in updated values in accordance with international standards) amounted to about 22.2 billion euros for the end of the nuclear fuel cycle (management of spent fuel and long-term management of radioactive waste) and about 19.6 billion euros for the dismantling of the NPPs and management of the final reactor cores.

These provisions are created on the basis of the evaluations made of the cost of waste processing and disposal, as and when it is generated by burn-up in the reactor, taking account of the schedules of future expenditure.

More specifically with regard to the decommissioning of nuclear reactors and the processing of the resulting waste, EDF sets up accounting provisions throughout the operating life of these reactors prorata the investment costs in order to be able to cover these expenses when the time comes. This provision is the sum of the provisions for decommissioning EDF's 58 power reactors in service, for which annual appropriations are determined each year, and the provisions for the decommissioning of the 9 EDF reactors that have been definitively shut down and for which the dismantling operations have started.

Furthermore, to secure financing of its long-term nuclear commitments, EDF has in the past few years set up a portfolio of assets exclusively devoted to meeting provisions linked to dismantling of the NPPs and the back-end fuel cycle facilities. The Environment Code and the implementing texts of the Waste Act have defined the provisions that are not part of the operating cycle and which must therefore be covered by dedicated assets (dismantling of nuclear power plants, long-term management of radioactive waste). As at 31 December 2019, these dedicated assets represented an actual value of 31.6 billion euros, as compared with the 29.9 billion euros updated cost of the long-term nuclear obligations (share of the provisions to be covered by dedicated assets).

EDF considers that all of the above shows that it has financial resources to meet the safety needs of each nuclear facility throughout its lifetime, including for the management of spent fuel, waste processing and dismantling of the installations.

Moreover, since 1 January 2018, EDF has taken over the main activities of Areva, via its subsidiary Framatome. Framatome took over the Romans-sur-Isère nuclear site regulated by the BNI system. For the Romans site, the provisions set up by Framatome as at the end of 2019 amounted to about 83 million euros for decommissioning and the management of the corresponding radioactive waste.

[1] Source: EDF. Figures calculated according to accounting consolidation rules.

2.2.5. ILL human and financial resources

The Institut Laue Langevin (ILL) is a research institute founded in 1967 by France and the German Federal Republic, joined in 1973 by the United Kingdom. Its High Flux Reactor (RHF), with a thermal power of 58.3 MW entered service in 1971 and provides the scientific community with the most intense neutron source, mainly for fundamental research.

The Institut Laue Langevin is managed by three associate countries, France (CEA and CNRS), Germany and the United Kingdom. Ten scientific partners also take part in its financing. Its budget for 2019 was €100 M.

At the end of 2019, the ILL workforce stood at 517 staff, of 24 different nationalities. The human resources allocated to safety represent 30 staff. The ILL also draws on external skills and expertise.

2.3. State oversight

2.3.1. Administrative Authority oversight for safeguarding the financing of long-term nuclear costs

The Environment Code defines the arrangements for overseeing the financing of long-term nuclear costs, with the obligations of the licensees being defined in section B.1.7.

There are several levels of control for compliance with these obligations:

- the internal control performed by the licensees and stipulated in Article 7 of the Decree of 23 February 2007. This concerns both the evaluation of long-term nuclear costs and the management of the covering assets;
- the control carried out by the company auditors, who more specifically audit the annual accounts;
- the control carried out by an “administrative authority”, mentioned in Articles L. 594-2, L. 594-4, L. 594-5, L. 594-9 and L. 542-12-2 of the Environment Code. The Minister in charge of the economy and the Minister in charge of energy constitute this administrative authority. The General Directorate for Energy and the Climate (DGEC), together with the General Directorate for the Treasury, exercise this function with delegation from the Ministers.

Under the terms of Article L.594-4 of the Environment Code, the licensees send the administrative authority a report every three years describing the evaluation of the long-term nuclear costs, the methods applied for calculating the provisions corresponding to these costs and the choices made regarding the composition and management of the assets set up to cover them. Every year, they also send the authority a note updating this report and must inform it immediately of any event liable to modify the content. They also send the authority a quarterly inventory of the dedicated assets.

Under the terms of Article 12 of the Decree of 23 February 2007, ASN and the Defence Nuclear Safety Authority (ASND) analyse the reports transmitted every year and give their opinion on the consistency of the decommissioning and spent fuel and radioactive waste management strategy presented by the licensee with regard to the requirements in their field of competence (see § F.2.3.2).

The authority may ask the licensees for any information, documents, whatever the medium, and any clarifications or substantiations necessary for the performance of its duties. It may obtain copies of these documents. It may ask the licensees to communicate the auditors' reports and, as a general rule, any accounting documents for which it may, as required, request certification.

The authority has the power to issue binding requirements and impose penalties. If the authority identifies any insufficiency or inadequacy, it may, after hearing the licensee’s observations, prescribe the steps needed to remedy the situation, setting deadlines for compliance (Article L.594-5 of the Environment Code). If these requirements are not met within the allotted time, the authority may order the creation of the necessary assets as well as all and any measures concerning their management.

In the event of any breach of the obligations incumbent upon the licensee, the authority may also pronounce an administrative penalty against it (Article L. 594-9 of the Environment Code).

If the authority finds that there is a potential breach in the application of the Environment Code, it may, if necessary with application of daily penalty payments, require that the licensee pay the sums needed to cover its long-term costs into an Andra fund (Article L. 542-12-2 of the Environment Code).

The authority may also request audits at the expense of the licensees in order to check the licensees' evaluations of their costs, as well as how they manage their assets. To date, the authority has thus supervised three external audits on EDF, Orano and CEA. On the whole, these audits confirm the estimations made by the licensees. Following these audits, the authority asked the licensees to implement the recommendations made by the auditors, notably concerning topics such as:

- the validity of the method used by EDF to extrapolate the estimate from a standard NPP to the fleet as a whole;
- the inclusion in the Orano provisions of the buildings dismantling and polluted earth excavation risks which could occur if pollution greater than expected were to be detected;
- analysis and handling of the risks associated with the operations scheduled by CEA.

2.3.2. ASN support to the administrative authority with regard to the oversight of long-term nuclear costs

ASN has no competence in the financial aspects relative to the oversight of long-term nuclear costs, but it analyses and compares the submitted reports in order to give an opinion on the coherence of the strategy for installation decommissioning and the management of spent fuel and radioactive waste.

An agreement signed by ASN and the DGEC for application of procedures for ASN oversight of the long-term costs defines:

- the conditions in which ASN produces the opinions it is required to submit pursuant to Article 12, paragraph 4 of the Decree of 23 February 2007 on the consistency of the decommissioning and spent fuel and radioactive waste management strategy.
- the conditions in which DGEC can call upon ASN's expertise pursuant to Article 15 of paragraph 2 of the same decree.

ASN thus published opinions on the three-yearly reports submitted by the licensees to meet the requirements of the Environment Code, in 2007, 2010, 2014 and early 2017.

In its opinion CODEP-CLG-2017-022588 of 8 June 2017, ASN notably recommends that the licensees evaluate the costs relating to:

- clean-out operations in civil engineering structures and soils, aiming to achieve a final state in which all hazardous and radioactive substances have been removed or, if it can be proven that this is impossible, a final status in which clean-out operations are taken as far as possible;
- the unavailability of certain installations at the required moment;
- as well as, systematically, the costs involved in the storage, retrieval and conditioning of radioactive waste.

The review of the 2019 three-yearly reports is currently being finalised and ASN's opinion will be issued in 2020.

2.4. The case of ICPEs

ICPE legislation contains an obligation to create financial guarantees for quarries, waste storage facilities and ICPEs presenting the greatest risks, those subject to authorisation with active institutional controls.

Depending on the nature of the hazards or detrimental effects of each category of installations, these guarantees are intended to cover the monitoring and surveillance of the site and maintain the safety of the installation, as well as any interventions in the event of an accident before or after closure. This measure aims to protect against the potential insolvency or legal disappearance of the licensee. It does not cover compensation due by the licensee to any third parties who could suffer prejudice as a result of any pollution or accident caused by the installation.

These provisions apply in particular to ICPEs whose function is the disposal of radioactive waste (in practice, in France, this only concerns uranium ore mining residues disposal and VLL waste disposal sites). The licensee is responsible for the facility during its operation and for at least 30 years following its closure (after this period, the State decides whether it can take over responsibility for the site). For the disposal of VLL waste, the licensee is Andra, which will retain responsibility for surveillance and monitoring of the Centre.

For the ICPEs subject to authorisation and utilising radioactive substances, the Ministerial Order of 23 December 2015 prescribes the provision of financial guarantees to safeguard the facilities.

For mines, and depending on the nature of the hazards or detrimental effects of each installation category, Article L.162-2 of the Mining Code requires the setting up of financial guarantees to ensure the monitoring of the site and the maintained safety of the installation, any interventions in the event of an accident before or after closure, and rehabilitation after closure. Existing sites are required to ensure this guarantee as of 1 May 2014. Furthermore, the relinquishing of mining concessions at the end of operation was already conditional upon taking the measures prescribed by the Prefect to preserve the health and safety of the general public and the environment.

2.5. The case of radioactive sources

Under the provisions of the Public Health Code (Articles L. 1333-15 and R. 1333-161 and 162), all users are required to have the sealed sources delivered to them recovered by their suppliers, by a supplier other than the original supplier, or by Andra, once these sources are no longer used, and in any case no later than ten years after acquisition.

The supplier is required to recover them further to a simple request from the user. It must also create financial guarantees to offset the consequences should it default.

The collecting organisation shall provide the user with a certification of recovery relieving the user of all responsibility with respect to the use of the source. On the basis of this document, the source is removed from the user's inventory in the National Inventory of sources managed by the IRSN, but a trace of it is kept in the IRSN archives.

In 1996, the source suppliers created a non-profit association called Ressources, the main aim of which is to create a pooled guarantee fund to reimburse Andra, or any other qualified organisation, for the expenses incurred in recovering sources from the user, either owing to defaulting by the supplier normally responsible for recovering them, or in the absence of any supplier liable to do so, in the case of orphan sources.

3| QUALITY ASSURANCE (ARTICLE 23)

Each Contracting Party shall take the necessary steps to establish and carry out appropriate quality assurance programmes regarding the safe management of spent fuel and radioactive waste.

3.1. ASN requirements concerning BNIs

The BNI Order repeals the Order of 10 August 1984 ("Quality" Order) regarding the quality of BNI design, construction and operation.

The BNI Order notably defines the steps to be taken by all BNI licensees to design, obtain and maintain the quality of its installation and the operating conditions needed to ensure its safety.

The Order also requires that:

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

With regard to the oversight of external contractors, the BNI Order notably states that:

- the licensee notifies the outside contractors of the necessary provisions for application of this order;
- the licensee itself monitors or has others monitor the outside contractors to ensure that they apply the notified provisions; more specifically, the licensee ensures that the goods or services provided are subject to inspection to verify their conformity with the specified requirements;
- the licensee presents the methods used to monitor the outside contractors. It more particularly specifies the principles and organisation of this monitoring and the resources assigned to it.

The Act of 17 August 2015 and the Decree of 2 November 2007, now codified in the Environment Code, as modified by Decree 2016-846 of 28 June 2016 concerning the modification, final shutdown and decommissioning of BNIs and subcontracting, reinforced the provisions concerning subcontracting in order to regulate or limit the use of contractors or subcontractors for the performance of certain activities owing to their particular importance for the protection of security, public health and safety, protection of nature and the environment. The provisions of the BNI Order will be modified and supplemented to take account of the new provisions of the Act and the Decree.

ASN may now issue binding requirements concerning activities performed outside the perimeter of the BNIs and which contribute to the BNI safety case, whether carried out by the licensee or by its suppliers, contractors, or subcontractors. These activities are monitored by the ASN inspectors.

Generally speaking, ASN monitors correct application of the regulations by the licensee, notably the BNI Order, by means of inspections. The inspectors in particular examine the steps taken by the licensee and its contractors (licensee's requirements for the contractor, contractor documents, results of checks carried out by the licensee on its contractor, etc.). Visits or inspections may be held in the premises of the contractor companies and the inspectors may question the employees accordingly. The reports on any deficiencies found during an inspection are sent to the licensee for action, with the licensee remaining responsible for its facility, including with respect to the tasks performed by the contractors. The effectiveness of the internal checks carried out by the licensees is also evaluated by ASN by means of inspections.

Finally, operating experience feedback from incidents and accidents occurring in BNIs, analysis of any malfunctions, and the inspection reports, enable ASN to assess the application of the BNI Order by each BNI licensee.

3.2. Steps taken by BNI licensees

3.2.1. Andra's quality, safety, environment policy

Andra benefits from a robust legislative and regulatory framework which defines its duties and what is expected from its actions. More specifically, the "Waste" Act states that the Agency is responsible for the long-term management of radioactive waste. Its roles are set out in section B.5.6.

Andra has clearly adopted a sustainable development approach. It has implemented an integrated quality, health-safety and environment system addressing all the requirements of standards ISO 9001 (quality), ISO 14001 (environment), specification OHSAS 18001 (health-safety), and the binding requirements of the BNI Order.

Since 2010, the Agency has held triple AFNOR certification in these three areas, for all its activities and all its sites.

3.2.2. CEA's quality assurance policy and programme

Protection of the environment, security, safety and quality culture are priorities for CEA in the implementation of the Medium/Long Term Plan (PMLT) and the State-CEA multi-year objectives and performance contract.

The main quality measures undertaken at CEA central level concern project-based management, identification of processes, control of their interfaces and the production of a generic internal reference baseline defining the applicable rules, the associated organisation and the appropriate training. This management system is adapted for application in the various CEA departments, some of which have obtained certification (ISO 9001, 14001 and OHSAS 18001) of their system as implemented and/or COFRAC (French accreditation committee) accreditation for laboratories (standard ISO/IEC 17025).

On 22 March 2018, AFNOR sent the DEN the official certificate of transition to the 2015 version of the ISO 9001 (quality) and 14001 (environment) standards for all of its activities. This transition to the 2015 version was issued following a follow-up audit carried out by AFNOR in November 2017, as a result of the work done by the DEN teams to optimise the performance of its QSE projects, while complying with the legal and regulatory requirements. In this context, the Energies Department (DES, previously DEN), which operates all CEA's BNIs, has included provisions in its integrated management system enabling it to ensure compliance with the requirements of the BNI Order, more particularly in terms of quality, for the activities important for the protection of the interests mentioned in Article L. 593-1 of the Environment Code (security, public health and safety, protection of nature and the environment).

In the field of the design, construction, operation and decommissioning of BNIs, CEA uses a project management methodological baseline requirement with specific sections for "performance of installation projects" and "clean-out and decommissioning projects", which clearly show the requirements linked to waste management, including the obligations under the regulations.

In it, good practices are identified, enhanced and made available to all the units concerned. Remarks and non-compliances may be highlighted by audit and internal inspection mechanisms and then lead to both corrective and preventive measures.

3.2.3. Orano's quality assurance policy and programme

Since 1978, management systems have been supplemented over the years by environmental and health-safety aspects, leading to the ISO 9001, ISO 14001 and OHSAS 18001 integrated management systems, certified on all the establishments concerned, allowing compliance with the requirements of the BNI Order of 7 February 2012. This certification is periodically reassessed by a third-party organisation.

Pursuant to the BNI Order of 7 February 2012 and Decree 2016-846 of 28 June 2016, Orano evaluates the ability of external contractors liable to intervene on its sites or take part in safety-related activities, for the purposes of their selection, and monitors its contractors and their subcontractors. Orano Group's Safety-Environment Policy (accessible on www.orano.group) is transmitted to the outside contractors bidding for contracts with significant safety-environment implications. They are asked to acknowledge receipt. In addition, a Radioactive Clean-Out Contractors Acceptance Committee monitors the contractors concerned and grants the "acceptance" needed to be able to bid for clean-out or decommissioning contracts. Finally, Orano has limited the number of subcontractors to two and systematically implements the formal oversight plan for contracts with major safety or environmental protection implications.

Environmental radioactive monitoring laboratories are also approved by ASN under ratified resolutions 2008-DC-0099 of 29 April 2008, as amended. Medical biology and dosimetry laboratories are approved by ASN and accredited by COFRAC under the Order of 21 June 2013.

Among the other actions specific to the sustainable development approach, overall extra-financial indicators for the continuous progress management, environment, social and societal aspects are monitored.

3.2.4. EDF's quality assurance policy and programme

The steps taken by EDF regarding the quality and management of spent fuel and waste management, as well as decommissioning activities, are part of its general quality and safety organisation.

To ensure management of the protection of interests over the entire lifecycle of a BNI (design, construction, operation and decommissioning), the EDF entities (Nuclear Production Division and the entities of the Department of Engineering and New Nuclear Projects, the Department of Dismantling Projects and Waste, the Nuclear Fuel Division, and the Fleet Engineering, Dismantling and Environment Division, working on behalf of the BNIs) put in place a management system for their activities that ensures the quality of manufacturing and operations.

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

Furthermore, in order to strengthen the quality of the partnership with the contractors, an improvement programme is put into place. This more specifically concerns the quality of work done, contracts, giving more importance to the "best bidder", and facilitation of the working conditions in the field.

3.3. ASN oversight and its analysis

Article L. 593-6 of the Environment Code states that the licensee of a BNI is responsible for managing the potential risks and detrimental effects of its facility for the interests mentioned in Article L. 593-1. For this purpose, Article L. 593-6 also states that the licensee must set up a formal integrated management system (IMS) to ensure that the requirements concerning the protection of the above-mentioned interests are taken into account.

These requirements concerning licensee safety policy are regulated by title II of the Order of 7 February 2012 as part of an integrated approach proportionate to the issues. Pursuant to these provisions, the licensee draws up and undertakes to implement a protection of interests policy (PPI). The licensee must also ensure that it is disseminated, known, understood and applied by all the personnel required to implement it, including outside contractor personnel. The licensee must also define and implement an integrated management system (IMS) which ensures that the requirements concerning the protection of interests are systematically taken into account in any decision concerning the facility, along with organisational measures and appropriate resources.

With regard to the monitoring of outside contractors, the licensee must ensure that its policy is applied and that the operations it performs and the goods and services it supplies comply with the defined requirements. This monitoring, proportionate to the potential impact of the activities concerned in terms of protection, is documented and carried out by persons with the necessary skills and qualifications. The monitoring of outside contractors who carry out an activity important for the protection of the interests mentioned in Article L. 593-1 of the Environment Code (AIP) is the responsibility of the licensee, which may not entrust it to a contractor. However, the licensee may from time to time obtain assistance with these monitoring activities.

Finally, the last chapter of title II of the Order of 7 February 2012 deals with the means of information of the public. Article 2.8.1 states that “The licensee determines the procedures to allow any person:

- to have access to the information made public at the initiative of the licensee or pursuant to the legislative or regulatory provisions applicable to it;
- to obtain the information mentioned in article L. 125-10 of the Environment Code.

These procedures are published on a website chosen by the licensee, updated periodically and transmitted for information to the local information committee.

Act 2015-992 of 17 August 2015, called the TECV Act, and decree 2016-846 of 28 June 2016, now codified in the Environment Code, introduced new provisions concerning the management of subcontracting in nuclear installations. These provisions first of all include existing aspects of the BNI Order of 7 February 2012, more particularly the ban on the licensee delegating the monitoring of outside contractors performing an “activity important for the protection of interests” (AIP). They also introduce the possibility of managing or limiting the use of contractors or subcontractors for the performance of certain AIP.

Article R.593-10 of the Environment Code states that when the licensee entrusts the performance of services or work important for the protection of interests to an outside contractor, within the perimeter of its facility either in operation or undergoing decommissioning, this may be performed by subcontractors of no more than tier two.

In addition, the TECV Act enables ASN to manage and monitor the performance of AIP outside the perimeter of a BNI.

The findings of the inspections in the BNIs, in the head office departments of the licensees or their suppliers and the experience feedback from incidents and significant events occurring in the BNIs enable ASN to verify and analyse compliance with these provisions.

ASN oversight also relies on the assessments conducted at its request by IRSN and the Advisory Committees of experts.

3.3.1. ASN opinion on EDF’s quality assurance policy and programme

ASN oversight of the organisational aspects at EDF is notably based on inspections on-site, at the suppliers and in the head office departments, as well as on analysis of the significant event (ES) reports. These inspections fall within the broader framework of ASN oversight of the steps taken by EDF to verify integration of organisational and human factors in general into all the phases of the lifetime of an NPP.

Finally, EDF and other licensees worked on a professional guide concerning the practical implementation of the regulatory requirements of the PPI and the IMS.

3.3.2. ASN opinion on Orano Group's quality assurance policy and programme

With regard to Orano, and during various BNI periodic safety reviews, ASN examined the managerial processes which could not be covered by the overall safety management review, the conclusions of which were transmitted to Orano in 2012. Orano notably made very significant process in incorporation the EIP[1] regulations into the periodic safety review of the UP3-A plant at La Hague.

This process of identifying and ranking EIPs underpins the entire approach implemented by Orano for managing the effects of ageing in its installations. Regular ASN inspections are carried out on its deployment, and these show improvement on this subject, even though progress is still needed for the next periodic safety review of UP3-A so that management of the effects of ageing is based more on the organisation itself than on the individuals in the organisation.

3.3.3. ASN opinion on CEA's quality assurance policy and programme

In 2019, CEA sent ASN its five-year report on the management of safety and radiation protection, covering the period 2012-2017. This report, which is currently being reviewed by ASN, describes CEA's organisation and its working and presents a review as at the end of 2017, although with no real proposals for strategic changes to safety management. Since then, CEA has started to make changes to its organisation. Additional data regarding these changes are expected in 2020.

3.4. The case of ICPEs

French waste legislation gives responsibility for elimination to the party producing or possessing the waste. It organises oversight of the disposal circuits and imposes an obligation of notification on certain producers, carriers and disposers of waste generating detrimental effects.

The headings of the ICPE list regarding waste processing were modified by three successive decrees between the end of 2009 and mid-2010. The purpose of this modification is to classify waste processing activities no longer on where the waste came from, but rather according to its type and harmfulness, consistently with the scale of the hazards and detrimental effects created by the processing of such waste.

The radioactive waste produced by ICPEs, in the same way as all special industrial waste, requires special precautions during collection and storage (adequate packaging and labelling), transport (compliance with the regulations for the transport of hazardous materials) and processing (must be carried out in a centre authorised by the legislation concerning ICPEs).

Any producer of special industrial waste (DIS) sending a consignment of more than 100 kg of waste to a third party must issue a hazardous waste tracking sheet (BSDD). This tracking sheet accompanies the waste up to the destination facility, which can be a final disposal centre, a collection centre or a pre-processing centre. The final disposal centre must send the last page of the sheet to the producer within one month in order to confirm that it has taken charge of the waste. The producer must send a sample of its waste to the licensee of the destination facility, to obtain its consent prior to shipment.

A chronological register of the waste consignment operations must be kept by the producers of hazardous industrial waste. It contains the information marked on the sheets. The licensees of facilities receiving waste (hazardous or otherwise) must for their part keep a double register showing waste in and waste out. The registers are kept at the disposal of the inspectorate for classified installations.

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[1] This regulation aims to ensure that each BNI component on which the licensee based the installation's safety case does actually meet the requirements set out in this safety case.

An annual declaration is transmitted to the administration by the hazardous waste producers (more than 2 tonnes per year). This document summarises the types of waste produced, the corresponding quantities and the disposal routes. The installations receiving hazardous or non-hazardous waste also declare the quantities accepted in the previous year and the processing operation carried out (elimination or reuse).

3.5. The case of sealed radioactive sources

Independently of any individual requirement in the licenses for the manufacture, distribution, import, export, possession or use of sealed radioactive sources, the existing general regulations set provisions for tracking each source movement (Articles R1333-152 et seq. of the Public Health Code). These provisions were clarified in ASN resolution 2015-DC-0521 of 8 September 2015 relative to the tracking and registration of radionuclides in the form of radioactive sources and products or devices containing them.

The transfer processes (acquisition, transfer, import, export) for sealed radioactive sources require prior information of the IRSN, which checks the compatibility of the transfer with the licenses held by the companies concerned, alerts the competent authority of any anomaly and updates the National Inventory of sources.

The Public Health Code and the Labour Code require that all holders of sources must at all times be familiar with the inventory of their sources and periodically send it to the IRSN (Article R.1333-158 of the Public Health Code). When reviewing licence renewal applications, in cessation of activity situations, during occasional checks or for inspections, ASN checks compliance with these provisions and the fate of the used sealed radioactive sources.

4| RADIATION PROTECTION DURING OPERATION (ARTICLE 24)

1. Each Contracting Party takes appropriate measures to ensure that, during the useful life of a spent fuel or radioactive waste management facility:

i) the exposure of the workers and the public to the radiation caused by the facility is maintained at the lowest reasonably achievable level, given the economic and social factors;

ii) no person is exposed under normal situations to radiation doses that exceed the nationally prescribed dose limits, which take due account of the approved international radiation protection standards;

iii) measures are taken to prevent unscheduled and uncontrolled emissions of radioactivity into the environment.

2. Each Contracting Party shall take appropriate steps to ensure that effluent discharges are limited:

i) in order to maintain exposure to ionising radiation at the lowest reasonably achievable level, given the economic and social factors;

ii) such that no person is exposed under normal situations to radiation doses that exceed the nationally prescribed dose limits, which take due account of the approved international radiation protection standards.

3. Each Contracting Party shall take appropriate measures to ensure that during the useful life of a regulated nuclear facility, in the event that an unscheduled or uncontrolled emission of radioactive material into the environment should occur, appropriate corrective measures will be implemented to control the emission and mitigate its effects.

4.1. The general regulatory framework for radiation protection

The regulatory framework for radiation protection is presented in section E. 2.1

4.2. Radiation protection measures taken by the BNI licensees

4.2.1. Radiation protection and effluent limitation at Andra

Radiation protection and effluent limitation are major focuses of the Andra's environmental policy.

4.2.1.1. Radiation protection objectives

Andra considers that, for the public, the dosimetric impact of the waste disposal facilities in normal operation must be as low as possible and must, at the most, represent only a fraction of the regulatory limit set down in the Public Health Code (Book III, Title III, Chapter III), that is to say 1 mSv/year. As indicated in section D.3.2.2.2 and D.3.2.2.3, Andra has set an in-house individual dose target of 0.25 mSv/year in normal operation. This approach is consistent with the IAEA and ICRP recommendations and with the French basic safety rules applicable to the long term safety of radioactive waste disposal facilities.

As far as workers are concerned, Andra has decided to go beyond Directive 96/29/Euratom (transcribed in the Public Health Code) by setting a more ambitious target. Given the growing importance of the optimisation principle and the lessons learned from the CSA repository, Andra is setting itself, from the design stage, an in-service radiation protection target not to exceed an annual dose of 5 mSv/year. This target must be achieved for Andra personnel and the personnel of outside contractors working in Andra facilities.

4.2.1.2. Monitoring and surveillance by Andra in the disposal facilities in operation

Monitoring and surveillance of the impact of the disposal facilities operated by Andra is ensured by applying a monitoring and surveillance plan which is proposed by Andra and subject to ASN approval. The monitoring and surveillance has 3 aims:

- check that there is no impact;
- check compliance with the technical requirements issued by the administrative authority (ASN for the CSA repository and the Prefect for Cires);
- detect any abnormal development as early as possible.

Radiological measurements are taken from the air, the surface water (rivers, run-off water), groundwater, rainwater, rivers sediments, flora and the food chain (milk, for example). The personnel of the centres are subject to individual dosimetric monitoring.

The monitoring and surveillance results are communicated periodically to ASN. The results for both the CSM and the CSA are published in quarterly brochures which are issued to the public and the press. They are presented to the CLIs of the disposal centres.

For the CSM, the dose received by any worker was below the detection limit of the personal passive dosimeters used (< 0.05 mSv). The maximum dose registered in 2019 was:

- 0.93 mSv at the CSA with a collective dose of about 8.88 man-mSv;
- 0.49 mSv at Cires with a collective dose of 1.18 man-mSv (active dosimetry); this latter figure includes the dose associated with the grouping activities.

Furthermore, the radiological monitoring of the disposal facilities is supplemented by monitoring of the physical-chemical quality of the water and ecological monitoring of the environment.

4.2.1.3. Effluents and discharges from Andra facilities

With a view to the CSM's entry into the monitoring and surveillance phase, the disposal structures have been protected from rainwater by alternating layers of permeable and impermeable materials, including a bituminous membrane. This has resulted in a very significant reduction in the volume of water collected at the base of the disposal structures.

Andra filed a radioactive and chemical discharge authorization application in 2000. This application concerned the surface waters (stormwater, collected above the bituminous membrane) and their discharge into the river, and the waters collected at the base of the structures and transferred to the La Hague plant for discharge into the sea. The discharge Order was published on 11 January 2003 and constitutes the regulatory baseline for the CSM.

The impact of the CSM For 2018 is estimated for reference groups at 3.8 10^{-5} µSv for discharges into the sea and 0.16 µSv for discharges into the river the nearest to the centre.

The discharge conditions for the CSA are regulated by Decree 2006-1006 of 10 August 2006 and the Discharge Order of 21 August 2006.

Radionuclides	Gaseous discharge s (GBq/year) (conditioning/packaging units)	Liquid discharges (GBq/year)
Tritium	50	5
Carbon 14	5	0,12
Iodine	2 10^{-2}	-
Other beta-gamma emitters	2 10^{-4}	0,1
Alpha emitters	2 10^{-5}	4 10^{-4}

Table 20: Discharge limites figuring in the Order of 21 August 2006 for the CSA

The volumes of effluents produced by the disposal facilities are very low given the measures taken for the operation of the structures which are sheltered by rail-mounted moving hangar structures further to experience feedback from the operation of the CSM.

The calculated impact of the discharges from the CSA for 2018 for a hypothetical reference group is about one thousandth of µSv/year for the liquid discharges and a further two orders of magnitude lower for gaseous discharges.

4.2.2. Radiation protection and effluent limitation at the CEA

4.2.2.1. Occupational radiation protection

The control of external and internal exposure of workers at the CEA starts from the design of the facilities and continues throughout their operational life and their decommissioning. All operations involving a risk of exposure to ionising radiation are carried in accordance with the ALARA optimisation principle. The optimisation process concerns the layout and equipping of the premises in particular, but also the work organization. The layout is designed as much to facilitate the tasks as to limit the work intervention times and avoid having personnel passing close to or remaining in the vicinity of sources of ionising radiation. It integrates the needs associated with the implementation of the processes and those associated with preventive and corrective maintenance, and the removal of the waste.

The work organisation provides for both the classification and the monitoring of the workplaces, the classification of the workers and the individual monitoring of exposure to ionising radiation:

- the classification of the workplaces, established to materialise the extent of the radiological risk, is kept up to date throughout the operation of the facilities on the basis of the work station radiological monitoring results;
- the classification of the workers depends on the potential level of exposure at their work stations. Collective and personal protection measures are taken to limit any such exposure: biological protection in the case of external exposure risks, static and dynamic containment in the case of internal exposure risks;
- radiological monitoring of the workplaces is ensured in real time by collective measuring devices (external and internal exposure) or by post-processing;
- individual monitoring of occupational exposure to ionising radiation is ensured by personal dosimetric monitoring (passive dosimetry) or by whole-body radiation measurements and radio-toxicological analyses, depending on the type(s) of radiological risk).

7,082 CEA workers were subject to personal dosimetric monitoring in 2018. For 92% of them, the dosimetry results were below the recording threshold (100 µSv). For the others, the average annual individual dose was 0.27 mSv/year. The maximum dose measured over the year was 3.5 mSv.

4.2.2.2. Exposure of workers and the public

The sizing of the biological protections of the facilities adjoining public areas is assessed on the basis of a level of exposure below the regulatory limit for the public (effective dose of 1 mSv/year) that is as low as reasonably achievable.

The same goes, even more so, for the public situated outside the boundary fences of the various CEA centres. Although based on conservative hypotheses, this impact calculated from the actual discharges from the facilities of each centre is extremely low, with an annual dose estimate for the reference groups in 2018 which was always well below 10 µSv/year.

4.2.2.3. Limiting effluent discharges

The CEA's research facilities use radioactive, chemical or biological products and generate effluents and wastes which may contain traces of these substances. Depending on the processes and the activity levels, all or some of these effluents may be either filtered or transferred to a facility for possible processing, or discharged into the environment after verification, or disposed of as waste in authorised management routes.

The effluent checks, their discharge conditions and monitoring of the environment are subject to the environmental management system implemented in each centre. This approach demonstrates the ability of the centres to improve their environmental performance for all their activities and bears witness to their desire to reduce their environmental footprint.

All steps are taken to limit the effluents discharged: separation and collection of the effluents at source according to their radiological and physical-chemical properties and processing in appropriate facilities.

These discharges of radioactive effluents into the environment are subject to the general regulations and to regulations specific to each site (interministerial orders or ASN resolutions setting prescriptions for water intake by and discharge of liquid and gaseous effluents from the facilities), defining the authorised limits for the discharges (annual, monthly limits, maximum added concentrations in the receiving environment), the discharge conditions and environmental monitoring procedures.

When carrying out sampling and measurements, the centres call on the services of test laboratories, the competence of which is verified notably by means of periodic inter-laboratory comparisons and COFRAC (French accreditation committee) accreditations.

Discharges of liquid effluents

Only liquid effluents whose characteristics (radiological and physical-chemical) are compatible with the limits specified in the texts regulating discharges may be released into the environment after verification. The radioactivity checks prior to discharge comprise continuous measurements and subsequent laboratory analyses of the total alpha and beta activities, of specific pure beta emitter radionuclides, such as tritium, gamma emitter radionuclides and alpha emitters.

The liquid radioactive effluents which cannot be discharged into the environment are systematically stored in special tanks, according to their nature and level of activity. They are then transferred to one of the CEA radioactive effluent treatment plants that produce solid waste.

Effluent discharges to the atmosphere

Atmospheric effluents are filtered on leaving the nuclear facilities, in order to reduce the emission of radioactive particles into the atmosphere. The discharge outlets are equipped with continuous monitoring systems and sampling devices for subsequent laboratory measurement of the radioactivity of the aerosols and gases (tritium, carbon 14, total alpha, total beta-gamma, halogens). On all the sites, gaseous radioactive effluent discharges are well below the authorised discharge limits.

The continuous improvement of the environmental performance of the facilities and processes has allowed a gradual reduction in effluent emissions into the environment for many years now.

4.2.2.4. Environmental monitoring

Environmental monitoring is carried out in the immediate vicinity of each centre, in addition to the effluent discharge checks. The monitoring programme is updated regularly and adapted to changes in activities and local characteristics.

This monitoring ensures that the measures taken by the facilities are effective. Samples covering the main radionuclide transfer routes into the environment are taken for subsequent analysis by the CEA test laboratories.

This monitoring serves several purposes, including:

- to detect any abnormal rise in the level of radioactivity in the near environment of the centre;
- to identify the radiological status of the environment and monitor its development over time;
- to verify compliance with the requirements applicable to the facilities.

Environmental monitoring therefore represents several tens of thousands of radiological and physical-chemical analyses each year. The levels of the substances in the environment are close to the quantification limits of the laboratory measurement protocols and often cannot be detected by the highest-performing measuring devices.

Water monitoring

The hydrographic system, which receives the liquid effluents discharged, is closely monitored in the vicinity of the centres. Regular samples are taken from the surface waters (streams, rivers, creeks, lakes or ponds) upstream and downstream of the effluent emission point, as well as from the groundwater.

The radioactivity measured is essentially natural in origin (potassium 40 and radionuclides of the decay chains of uranium and thorium). Tritium is the main artificial radionuclide detected at levels representing a few tens of Bq/L in the environment of certain centres.

The surface waters receiving effluents and groundwater are also monitored. This concerns a large number of physical-chemical, biological and microbiological parameters. This monitoring includes the following elements: suspended solids, potassium, uranium, nitrogen or phosphorus compounds, metals and organic compounds.

Atmospheric monitoring

Atmospheric radioactivity in the environment is continuously monitored by more than 140 measuring instruments providing real-time data.

Dosimeters positioned around the perimeter of the site measure the ambient gamma radiation, primarily due to natural radioactivity, the intensity of which varies significantly with the geological nature and geographical location of the site.

Atmospheric radioactivity is mainly due to radon and its decay products fixed on dust in suspension in the air, as well as to natural radionuclides such as beryllium 7. The activity of the atmosphere fluctuates with the seasons and with variations in the amount of dust in the air, but is on average stable from one year to another.

Monitoring of soils and sediments

Sediments in the water courses receiving liquid effluents undergo radiological monitoring and periodic searches for metals.

The radioactivity of the soils in which radionuclides are liable to build up, in the form of dry and wet deposits, is characterised every year.

Monitoring of the flora and fauna

Each centre monitors the level of radioactivity in the foodstuffs produced nearby. Local products, whether or not edible (grasses, fruit, vegetables, fish, milk, etc.) are regularly measured.

The radioactivity in plants and milk is primarily due to naturally occurring potassium 40.

Tritium is detected in the grass sampled from the environment of those sites with licenses for the most significant emissions. It is only detected in milk extremely locally and at trace levels.

Metal elements are also measured from time to time on certain species of aquatic mosses.

In 2018, the CEA laboratories - which have held COFRAC accreditation for many years - held 119 COFRAC accreditations and 185 approvals issued by ASN for taking environmental radioactivity measurements.

The CEA transmits its environmental radioactivity measurement results to the national network of environmental radioactivity measurements (RNM) and they can be freely accessed via a dedicated website (www.mesure-radioactivite.fr). As a key player since this network was set up, nearly 10% of the data available on the website come from the CEA, which has already transmitted more than 300,000 measurement results, including nearly 2,800 in 2018.

4.2.2.5. Shared information

All of the results are transmitted to the supervisory authorities. The CEA also ensures that the environmental monitoring results concerning its centres are disseminated as widely as possible to the public.

All CEA sites maintain regular relations with their local authorities and their local information committees (CLI) or information committees (CI).

This information supplements the publication of the annual "transparency and nuclear security" reports, in accordance with Article L.125-15 of the Environment Code, for its BNIs, which are available on www.cea.fr. These reports describe the working of the facilities, the emissions of effluents in the environment, the radioactive waste produced and any incidents. They present all the inspection and monitoring measures taken.

4.2.3. Radiation protection and effluent limitation at Orano

4.2.3.1. Radioprotection and emissions

Exposure of workers

Control of worker exposure has always been one of Orano's major responsibilities. When the facilities currently in service at the La Hague site were designed in the early 1980s, a dose constraint of 5 mSv/year was set for the design of the work stations, that is to say one tenth of the limit for workers at the time and one quarter of the limit set at European level 15 years later. This dose only concerned external exposure, as all measures were taken to ensure zero internal exposure.

The average individual exposure of personnel working on the La Hague site (employees of the Orano group and its service providers) remains low and stable (figure 11). In 2019, the average dose was 0.18 mSv/year and the collective dose was 1,088 man-mSv.

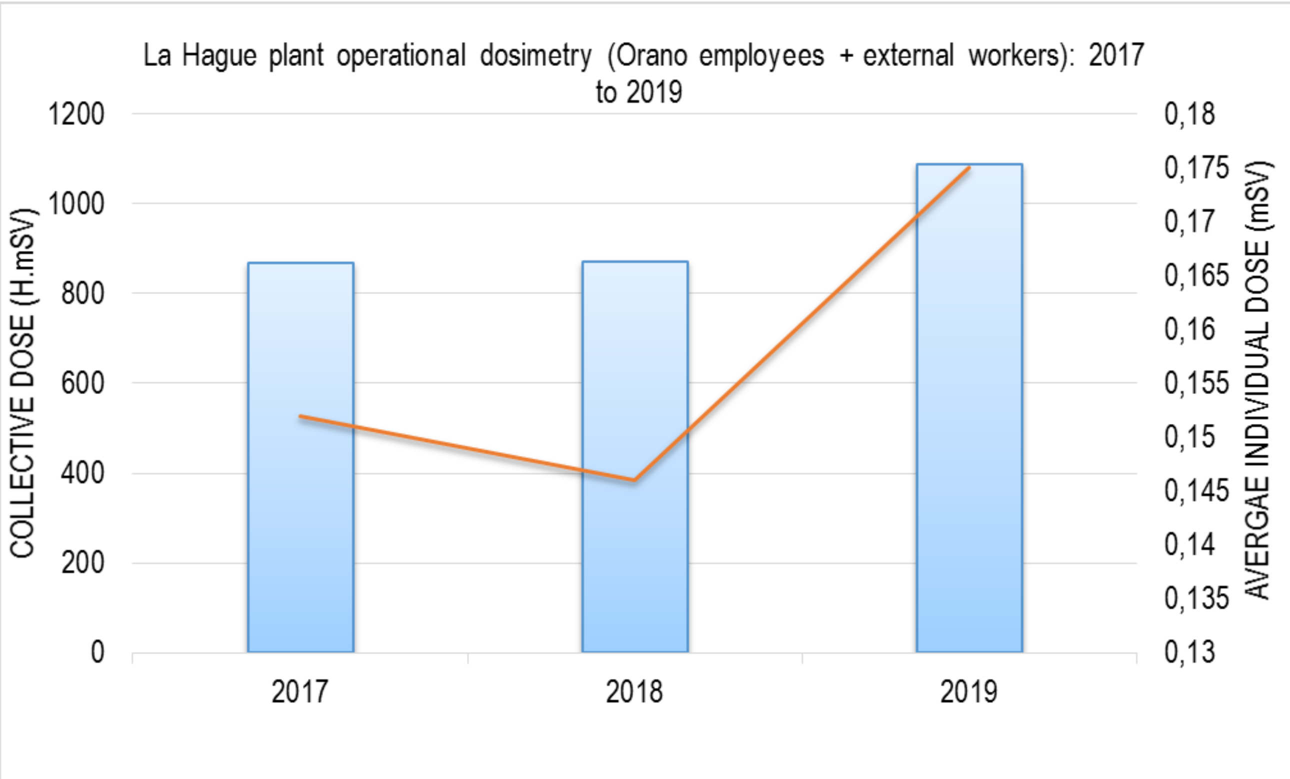


Figure 11: Doses received per year by the employees and service providers on the La Hague site

These results were obtained using the following means:

- by designing effective and reliable process equipment resulting from substantial R&D programmes;
- by widely using remote control of operations;

- conventionally, by installing shielding (biological protections) adapted to all the foreseeable operating and maintenance situations;
- by planning for extremely rigorous containment of the facilities;
- by taking into account all the maintenance operations at the design stage, which means that the equipment was designed according to these operations, particularly to allow the remote replacement of consumable items (pumps, valves, measurement sensors, etc.), without breaking containment and under biological protection (use of mobile chambers for material removal);
- by continuing the prevention work by assessing and controlling risks before acting, in order to limit occupational exposure by reducing the possible causal factors;
- by rigorously applying the principle of dose optimisation so that the dosimetry results remain at the lowest possible level, in the light of current technology, economic factors and the nature of the operations to be performed, as prescribed in the French regulations.

At least two complete physical barriers are placed between the radioactive materials and the environment. The chemical process equipment items are entirely welded and enclosed in sealed cells. They are ventilated by an entirely separate system, including for the atmospheric discharge outlet. The mechanical equipment items are equipped with dynamic containment systems (negative pressure, air curtain) and placed in closed cells with specially designed penetrations leading to the work areas. Complete dynamic containment of the static systems by establishing a negative pressure cascade that circulates the air from the least contaminated areas to the most contaminated areas. The ventilation comprises several separate systems depending on the level of contamination of the ventilated premises, so as to avoid contamination refluxes in the event of a malfunction. These combined means maintain the premises in a state of radiological cleanliness when in operation that prevents internal exposure.

Exposure of the public

The measures adopted limit exposure around buildings to values that are practically indistinguishable from the natural background radiation. Visitors to the site therefore cannot be subjected to doses that exceed the dose limits in effect for the public.

The same goes, even more so, for the public situated outside the boundary fences of the site.

The radiation level is monitored within the La Hague site and at its boundary fence by numerous dosimeters which are read monthly (11 points on the boundary fence: measured values between 60 and 80 nGy/h), supplemented at the boundary fence by eight continuous dose rate measuring stations. Lastly, continuous measuring systems are installed in five neighbouring villages. All the continuous measurements are transmitted to the site environmental control station.

Impact of discharges

The reduction of discharges and their impact has always been a core concern of Orano, in consultation with the authorities. The choice of the La Hague site was influenced in particular by this concern.

The discharge licenses have always been issued on the practical basis of dose constraints that are well below the regulatory limits, considering application of the best techniques available and aiming to be as close as possible to the maximum values of the actual discharge levels of the facilities under their normal conditions of operation. Furthermore, the process facilities can only be licensed if they are sufficiently safe for the risk of an uncontrolled emission to be kept to a very low level. Very-low-probability events are nevertheless considered in a beyond design-basis approach, if their consequences could be severe and measures are taken to mitigate them. Under these conditions, it can be considered that the risk of exposing a person to doses exceeding the prescribed national limits on account of the discharges is extremely low.

The following principles are adopted to reduce the volume and activity of discharges:

- utilisation of a strict containment system to avoid losses, as indicated above;
- optimisation of the destination of the effluent treatment by-products;
    - the first priority is to recycle them within the process insofar as possible,
    - the second priority is to send them to the vitrification or cementation conditioning process, as the case may be,
    - the residual by-products are discharged after treatment, either into the atmosphere or into the sea, in order to minimise the impact on the environment and on the reference groups (representative persons in the new regulations).
- taking worker exposure and the risks for the public and the workers into account in the choice of options;
- recycling is an initial and very important means of reducing the volume and activity of the effluents. All the aqueous solutions used to rinse the fuel assembly structural elements are recycled in the dissolution solution. After extracting the fission products, the uranium and the plutonium, the nitric acid used to dissolve the fuel is concentrated and purified by evaporation for subsequent recycling. The solvent and diluent used to extract the uranium and plutonium are cleared of the radioactivity and decay products they contain by vacuum distillation in a special evaporator, for subsequent recycling. The residue is conditioned by encapsulation in cement after being calcined in a specific unit;
- treatment of the effluents is a second and very important means of reducing the activity and volume of both effluents and solid waste. High-level effluents that cannot be recycled are sent to the vitrification process;
- intermediate and low-level effluents are collected according to their acidity, the acidic effluents on one side and the basic effluents on the other. They are concentrated in specific evaporators. The largest part of the input to the acid and base evaporators comes out as virtually contamination-free distillates which are sent to the "V" effluents[1] and discharged with them. The residual concentrate takes away all the radioactivity and thus becomes a high-level effluent (but of much smaller volume than the initial effluent) which is sent to the vitrification process with the other high-level effluents;
- the most important measures taken to reduce the activities of the effluents from the analysis laboratory have been to develop on-line analysis techniques that no longer necessitate the taking of samples from the process and using the plasma chromatography technology, but simply samples of extremely small volume;
- some analyses of subsisting plutonium solutions caused the high alpha activity level in the effluents from the analysis laboratory. The installation of a special plutonium recovery unit on this flow path brought a significant reduction in the alpha activity discharged by the laboratory.

Application of the principles mentioned above has brought significant reductions in discharges along with a reduction in the volume of solid waste; instead of being bituminized or cemented, the radionuclides are routed to the vitrification process which accepts much higher activity concentrations. Thanks to this, the reduction in discharges has not been obtained at the expense of an increase in solid waste, but along with greater compactness of the solid waste. Orano deploys substantial means to monitor its discharges which are recorded in regulatory registers sent monthly to ASN. The discharge measurements are also subject to cross-checks by a laboratory that is independent of the licensee and to unannounced checks by ASN.

[1] Note: The "V" effluents (as in "Verify") are low-activity effluents which can be discharged into the sea after treatment if necessary.

The impact of these discharges is now at a very low level, about 0.012 mSv/years (values in 2017 and 2018) for the representative person likely to be the most exposed, which is well below the regulatory limit of 1 mSv/year. Since 1999, Orano La Hague has set itself the target of keeping the impact of its dosimetric discharges below 0.03 mSv/year for the reference population groups, i.e. about 1% of the average exposure of the French population to naturally occurring radioactivity, which is 2.9 mSv/year (source IRSN Report/2015 00001: Exposure of the French population to ionising radiation - 4 January 2016)". Whatever the case, the impact of the discharges, whether gaseous or liquid, has never exceeded the current dose limits for the public (nor, even more so, has it exceeded those that were in effect at the time). Application of the principle of the best available technology (BAT) nevertheless leads to a continuation of the reduction efforts by considering the progress made in similar processes or operating situations, the development of scientific and technological knowledge, the economic feasibility of new techniques and the time required to put them in place, and the nature and volume of the wastes in question.

Radioactive discharges have greatly decreased over the last 30 years. The radiological impact of the La Hague site has been reduced by a factor of 4: the impact on the reference group, which was about 70 µSv/year in 1985, has stabilised at below 20 µSv/year. These efforts meant the site was a step ahead of the tightening of the regulatory standards in the European Union, transposed into French law, which currently sets the maximum cumulative effective annual dose for the general public at 1 mSv, in comparison with the average natural exposure in France estimated at 2.9 mSv/year by IRSN[1].

The calculated impact values have been underpinned by a very exhaustive study by the Nord-Cotentin Group of Radioecology Experts which, at the request of the Government, examined the discharge values and more than 50,000 results of samples taken by various organisations. The Nord-Cotentin 2000 exercise revealed that the environmental marking by discharges from the site were insignificant in comparison with natural radioactivity, the fallout from the Chernobyl accident and atmospheric nuclear weapons tests, all of which are already at a very low level.

4.2.3.2. Environmental monitoring

Upstream of the checks carried out by the competent authorities and by the European Commission (provisions of Article 35 of the Euratom Treaty), Orano deploys substantial environmental monitoring means.

Within the framework of the French national environmental radioactivity measurement network (RNM), the group's four environmental laboratories concerned (La Hague, Pierrelatte, Malvési and SEPA Bessines) have obtained ASN approvals for the analyses they have to perform.

The IRSN report presenting the radiological results of the RNM for the 2015-2017 period concludes that: "the doses likely to be received by the population living around the French nuclear installations, are estimated by calculation (modelling of dispersion and transfers) by the nuclear site licensees, from the activities actually discharged. This validates the overall consistency of the monitoring system and the impact estimation models, with regard to the results of the annual discharge reports.

4.2.3.3. Informing the public

Orano, through a policy of information transparency, makes the discharge values and environmental monitoring results available to the public regularly via the website www.orano.group as well as via the French national network of environmental radioactivity monitoring www.mesure-radioactivite.fr.

Furthermore, each of the Orano group nuclear sites publishes annually:

- under Article 4.4.4 of the Order of 7 February 2012 amended setting the general rules relative to basic nuclear installations, a report presenting, among other things, the status of the water intakes and the results of the check of the sampling environments, the status of the discharges, and an estimation of

[1] IRSN Review "Repères" No. 29, April 2016

the doses received by the population as a result of the activity exercised. This report is issued before 30 June of the following year to ASN, to the national and local government administrations concerned and to the Local Information Committee (CLI).

- under Article L. 125-15 of the Environment Code, a report that sets out the measures taken with regard to nuclear safety and radiation protection, the incidents, the nature and results of the radioactive and non-radioactive discharge measurements, the nature and quantity of radioactive waste stored on the site, and the measures taken to limit its volume and effects on health and the environment, especially soils and water. This report must be issued before 30 June of the following year. It is presented to the Committee for Health, Safety and Working Conditions (CHSCT) of the site concerned and addressed to the HCTISN (French High Committee for Transparency and Information on Nuclear Security), to the ASN and CLI representatives, and to a wide audience of external and internal stakeholders (elected officials, journalists, suppliers, etc.). The Orano group also publishes an annual report on the safety of the nuclear installations, an annual report on its activity and its policies with regard to safety, radiation protection and the environment. All these documents are available on the Orano website (www.orano.group).

In addition, the Orano La Hague site publishes each year:

- under Article 12 of the Appendix to ASN Resolution 2014-DC-0472 of 9 December 2014, a report to inform the public on the state of progress of the various waste retrieval and packaging (WRP) projects in progress on the Orano La Hague site. This report is sent to the Local Information Committee at the same time. It is also posted on line on the Orano website, (www.orano.group).
- under article L. 542-2-1 II of the Environment Code, a report whose content is prescribed in Article 8 of Decree 2008-209 of 3 March 2008 amended, which includes more specifically:
    - an inventory of the quantities of spent fuel, radioactive waste and radioactive materials, especially plultonium and uranium, stored in the processing facilities of the La Hague site, indicated for each one of them the share belonging to each country, including France,
    - the results with figures, settled as at 31 December, of the system for tracking incoming spent fuel and radioactive waste from foreign countries and the outgoing radioactive waste to be shipped back to the foreign countries.

This report also sets out the history of the recycling treatment of French and foreign fuel and the contracts signed. This report is submitted to the Ministers responsible for energy, nuclear safety and radiation protection, to Andra and to ASN. It is transmitted at the same time to the Local Information Committee. It is also posted on line on the Orano website, (www.orano.group).

In France the Local Information Committees foster direct interchange between the principal local stakeholders (elected officials, associations, experts, etc.), mainly through regular meetings. These meetings, to which the press is also invited, provide the opportunity to present the current news of the Orano sites and to assess the actions taken with respect to the environment, security and nuclear safety.

Orano is moreover a member of the HCTISN (French High Committee for Transparency and Information on Nuclear Security) and contributes actively to the work of this committee.

4.2.4. Radiation protection and effluent limitation at EDF

4.2.4.1. Occupational radiation protection

Any action aiming to reduce the doses received by the personnel must start with a sound knowledge of the risks that can lead to internal or external exposure to radiation. EDF's radiological cleanliness policy and the systematic use of breathing apparatus in the event of a suspected risk of internal contamination, mean that cases are rare and not very serious.

The essential part of the doses received can thus be assigned to external irradiation, which EDF also endeavours to reduce. This policy and its results constitute a whole and it is impossible to distinguish what is linked strictly to the management of spent fuel or to the management of radioactive waste. The following presentation therefore concerns the operation of nuclear power reactors as a whole.

To better optimise and reduce the doses received by exposed persons, EDF initiated an ALARA (as low as reasonably achievable) policy back in 1992. This brought significant improvements in terms of collective and personal dosimetry. To continue making progress, EDF launched a new ALARA initiative in 2000, applying the optimisation principle in its entirety and aiming to reduce the collective dosimetry. This initiative is based on three lines of progress:

- reduction in system contamination (injection of zinc, decontamination operations, optimisation of filtration, optimisation of cold shutdowns, etc.);
- preparation for work interventions by optimising the doses (estimated dosimetric evaluation, optimisation analysis according to the dosimetric risk, real-time monitoring of the development of collective and personal dosimetry, analysis of any deviations, etc.);
- experience feedback, analysis of deviations and good practices.

The dose received by workers on certain work sites with potentially high dosimetry can be forwarded to a supervisor in real-time via a system of teledosimeters. This supervisor advises the worker and checks that any changes in the dose received are in compliance with the forecasts. More generally, fter an experimental phase and validation of an industrial prototype, the period 2016-2018 enabled all the sites to be fitted out with a centralised supervision station (video monitoring of worksites, remote-transmission of radiological measurements and dosimetry data, remote-monitoring of equipment important for the protection of workers, etc.). The general adoption of this development now provides each site with a working conditions monitoring and control tool, thus helping to optimise worker dosimetry.

Between 2003 and 2019, these measures reduced the number of workers with an annual individual dose of between 14 and 20 mSv from 322 down to 0 and brought a significant reduction in the average individual dose from 1.93 to 0.95 mSv. Since 2015, no worker has exceeded the threshold of 15mSv. Likewise, the collective dosimetry per plant unit (pu) has continued to drop and reached its historically lowest level in 2017 with 0.76 man-Sv/pu in 2016. Despite an industrial context with high and fluctuating volumes of maintenance work since 2011, with successive 10-year outages and introduction of new modifications to the facilities, the average collective dose observed over the last two decades has dropped from 0.82 man-Sv/pu to 0.71 man-Sv/pu.

In addition, EDF has maintained measures aiming to ensure better control of the risk situations represented by radiographic exposures, prohibited areas (red) and limited stay areas (orange) by:

- reducing the repeat exposure situations and learning lessons from events involving jammed radioactive sources;
- increasing the utilisation of Selenium 75 sources;
- continuing the proactive procedure for identifying, counting, protecting and reducing the hot spots and by reinforcing the preparation and inspection of activities, particularly when they can lead to exposure levels exceeding 2 mSv/h, in close collaboration with the industrial gamma radiography service providers.

The preparation of the activities going from the initial assessment through to final optimisation which concludes with integration of the experience feedback is carried out using a computer application called PREVAIR, which is common to all the nuclear and engineering sites of the nuclear power reactor fleet. This application is also used for the preparation of activities contracted to service providers.

In the production phase, PREVAIR ensures automated collection and monitoring of doses integrated by work intervention. Furthermore, when coupled to new dosimeters with alarms, this system provides reinforced protection of each worker by adapting the alarm thresholds of their electronic dosimeter to the dosimetric estimate for their work intervention.

At the end of the work intervention, PREVAIR can construct feedback by archiving the integrated doses on each work intervention. Active dosimetry allows real-time monitoring of worker dosimetry and viewing of deviations with respect to the set targets.

Utilisation and dissemination of experience feedback

To limit the doses received by the workers, alert thresholds are set up on their dose monitoring in the operational doses management application common to all EDF nuclear sites. In 2016 and 2017, several thresholds were updated and lowered. The minimum alert threshold on the dose received during work has been lowered to 0.2 mSv. The individual dose monitoring thresholds cumulated over 12 months are set according to the estimated and possible level of exposure of a worker and that worker's classification category. This threshold is 13 mSv in category A and 5 mSv in category B. The check of the workers' dose on entry into the controlled area takes account of this dose over 12 months as well as their dosimetric estimate. If the alert threshold is reached for a worker's classification category, special consultation processes are put in place between the radiation protection specialists of the companies and those of EDF. They lead to an assessment and precise optimisation of the subsequent doses, as well as tightened monitoring to prevent the regulatory limit from being exceeded. The professions identified as being the most exposed (insulation technicians, welders, mechanics and logistics personnel) are subject to special monitoring which has enabled their exposure optimisation to be maintained, in the light of the assessment of average annual individual doses which dropped by 20 to 30%, depending on the specialities, between 2009 and 2018.

Implementation of an ALARA approach for transport operations

To optimise the dosimetry associated with the transport of radioactive materials, EDF has extended its ALARA approach to the transport of spent fuel: the available data are used by the operators in charge of the removal operations, but also by the designer to define the tooling associated with the new waste packages.

4.2.4.2. Effluent discharges and environmental monitoring

The effluent discharges are subject to general regulations which define more specifically:

- the procedures for obtaining the discharge licenses;
- the discharge standards and conditions;
- the role and responsibilities of the head of the nuclear site.

In addition, orders or ASN resolutions specific to each site set in particular:

- the limits not to be exceeded, for example in the form of annual authorised limits or maximum added or total concentrations in the receiving environment (the concentration limits are associated with annual total activity limits set to ensure good management);
- the discharge conditions;
- the procedures for checking discharges and the environmental monitoring programme.

This regulatory framework also implies applying the optimisation principle, the aim of which is to reduce the impact of the radioactive discharges to a level that is "as low as reasonably achievable given the economic and social aspects".

This procedure has been integrated as from the structure design stage (installation of effluent treatment capabilities, etc.) and has resulted in the setting up of rigorous effluent management during operation with the aim of mitigating the environmental and dosimetric impacts. Efforts are therefore being made to limit discharges by improving the effluent collection and treatment channels and by reducing their production at source.

These measures have reduced very significantly the liquid effluent discharges, apart from tritium and carbon-14 (proportionate to the electricity production), which originally had the biggest impact on the environment and on health (dose).

The large reduction in liquid discharges (apart from tritium and carbon-14) observed for several years now (divided by 100 since 1984) means that the dosimetric impact of the discharges from nuclear power plants today is essentially determined by the discharges of tritium and carbon-14.

The dosimetric impact of the radioactive discharges nevertheless remains extremely low, since it is of the order of a few µSv per year, calculated for the reference group living near a nuclear power plant. This value is well below the natural exposure level in France (2400 µSv/year) and the limit set for the public (1000 µSv/year, excluding exposure to natural radioactivity and exposure for medical purposes).

Environmental monitoring

In order to check on compliance with the regulatory provisions, EDF implements a programme for monitoring effluent discharges and the environment. This programme, established in agreement with ASN, is conducted under the licensee's responsibility.

In addition to the monitoring and measurements carried out on the effluent discharges, EDF deploys substantial resources to measure the radioactivity in the periphery of the BNIs to detect any abnormal change in environmental radioactivity levels near the NPPs. These surveillance measures cover the various external and internal human exposure pathways (inhalation, ingestion):

- atmospheric radioactivity measurements (dust and gas) and the ambient gamma dose rate;
- measurements on environmental matrices taken from terrestrial and aquatic environments and on consumer products.

EDF's monitoring of the environment around the NPPs fulfils three separate but complementary functions:

- an alert function, through a network of radiation meters set up in the vicinity of the installation. By forwarding the alert to the control room, any abnormal change in the ambient radioactivity level near the site can be detected in real time;
- a routine surveillance function that concerns the daily to monthly analyses (essentially overall beta and tritium activity measurements) performed on atmospheric dust, rainwater, groundwater, plants, milk, etc.;
- a scientific monitoring and studies function which corresponds to the radioecological measurement campaigns, usually carried out between April and October. It aims at making a highly precise evaluation of radionuclide activities in the terrestrial and aquatic ecosystems and any spatial and temporal changes thereto.

Added to these technical functions is a communication function targeting the authorities and the public. The regulatory registers (effluents and environment) which are sent monthly to ASN are kept by a single service which is functionally independent of the services tasked with requesting and making the discharges.

Following the setting up of the National Radioactivity Measurements Network (RNM) by the French authorities (see section E.2.1), all the environmental laboratories of the EDF NPPs have engaged in a process with the aim of obtaining ASN approval for taking the various measurements whose results are transmitted to this network and, at the same time, in an accreditation process per standard NF EN ISO/IEC 17025.

Furthermore, a ten-yearly assessment of the radiological status of the site and its environment must be carried out, comparable with the "background level" assessment performed when the first reactor of a site is commissioned. Depending on their age, all the sites have now carried out their second ten-yearly assessment, and the majority also their third. In 2019, the Fessenheim site was the first to have produced its fourth ten-yearly assessment.

Each year EDF thus takes more than 40,000 regulatory samples to which it voluntarily adds hundreds of annual analyses to determine more precisely the radiological and radioecological status of the environment. All these measurements confirm the very low environmental impact of radioactive discharges from the NPPs and a general reduction in the activity of artificial gamma-emitting radionuclides measured in the monitored environmental matrices.

5| ORGANISATION FOR EMERGENCY SITUATIONS (ARTICLE 25)

1. Each Contracting Party makes sure that, before and during operation of a spent fuel or radioactive waste management facility, there are on-site emergency plans and, if necessary, appropriate off-site emergency plans.

2. Each Contracting Party takes appropriate measures to prepare and test the emergency plans for its geographical area insofar as it is liable to be affected in the event of a radiological emergency situation in a spent fuel or radioactive waste management facility located in the vicinity of its geographical area.

5.1. General organisation for emergencies in the BNIs

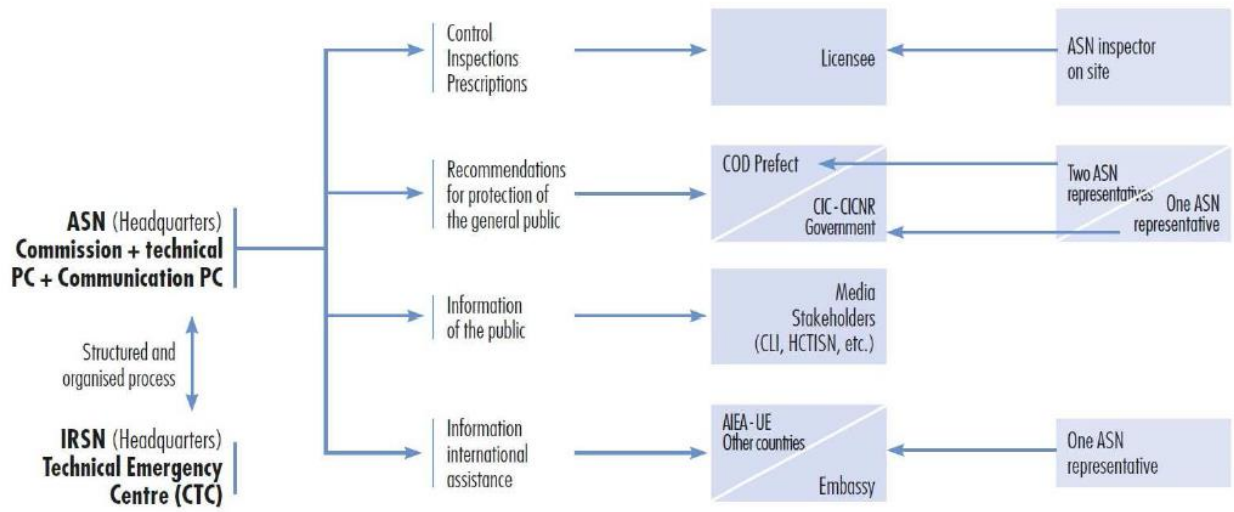
The organisation of the response by the public authorities in a nuclear or radiological emergency situation is a particular case of the government's organisation for dealing with major emergencies, as presented in circular 5567/SG from the Prime Minister dated 2nd January 2012. This circular describes the role and the responsibilities:

- at government level (ministries and interministerial crisis committee);
- at defence and security zone level (zone operations centre);
- at *département* level (departmental operations centre);
- of the various stakeholders and regional agencies taking part in the response to a major emergency.

The management of a radiological emergency situation is covered by the "national response plan for a major nuclear or radiological accident" of February 2014 and by the interministerial directive of 7 April 2005 concerning the organisation of the public authorities in the event of a nuclear or radiological emergency.

International notification of the emergency situation is the subject of the interministerial directive of 30 May 2005 relative to the application of the international convention on the early notification of a nuclear or radiological accident and the decision of the council of the European Communities concerning the community procedures for the rapid exchange of information in the event of a nuclear or radiological emergency situation.

Information exchange protocols are in place with France's neighbours liable to be affected by a nuclear or radiological emergency situation in a facility close to a border.



COD: Departmental Operations Centre
CIC: French Inter-ministerial Crisis Committee
CICNR: Inter-ministerial Committee for Nuclear or Radiological Emergencies
CLI: Local Information Committee
HCTISN: High Committee for Transparency and Information on Nuclear Security
PC: Command Post

Figure 12: Emergency organisation for accident situations

5.1.1. Organisation at the local level

In a nuclear or radiological emergency situation liable to have an impact outside a BNI, the Prefect of the *département* where this facility is situated takes charge of the emergency response operations. He or she implements the provisions of the off-site emergency plan (PPI) and orders population protection measures.

To ensure local management of the emergency, he or she activates and utilises the emergency management centre (departmental operations centre), which comprises representatives from all the response services (police, gendarmerie, civil protection), the decentralised regional agencies of ASN and IRSN. He or she is also responsible for communication with the media and informing the general public and elected representatives.

The licensee of the BNI affected by the accident must deploy an organisation and means for controlling the accident, assessing it and mitigating the consequences, for protecting the persons on the site and alerting and regularly informing the public authorities. These arrangements are determined beforehand in the on-site emergency plan (PUI) that the licensee is required to prepare.

5.1.2. Organisation at the national level

In the event of a major crisis requiring the coordination of numerous players, a governmental crisis organisation is set up, under the supervision of the Prime Minister, with the activation of the interministerial crisis committee (CIC). The purpose of this committee is to centralise and analyse information in order to prepare the strategic decisions and coordinate their implementation at interministerial level. It comprises:

- all the ministries concerned, or their representatives;
- the competent safety regulator (ASN) and its technical support organisation (IRSN);
- the representatives of the licensee;
- the administrations or public institutions providing assistance, such as Météo-France.

In a radiological emergency situation, each ministry - together with the decentralised State services – is responsible for preparing and executing national level measures within their field of competence.

The ministries concerned also work together with ASN in order to advise the Prefect on the protection measures to be taken. They provide the Prefect with the information and advice such as to enable him or her to assess the state of the facility, the seriousness of the incident or accident and its possible developments.

5.1.2.1. The emergency plans

The licensee of a BNI is obliged by the regulations to draw up a nuclear or radiological emergency response plan. This plan is called the on-site emergency plan (PUI) and its purpose is:

- to return the facility to a stable, controlled state;
- to prevent, mitigate or delay the consequences of the accident outside the facility;
- to alert the response services outside the facility and facilitate their on-site response actions;
- to alert and protect the persons on the site;
- to alert the public authorities;
- to take the steps provided for in the off-site emergency plan which are under the responsibility of the licensee.

For certain BNIs, such as NPPs or research reactors, the public authorities in the *département* are required by the regulations to draw up a contingency plan for the population living within a specified area around the facility. This plan is called the “off-site emergency plan” (PPI) and its purpose is to protect populations in the short term from the threat of radioactive releases and provide the licensee with outside emergency response resources. It defines the duties of the various services concerned, the ways of broadcasting the alert and the material and human resources.

At the Government level, the national "major nuclear or radiological accident" plan published in February 2014 covers the major radiological emergency situations concerning BNIs or the transport of radioactive materials. It details the national emergency management organisation, the response strategies and principles and contains a decision support guide intended for the ministerial authorities. This plan is implemented nationwide (defence and security zones and *départements*) to supplement the off-site emergency plans.

5.1.2.2. Countermeasures in the emergency plans

In the event of a major nuclear or radiological accident, a number of measures can be envisaged by the Prefect in order to protect the population:

- sheltering and staying tuned in to the media: when alerted by a siren, the persons concerned take shelter at home or in a building, with all openings completely closed (and ventilation equipment switched off) and wait for instructions from the Prefect over the radio;
- taking stable iodine tablets: when ordered by the Prefect, the persons liable to be exposed to releases of radioactive iodines are instructed to take the prescribed dose of potassium iodide tablets;
- evacuation: in the event of a threat of large-scale radioactive releases, the Prefect may order evacuation. The populations are then asked to prepare a bag, secure their home, leave it and then evacuate by their own means or go to the nearest assembly point.

The Prefect may also take measures to ban the consumption of foodstuffs liable to have been contaminated by radioactive substances as of the emergency phase.

The dose levels triggering implementation of population protection measures in a radiological emergency situation are defined by Article D 1333-84 of the Public Health code which defines the following reference values:

- an effective dose of 10 mSv for the sheltering recommendation;
- an effective dose of 50 mSv for the evacuation recommendation;
- an equivalent dose to the thyroid of 50 mSv for the recommendation to administer stable iodine tables in situations liable to cause emissions of radioactive iodine.

The predicted doses are those that it is assumed will be received until releases into the environment are brought under control, generally calculated over a period of 24 hours for a one year old child (age at which sensitivity to ionising radiation is highest) exposed to the releases.

In the event of the release of radioactive substances into the environment, measures are decided on to prepare for management of the post-accident phase; they are based on the definition of area zoning to be implemented as of the end of the releases on exiting the emergency phase and including:

- an evacuation zone, defined according to the ambient radioactivity (external exposure) within which the residents must be evacuated for a period of time which will depend on the situation;
- a zone, including the first zone, within which action is required to reduce both the exposure of the populations to ambient radioactivity and the consumption of contaminated foodstuffs, as far as is reasonably possible (for example a ban on consumption of produce from the garden, restrictions on access to wooded areas, ventilation and cleaning of homes, etc.);
- a last zone, larger than the first two, which is intended more for the economic management of the regions, within which specific surveillance of foodstuffs and agricultural produce will be implemented;

5.2. Role and organisation of ASN

5.2.1. ASN duties in emergency situations

In a nuclear or radiological emergency situation, ASN, with the support of IRSN, has the following four duties:

- to check and ensure the validity of the nuclear safety measures taken by the licensee;
- to advise the Government and its local representatives;
- to help disseminate information;
- to act as competent Authority within the framework of international conventions.

5.2.2. ASN organisation with regard to nuclear safety

The ASN emergency response organisation set up for a nuclear accident in a BNI more specifically comprises:

- participation by ASN staff in the various CIC units, the zone emergency centre and the departmental operations centre;
- at the national level, an emergency centre in Montrouge (ASN head offices) consisting of three command posts (PC):
    - a strategic command post, set up by the ASN Commission, which can be called on to issue resolutions and impose prescriptions on the licensee of the installation concerned in an emergency situation;
    - a technical command post (PCT) that is in constant contact with its technical support organisation - IRSN, and with the ASN Commission. Its role is to adopt positions to advise the Prefect, who is the emergency operations director;
    - a communication command post (PCC), positioned near the PCT. The ASN Chairman or his representative acts as the spokesperson, separately from the duties of head of the PCT.

The operation of the emergency centre is regularly tested during national emergency exercises and is activated in real incident or accident situations. At the local level, ASN representatives visit the *département* and zone Prefects to help them with their decisions and their communication actions. ASN inspectors may also go to the site affected by the accident; others take part in emergency management at the headquarters of the regional division involved.

Experience feedback from the Fukushima Daiichi accident may also lead ASN to envisage sending one of its representatives, if necessary, to the French embassy in the country in which a nuclear accident has occurred.

During exercises, or in the event of a real emergency, ASN is supported by an analysis team located at IRSN's technical emergency centre (CTC).

ASN's alert system allows mobilisation of its emergency centre staff and those of the IRSN. This automatic system sends an alert signal to the staff equipped with appropriate reception devices, as soon as it is remotely triggered by the BNI licensee originating the alert. It also sends the alert to the SGDSN (General Secretariat for Defence and National Security) which is attached to the Prime Minister's office, to the DGSCGC (General Directorate for Civil Protection and Emergency Preparedness), the COGIC (Interministerial Emergency Management Operations Centre), to Météo-France and to the Ministerial Operational Standby and Alert Centre of the Ministry of Ecological and Solidarity-based Transition.

The severity of the situation is evaluated by the various parties, who if necessary decide to activate their own emergency management centres to manage the situation.

Table 21 shows the positions of the public authorities (Government, ASN and technical experts) and the licensees in a radiological emergency situation. These players each operate in their respective fields of competence with regard to assessment, decision-making, action and communication, for which regular audio-conferences are held. The discussions between parties lead to decisions and orientations concerning the safety of the facility and the protection of the general public. Similarly, relations between the communication units and the spokespersons of the emergency centres ensure the consistency of the information given to the public and the media.

	Decision	Assessment	Intervention	Communication
Public authorities	Government (CIC) Prefect (COD, COZ)	/	Prefect (PCO) Civil protection	Government (CIC) Prefect (COD)
	ASN (PCT)	IRSN (CTC) Météo-France	IRSN (mobile units)	ASN IRSN
Licensees	National and local levels	National and local levels	Local level	National and local levels

CIC: Interministerial Crisis Committee, COD: Departmental Operations Centre, PCO: Operational Command Post, CTC: Emergency Technical Centre

Table 21: Positioning of the various players in the radiological emergency situation

5.2.3. Role and organisation of the licensees in an emergency situation

The licensee's emergency organisation is provided to support the operating team in the event of an accident. It fulfils the following duties:

- on site: triggering of the on-site emergency plan (PUI);
- off site: mobilising accident situation specialist experts in the national emergency teams (ENC) to assist the site supervisors;
- informing the public authorities who can, depending on the severity of the situation, implement the off-site emergency plan (PPI).

5.2.4. The role of ASN emergency situation preparedness

5.2.4.1. Approval and oversight of implementation of on-site emergency plans (PUI)

Under the Public Health Code and the Environment Code, the on-site emergency plan (PUI) - like the safety analysis report and the general operating rules - must be included in the safety documents the licensee has to submit to ASN at least 6 months before radioactive materials are used in a BNI. In this context, the PUI undergoes in-depth analysis by IRSN.

ASN ensures proper implementation of the on-site emergency plans in particular by means of inspections.

5.2.4.2. Participation in off-site emergency plan (PPI) preparation

Pursuant to the decree of 13 September 2005 concerning off-site emergency plans and the ORSEC plan (emergency response organisation), implementing article L741-6 of the Domestic Security Code, the Prefect of the *département* is responsible for drafting and approving the PPI. ASN assists the Prefect by analysing the technical data to be provided by the licensees, in order to determine the nature and scope of the consequences outside the nuclear facility. This analysis is performed jointly with the technical support organisation, IRSN.

ASN also gives its opinion on the part of the ORSEC plans drafted by the Prefects concerning the transport of radioactive materials.

5.2.4.3. The steering committee for managing the post-accident phase (Codirpa)

The “post-accident” phase concerns the handling over a period of time of the consequences of lasting contamination of the environment by radioactive substances following a nuclear accident. It includes dealing with varied consequences (economic, health, social), by their very nature complex, which need to be addressed in the short, medium or even long term, with a view to restoring a situation considered to be acceptable.

The conditions of reimbursement for the damage resulting from a nuclear accident are currently stipulated by Act 68-943 of 30 October 1968, amended, concerning civil liability in the field of nuclear energy. France has 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 civil liability in the field of nuclear energy. These protocols and the measures necessary for their implementation are codified in the Environment Code (section I of chapter VII of title IX of book V). These provisions and the new liability thresholds set by the two protocols entered into force in February 2016, pursuant to the 17 August 2015 Act on energy transition for green growth (TECV Act). An order of 19 August 2016 sets the list of sites with more limited risks which benefit from a reduced liability amount.

Pursuant to the interministerial directive of 7 April 2005, and in association with the ministerial departments involved, ASN was tasked with establishing the framework and defining, preparing and taking part in implementing the necessary provisions in response to post-accident situations following a nuclear accident. In order to draw up the corresponding aspects of doctrine, ASN in June 2005 created the steering committee for managing the post-accident phase of a nuclear accident or radiological emergency situation (Codirpa), for which it acts as Chair and technical secretary. ASN’s mandate was updated in a letter from the Prime Minister dated 29 October 2014, and renewed in 2020.

At the request of the Prime Minister, and under ASN coordination, the Codirpa worked from 2014 to 2019 on the management of post-accident situation risks. On completion of the work, ASN published the new doctrine development recommendations which were addressed to the Prime Minister.

The first aspects of the Cordirpa doctrine published by ASN in 2012 were taken into account by the Government in the National Major Radiological or Nuclear Accident Response Plan published by the SGDSN (General Secretariat for Defence and National Security) in February 2014, then applied in the *départements* by the Prefects.

The lessons learned from the Fukushima accident and application of the post-accident doctrine during nuclear / radiological emergency exercises made it possible to determine the changes to be made to this doctrine, particularly regarding the consideration of long-lived radioactive releases, coherence between the emergency and post-accident phases, and waste management.

At the end of the work carried out between 2014 and 2019, the Codirpa recommended several changes in the post-accident doctrine. The main change consists in simplifying the post-accident zoning which underpins the population protection measures:

- to protect the population against the risk of external exposure, it is proposed to maintain the population evacuation perimeter (uninhabitable zone), on the basis of an annual effective dose value of 20 mSv/year for the first year. The consumption and sale of foodstuffs produced locally would be prohibited within this zone;
- to limit exposure of the population to the risk of contamination through consumption, a perimeter of non-consumption of locally produced foodstuffs that extends beyond the evacuation perimeter is proposed. This perimeter would initially be defined on the basis of the largest of the population

protection perimeters (sheltering, ingestion of iodine, etc.) established during the emergency phase. It would then be refined using environmental contamination measurements and the available models;

- with regard to the sale of local produce, the Codirpa proposes adopting a regional approach per agricultural production and livestock sector, based on the maximum permissible radioactive contamination levels defined by the European authorities for the sale of foodstuffs.

The Codirpa recommends accompanying this zoning approach by the gradual implementation of protection measures adopted in the National Plan (reduction of contamination by cleaning urban areas, waste management, radiological surveillance of foodstuffs and consumer goods, etc.), after identifying the regions concerned, taking into account the scale of the accident, the measurement results and how the population perceives the situation.

5.2.4.4. Emergency exercises

The main aim of these nuclear and radiological emergency exercises is to test the planned response in the event of a radiological emergency, in order:

- to ensure that the plans are kept up-to-date, that they are well-known to those in charge and to the participants at all levels and that the corresponding alert and coordination procedures are effective;
- to train those who would be involved in such a situation;
- to implement the various aspects of the organisation and the procedures set out in the interministerial directives: the emergency plans, the contingency plans, the local safeguard plans and the various conventions;
- to develop a general public information approach so that everyone can, through their own individual behaviour, make a more effective contribution to civil protection;
- to build on emergency situation management knowledge and experience.

These exercises, which are the subject of an annual interministerial review, involve the licensee, the ministries, the offices of the Prefects and services of the *départements*, ASN, ASND, IRSN and Météo-France, which can represent up to 300 people when resources are deployed in the field. They aim to test the effectiveness of the means of assessing the situation, the ability to ensure that the facility or package is brought to a controlled state, to take appropriate measures to protect the population and set up satisfactory communication with the media and the populations concerned.

Each year the International Atomic Energy Agency (IAEA) organises several "ConvEx" (Convention Exercises). These exercises aim to partially or fully test application of the two international conventions on early notification of a nuclear accident and on assistance in the case of a nuclear accident or radiological emergency situation by the member States that have signed these conventions. ASN participates regularly as a competent authority within the meaning of these two conventions.

ASN also participates in the "Ecurex" exercises organised regularly by the European Union.

5.3. Emergency organisation for accidents not involving BNIs

Apart from the incidents or accidents which could affect nuclear installations or radioactive substances transport operations, radiological emergency situations can also occur:

- during performance of a nuclear activity for medical, research or industrial purposes;
- in the event of intentional or unintentional dissemination of radioactive substances into the environment;

- following the discovery of radioactive sources in places not designed to accommodate them.

It is then necessary to intervene to limit the risk of exposure of individuals to ionising radiation. Together with the ministries and the stakeholders concerned, ASN thus drafted interministerial circular DGSNR/DHOS/DDSC n° 2005/1390 of 23 December 2005. This supplements the provisions of the interministerial directive of 7 April 2005 presented in § F 5.1 and defines the organisation of the State's departments for these radiological emergency situations, more specifically:

- the context of the intervention;
- the responsibilities of the various parties;
- the methods for alerting the public authorities;
- the intervention principles;
- the departments that could provide their assistance.

Given the large number of potential originators of an alert and the corresponding alert circuits, all the alerts are centralised in a single location, which then distributes them to all the stakeholders: the centralising body is the fire brigade's centralised alert processing centre CODIS-CTA (departmental operational fire and emergency centre - alert processing centre), that can be reached by calling 18 or 112.

The management of accidents of malicious origin occurring outside BNIs are not covered by this circular, but by the Government's NRBC (nuclear, radiological, biological and chemical) plan.

6| DECOMMISSIONING AND DELICENSING (ARTICLE 26)

Each Contracting Party takes appropriate measures to ensure the safety of the delicensing of a nuclear facility: These measures must guarantee that:

i) qualified personnel and adequate financial resources are available;

ii) the provisions of article 24 concerning radiation protection during operation, effluent discharges and unscheduled and uncontrolled emissions are applied;

iii) the provisions of article 25 concerning the organisation for emergency situations are applied;

iv) the files containing information that is important for delicensing are retained.

6.1. ASN requests for the BNIs

6.1.1. Definitions

The following definitions are taken from ASN Guide No. 6 "*Final shutdown, decommissioning and delicensing of basic nuclear installations in France",* updated in 2016.

Decommissioning

Decommissioning concerns all the technical operations carried out with a view to achieving a predefined final state that makes delicensing possible. The decommissioning phase follows on from the installation operation phase and ends on completion of the installation delicensing process.

Post-operational clean-out

"Post-operational clean-out" corresponds to the operations to reduce or eliminate radioactivity or any other hazardous substances remaining in structures or soils.

Delicensing

The "delicensing" of a BNI is an administrative act whereby the installation is removed from the list of basic nuclear installations (BNI). Pursuant to the provisions of Article R. 593-73 of the Environment Code, delicensing of the installation is pronounced by an ASN resolution subject to the approval of the Minister responsible for nuclear safety. From the moment the delicensing resolution enters into effect, the installation is no longer subject to the legal and administrative system governing basic nuclear installations (BNI).

The delicensing of a basic nuclear installation is not authorised until an optimisation process has been put in place which will lead to a post-operational clean-out of the entire BNI perimeter that is as thorough as possible under acceptable technical-economic conditions. For this, the licensee submits a delicensing application file presenting the decommissioning work performed and proof of achievement of the targeted final state. Nevertheless, if residual radiological or chemical contamination persists in the soils and groundwater after cleaning out the site, the licensee can propose introducing active institutional controls around the site or on the land on which the installation was situated. ASN examines the delicensing application concomitantly with the examination of the abovementioned active institutional controls application file, which is under the responsibility of the State representative. For these examinations, and in order to better inform the stakeholders, the regulations provide for several public consultations and information campaigns.

6.1.2. Decommissioning policy and strategy

The issues and implications

Many BNIs were built in France between the 1950s and 1980s. Consequently, for about twenty years now, a large number of them have been shut down and decommissioned or are undergoing decommissioning. As indicated in section D.6, about thirty BNIs have been decommissioned and delicensed and another thirty BNIs of all types (power generating or research reactors, laboratories, spent fuel reprocessing plants, waste processing facilities, etc.) have been shut down or are undergoing decommissioning as at the end of 2019. Given the context, the safety and radiation protection of the decommissioning operations in these installations have gradually become major issues for ASN.

The general principles

Two decommissioning strategies have been defined by the IAEA at international level:

- immediate dismantling;
- deferred dismantling.

The IAEA adopted a position on the fact that safe enclosure, which corresponds to the notion of "entombment" or "in situ disposal", was not considered to be a decommissioning technique. This practice can only be envisaged in the case of accident-stricken sites and where the necessary precautions are taken.

In accordance with the IAEA recommendations, the French policy obliges the licensees to adopt a strategy of decommissioning within the shortest time possible, with the aim of removing all the hazardous substances and ensuring the most thorough clean-out possible. The aim of this strategy is to avoid placing the technical and financial burden of decommissioning on future generations. It also provides the benefit of having the knowledge and skills of the teams present during operation of the installation, which are vital during the first decommissioning operations.

This principle, which figured in Article 8.3.1 of the BNI order and had been included since 2009 in the decommissioning and delicensing doctrine established by ASN, was taken up in legislation by the TECV Act of August 2015 which introduces it into the Environment Code. The Decree of 28 June 2016 has also updated the procedures governing the final shutdown and decommissioning of the BNIs.

These changes in the regulatory framework have brought several major modifications which are presented in detail in section E 2.2.4.4 and whose principles are set out in the following ASN guides:

- Guide No. 6 "*Final shutdown, decommissioning and delicensing of basic nuclear installations in France*", updated in 2016;

- Guide No. 14 "*Post-operational clean-out of structures in BNIs*", updated in 2016;
- Guide No. 24 "*Management of soils contaminated by BNI activities*" published in 2016.

An overall view of the decommissioning of an installation

In accordance with legislation and the regulations, ASN requires that the operating and decommissioning phases be clearly distinguished (see section E.2.2.4.4). This is because the decommissioning phase presents particularities in terms of risks and radiation protection in a context where the installation undergoes rapid technical changes. It must therefore take place within the framework of specific baseline safety requirements, after the decommissioning license has been issued by decree. Certain preparatory or pilot operations can nevertheless be carried out between installation shutdown and issuing of the decree, but they must be compatible with the creation authorisation decree and remain limited.

To avoid splitting up decommissioning projects and to improve overall consistency, the decommissioning file - submitted no later than two years after the licensee has stated its intention to definitively shut down the installation – must explicitly describe all the work planned from final shutdown through to achievement of the targeted final state, and detail for each stage the nature and extent of the risks presented by the installation and the means used to control them. This file defines the broad technical and administrative stages of the planned decommissioning.

This procedure prevents the splitting of the project and fosters overall consistency of the operations.

By regulation (see § F.6), as soon as a BNI is definitively shut down, it must be decommissioned and therefore changes purpose. The decommissioning operations involve a change in the risks presented by the installation. Consequently, these operations cannot be performed without modifying the framework set by the creation authorisation decree. In accordance with the provisions of article L.593-25 of the Environment Code, decommissioning of a BNI is prescribed by a new decree, issued on the advice of ASN following the decommissioning file examination process.

The decommissioning decree does not revoke the creation authorisation decree, but modifies it, notably by:

- revoking the provisions relating to operation, which are no longer applicable;
- prescribing decommissioning operations and the essential aspects of these operations with regard to protection of the interests mentioned in article L. 593-1 of the Environment Code.

The operations prior to decommissioning thus take place within the framework created by the facility's creation authorisation decree and may be completed after entry into force of the decommissioning decree. These operations are authorised on a case-by-case basis in accordance with Articles R. 593-56 to R. 593-58 26 of the Environment Code, or, if applicable, declared in application of Article R. 593-59 of the Environment Code, taking into account the particularities of the installation in question.

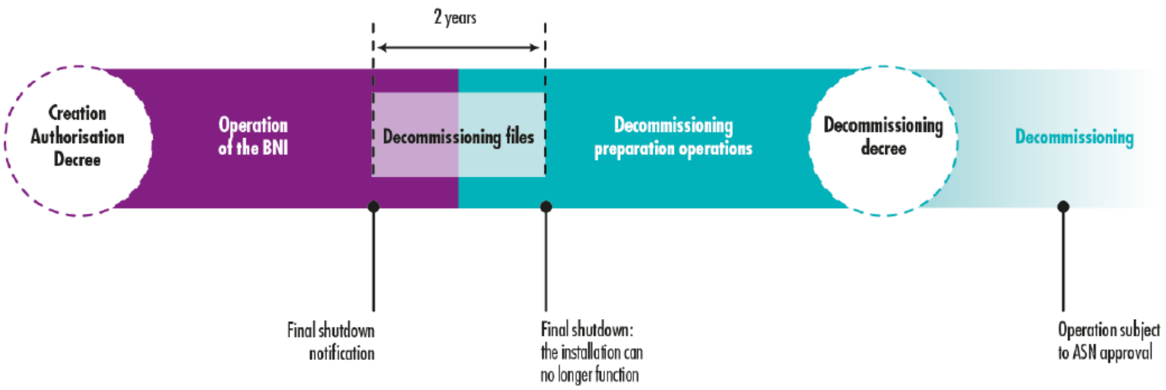


Figure 13: Phases in the life cycle of a Basic nuclear installation

Two assessment levels

The licensees are assessed at two levels.

The first level concerns the *overall* decommissioning *strategy* adopted by a licensee with numerous facilities to be decommissioned (EDF, CEA, Orano). Its key aim is to examine:

- the priorities to be considered, given the status of the facilities and their level of safety;
- the management policy for the waste and effluents generated by decommissioning and, more particularly, the availability of the associated disposal routes;
- the technical feasibility of the scenarios presented for ongoing or future decommissioning;
- the particular organisation put into place to manage these decommissioning operations.

The second level of assessment concerns each facility to be decommissioned and more particularly the safety and radiation protection of the operations to be performed. Its aim is to assess the provisions proposed by the licensee in the file enclosed in support of the decommissioning application for the facility concerned or during the periodic safety reviews of the facility.

The importance of having an overall view of all of a licensee's facilities

ASN considers that it is impossible to examine the overall strategy adopted by a licensee by separating its BNIs and SBNIs, which have related implications. It is necessary to have an overall view of the prioritisation of the operations envisaged and the human and financial resources deployed to perform them.

The CEA and Orano thus presented their decommissioning and waste (and materials in the case of the CEA) management strategy to ASN and ASND in 2016, for all the BNIs and DBNIs.

The importance of retrieval and packaging of legacy waste

ASN considers that the accelerated progress of legacy waste retrieval and packaging (WRP) in the facilities undergoing decommissioning is a prime condition for the safety of these facilities. This is because, in most cases, this waste has been stored in pits or units which have aged and do not comply with current safety standards, while at the same time presenting significant potential radiological activities in the event of an incident or accident. On this account, ASN has undertaken an exploratory approach, supported by the Ministry of Energy, aiming to assess and check the way in which the licensees conduct their WRP projects in order to comply with their announced schedules which are taken up in the individual regulatory texts (decrees and ASN resolutions). In 2019, ASN assessed Orano's WRP project management for the UP2 400 facility. This approach will be continued with EDF in 2020 and with the CEA in 2021.

The importance of waste management

ASN considers that management of the waste generated by decommissioning operations is a key factor which determines the smooth running of the decommissioning programmes in progress. This is because the decommissioning of a nuclear facility necessitates the availability of management routes permitting the removal of all the waste resulting from the decommissioning operations, or at least its storage in suitably safe conditions.

The overall decommissioning strategy of the licensees is thus examined along with their overall waste management strategy.

It is to be borne in mind that in France there is no generalised clearance level for waste that is or could be contaminated or activated. The Cires disposal facility for very low level (VLL) waste accepts the least radioactive waste coming from potential radioactive waste production areas (in accordance with the facility's "waste zoning plan"). Particular attention must however be paid to the optimisation of VLL waste management to avoid prematurely filling the Cires facility to maximum capacity.

This issue is addressed under the PNGMDR (see section A. 1.2) which encourages approaches aiming to reuse VLL waste, notably rubble or metal waste, including studies into the possibilities of recycling rubble as infill material for the voids in the Cires vaults, or by melting in the case of metal waste. These possibilities are covered by decree 2017-231 of 23 February 2017 establishing the prescriptions of the PNGMDR 2016-2018 (see § F.6.3.2). A study of the prospects of reusing the large uniform metal waste batches from EDF and Orano has been submitted (see § F.6.3.2). The work on this subject will be continued in the context of the fifth issue of the PNGMDR.

Need for particular vigilance

ASN considers that decommissioning work sites require particular vigilance in terms of worker radiation protection. This is because the change in the physical state of the installation and the risks it presents raise the constant question of the appropriateness of the means of surveillance deployed. It is often necessary to replace, either temporarily or lastingly, the centralised means of operating surveillance by other more appropriate means of surveillance.

Funding

Lastly, ASN considers that the ring-fencing of the funding of the future decommissioning operations and the utilisation of dedicated funds contribute to the safety of the future decommissioning operations (see § F.2.3.2). In the exploratory approach to monitor the progress of the legacy waste retrieval and packaging projects, the financial aspect is assessed and checked at the same time as the quality of the project schedule and scope by the administrative authority in charge of this aspect - the Ministry responsible for energy.

6.1.3. Regulatory requirements

The regulatory requirements specific to decommissioning are indicated in section E.2.2.4.4. It is pointed out that they figure essentially in the Environment Code and the BNI Order of 7 February 2012.

ASN Guides No. 6, No. 14, No. 23 and No. 24 accompany the regulatory system. As indicated in section E.2.2.5.2, the ASN guides contain recommendations describing the practices that ASN considers satisfactory for achieving the defined safety targets.

The following paragraphs detail some important points.

6.1.3.1. Decommissioning plan

The regulations require that the licensee provide a decommissioning plan for all BNIs as of their creation authorisation application. This plan must be regularly updated, and more specifically:

- when the facility is commissioned;
- when the creation authorisation decree is modified in any way;
- if necessary, when the facility undergoes modifications stipulated in Article R. 593-56 of the Environment Code;
- each time a periodic safety review report is submitted;
- at notification of final shutdown (at least two years before the shutdown date envisaged) as set out in Article L. 593-26 of the Environment Code, constituting an item of the decommissioning file. The final shutdown notification is submitted at least two years before the envisaged shutdown date. The time between submission of the decommissioning file and publication of the decree shall not exceed three years, except in special cases. The decree enters into force when ASN approves the revision of the facility general operating rules (RGE), at the latest one year after its publication.

For installations whose authorisation preceded this requirement, the BNI order requires creation of this plan no later than the next periodic safety review.

This plan must present, with the necessary substantiations:

- the design measures taken to facilitate decommissioning and the measures to preserve the history of the facility and data accessibility, and the measures to maintain skills and knowledge of the facility;
- the planned operations, the methodology and the decommissioning steps, the equipment, the schedules;
- the safety and radiation protection objectives;
- the waste management procedures, taking account of the existing or projected management solutions, and the effluent management procedures;
- the final status after decommissioning, the projections for the future use of the site, the assessment of the impact of the installation and the site after reaching the final state and the potential methods of monitoring it.

This corresponds to the plan defined by the IAEA in document WS-R-5.

A typical table of contents is provided in Guide No. 6 mentioned above.

6.1.3.2. Authorisation decree:

The regulatory aspects are detailed in section E.2.2.4.4. It is pointed out here that, according to the Environment Code (Articles L. 593-25 et seq.), the decommissioning of any BNI is subject to prior authorisation issued, following a public inquiry and the opinion of ASN, by decree from the Minister responsible for nuclear safety.

The file submitted by the licensee when it makes the decommissioning application for its facility, must describe all the work envisaged until the final targeted state is reached. It must detail the works planned in the short term (time frame of a few years). The other works, beyond the above time frame, must be presented - possibly in less detail - in which case they will form the subject of a hold point in the decree if made necessary by the risks.

The licensee must include in the file a notice updating the presentation of its technical capabilities, including its experience and the planned resources and organisation. It must also indicate its financial capacities and update the report required by Article L. 594-4 of the Environment Code relative to the decommissioning costs and the long-term management of the radioactive waste.

The decree sets, among other things, the final state to reach, the end-of-commissioning date, and the main stages and hold points that require approval before starting the corresponding works.

The prescriptions issued by ASN supplement the decree. They concern subjects such as incident and accident prevention and the mitigation of their consequences, the limiting and management of waste, discharges, the procedures for informing ASN and the public.

6.1.3.3. ASN authorisations and notifications

For the hold points concerning major operations, such as indicated in the decommissioning decree, the licensee must submit a file to ASN with a view to obtaining its prior consent for execution of the works Should the works represent a noteworthy modification of the elements presented to support the authorisation application, it would be necessary to modify the decree.

Apart from these hold points, the licensee must notify ASN of any modification (in the stages, works, procedures, etc.) having potential consequences on safety and provide the necessary substantiating documents and updates under Article R. 593-56 of the Environment Code.

Under Article R. 593-59 of the Environment Code, the modifications that do not call into question the safety analysis report to any notable extent, or significantly increase the impact on safety, public health or sanitation or the protection of nature, are only required to be notified to ASN. If ASN considers that the notified modification falls under Articles R. 593-56 to R. 593-58 of the Environment Code or II of Article L. 593-14 of the Environment Code, it invites the licensee to file the corresponding authorisation application.

The criteria for determining whether a modification is subject to an authorisation or notification are specified by ASN resolution 2017-DC-0616 of 30 November 2017 relative to noteworthy modifications to basic nuclear installations, presented in section E.2. 2.4.2.

6.1.3.4. Periodic safety reviews

For each BNI undergoing decommissioning, a periodic safety review must be carried out every 10 years (unless otherwise specified), as is the case with the BNIs in operation (see section E.2. 2.3.1).

6.1.3.5. Delicensing

As decommissioning proceeds, the potential radioactive waste production zones are cleaned out and can be put forward for delicensing into conventional waste zones. The licensee must notify ASN of any zone it wants to delicense and submit a substantiating file to support its request, containing an assessment of the clean-out of the zone concerned. Guide No. 14 provides a typical table of contents for such an assessment. ASN reserves the right to conduct an inspection and take samples and measurements before giving its approval.

After cleaning out all the zones and when the final targeted state is reached, the licensee applies for the delicensing of its facility. The legal and regulatory aspects concerning such delicensing are detailed in section E.2.2.4.5. ASN is required to conduct on-site sampling checks to verify that the objectives have effectively been achieved.

The procedure ends, after submitting the file to the Prefect and obtaining the opinion of the municipalities and the CLI, by an ASN resolution approved by the Minister responsible for nuclear safety.

It has proved necessary to preserve the memory of the past existence of the BNIs after their delicensing and, when necessary, to put in place restrictions on use as appropriate for the final state of the site. Two cases can arise:

- either the licensee is able to demonstrate that the decommissioned facility and the land on which it was located present no risk whatsoever, that is to say they are free of any radioactive or chemical pollution, and in this case passive institutional controls are applied as a matter of course (the aim of this institutional control is to preserve the information regarding the presence of a former BNI on the plots of land concerned, so that successive buyers can be informed of the fact);
- or the licensee is unable to demonstrate the absence of any residual radioactive or chemical pollution, in which case active institutional controls are put in place with restrictions on the utilisation of the site or the implementation of surveillance measures. A public inquiry is necessary in this case.

6.1.4. Clean-out of structures and soils

The decommissioning and clean-out operations for a nuclear installation must progressively lead to the elimination of the radioactive substances resulting from the activation phenomena and any contamination deposits or migrations, in both the structures of the installation premises and the soil of the site.

The structure clean-out operations are defined on the basis of the prior updating of the facility's waste zoning plan which identifies the areas in which the waste produced is, or could be, contaminated or activated. As the work progresses (for example after cleaning the walls of a room using appropriate products), the "possible nuclear waste production areas" are downgraded to "conventional waste areas".

In accordance with the provisions of article 8.3.2 of the order of 7 February 2012, "the final state reached on completion of decommissioning must be such that it prevents the risks or inconveniences that the site may represent for the interests mentioned in article L. 593-1 of the environment code, in view more particularly of the projections for reuse of the site or buildings and the best post-operational cleanout and decommissioning methods available under economically acceptable conditions".

In line with its decommissioning policy defined in 2009, ASN therefore recommends that the licensees adopt clean-out and decommissioning practices taking account of the best scientific and technical knowledge at the time and in economically acceptable conditions, such as to achieve a final state in which all dangerous and radioactive substances have been removed from the BNI. This is the reference approach for ASN. If, depending on the characteristics of the pollution, this approach were to pose implementation difficulties, ASN considers that the licensee must go as far as is reasonably achievable in the post-operational clean-out process. It must in any case provide technical or economic data to demonstrate that the reference approach cannot be used and that the clean-out operations cannot be taken further with the best available post-operational clean-out and decommissioning methods and techniques in economically acceptable conditions.

In 2016, ASN thus updated and published the technical guide for post-operational clean-out of structures (Guide n° 14). In 2016, ASN also published a guide on the management of contaminated soils in nuclear facilities (Guide n° 24).

6.1.5. Financing decommissioning

The Environment Code obliges BNI licensees to evaluate the costs of decommissioning their facilities and managing their spent fuel and radioactive waste. Moreover, they must make provisions for all these costs and assign, on an exclusive basis, the necessary assets to cover these provisions. Verifications are provided for by law to ensure compliance with these provisions (see section B.1.7 and § F.2. 3.2).

6.2. Measures taken by the BNI licensees

6.2.1. Post-operational clean-out and decommissioning of the CEA facilities

The rising number of clean-out/decommissioning worksites and the corresponding WRP work has become a serious constraint which weighs on the scheduling and performance of clean-out and decommissioning projects. CEA was thus required to conduct an in-depth review of the prioritisation of all of its clean-out/decommissioning and WRP projects, the overall management strategy for wastes, materials and traffic, as well as the organisation put in place for running these projects.

This prioritisation more specifically takes account of the potential source term (TSM)[1], the other nuclear and non-nuclear risks, the state of progress of the worksites, the state of knowledge, the monitoring costs and other fixed costs and the robustness of the scenarios.

At the end of 2016, CEA sent a file specifying these aspects and answering the July 2015 request from the nuclear safety authorities to review the overall decommissioning strategy, to review the radioactive materials and waste management strategy, to prioritise the operations, to reinforce the organisation and staff and to examine the pertinence of the financial resources devoted to the operations. The authorities basically confirmed the prioritisation proposed by the CEA when the conclusions of the examination of this strategy were submitted in late May 2019, but identified weak spots that the CEA must now take into consideration.

[1] The Potential Source Term ("TSM" from the French "Terme source mobilisable") corresponds to the quantity of radioactive activity that could be involved in an incident or accident. It is defined from the "source term" (activity of all the radioactive substances present in the facility) weighted by factors linked to:

- the dispersibility of the matrix (according to whether or not the radioactive substances are blocked in the materials and the nature of the blocking matrix),
- the effectiveness of the containment barriers (according to the seismic strength of the building and whether or not the ventilation is available for operation),
- the susceptibility of the source term to external hazards (the accident scenario adopted is an earthquake combined with a fire),
- the radiotoxicity of the inventory (β-γ, tritium or α spectrum).

Following on from the previous years, but with a more precise breakdown of the operations, the priorities concern the WRP operations on the Marcoule, Saclay, Fontenay-aux-Roses and Cadarache facilities.

In accordance with the strategy adopted in France, the CEA opts for immediate dismantling, which consists in initiating the dismantling of a facility as rapidly as possible after final shutdown. However, faced with the complexity of some of the operations involved and the fact that the operations can last several years or even decades, the CEA in certain cases proposes the option of a two-phase decommissioning process. Use of this option is justified on a case-by-case basis. The CEA may in particular adopt this option when the potential source term (TSM) has been completely removed and only a low level of risk, radiological in particular, remains in the facility.

With regard to the final state, the main principles of the CEA strategy are as follows:

- the priority target is always delicensing of the BNIs for which shutdown has been decided and for which the shutdown decision has been notified;
- as a priority and whenever possible, the CEA aims to keep the buildings standing for possible reuse or because they are located in a Centre scheduled to remain in operation, and primarily seeks in priority to obtain delicensing of the buildings without any restrictions on use.

Facility by facility, the CEA proposes adopting an approach proportionate to the issues, which is the result of a search for technical, economic, environmental protection and waste production optimisation. When implementing this approach, clean-out must be taken as far as is reasonably achievable in the light of the technical, economic, health and social constraints, the quantity of resulting waste and the best available techniques. Following these operations, the CEA will determine the radiological impact of any residual contamination depending on the future usage, which varies from one site to another (nuclear site with other continuing operations, site closed to the public, possible industrial reutilisation).

6.2.2. Measures taken by Orano

Within Orano, the end-of-cycle operations for nuclear installations are placed under the responsibility of the Waste and Decommissioning Project Ownership Department (DM2D), which entrusts the Project Management duties to its Decommissioning and Services Business Unit (BU) or, for the WRP developments, to the Projects BU.

The decommissioning and clean-out objective set by Orano for the structures and soils of its nuclear installations is to achieve a final state such as to prevent the risks or drawbacks the facility can present for the interests mentioned in Article L. 593-1 of the Environment Code, in view more specifically of the projected reuse of the site or the buildings and the best clean-out and decommissioning methods and techniques available under economically acceptable conditions.

Orano's aim is for the decommissioned nuclear facilities to be delicensed with a final physical state that is compatible with reuse of the site or the buildings with the prospect of them being reused for industrial purposes on industrial sites with continuing operations, and to have a residual sanitary impact on workers and the public that is as low as reasonably possible.

At the end of 2019, the Orano BNI clean-out and decommissioning projects are at various stages of progress:

- by Orders of 12 December 2019 approving the ASN resolutions of 29 October 2019, BNIs No. 65 and 90 installed on the SICN site of Veurey-Voroize, have been delicensed as defined in Article L. 593-30 of the Environment Code and removed from the list of basic nuclear installations. The delicensing of these two BNIs and the introduction of active institutional controls will make it possible to finalise the complete reindustrialisation of this site in partnership with the industry players who already occupy more than half the site;

- the SICN site at Annecy, which accommodated nuclear activities regulated under the ICPE system, has undergone rehabilitation operations. Three companies conducting industrial or energy production activities for the local authorities are still present on this site;
- on the Orano La Hague site, the UP2-400 plant decommissioning studies and work, which began several years ago, is continuing on the 4 BNIs undergoing decommissioning. These operations were authorised in 2009 for BNI 80, and 2013 for BNIs 33, 38 and 47. Two new partial decommissioning applications for BNIs 33 and 38 were filed in 2015 and are currently being examined by the authorities;
- on the Orano Tricastin site, decommissioning applications for the George-Besse 1 plan (BNI 93) and the Uranium conversion facility (BNI 105) have been examined by the authorities. The decree requiring Orano Cycle to proceed with the decommissioning of BNI 105 was signed on 16 December 2019, while the decree for BNI 93 is expected to be signed in early 2020.

6.2.3. Measures taken by EDF

The aim of the dismantling programme currently deployed by EDF is to completely decommission BNI 11 comprising:

- nine shut down reactors: six graphite-moderated gas-cooled reactors at Chinon, Saint-Laurent-des-eaux[1] and Bugey; the Brennilis heavy water reactor, built and operated jointly with the CEA; the Chooz A PWR reactor; the Superphénix fast-neutron reactor at Creys-Malville;
- the graphite sleeve storage facility at Saint-Laurent-des-Eaux, the Irradiated Material Facility (AMI) at Chinon and the Operational Hot Base (BCOT) at Tricastin.

This programme also includes the building and operation of ICEDA (Activated Waste Packaging and Interim Storage Facility) which will store the activated intermediate-level long-lived waste (ILW-LL) in the coming years, pending commissioning of the final disposal route for this waste (Waste Act).

Nature of the facilities	Units	Power (MWe)	Industrial commissioning	Shutdown	BNI No.
6 PWR reactors	Chinon A1	70 MWe	1963	1973	**133**
	Chinon A2	200 MWe	1965	1985	**153**
	Chinon A3	480 MWe	1966	1990	**161**
	Saint-Laurent A1	480 MWe	1969	1990	**46**
	Saint-Laurent A2	515 MWe	1971	1992	
	Bugey 1	540 MWe	1972	1994	**45**
1 heavy water reactor	Brennilis	70 MWe	1967	1985	**162**
1 PWR reactor	Chooz A	300 MWe	1967	1991	**163**
1 fast neutron reactor (Superphénix)	Creys-Malville	1 240 MWe	1986	1997	**91**
2 silos at Saint-Laurent-des-Eaux	Silos	-	1971	-	**74**
Irradiated materials facility at Chinon	AMI	-	1963	2015	**94**
Tricastin Operational Hot Unit (BCOT)	BCOT		2000	2020	**157**
1 packaging and storage facility (ICEDA) under construction	ICEDA	-	-	-	**173**

Table 22: EDF facilities concerned by the decommissioning programme

The first decommissioning strategy for the shutdown EDF reactors was sent in 2001 at the request of ASN. This strategy has been regularly updated more specifically to adjust the decommissioning schedule for these facilities and to incorporate the additional studies requested by ASN and the elements concerning the future

[1] The 2 reactors SLA1&2 are grouped in a single BNI

decommissioning of the reactor fleet in service. Until now, the updates called into question neither the decommissioning scenarios, nor the pace of decommissioning.

Up until 2001, the preferred scenario consisted in aiming for immediate dismantling of the power reactors to level 2 (removal of fissile material and readily dismantled parts, reduction of contained area to the minimum and arranging of the external barrier) and changing to the status of Storage BNI (SBNI). Complete decommissioning, called level 3, was considered after several decades of containment.

Since 2001 when it was decided to speed up the dismantling programme, dismantling as early as possible is the chosen option.

At the end of 2013, EDF submitted a file presenting its waste management strategy. This file was examined by the Advisory Committee of Experts in 2015. In March 2016, EDF informed ASN of a complete change in its strategy for the gas-cooled reactors (GCR), pushing back their decommissioning by several decades. This change in strategy is linked to major technical difficulties in decommissioning the reactors "under water", as had been initially planned. The alternative solution of decommissioning "under air" is accompanied by significant changes in the reactor decommissioning operations and their scheduling.

EDF has therefore abandoned the decommissioning approach based on opening the reactor vessels one after the other and extracting the graphite blocks, and now wants to completely dismantle one reactor before beginning to dismantle the others, in order to benefit from exhaustive experience feedback. EDF stated that it will however decommission all the installations peripheral to the reactor vessels within the next fifteen years.

ASN asked EDF to demonstrate that this change meets the regulatory requirement for decommissioning in the shortest time possible and to present the measures taken to meet the safety requirements. The requested information was provided in 2017.

Facility	DAD[1] file submitted	Start of public inquiry	Publication of decommissioning authorisation decree
Creys-Malville	06/05/03	01/04/04	21/03/06
Brennilis	22/07/03	sans objet	12/02/06
Chooz A	30/11/04	28/08/06	29/09/07
Bugey 1	29/09/05	13/06/06	20/11/08
Saint-Laurent A	11/10/06	26/01/07	20/05/10
Chinon A3	29/09/06	02/03/07	20/05/10

Table 23: Administrative dates for the complete decommissioning decree

The GCR reactor decommissioning schedule is based on the following principles:

- decommissioning under air of a first-off reactor (Chinon A2) as of 2030. With this in view, EDF has announced the construction of an industrial demonstrator to test the remote-manipulator tools needed to carry out these operations;
- decommissioning of the other 5 reactors after completing the first one in order to maximise the benefits of experience feedback from dismantling of the first pressure vessel, and placing in safe configuration to guarantee the lasting integrity of the pressure vessels and look ahead to the decommissioning operations that can be carried out in the peripheral buildings.

To successfully complete all the decommissioning programmes, the Decommissioning and Waste Projects Department (DP2D) was created in 2016 comprising a project team dedicated to each of the structures currently being dismantled (Chooz A, Creys-Malville, Brennilis, Bugey 1, Saint Laurent A (including units A1 / A2

[1] Decommissioning authorisation decree

and the graphite sleeves silos), Chinon A comprising the three reactors A1, A2 and A3 and the AMI). One project team is also dedicated to the BCOT and another to the ILW-LL waste conditioning and storage facility (ICEDA) currently under construction.

The corresponding human and financial resources have been mentioned in § F.2. 2.4.

These measures guarantee that these operations will be able to be carried out under satisfactory conditions.

6.3. ASN analysis

ASN considers that the current regulations provide for satisfactory conditions for conducting the nuclear facility decommissioning programmes. These regulations are based on the Environment Code and on the BNI Order of 7 February 2012. They contain the essential requirements to guarantee the safety of the corresponding operations and the appropriateness of the final state of the facilities after decommissioning. They also provide the flexibility needed for carrying out such operations (a single authorisation decree for a given BNI, but with possible hold points and the possibility of using a system of internal authorisations for the less risky operations).

ASN contributed to this overhaul of the regulatory framework and in 2016 updated and published guides No. 6, No. 14, No. 23 and No. 24 concerning BNI decommissioning and waste management.

6.3.1. Licensee policy and strategy

6.3.1.1. CEA policy and strategy

ASN and the Defence Nuclear Safety Authority (ASND) have observed:

- significant delays in the performance of decommissioning operations and the retrieval and packaging of CEA legacy waste;
- extremely significant increases in the envisaged duration of the decommissioning and legacy waste retrieval operations (about fifteen years for the Fontenay-aux-Roses facilities and for the UP1 plant of the Marcoule DBNI for example);
- as well as significant delays in the submission of the decommissioning files.

ASN and ASND thus asked the CEA to present them in 2016 with an overall review of its strategy for the decommissioning of nuclear facilities and management of radioactive waste for all the BNIs and DBNIs. This review more specifically concerns the prioritisation of the operations, the human resources and the effectiveness of the organisation in place to perform them, as well as the appropriateness of the financial resources devoted to these operations.

The file was received in December 2016. ASN and ASND issued their opinion in mid-2019.

ASN and ASND consider that, given the resources allocated by the State and the large number of facilities undergoing decommissioning, for which legacy waste retrieval and storage capacity will need to be built, it appears acceptable for the CEA to envisage staggering the decommissioning operations.

However, in view of the forward-looking schedules presented, even if no contingencies or delays affect the projects, the reduction in risks will at best not be effective before ten years or so. This is because many WRP projects classified as priorities necessitate the prior creation or renovation of means for retrieving, conditioning & packaging, storing and transporting the radioactive materials and waste. Consequently, despite the CEA having put in place a suitable organisation for the long-term management of its decommissioning programme, ASN and ASND question the robustness of the CEA's action plan and the adequacy of the available resources, both human and financial, to handle as early as possible all the situations with implications for safety or the most significant adverse effects for the environment. The two Authorities observe several vulnerabilities in the

CEA's strategy, due in particular to the envisaged sharing of resources between centres, for the management of liquid radioactive effluents or solid radioactive waste for example, which means that for some operations which can only be carried out by one facility, there could problems due to capacity limitations. This strategy leads firstly to a large increase in the number of transport operations, and secondly to major uncertainties concerning the availability of radioactive material and waste conditioning, packaging and storage facilities and transport packaging. The two Authorities also note uncertainties concerning the management of spent fuels or irradiated materials, which will have to be clarified.

ASN and ASND have therefore made several demands of the CEA with the aim of limiting these vulnerabilities, consolidating its strategy and detailing the operations schedule.

They demand that the CEA make regular progress reports on the decommissioning and waste management projects, and ensure regular communication with the public, applying procedures appropriate to the nature of the facilities, whether civil or defence. Lastly, they want special measures to be implemented to monitor the progress of these projects.

6.3.1.2. Orano group policy and strategy

With regard to Orano, ASN and ASND have requested an update of the decommissioning strategy applicable to all the Group's facilities, along with that relative to radioactive waste management, particularly given the scale of the forthcoming legacy waste retrieval and decommissioning operations. The file was received in June 2016. It was jointly examined by ASN and ASND and the results are expected in 2020.

ASN resolution 2014-DC-472 of 9 December 2014 set prescriptions concerning the strategy for legacy waste retrieval and packaging (WRP) from the La Hague site, along with a large number of deadlines. On 12 May 2015, Orano submitted its WRP strategy giving the results of the first actions undertaken, and it updates this document annualy. A present, many deadlines are not being met. The reasons put forward by Orano to explain these delays primarily concern the complexity of the legacy waste retrieval operations. As a result of this, ASN has initiated an exploratory procedure with the aim of better assessing the WRP project management measures. A first inspection took place in October 2019, with the support of the Ministry responsible for energy. It revealed that Orano needed to make fundamental improvements in the way it organised the management of these complex projects.

6.3.1.3. EDF policy and strategy

After examining the evidence presented by the licensee, then consulting both the licensee and the public, ASN adopted two resolutions on 3 March 2020 regulating the next steps in the decommissioning of these reactors. The following are notably specified:

- continued decommissioning of the equipment outside the pressure vessels of the Bugey 1, Chinon A3 and Saint-Laurent A1 and A2 reactors,
- commissioning and operation of an industrial demonstrator designed to validate the phasing of reactor pressure vessel decommissioning,
- in-depth work on the management routes for the waste that will be produced by decommissioning,
- compilation of the decommissioning files for the six reactors, which will be transmitted in 2022.

EDF shall demonstrate its ability to manage the deadlines and the interfaces between these projects, so that decommissioning of the GCR reactor pressure vessels can begin.

In view of the considerable delays accumulated in the decommissioning projects, ASN initiated a decommissioning projects inspection process in 2019 (see § F.6.3.3). These inspections shall be complementary to the examination of the decommissioning files, which shall present detailed information on the safety of the facilities. This information will be examined by ASN in the light of the risks associated with postponement of the decommissioning of the reactor pressure vessels by several decades.

ASN considers that waiting for the end of decommissioning of a first reactor pressure vessel and analysis of the lessons learned - which would not happen until about 2070 - before starting to decommission the other reactor pressure vessels, is not compatible with the obligation to decommission within the shortest possible time-frame. ASN however considers that, given the complexity of these operations, which have never before been carried out, it is acceptable for there to be a reasonable time between the beginning of decommissioning of the first pressure vessel and that of the other five vessels. The inspections and examinations mentioned above should, over the coming decade, enable ASN to assess the pertinence of the deadlines that EDF will be proposing for the main steps in the decommissioning of these reactors.

In a letter, ASN informed EDF that it required it to shorten the overall decommissioning schedule for these reactors, given the need to decommission each of the reactors in as short a time as possible. This optimisation shall be taken into account when drawing up the decommissioning or modification files resulting from the ASN resolutions.

The decommissioning strategy for the other reactors, Chooz A, Brennilis, and Creys-Malville has not, however, been significantly modified.

6.3.2. Reuse of very low level materials

Ongoing and future facility decommissioning operations will generate a very large amount of very low level (VLL) waste. The currently preferred management route is above-ground disposal, whereas some of the materials could potentially be reused by adopting a circular economy approach. For example, the decommissioning of the EURODIF Georges Besse I plant should generate about 130,000 tonnes of metal waste.

Cires, which is the only facility today authorised for disposal of VLL waste, will not be able to absorb all the VLL radioactive waste produced by the French nuclear facility decommissioning operations.

In 2015, within the context of the PNGMDR 2013-2015, Andra submitted an overall industrial scheme meeting the need for new VLL waste disposal capacity. This scheme was examined by ASN, which sent the Government an opinion on 18 February 2016 concerning the management of VLL waste.

These recommendations were taken up in the PNGMDR 2016-2018, which requires Andra and the licensees to reduce the quantities of waste by examining the recycling possibilities for certain types of VLL waste, and diversifying the waste management options. Therefore:

- In March 2017, Andra submitted a study on the reuse of VLL rubble as a material to fill in the voids in the vaults of the Cires facility;
- In June 2018, EDF and Orano submitted the technical and safety options for the treatment and reuse of large uniform batches of VLL metallic materials from Eurodif's Georges-Besse I plant and the steam generators from the EDF NPPs;
- in July 2018, Andra submitted a comparative study of the incineration of incinerable VLL waste followed by disposal of the residues, versus direct disposal, with regard to protection of human health, protection of the environment and safety.

The decision of the Minister responsible for energy and the ASN Chairman following the public debate on the fifth issue of the PNGMDR indicates, among other things, that the Government will provide the possibility of targeted waivers, allowing the reuse - after melting and decontamination - of VLL radioactive metallic waste on a case-by-case basis. Furthermore, this decision specifies that the fifth issue of the PNGMDR will provide recommendations as to the conditions of application of such waivers in terms of safety, radiation protection, citizens associations, transparency, verification and traceability.

6.3.3. The approach for monitoring the progress of decommissioning and waste management projects

Significant delays are observed in a large number of the decommissioning and legacy waste retrieval and conditioning (RCD) projects. Yet the facilities concerned are often ageing and do not meet today's safety standards. The progress of the decommissioning projects, which leads to a gradual reduction in the risks in the facility, is a major safety challenge for shut down facilities. In order to assess the licensee’s ability to implement its decommissioning projects or its legacy WRP projects in accordance with the stipulated time-frames, ASN has decided to develop an approach for monitoring the progress of decommissioning and WRP projects, allowing a combined assessment of compliance with deadlines, scope and cost, as these three aspects are interdependent in a project. With regard to the assessment of costs, and considering the competence of the DGEC (General Directorate for Energy and the Climate) of the Ministry responsible for energy, with respect to oversight of the regulations concerning the ring-fencing of funding of long-term costs, ASN involved it in this oversight approach from the outset.

After getting initial experience feedback on the monitoring of project progress initiated by the ASN Caen regional division since 2016 on the shutdown facilities of the Orano La Hague site, ASN – together with the DGEC – implemented an exploratory approach in 2019 to acquire a more detailed understanding of Orano's baseline requirements and project management organisation.

In October 2019, ASN conducted an in-depth inspection of a complex WRP project on the La Hague site. This project differs from a simple project in the number of interfaces between the project and the existing facilities, in the uncertainties with regard to the existing equipment to be reused, in the uncertainties with regard to the feasibility of the process and the packages, and in the challenge of building and commissioning a new facility and process.

This inspection was carried out with the participation of the DGEC, IRSN and a consulting firm selected by ASN. This inspection allowed the testing of new project monitoring methods applied to the control of decommissioning projects. The inspection themes focused on the control of the technical scope, control of the production strategies (construction, installation, commissioning), control of project risks, control of procurements, control of cost estimate, the maturity and robustness of the integrated project schedule, and control of project monitoring. It revealed significant lines for improvement, the extent of which goes beyond the inspected project.

The results of the exploratory approach allowed the identification of new methods of informing ASN about project progress, particularly through the development of new project monitoring tools.

6.3.4. On-site works

6.3.4.1. EDF / Brennilis NPP

The Brennilis NPP on the Monts d’Arrée site, called EL4-D, is an industrial prototype for a heavy water-moderated and carbon dioxide-cooled NPP that was definitively shut down in 1985. After the cancellation of the decommissioning authorisation decree in 2006, a new file was submitted in 2008 and underwent a new public inquiry. In its opinion to the Government, ASN recommended that EDF be authorised to carry out the operations mentioned in the report by the board of inquiry and that it initiate a new procedure for complete decommissioning. A partial decommissioning decree was published in July 2011. Following the opinion of ASN, the decree of 16 November 2016 extended the time to perform the decommissioning operations authorised by the decree of 27 July 2011, more specifically:

- the dismantling of the exchangers, which had been interrupted since 23 September 2015 further to a fire;
- the clean-out and demolition of the effluent treatment station.

In July 2018, EDF submitted the file for complete decommissioning of the facility which provides for decommissioning around 2040. In addition to this, further to ASN's examination of the periodic safety review guidance file, EDF submitted the safety review concluding report in December 2019.

Decommissioning of the heat exchangers ended in May 2018. The effluent treatment station has been decommissioned. A first clean-out of the soils subjacent to the STE has been carried out. ASN must verify achievement of the objectives in 2020. EDF is going to take samples from the reactor block in 2020 to prepare for its decommissioning.

6.3.4.2. EDF / Gas-cooled reactors

Bugey 1, Saint-Laurent A1 and A2 and Chinon A1, A2 and A3, are the reactors of the GCR series. These first-generation reactors functioned with natural uranium as the fuel and graphite as the moderator. They were cooled by gas. The last reactor of this type to have been shut down was Bugey 1 in 1994.

This plant series includes "intregrated" reactors, where the heat exchangers are under the reactor core inside the vessel, and "non-integrated" reactors, where the heat exchangers are situated on either side of the reactor vessel.

The Bugey 1 reactor (BNI 45)

The Bugey 1 reactor is an "integrated" GCR. Complete decommissioning of the facility, which was finally shutdown in 1994, was authorised by the decree of 18 November 2008. The corresponding scenario is “under water” dismantling of the reactor vessel.

EDF has changed the reactor decommissioning scenario (see § F.6.3.1.3), and will have to submit a modification application file for the current decree. Finally, contrary to the initial plans, Bugey 1 will not be the first GCR reactor to be decommissioned. The decommissioning operations outside the reactor vessel are to be continued over the next few years.

Alongside this, following ASN's examination of the periodic safety review guidance file, EDF submitted the safety review concluding report at the end of 2018.

The Chinon A1, A2 and A3 reactors (BNI 133, BNI 153, BNI 161)

The Chinon A1, A2 and A3 reactors are “non-integrated” GCR reactors. They were shut down in 1973, 1985 and 1990 respectively.

Reactors A1 and A2 were partially decommissioned and transformed into storage facilities for their own equipment. These operations were authorised by the decrees of 11 October 1982 and 7 February 1991 respectively. Chinon A1 is currently partially decommissioned and has been set up as a museum since 1986. Chinon A2 is also partially decommissioned. To integrate the new decommissioning strategy, EDF must submit decommissioning files for Chinon A1, A2 and A3 by 2022 at the latest.

EDF has changed decommissioning strategy and pushed back the date of end of decommissioning of the Chinon A reactors. These reactors should be the last GCRs to be decommissioned. EDF has decided to start by decommissioning Chinon A2, which presents the least difficulty, in order to gain experience for the decommissioning of the other GCR reactors.

Moreover, further to ASN's examination of the periodic safety review guidance file, EDF submitted the safety review concluding reports for Chinon A1 and A2 at the end of 2017. Complete decommissioning of the Chinon A3 reactor was authorised by a decree of 18 May 2010 with an "under water" decommissioning scenario. Decommissioning of the heat exchangers in the South hall of Chinon A3 ended in June 2018 with removal of all the heat exchanger cylinders. The work in the North hall has again been interrupted due to the presence of asbestos and is planned to restart in 2020.

The Saint-Laurent-des-Eaux A1 and A2 reactors (BNI 42)

The Saint-Laurent-des-Eaux reactors A1 and A2 are integrated GCR reactors.

Complete decommissioning of the facility, which comprises two reactors and for which final shutdown was pronounced in 1994, was authorised by the decree of 18 May 2010. The change in EDF decommissioning strategy for the GCRs (see above) pushes back the start of decommissioning of the pressure vessels of Saint-Laurent reactors A1 and A2. The decommissioning operations outside the reactor vessel are to be continued over the next few years.

Lastly, following ASN's examination of the periodic safety review guidance file, EDF submitted the safety review concluding report for Saint-Laurent A at the end of 2017.

6.3.4.3. EDF / Chooz A

The Chooz A reactor (PWR type reactor) located in the Ardennes was shut down in 1991. Its decommissioning authorisation decree was published on 27 September 2007.

Chooz A is the first pressurized water reactor built in France. The decommissioning of this reactor is considered to be a precursor for the future decommissioning of the PWRs, the technology used in the French nuclear power reactors currently in operation.

The primary cooling system decommissioning operations have been carried out. The decommissioning of the pressure vessel internal components is currently in progress.

The four steam generators in the plant have been removed and decontaminated and are now emplaced in the Cires facility.

The decommissioning of Chooz A presents a difficulty due to the presence of alpha particle contamination which necessitates being particularly attentive to protection of the workers.

Lastly, following ASN's examination of the periodic safety review guidance file, EDF submitted the safety review concluding report for Chooz A at the end of 2017.

6.3.4.4. EDF / Superphénix (BNI 91) and the APEC fuel storage facility (BNI 141)

Superphenix (BNI 91) is an industrial prototype sodium-cooled fast-neutron reactor located in Creys-Malville. It was definitively shut down in 1997.

The decommissioning decree was published in March 2006.

This facility is associated with another BNI, the fuel storage facility (APEC, BNI 141), which consists primarily of a storage pool in which the spent fuel removed from the Superphenix reactor vessel is stored, and a storage area for packages of soda concrete from the sodium treatment installation (TNA).

ASN considers that the safety of operation of BNIs 91 and 141 is satisfactory on the whole. Their periodic safety review has been carried out. The safety review concluding reports were received in 2015 and 2016. The report examinations are being finalised.

6.3.4.5. EDF / Irradiated material facility (BNI 94)

The irradiated material facility (AMI, BNI 94), notified and commissioned in 1964, is located on the Chinon nuclear site and operated by EDF. This installation (BNI 94) is not yet undergoing decommissioning even though it is shut down. It was primarily intended for examination and appraisal of activated or contaminated materials from the PWR reactors.

With a view to the decommissioning of the facility, the activities in the AMI are now mainly operations to prepare for decommissioning and monitoring.

The decommissioning file was submitted in June 2013. In view of the ASN requests formulated in 2014, EDF was to supplement its file to detail the initial status of the facility at the time of publication of the decommissioning decree, targeted for 2018. The licensee provided the supplements in 2016.

The decommissioning file underwent a public inquiry in early 2017. The decommissioning decree was published on 2 May 2020.

Within the framework of the decommissioning preparation operations, certain types of waste are subject to specific packaging and storage measures. This concerns legacy waste for which appropriate management routes are pending. ASN will be attentive to the execution of these legacy waste retrieval and packaging operations, the conditions of which are stipulated in the decommissioning decree. The decree comprises three stages which will span 13 years. The last stage corresponds to the clean-out of the structures and soils and is subject to ASN authorisation on the basis of a specific file which will lead to the submission of the delicencing file

ASN acknowledged receipt of the periodic safety review concluding report late 2017. It is currently being examined.

6.3.4.6. CEA / Fontenay-aux-Roses and Grenoble centres

The two centres at Fontenay-aux-Roses and Grenoble are in the process of delicensing.

In the case of Fontenay-aux-Roses, the decommissioning of two facilities, namely PROCÉDÉ (BNI 165)[1] and SUPPORT (BNI 166)[2], was authorised by two decrees dating from 30 June 2006. These facilities stopped their activities in the years 1980-1990. The initially planned time frame of the decommissioning operations was about ten years, but due to strong presumptions of contamination beneath one of the buildings and difficulties not foreseen by the licensee, the operations will extend beyond the originally planned date, at least until 2037 for PROCÉDÉ and 2040 for SUPPORT. The first versions of the final shutdown and decommissioning decree modification applications submitted by CEA in 2015 were deemed inadmissible by ASN and the MSNR (Nuclear Safety and Radiation Protection Mission). In 2018, the CEA submitted new versions of the decree modification applications, particularly concerning the decommissioning time frames and the final state. ASN considered these files admissible but proposed requests for additional information on the methodology for cleaning out the soils and structures and managing the waste, which were taken up by the MSNR.

The Grenoble site had six nuclear facilities:

- the SILOETTE reactor (BNI 21), which was delicensed in 2007;
- the MELUSINE reactor (BNI 19), which was cleaned-out and then delicensed in 2011;
- the LAMA[3] laboratory (BNI 61), which was delicensed in 2017;
- the Siloé reactor (BNI 20), which was delicensed in 2015;
- the Radioactive waste treatment station (BNI 36) and the Interim radioactive waste decay storage facility (BNI 79) for which the final shutdown decree was published in 2008. The decree of 18 September 2008 prescribes a time frame of eight years for completion of the works involved. The technical discussions between ASN and the CEA concluded that the clean-up (remediation) of the soils

[1] The PROCÉDÉ facility accommodated the research and development activities on nuclear fuel reprocessing, transuranium elements, radioactive waste and the examination of irradiated fuels.
[2] The SUPPORT facility is used to characterise, treat, repackage and store legacy radioactive waste and waste from the decommissioning of the PROCÉDÉ facility.
[3] The LAMA laboratory conducted post-irradiation studies of uranium and plutonium based nuclear fuels, and structural materials from nuclear reactors.

has been completed. Nevertheless, slight radioactive contamination persists in the soils, requiring the implementation of active institutional controls. The CEA lodged its BNI delicensing application file in December 2019 along with a file for the introduction of active institutional controls. ASN will examine the delicensing file in 2020.

ASN considers that the CEA Grenoble centre is delicensed.

6.3.4.7. CEA / Cadarache centre

The RAPSODIE reactor (BNI 25)

The RAPSODIE experimental reactor (BNI 25) is the first sodium-cooled fast-neutron reactor built in France. It functioned until 1978. A reactor vessel sealing defect led to its final shutdown in 1983.

Decommissioning operations have been undertaken since its final shutdown but were partly stopped further to a fatal accident in 1994.

In December 2014, CEA sent ASN its complete decommissioning authorisation application and the periodic safety review file for the facility in May 2015. Requests for additional information were made in October 2015 by the Ministry responsible for nuclear safety. The licensee replied to these requests in 2016. The technical examination should be completed in 2020. The operations carried out by the CEA at present mainly involve removing waste containing sodium.

The fuel assembly shearing laboratory

The purpose of the fuel assembly shearing laboratory (LDAC), located within BNI 25, was to perform inspections and examinations on irradiated fuels from the fast-neutron reactors. This laboratory has been shut down since 1997 and partially cleaned out. Its decommissioning is planned for in the decommissioning project for the entire BNI.

The enriched uranium processing facilities (BNI 52)

Until 1995, the enriched uranium processing facilities (ATUE, BNI 52) converted uranium hexafluoride from the enrichment plants into sinterable oxide, and ensured the chemical reprocessing of waste from the manufacture of fuel elements. The facility comprised an incinerator for low-contamination organic liquids. The production activities in the facilities ceased in July 1995 and the incinerator was shut down at the end of 1997.

The final shutdown and decommissioning decree for the ATUE facility was issued in February 2006, and prescribed work completion in 2011. After having observed that the decommissioning operations were stopped and that the CEA had not responded to its request to file an application for a new authorisation to complete the decommissioning, ASN gave the CEA formal notice on 6 June 2013 to submit a new file. CEA submitted the file in question at the end of February 2014. The environmental authority issued its opinion on this file in early 2017. A draft decree was transmitted to the MSNR in 2019.

The plutonium technology facility (BNI 32) and the chemical purification laboratory (BNI 54)

The plutonium technology facility (ATPu, BNI 32) produced plutonium-based fuel elements intended for fast neutron or experimental reactors and then, as of the 1990s, for pressurised water reactors using MOX fuel. The activities of the chemical purification laboratory (LPC, BNI 54) were associated with those of the ATPu: physical-chemical inspections and metallurgical examinations, processing of contaminated effluents and waste. The two facilities were shut down in 2003.

The final shutdown and decommissioning decrees for the ATPu facility and the LPC laboratory were published in March 2009. The decommissioning of the two facilities – which was governed by the resolutions of 26 October 2010 - continued in 2016, with the substantial scale of operations resulting in a significant reduction of the source term. For some of them, the licensee submitted modification notifications, examined by ASN, such as the sorting, repackaging and metal scrap transfer operations, or organisational changes to maintain sub-criticality.

ASN has acknowledged receipt of the periodic safety review concluding report submitted late 2019. This file is currently being examined.

The Central fissile material warehouse (BNI 53)

The central fissile material warehouse (MCMF) (BNI 53) was a warehouse for storing enriched uranium and plutonium until all the nuclear materials it contained were removed, marking the final shutdown of the facility on 31 December 2017. The CEA submitted its decommissioning file in November 2018 and it is currently being examined by ASN.

The ÉOLE reactor (BNI 42) and MINERVE reactor (BNI 95)

The experimental reactors ÉOLE and MINERVE are very-low-power (less than 1 kW) critical mock-ups that were used for neutron studies, in particular to evaluate the absorption of gamma rays or neutrons by materials.

The ÉOLE reactor (BNI 42), whose construction was authorised by a Decree of 23 June 1965, was intended primarily for neutron studies of moderated arrays, in particular those of pressurised water reactors and boiling water reactors. The MINERVE reactor (BNI 95), whose transfer from the Fontenay-aux-Roses studies centre to the Cadarache studies centre was authorised by a Decree of 21 September 1977, is situated in the same hall as the ÉOLE reactor. Teaching and research activities were carried out on these mock-ups until their final shutdown on 31 December 2017.

ASN's examination of the decommissioning file for these facilities began in July 2018 and continued in 2019, and the expert appraisal by IRSN has begun. Pending decommissioning, operations in preparation for decommissioning, such as the removal of radioactive and hazardous substances, took place in 2018 and 2019.

The PHEBUS reactor (BNI 92)

The Phébus reactor (BNI 92) is an experimental pool-type reactor with a power rating of 38 MWth which functioned until 2007. The CEA submitted its decommissioning file in February 2018 and it is currently being examined by ASN. Evacuation of the fuel, which represented the essential part of the facility's source term, was completed in January 2019. On completion of the technical appraisal, the BNI 92 decommissioning file will be reviewed at the meeting of the Advisory Committee for Decommissioning (GPDEM) in 2020.

6.3.4.8. CEA / Saclay site

The Saclay site counts four facilities in final shutdown status: BNI 18 (Ulysse reactor, BNI 40 (Osiris and Isis reactors), BNI 101 (Orphée reactor) and BNI 49 (high activity laboratory). Among these facilities, BNIs 40 and 101 are in the decommissioning preparation phases, BNI 49 is in the decommissioning phase, and the decommissioning of BNI 18 was completed in August 2019. BNIs 35 and 72, which are still in operation but have parts which have ceased their activity, are also preparing for decommissioning.

Solid radioactive waste management zone at Saclay (ZGDS)

The CEA declared the shutdown of BNI 72 on 31 December 2017, then revised its request so that the waste retrieval and conditioning activities to support the Saclay site could be continued until the date of publication of the decommissioning decree or the end of 2022 at the latest. The CEA submitted its decommissioning file in December 2015. ASN has made several requests for additional information, particularly concerning the equipment for retrieving the waste and fuel contained in the facility wells (EPOC). The GPDEM issued an opinion on the decommissioning in May 2019, at the same time as the periodic safety review of the facility transmitted in 2017. The environmental authority also issued its opinion in September 2019. The public inquiry will take place in 2020.

The High activity laboratory (BNI 49)

The high activity laboratory (LHA, BNI 49) comprises several laboratories which were intended for research into, or the production of, various radionuclides.

On completion of the decommissioning work authorised by a Decree of 18 September 2008, only two laboratories should ultimately remain under the ICPE system. Despite the progress of the clean-out and decommissioning operations, the accumulated delays have prevented the CEA from meeting the deadline of 21 September 2018 set by the decree authorising LHA decommissioning. The discovery of pollution in certain intercell yards in 2017 also led to changes in the operations to be carried out. The licensee must therefore draw up a decommissioning decree modification file. It is expected in 2021.

The ULYSSE reactor (BNI 18)

The ULYSSE reactor (BNI 18) was a French university reactor which was definitively shut down in February 2007.

The final shutdown and decommissioning authorisation decree for the BNI was published on 21 August 2014 and provided for a five-year decommissioning period.

On 8 August 2019, the CEA announced the end of the decommissioning operations provided for in the decommissioning decree, with the completion of final post-operational clean-out. The facility therefore no longer has any areas regulated on account of radiation protection, or areas where nuclear waste can be produced.

Some one hundred blocks of concrete resulting from the cutting-up of the "conventional" part of the reactor block are still present in the facility. Samples were taken from these blocks at the end of 2019 to check that the planned clean-out targets had been met. When the analysis results are received, which should be during the first half of 2020, and provided they are satisfactory, the last concrete blocks from the Ulysse reactor will be able to be removed.

In 2020, the CEA will start the procedures aiming to delicence the facility and withdraw it from the BNI System.

The Osiris / Isis reactor (BNI 40)

BNI 40 comprises the Osiris pool-type reactor with a power rating of 70 MWthn associated with its critical mock-up Isis, with a power rating of 700 KWth. In view of its old-generation design and its ageing, the Osiris reactor underwent final shutdown at the end of 2015, while final shutdown of the Isis reactor took place in March 2019. In October 2018, the CEA submitted the BNI 40 decommissioning file which was subject to an admissibility analysis by ASN. This first stage of the examination revealed in particular the need to describe the operations planned at each stage of decommissioning in greater detail, to better substantiate the initial state envisaged at the start of decommissioning, and the results of the impact study. The Advisory Committee for Decommissioning will issue an opinion on the decommissioning file in 2021.

The Orphée reactor (BNI 101)

The Orphée reactor (BNI 101), with an authorised power of 14 MWth, was a pool-type research reactor moderated by heavy water and intended to produce neutron beams. It was authorised by a Decree of 8 March 1978 and its first divergence was in 1980.

The Orphée reactor was definitively shut down in October 2019. A decommissioning file was submitted in March 2020.

6.3.4.9. CEA / Marcoule site

The facilities undergoing decommissioning and the WRP projects on the CEA Marcoule site represent the highest priorities of the CEA's decommissioning and waste management strategy, on account of the high hazard potential present on the site. Furthermore, this site accommodates the sole waste and effluent treatment facilities for handling all the CEA centres' output.

The PHENIX reactor (BNI 71)

The PHENIX reactor (BNI 71), built and operated by CEA, is a sodium-cooled fast-neutron reactor demonstrator. It was definitively shut down in 2009.

The decree requiring the CEA to proceed with the decommissioning operations was published on 2 June 2016. The ASN resolution of 7 July 2016 supplemented the provisions of the abovementioned decree.

In addition to specifying the prescriptions concerning the decommissioning of the BNI and its periodic safety review, the resolution defines the expected content of the commissioning file for the future NOAH facilitycurrenlty being built, whose function is to transform the sodium from PHENIX and other CEA facilities into sodium hydroxide.

ASN keeps regular track of application of the conclusions of the safety review conducted in 2014 and on the progress of the core unloading operations which should be completed in 2025.

The facilities of the CEA Marcoule DBNI

The DBNI is made up of 17 individual facilities, each of them being equivalent to one BNI in the civil sector.

Seven facilities are in service:

- the Liquid Effluent Treatment Station;
- the "NUCLAB" analysis laboratory
- the Solid Waste Conditioning Unit, before transfer to Andra;
- the Marcoule Materials Decontamination Unit;
- The Marcoule Treatment Unit;
- the Irradiated Fuel Assemblies Surveillance Facility;
- the Alpha Waste Storage and Conditioning Facility.

Ten facilities are shut down or undergoing decommissioning:

- The Marcoule Vitrification Unit;
- the spent fuel reprocessing plan (UP1), undergoing decommissioning;
- Marcoule pilot spent fuel reprocessing unit, currently undergoing post-operational clean-out;
- the GCR reactors G1, G2 and G3, decommissioned to IAEA level 2 at present;
- the Célestin reactors 1 and 2, moderated and cooled by heavy water, used for the production of tritium;
- the 2 units for decladding and pre-processing spent fuel from the GCR reactors, currently undergoing post-operational clean-out;
- the waste storage area in the North zone.

6.3.4.10. Orano La Hague UP2-400 plant (BNIs 33, 38 and 47)

The UP2-400 assembly comprises the former reprocessing plant UP2-400 (BNI 33) and the corresponding facilities, shut down since 2004:

- the STE2A effluent treatment station (BNI 38);
- the HAO oxide high activity facility (BNI 80);

- the ELAN IIB facility (BNI 47), which manufactured caesium-137 and strontium-90 sources until 1973.

BNI 80 carried out the first stages of the reprocessing of spent oxide nuclear fuels (reception, storage then shearing and dissolution). The dissolution solutions produced in BNI 80 were then transferred to the UP2-400 industrial plant in which the subsequent reprocessing operations took place.

Decommissioning of the HAO facility was authorised by the decree of 31 July 2009.

The waste retrieval and packaging (WRP) project currently under way in the HAO silo and the SOC (organised disposal of hulls) facility represents the first hold point in the decommissioning of the installation. The waste retrieval operations are carried out in a cell situated above the silo. The equipment of this cell is currently being tested. BNI 80 has also undergone a periodic safety review which led to a resolution dated 4 January 2018.

On account of the delays in the retrieval of waste from the HAO silo, the revising of the HAO/South decommissioning scenario (cells 904 and 906 in particular and the need to eliminate the interactions between the NPH pool and the HAO in an earthquake and strong wind situation, Orano has undertaken to submit, before the end of 2020, a modification application file for the BNI 80 decommissioning decree (substantial modification giving rise to a public inquiry).

In October 2008, Orano submitted three authorisation applications for final shutdown and decommissioning of the other facilities in the UP2-400 plant: BNI 33 (UP2-400), BNI 38 (STE2 and AT1 facility) and BNI 47 (Élan IIB).

After examining the files submitted in 2008, ASN considered that the provisions defined by Orano for the decommissioning of BNIs 33 and 38 comprised nothing unacceptable from the point of view of safety, radiation protection or the management of waste and effluents. Nevertheless, this examination did reveal the necessity for the licensee to provide a large number of additional studies. Consequently, for BNIs 33 and 38, only those operations for which the information provided in the safety cases was considered sufficient were able to be authorised.

The three decrees authorising commencement of the final shutdown and decommissioning operations for the three BNIs date from 8 November 2013. The decrees concerning BNIs 33 and 38 only authorise partial decommissioning, whereas the decree concerning BNI 47 authorises complete decommissioning of the installation.

Pursuant to the decrees of BNIs 33 and 38, Orano submitted new complete decommissioning application files for BNIs 33 and 38 in July 2015, and supplemented them in March 2017. It also submitted the periodic safety review files for BNIs 33, 38 and 47 which gave rise to an ASN resolution of 25 June 2019. On the same date, Orano requested modifications to the scopes of BNIs 117 and 118 so that some of the units of BNIs 33 and 38 that it intends to keep in operation could be attached to them.

In April 2018, the licensee updated the decommissioning applications for BNIs 33 and 38 in order to reintegrate the units that it intends to keep in operation and thus request the partial decommissioning of these BNIs. Orano submitted its reply to the opinion of the Environmental Authority, and explicitly requested that the deadline of 31 December 2022 for the elimination of interactions between the MAPu and BST1 buildings be pushed back. The public inquiry is scheduled for 2020.

During 2019, Orano continued the decommissioning operations on the UP2-400 plant authorised by the decrees in force. ASN has noted that the first retrieval deadlines prescribed by the ASN resolution of 9 December 2014 relative to the legacy waste retrieval and packaging have not been met, mainly because of the changes in the reference scenarios associated with situations that were not considered, and shortcomings in the initial characterisations. These deadlines concern more specifically the waste from silo 130, from the HAO silo, from the settling tanks and the retrieval and conditioning of the sludge from STE2. Insofar as retrieval of the legacy waste at the La Hague site is of major importance for safety due to the scale of the potential source term in the event of an accident and the ageing of the facilities, ASN - supported by the DGEC for the financial aspects concerning the long-term costs, and after completing an exploratory approach into the state of the Orano project baseline - wanted to conduct an inspection in October 2019 addressing the monitoring of progress of complex WRP projects and their management. ASN underlined the high standard of engineering competence for the development and command of technical solutions, but also noted shortcomings which represent safety risks for these old facilities and hamper the progress of the WRP projects as a whole.

6.3.4.11. Orano uranium fluorination plant at Tricastin

The Orano uranium fluorination plant is situated in the perimeter of BNI 105 on the Tricastin platform. This plant mainly produced uranium hexafluoride (UF_6) for the fabrication of nuclear fuel. Its production was stopped in 2008. The part of the plant manufacturing UF_6 from natural uranium is covered by the ICPE regulations. The part manufacturing UF_6 from reprocessed uranium is covered by the BNI regulations.

An initial decommissioning file submitted in 2011 by Comurhex was modified in February 2014 by Orano following the change of nuclear licensee operating BNI 105. Examination of the file ended in 2019 with the publication of the decommissioning decree. The main issues associated with the decommissioning of BNI 105 are linked to the risks of dissemination of radioactive substances and exposure to ionising radiation due to the residual uranium-containing substances present in some equipment items.

6.3.4.12. Georges Besse I plant (BNI 93)

The Georges Besse I facility operated by Orano (BNI 93) was a plant for separating uranium isotopes using the gaseous diffusion process which ceased production in May 2012.

The decommissioning presents major challenges with regard to the volume of VLL waste produced and the duration of decommissioning (currently estimated at 30 years).

The licensee submitted its decommissioning file in March 2015. Examination of this file was concluded by the publication of a Decree of 5 February 2020 instructing Orano Cycle to proceed with the George-Besse I plant decommissioning operations.

ASN will be attentive to the maintaining of rigour in facility monitoring and of a safety culture that is appropriate for the specific shutdown situation of the facilities.

The main residual risk in the facility now is associated with the UF6 containers in the storage yards, which are still within the facility perimeter. These yards should ultimately be attached to the Tricastin uranium storage areas (BNI 178).

6.3.4.13. SICN plant in Veurey-Voroize

The former nuclear fuel fabrication plant in Veurey-Voroize operated by Société industrielle de combustible nucléaire (SICN - Orano) comprised two nuclear installations, BNIs 65 and 90. The fabrication activities were stopped in early 2002. The decommissioning authorisation decrees dated from 15 February 2006. As the decommissioning works have been completed, delicensing of the facilities has been considered, accompanied by a request from the licensee to introduce institutional controls to restrict the use of the soils and the groundwater which display an acceptable level of residual contamination, and guarantee that the use of the land remains compatible with the state of the site. SICN submitted this file to the Prefect's office of the Isère *département* in March 2014 and sent the delicensing application file for the two BNIs to ASN with a 2018 update. Active institutional controls on the use of the water and soils were introduced by the Prefect of Isère on 1 October 2019, after completing the examination procedure and the public inquiry. The delicensing of BNIs 65 and 90 was pronounced by ASN resolutions of 29 October 2019, approved by ministerial orders.

6.4. State oversight of the ring-fencing of BNI decommissioning funding

The conditions of State oversight of the ring-fencing of funding for BNI decommissioning are the same as those applicable to the oversight of the ring-fencing of funding for the "long-term costs" as described in § F.2. 3. The Environment Code provides for a financial securing mechanism that covers both the management of radioactive waste and spent fuel and the costs of decommissioning the BNIs.

6.5. The case of ICPEs and mines

6.5.1. The case of ICPEs

The conditions of rehabilitation of an ICPE site after the end of operation can be provided for in authorisation order. In the case of facilities subject to notification, the conditions of post-operational rehabilitation of the site must be specified in the impact notice provided at the time of notification.

The ICPE regulations stipulate that the licensee must notify the Prefect of the intended cessation of activity at least three months before stopping operations. Where waste storage facilities with a limited authorised duration are concerned, notification must be given at least six months before the authorisation expiry date.

For facilities subject to notification, the notification must indicate the actual or planned site rehabilitation measures. The site must be restored to a state compatible with an industrial or commercial activity.

For facilities subject to authorisation, the licensee must include with the notification a file containing an updated plan of the land on which the facility is installed and a review on the state of the site specifying the actual or planned environmental protection measures. This review addresses:

- the removal or elimination of hazardous products, of the fire and explosion risks, and the removal of the waste present on the site;
- the depollution of the facility site and of the groundwater if polluted;
- integration of the facility site into its environment;
- if necessary, measures to monitor the impact of the facility on its environment.

The licensee must restore the site to a state such that it presents no hazard or nuisance for the neighbourhood or the environment. If the rehabilitation works have not been envisaged in the authorisation order or if they merit being detailed, the former licensee and the mayor of the municipality concerned have negotiations to determine the future use of the site. If they fail to agree, it is the Prefect who determines the future use of the site, with reference to the last period of operation, save incompatibility with the urban planning documents in force on the date of cessation of activity. The ICPE inspectorate can propose that the Prefect issue a complementary order laying down the requirements for the rehabilitation of the site.

The Prefect must be informed of completion of the rehabilitation work as stipulated in the authorisation order or in a complementary order. The ICPE inspector establishes the conformity of the work through an as-built inspection report.

If ownership of the land is transferred, the acquiring entity must be informed that an ICPE subject to authorisation was operated on the land, and also be informed of any pollution problems that might subsist on the site.

It should be noted that the Prefect can at any time issue an order imposing on the licensee the prescriptions necessary for protection of the environment, even after the site has been rehabilitated.

6.5.2. The case of mines

The end of mining operation is marked by a dual procedure: the notification of final cessation of operations, which comes under the authority of the Prefect's office, and surrendering of the concession which is pronounced by the Minister in charge of mines. The purpose of these procedures is to relieve the licensee of responsibility for policing the mines on condition that it has met all its obligations.

Although acknowledgement of cessation of operations and the surrendering of the concession mean that the licensee can no longer be held accountable for special policing of the mines, the civil liability of the licensees and concession holders with respect to third parties nevertheless remains permanent. Since the act of 30 March 1999 concerning the disappearance or defaulting of the responsible person or entity, the State is the guarantor of compensation for damages; it is now subrogated in the rights of the victims against the responsible person or entity. On completion of the cessation of operations procedure, the licensee can transfer to the State the management of the hydraulic safety facilities (treatment plant for example) and the surveillance of mining risks. This transfer is accompanied by a cash payment corresponding to the maintenance of the facilities for a period of 10 years.

Acknowledgement of final stopping of the mining of radioactive substances has most often obliged the licensee to continue monitoring all the parameters as was required during operation. If this monitoring reveals no abnormality, complementary orders can put an end to the monitoring operations. Given that the ICPEs are the main potential sources of radioactive pollution, the mine policing orders simply accompany the orders issued on account of the ICPEs.

SECTION G | SAFETY OF SPENT FUEL MANAGEMENT (ART. 4 TO 10)

1| GENERAL SAFETY REQUIREMENTS (ARTICLE 4)

Each Contracting Party shall take appropriate measures to ensure that, at all stages of spent fuel management, persons, society and the environment are adequately protected against radiological risks.

In doing so, each Contracting Party shall take the appropriate steps to:

i) ensure that criticality and removal of the residual heat produced during spent fuel management are suitably taken into account;

ii) ensure that the production of radioactive waste associated with the management of spent fuel is maintained at the lowest level that can be reached, given the type of fuel cycle policy adopted;

iii) take account of the interconnections between the different stages of spent fuel management;

iv) ensure effective protection of persons, society and the environment by applying nationally appropriate methods of protection which have been approved by the regulatory body in the framework of its national legislation, which takes due account of the internationally approved criteria and standards;

v) take into account the biological, chemical and other risks that can be associated with spent fuel management;

vi) try to avoid actions whose reasonably foreseeable effects on the future generations are greater than those accepted by the current generation;

vii) try to avoid imposing excessive constraints on future generations.

1.1. Legal framework and ASN oversight

In France, most of the spent fuel management facilities have basic nuclear installations (BNI) status. As such, the fuel management facilities are subject to the BNI authorisation and oversight system built around the provisions of chapters III, V, VI of title IX of book V and the provisions of chapter II of title IV of book V of the Environment Code (see section E.2. 2).

This system is said to be "integrated" because it aims to prevent or control all risks and detrimental effects a BNI is liable to create for people and the environment, whether or not these are of a radioactive nature. Radiological, biological, chemical and other risks are addressed in terms of protection of the interests mentioned in article L. 593-1 of the Environment Code (security, public health and safety, or protection of nature and the environment).

Issued pursuant to article L. 593-4 of the Environment Code, the order of 7 February 2012 defines the essential requirements applicable to the BNIs in order to protect the above-mentioned interests throughout their lifetime, from design to delicensing. Article 1.2 of the order of 7 February 2012 states that the licensee must ensure that its activities related to the safety case, the management of detrimental effects and the impact on health and the environment, or waste management, take account of the current state of the knowledge and the best techniques available. Article 3.4 also stipulates that management of nuclear chain reactions, the removal of heat from radioactive substances and nuclear reactions, the containment of radioactive substances, the protection of people and the environment against ionising radiation must be taken into account in the safety case. Finally, article 6.1 requires that the licensee take all necessary measures as of the design stage to prevent and reduce, particularly at source, the production and the harmfulness of the waste generated by its installation.

Article L. 542-1 of the Environment Code stipulates that means to ensure the definitive safeguarding of radioactive waste must be sought and implemented in order to prevent or minimise the burdens to be borne by future generations. For this purpose, article L. 542-1-2 of the Environment Code requires that every three years, a National Radioactive Materials and Waste Management Plan (PNGMDR) be drawn up to inventory the existing management methods for radioactive materials and wastes and the technical solutions adopted, identifying the foreseeable need for storage or disposal facilities and specifying the capacity necessary for these installations and the storage durations (see section A.1.2). The TECV Act of 17 August 2015 requires that for their shut down facilities, the licensees aim for decommissioning as rapidly as possible, which also tallies with the goal of limiting the burden placed on future generations.

The Environment Code also defines the requirements regarding the evaluation of the long-term costs, the provisions the licensees must take into account and their coverage by dedicated assets (see sections B.1.7.1 and F.2.3.2). These requirements regarding the funding of the long-term costs apply to the management of radioactive waste and spent fuel, and to the decommissioning of all the facilities.

An important aspect of the safety of the fuel cycle is linked to the necessary consistency between the developments in the fuel management approaches envisaged for the NPPs and the characteristic and possible changes in the cycle facilities (upstream and downstream of the cycle and management of radioactive waste). This consistency must be verified taking into account the texts applicable to the fuel cycle facilities and to the transport of radioactive and fissile materials, which means in particular: the facility creation authorisation decrees, the liquid and gaseous effluents and water intake authorisation orders and the associated ASN resolutions, and the technical requirements and regulations applicable to the transport of radioactive materials.

As the main ordering customer, EDF must identify and characterise the technical and regulatory constraints of the fuel cycle in order to make it possible to adequately anticipate the interconnections between the various steps: processing of the materials to be used, fuel fabrication, introduction into the reactor, transport of materials, removal of spent fuel, receipt and storage of spent fuels, possible reprocessing of spent fuels and management of the waste.

In order to verify compliance with these requirements, ASN:

- authorises the major steps in the life of the nuclear fuel cycle facilities and the modification requests;
- checks compliance with the prescriptions applicable to these facilities; among other things, ASN checks the licensees' organisation in order to ensure that satisfactory account is taken of the social, organisational and human factors (SOHF) and operating experience feedback;
- verifies that the overall consistency of the fuel cycle mentioned above has effectively been obtained. For this purpose and in collaboration with Orano Cycle and Andra, EDF periodically produces a "Cycle Impact" file which ASN uses as a basis for issuing an opinion.

ASN does not ensure the oversight of Defence-related facilities (DBNI) and certain radioactive waste management facilities that do not fulfil the conditions defined by Articles R. 593-1 et seq. of the Environment Code and its appendix. In the first case, the DBNIs are monitored by the ASND (for the fuel cycle, this concerns materials storage areas and support facilities). The facilities which are neither BNIs or DBNIs may have the status of Installations Classified for Protection of the Environment (ICPE), in which case they are placed under the control of the Prefects, or may be licensed by ASN under the Public Health Code.

An oversight procedure is also conducted through the examination of the "Cycle Impact" files, which are periodically submitted by the licensees (see § G.1.3.1).

1.2. Safety policies of the BNI licensees

1.2.1. CEA's safety policy

The CEA's safety policy consists in preventing the risk of dispersion of radioactive substances and limiting the exposure of workers to ionising radiation. To achieve this, a succession of lines of defence, that is to say physical barriers (equipment, enclosures, etc.) and organisational means (monitoring, procedures) are placed between the radioactive substances, the personnel and the environment.

Nuclear safety is a major priority for the CEA. This priority must translate into decisions and actions that foster nuclear safety. This attitude constitutes the "safety culture". The nuclear safety organisation in place at the CEA is based on a continuous line of responsibility.

The Chairman takes the necessary measures to implement the legislative, regulatory and particular provisions and requirements applicable to the activities presenting nuclear risks and to the organisation of nuclear safety at the CEA.

The Chairman is assisted by the Director of Security and Nuclear Safety as well as the other functional directors responsible for the preparation of General Management's decisions and the Security and Nuclear Safety Committee, the body tasked with preparing General Management's decisions relating to the objectives, strategic orientations and functioning with regard to nuclear safety.

Under the authority of the Chairman, the nuclear safety competences and responsibilities are divided between the senior management of each centre, lines of managers, means of support and an oversight function.

The persons responsible for the lines of action have access to means of support comprising a network of skills in the various areas of safety, logistic support and a methodological and operational support provided at each CEA centre.

The heads of facilities ensure, by delegation, the nuclear safety of the activities, facilities and materials under their authority.

The oversight function, referred to as "second level", consists in verifying – with regard to the nuclear safety objectives, the effectiveness and adequacy of the organisation, of the means and actions conducted by those responsible for the lines of action and their internal monitoring. The oversight function is carried out by entities independent of those constituting the lines of action. It is carried out by CEA General Management and by the senior management of each Centre.

The CEA has put in place a system of internal authorisations that fits into the ASN notification system and is based on the submission of an authorisation application file by the line of action to the Director of the Centre in which the facility is located. The Director asks for the opinion of the oversight unit of the Centre and, whenever necessary, that of a Safety Committee convened by the Director comprising permanent members and experts consulted according to the particularities of the operation being examined. The members and experts are appointed by the Chairman.

1.2.2. Orano's safety policy

Nuclear safety is a priority for Orano. The group has formalised its commitments in the area of nuclear safety and radiation protection in a Nuclear Safety Charter, mentioned in section F.3.2.3, which aims to guarantee the requirement for a very high level of safety throughout the lifetime of the facilities.

The prime responsibility of the licensee is clearly laid down in this charter: each entity director is responsible for safety and radiation protection within their entity. The levels of delegation of responsibility are established within each entity, in relation with the operational hierarchical line and within the limit of the assigned competences. The organisation in place is geared to meet the legal and regulatory requirements, particularly in the areas of nuclear safety, radiation protection and security of transport.

Over and beyond the technical checks, the internal checks are performed by personnel independent of the operating teams:

- the "first level" checks are carried out on behalf of the entity director and aim essentially at verifying that the safety baseline requirements and the system of delegations are correctly applied;
- the "second level" checks are carried out by the corps of safety inspectors, appointed by name by the General Director.

The concept of defence in depth is the fundamental safety principle for nuclear facilities. It is characterised by numerous levels of protection defined and applied on the basis of prior risk analyses. These levels are based on technical particularities, an organisation, procedures, operating modes and relevant skills. Any industrial project or change in the way of functioning or modification to an existing facility is subject to a prior analysis of the associated risks.

The utilisation of experience feedback is developed at different levels, and its dissemination so that all the group entities can benefit from it is the responsibility of the network of specialists of the central Safety Health Security Environment Department.

All people working in the facilities, whether employees of the group or of its subcontractors, are informed of the risks associated with their job, and the measures taken to prevent and control these risks. Employees have a duty to alert their supervisor if they observe blatant negligence or disregard for a legal requirement. They benefit from the same protections, whatever their status. They are trained and involved in the implementation of risk prevention and safety improvement actions.

The protection of workers against ionising radiation is a clearly stated priority, as much for the group employees as for the outside contractors.

Nuclear events are evaluated on the INES scale and made public in France if they are rated level 1 or higher on this scale. The level-0 events are indicated in the annual site information reports.

Emergency situation management is organised to guarantee optimum responsiveness and effectiveness on the ground. Exercises are held regularly to train the teams and learn lessons in terms of organisation, improvement in skills, communication and stakeholder involvement in order to achieve the best possible control of potential degraded situations or exceptional events.

Orano endeavours to provide reliable and relevant information that enables everyone to make an objective assessment of the state of safety of its facilities. In accordance with the Environment Code, the nuclear sites establish and issue a nuclear safety report each year. This report is submitted to the Health, Safety and Working Conditions Committee (CHSCT) of the site prior to publication. Alongside this, in application of the provisions of the nuclear safety charter, the General Inspectorate draws up an annual report on the safety of the group's facilities which is presented to General Management, to the Group's Board of Directors and is made public.

1.2.3. EDF's safety policy

Scope of application

The safety policy mentioned is that applied to the BNIs in operation and those undergoing decommissioning. As holder of the authorisation or decommissioning decrees, EDF SA is the nuclear licensee.

In accordance with the legislative and regulatory provisions in force, EDF SA establishes and undertakes to implement a policy clearly confirming:

- the priority given to the protection of the interests of public health and safety, nature and the environment, primarily by preventing accidents and mitigating their consequences with regard to nuclear safety;
- the constant search for improvements in the measures taken to protect these interests.

Chair of EDF SA

The Chief Executive Officer (CEO) has all the necessary powers to enable EDF SA to carry out its duties as nuclear licensee. He delegates nuclear licensee responsibilities to the Group's Executive Director in charge of the Nuclear and Thermal power plant fleet.

The Group Executive Director in charge of the Nuclear and Thermal fleet is the ASN point of contact and may ask the Director of the Nuclear Generating Division (DPN) to represent him in this role for the BNIs in operation or the Director of the of Dismantling and Waste Projects (DP2D) for the BNIs undergoing decommissioning. He may also call upon the Director of the Nuclear Fuel Division (DCN) for the purposes of his nuclear cycle integration duties.

Entities in charge of BNI operation and the design of BNI modifications at EDF SA

The Directors of the DPN, of the Fleet Engineering, Dismantling and Environment Division (DIPDE) and of the DP2D develop a Management System that contributes to compliance with the nuclear safety and radiation protection rules within the organisation and the functioning of their entity. In this respect, they ensure 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.

The Group Executive Director in charge of the Nuclear and Thermal Fleet appoints the Fleet Engineering, Dismantling and Environment Division (DIPDE) as the Design Authority for BNIs in operation and undergoing decommissioning. In this respect, the Director of the DIPDE guarantees that the design status of the facilities and their developments throughout their life cycle are in conformity with the baseline safety requirements in force. In so doing, the Design Authority draws on the expertise of the engineering centres designated as "Responsible Designers".

The Site

The NPP Director or the Site Director is the representative of the nuclear licensee EDF SA with regard to the installations for which he has received delegation from the DPN Director for the NPPs in operation, or the Director of the DP2D for the sites undergoing decommissioning. More specifically:

- he proposes and implements the principles of organisation and operation that ensure compliance with nuclear safety and radiation protection rules and allow the effective exercise of the responsibilities of the nuclear licensee, EDF SA;
- he relies on an Integrated Management System and has compliance with the requirements verified through appropriate internal monitoring. He ensures the development of continuous improvement and the adoption of best practices, including those identified internationally;
- he reports the information relating to nuclear safety and radiation protection to the Director of the DPN, for the BNIs in operation, or to the Director of the DP2D, for facilities undergoing decommissioning. He is the chief point of contact for the national and local competent regulatory authorities for the aspects specific to the facilities under his responsibility.

The Independent Safety Organisation

Each level of the company calls on the services of an Independent Safety Organisation (FIS) providing an independent opinion 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 support for the management. 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.

1.3. The ASN analysis

1.3.1. Review of the consistency of the fuel cycle

As mentioned in section G.1.1, ASN also monitors the overall consistency of the industrial choices made with respect to spent fuel management, in terms of safety and the regulatory framework[1].

To do this, on the basis of a “Cycle Impact” file transmitted by EDF and jointly drafted every ten years with the French fuel cycle stakeholders, namely Orano, Framatome and Andra, ASN examines the consequences on the various stages of the fuel cycle of EDF’s strategy of using new fuel products and new fuel management processes in its reactors. In 2015, ASN asked EDF for an overall revision of the “Cycle Impact” file to be carried out in 2016 in order to obtain a robust and long-term overview of the changes that could affect all cycle activities and the consequences of these changes on the facilities and transport activities.

The purpose of this file is to show that the changes in fuel characteristics or in irradiated fuel management, the developments to the fuel cycle facilities planned or envisaged by the industrial players concerned or the foreseeable changes in means of transport are in no respect unacceptable, over the coming fifteen years, whether with regard to the operating safety of the NPPs, the operation of the front-end and back-end plants in the cycle or the medium and long-term management of the waste. It shall also demonstrate long-term management of movements and stocks of materials, fuels and waste and anticipate difficulties or contingencies in the operation of the fuel cycle.

EDF submitted the updated "Cycle Impact" file to ASN on 30 June 2016. The 2016 update of the "Cycle Impact" file presents several new aspects compared with the previous approaches initiated in 1999 and 2006:

- the study period, which habitually covered ten years, is increased to fifteen years, in order to take account of the time actually observed in the nuclear industry to design and build any new facilities identified as being necessary further to the assessment carried out;
- radioactive substance transport contingencies are explicitly incorporated into the assessment;
- nuclear reactor closure scenarios are studied for the period of time considered, in particular assuming stable electricity demand until 2025, to take account of the scheduling planned for in the Energy Transition Act;

ASN issued its opinion on this file on 18 October 2018 (ASN Opinion 2018-AV-0316 of 18 October 2018 on the consistency of the nuclear fuel cycle in France). ASN considers that the "2016 Cycle Impact" file provides a satisfactory overview of the consequences of the various nuclear fuel cycle development scenarios on the nuclear facilities, transport operations and waste. It has noted that the consequences of the various nuclear fuel cycle development scenarios on the facilities, transport operations and waste were duly studied, but the consequences of contingencies that could affect operation of the fuel cycle should be examined in greater depth.

ASN has underlined the need to anticipate any strategic change in the functioning of the fuel cycle by at least ten years so that it can be designed and carried out under controlled conditions of safety and radiation protection. It emerges in particular that to avoid reaching the capacity limit of existing storage facilities too quickly (nuclear reactor pools and the La Hague site facilities), any reduction in the electricity produced by

[1] The other types of monitoring and oversight listed in section G.1.1 are addressed in sections F.3.3 (monitoring of quality management), F.6.3 (monitoring the decommissioning stratetgies), G.2.3 (examining the safety reviews of the cycle facilities) and H.1.3 (monitoring the waste management strategies).

reactors using MOX fuel over the next ten years or so must be accompanied by a reduction in the production of reactors using enriched natural uranium (ENU).

In the longer term, it will be necessary either to have new storage capacities that are very significantly greater than the current and projected capacities, or to be able to use MOX fuel in reactors other than the 900 MWe reactors, which are the oldest. This could be envisaged for the 1,300 MWe reactors, due to their number. Given the amount of work that the studies and modifications required to ensure the safety of operation of these reactors with MOX fuel represent, the time frame between the making the decision and its implementation will be about ten years. ASN considers it necessary to have, as soon as possible, relevant information to determine the feasibility of using MOX fuel in the 1,300 MWe reactors with regard to the safety and radiation protection issues. ASN also considers it necessary to define the strategy for interim storage of the spent fuels should the use of MOX fuel in the 1,300 MWe reactors be found impractical.

Moreover, the Government has published the "multi-annual energy plan" (MEP), which is updated every five years. ASN has asked the industry players to study the consequences in terms of safety and radiation protection of the MEP on the nuclear fuel cycle and its coherence.

The recommendations have focused in particular on:

- the need, in view of the closure of 14 reactors as required by law between now and 2035, to ensure there is a sufficient proportion of reactors using MOX fuel given the French capacities to store spent fuel and EDF's intention not to increase the stock of separated plutonium;
- the need to have alternative solutions on the assumption that France will not have new spent fuel storage capacities in service by 2030;
- the management strategy for a reactor fleet that is bound to evolve significantly in its size and will have to use several different types of fuel (MOX, ERU, ENU);
- the breakdown of the fuel cycle into functional units, making it easier to identify the possible malfunctions and adapt the ageing control strategies of the facilities concerned accordingly.

1.3.2. Decommissioning and waste management strategy

With regard to the CEA, ASN and the ASND sent a letter on 21 July 2015 to its Chairman, asking him to send them an update of the management strategy for radioactive waste (solid and liquid) and civil radioactive materials, including spent fuels. The file was received in December 2016 and ASN issued an opinion on it in mid-2019 (see section F.6. 3.1.1).

With regard to Orano, ASN and the ASND sent several letters in June 2014 to its Chairman and to the directors of the La Hague and Tricastin sites, asking them to transmit the group’s national strategy and the local strategy for the sites with regard to decommissioning and waste management. The files, received in June 2016, are currently being examined (see section F.6. 3.1.2).

2| EXISTING FACILITIES (ARTCILE 5)

Each Contracting Party shall take appropriate measures to examine the safety of any spent fuel management facility in existence when the Convention comes into effect and to ensure that, if necessary, all improvements that can reasonably be made to increase safety are effectively introduced.

2.1. Legal framework and ASN oversight

The law requires the licensees, in addition to the permanent analysis of operating experience feedback, to carry out a periodic safety review of their BNIs, whether they are in operation or undergoing decommissioning.

This process must allow continuous improvement of the safety of the facilities and may lead to modifications of the facility or its operating envelope. Questions relating to behaviour in the event of an earthquake, for example, often reveal the need to reinforce the facilities, the feasibility of which, once assessed, may lead the licensee to decide to shut down the facility in the more or less short term.

2.2. Review of the safety of facilities by BNI licensees

2.2.1. Safety review by the CEA

The CEA implements a project-based organisation for the periodic safety reviews. In view of their implications and the means required to conduct them, all the envisaged or planned periodic safety reviews are set down in a multi-year schedule which takes into account for each facility, in the form of a sliding plan, a 10-yearly review frequency, as well as the major modifications planned for and, if applicable, the projected end-of-life date for the facility.

The first aim of the periodic safety review is to take stock of the safety of the facility and identify any deviations from the baseline safety requirements in effect and from current safety and radiation protection regulations and practices.

To do this, the CEA first details its strategy for the facility with regard to the definition of the operating functions and duties, and their durability.

The second aim consists in conducting a safety re-assessment, with the aim of taking appropriate compensatory measures to:

- bring the facility to a level that is as safe as reasonably possible, consistent with its remaining life time and according to the estimated cost of any modifications required in view of the safety issues;
- reduce the exposure of the operating personnel to as low a level as reasonably possible, focusing on the most exposed jobs in priority;
- reduce the detrimental effects on the environment (discharges and waste) to as low a level as reasonably possible, by trying in particular to eliminate the production of waste for which there is no disposal route, limiting discharges to the environment, promoting internal recycling processes and consolidating the safety of the storage areas within the facility.

The CEA proposes measures to upgrade the safety of its facility which consist in reinforcing certain lines of defence or adding new ones, and is materialised by requirements concerning the safety-important components or components important for the protection of interests (systems and equipment or operating rules).

These measures form the subject of a safety analysis. The conclusions of the periodic safety review are presented to ASN, which gives its opinion on them before the modifications and the safety case of the modified facility are carried out. Then the baseline safety requirements of the facility are updated.

The periodic safety review therefore results in modifications to enhance safety (structures, equipment, operating rules, etc.), maintenance and clean-out work and revision of the operating documents.

2.2.2. Safety review by Orano

The periodic safety reviews represent a continuous and demanding process. The ten-yearly safety review is an important milestone in terms of safety of the facilities, and its merits are now widely acknowledged internationally. It contributes to and makes explicit the continuous actions to maintain and improve the safety of nuclear facilities.

Today it calls for continuous action within the Group, firstly due to the number of facilities undergoing a periodic safety review each year or whose review file is currently being examined, and secondly due to the implementation of the improvement actions resulting from the safety review.

This process, which has been regulated for several years in France, is based on two major technical lines: the conformity review and the safety review.

Emphasis is placed first on the conformity review. The conformity review of a facility consists in verifying that the regulatory developments and the changes to the facility and its operation, due to modifications (technical, process, production, organisation, etc.) or to its ageing do not call into question the design safety analyses and remain in conformity with the authorised operating envelope. This conformity review is based on the facility requirements baseline which is constantly kept up to date. This baseline is made up of texts comprising several levels: regulatory texts - both general and specific to the facility, discharge and water intake authorisation decrees, codes and standards, correspondence and exchanges with the authorities (ASN prescriptions, Advisory Committee of Experts follow-ups, licensees' commitments, etc.), directives, group standards and requirements, facility baseline requirements (safety analysis report, general operating rules, on-site emergency plan, waste study, decommissioning plan, impact study, etc.).

A physical verification schedule for the facility, in addition to the permanent actions in this area, has been drawn up and implemented. The licensee takes into account in priority the protection-important components (PIC) that contribute to the control of the BNI safety functions. The licensee also demonstrates its management of ageing of the facilities. It proposes adaptations to its maintenance or monitoring programmes and the implementation of compensatory measures defined on the basis of the study of ageing phenomena and knowledge acquired through experience.

A plan for verifying the conformity of the operating practices with the documents of the applicable safety baseline requirements has also been drawn up and implemented.

A compliance plan is defined and implemented if necessary.

The safety review serves to re-analyse the safety of the facility in the light of current safety and radiation protection practices (particularly the guides, standards and basic safety rules), by integrating all the operating experience feedback for the facility (dosimetry, effluents, waste, anomalies, incidents, etc.) and from accidents having affected similar facilities in France and abroad. This leads to the identification of lines of improvement for the facilities or their operation.

2.2.3. Safety review by EDF

2.2.3.1. EDF's periodic safety review process for existing facilities

In accordance with the French regulations governing BNIs, every 10 years EDF conducts a safety review of these installations by standardised plant series. This procedure comprises three phases:

- a description of the baseline safety requirements comprising a set of rules, criteria and specifications applicable to standardised plant series;

- a demonstration of the conformity of the standard state of each unit series with the baseline safety requirements, followed by a compliance check of all reactor units with the reference state;
- a reassessment of the safety requirements based on a review of all the safety-important information, identifying any modifications to be made to the standard design and operating status of the plant series. In view of the extent of the induced work, EDF carries out the work mainly during the 10-yearly outage, which is a long outage.

This procedure enables the conformity of the reactors with the applicable baseline requirements to be verified. It moreover highlights the safety aspects requiring an in-depth analysis in view of French or foreign operating experience feedback and developments in knowledge. This analysis can lead to a change in the baseline requirements which corresponds to a new reference status, with updating of the safety analysis report which underpins the associated safety case.

The probabilistic safety studies are applied, when relevant, particularly when looking for and analysing accident initiators or prioritising the main components of risk and assessing the level of safety, and for assessing the benefits of certain modifications with regard to their safety implications and difficulty of implementation.

Following each periodic safety review, the baseline safety requirements for each plant series change, taking account of the safety improvements made. On completion of the work on each plant unit, a report is sent to ASN to enable it to make a statement on the conditions of operation for another 10-year period.

Further to the nuclear accident at the Fukushima NPP in Japan (see section A. 3), a stress test approach was initiated. In September 2011, EDF presented to ASN the stress tests of the plant units of each site in extreme situations. This approach made it possible to (i) increase the existing margins of the nuclear plant units with respect to the external hazard risks taken into consideration in the current baseline and (ii) to define a first batch of proposed modifications to be implemented in the short and medium term to cope with extreme situations.

In June 2012, ASN issued a number of technical prescriptions concerning the implementation of additional measures to deal with extreme external natural hazards and prevent accidents and, were an accident to occur, to mitigate its effects and prevent long-term off-site contamination. These initial prescriptions were supplemented by ASN in January 2014 with resolutions setting additional requirements to be met by the structures, systems and components of the “hardened safety core”.

For EDF’s nuclear reactors, these new requirements correspond to major works and investments, which started in 2012 and will continue for several years and which entail:

- the implementation of a programme to improve coverage of total loss of water and electricity supply situations, consisting in:
    - providing all sites with new means, first of all mobile and then fixed, to increase their autonomy with regard to water and electricity,
    - reinforcing robustness to total loss of electrical power situations by installing on each plant unit a new ultimate backup diesel generator set (DUS) that is robust to extreme hazards,
    - improving emergency management, notably by setting up new local emergency management centres (CCL),
    - reinforcing and training the operating teams on shift.
- as of 2012, the gradual deployment of the "Nuclear Rapid Intervention Force" (FARN), an internal EDF national intervention force comprising specialised teams (about 300 staff) and equipment, capable of taking over from the teams of a site affected by an accident and implementing additional emergency

response means within 24 hours, with operations beginning on the site within 12 hours following mobilisation. This arrangement consisting of national and regional bases may be common to several nuclear sites. The arrangement has been fully operational since the end of 2015;

- a new on-site emergency plan (PUI) baseline has been deployed on all EDF sites since 15th November 2012. It takes into account accident situations simultaneously affecting several facilities on a given site;
- for the reactor fuel storage pools, reinforced measures to reduce the risk of uncovering of the fuel, including an ultimate make-up system, which is to be installed on all sites from 2017 to 2021, together with installation of the ultimate back-up diesel generator sets in the plant units;
- the implementation of a "hardened safety core" of material and organisational measures to control the fundamental safety functions in extreme situations. Its aim is to prevent or limit the spread of a severe accident, to minimise large-scale radioactive releases and – even in extreme situations – to enable the licensee to carry out its emergency management duties. The equipment of this hardened safety core shall be designed to withstand major events (earthquake, flood, tornado, etc.), of a greater scale than those considered in the current baselines to determine the level of resistance of the facilities.

The EDF post-Fukushima programme is on the one hand a response to the Fukushima Daiichi accident in Japan (phases 1 and 2) and on the other addresses the safety goals for EDF reactors with regard to the “operating duration” dossier (phase 3).

Thus, the hardened safety core will allow, in an extreme situation (i.e. natural hazard significantly more severe than the design-basis hazard):

- prevent reactor melt by prioritising cooldown by the secondary systems (ultimate secondary cooldown by the steam generators);
- remove residual power from the reactor containment without opening the containment venting system. This system consists of a new hardened safety core pump and an exchanger allowing long-duration operation in recirculation on the reactor building sumps;
- prevent containment basemat melt-through by installing a corium dry-spreading system and passive reflooding with water from the sumps;
- prevent uncovering of the spent fuel assemblies stored or being handled (ultimate make-up, robustness of pools and connected systems, etc.) and prevent the risk of falls by spent fuel packagings and fuel assemblies during handling.

This is in line with EDF’s NPP operating duration objective, which – for the current fleet – is to aim to meet the safety objectives of the generation 3 reactors (EPR-FLA3 in France) and minimise the risk of cliff-edge effects (large-scale, long-term radioactive releases into the environment), in the event of hazards significantly beyond the initial design-basis scenarios, by implementing the hardened safety core.

These new material and organisational provisions, which represent an industrial programme and level of investment of an unprecedented scale, will be deployed on the occasion of the 4th periodic safety review of the 900 and 1300 PWR plant series and as of the 3rd periodic safety review of the N4 plant series.

2.2.3.2. Spent fuel cooling pools on the sites, storage and removal of spent fuel

This review includes the safety of the fuel building (BK) and of the fuel assembly cooling pool (earthquake resistance, cooling capacity and required limits, surveillance, incident operating procedures).

The scenarios examined are the risks of emptying of the spent fuel storage pools and loss of cooling. The aim of the future modifications is to prevent uncovering of the fuel assemblies: we can mention, for example, the automatic shutdown of the cooling system pumps of the BK pool if very low level is detected, and measurement of rate of emptying which reduces very significantly the risk of fuel assembly uncovering.

As mentioned earlier, the design and the resistance of the spent fuel pools situated in the NPPs were examined in the framework of the stress tests performed further to the Fukushima Daiichi NPP accident.

More specifically, in response to the ASN requirements, EDF has presented the studies and modifications to be made to its facilities:

- measures to reinforce prevention of the risk of accidental emptying of the fuel building pool:
    - re-sizing of the siphon vacuum breaker on the fuel pool cooling system discharge line, allowing emptying to be stopped should this line suffer a guillotine break,
    - automation of isolation of the cooling system intake line, which will prevent gravity draining of the pool via the intake line,
    - studies of the robustness to an earthquake significantly beyond the design basis level of the transfer tube, with installation of a double casing if necessary; the transfer tube has been tested to the "hardened safety core" earthquake (SND) on the 900 MWe plant series,
    - prevention of the risk of rapid loss of the water inventory in the storage compartment in the event of hypothetical situations of leakage in the drainage line of the BK pool transfer compartment or the compartments of the reactor building (BR) pool.
- with regard to the accident situation management provisions:
    - ultimate backup water make-up system to be installed as of 2017 and until 2021, jointly with the installation of the ultimate backup diesel generator on the plant units (see above),
    - robustness of the pool instrumentation for managing the situation, particularly water makeup management.

Lastly, with regard to the increase in the level of defence in depth, EDF is deploying by the 4th periodic safety review of the 900 PWR series, an additional BK pool cooling system which will provide a resilient system that will subsequently increase the robustness of the reactors to loss of cooling situations.

This modification will be applied to all the 900 MWe reactors save the two Fessenheim reactors which are to undergo final shutdown in 2020, and for which removal of the spent fuel is scheduled within a time frame of 3 years after final shutdown.

2.2.3.3. Safety of transport operations

EDF has integrated the experience feedback concerning noncompliance with the regulatory limits of non-fixed surface contamination during the transportation of radioactive materials and waste and spent fuel, by revising a set of rules of good practice supplementing the official regulations and constituting the "EDF baseline transport requirements":

- the consignor is responsible for the conformity of the consigned packages, particularly the quality of the checks and the consignment documents;
- EDF qualifies and monitors the carriers it uses;
- notification, analysis and lessons learned from transport events in case of deviation and treatment of low-level events; monitoring of the effectiveness of the actions taken;
- putting in place Ministry of Transport-qualified transport security advisors, locally on the sites in accordance with the regulations and at national level for expert assessments, support and advice;

- requirement for the carriers to put in place an emergency response plan;
- periodic holding of Radioactive Materials Transport emergency exercises with the participation, at least, of the sites, the central services and the carriers.

2.2.4. Safety review by the ILL

The ILL (Laue-Langevin Institute) must specify, for the safety review scheduled in 2017, its strategy regarding the defining of the future functions and operating missions of the High Flux Reactor (HFR), and their duration.

The ILL takes appropriate measures to:

- bring the facility to as safe a level as reasonably possible;
- reduce the future ionising radiation exposure of the operating personnel to as low a level as reasonably possible;
- reduce the detrimental effects for the environment (discharges and waste) to as low a level as reasonably possible.

The ILL puts in place measures that reinforce the lines of defence (prevention, mitigation) or add lines of defence and are materialised by requirements concerning the protection-important components (PIC).

The ILL implements its safety analysis methodology recently evaluated by IRSN, to deduce these reinforcement measures. The PICs and their defined requirements result from this analysis. The ILL also conducts a conformity assessment, both regulatory and technical.

The conclusions of the periodic safety review are presented to ASN, which adopts a position before the modifications and the safety case of the modified facility are carried out. Then the baseline safety requirements of the facility are updated. The safety review will also make a statement on the safety organisation of the ILL.

Thanks to the regular investments made in the HFR, the safety review should lead to a very limited number of modifications (structures, equipment, operating rules, etc.). The complete 10-yearly safety review file was submitted to ASN on 2 November 2017. A meeting of the Advisory Committee of Experts is planned in 2020. Thanks to the work carried out for the stress tests and the good upkeep of the facility, the number of action commitments resulting from this review is relatively small.

2.3. ASN analysis

Orano and Framatome have carried out the periodic safety review of all their facilities in order to check that both their ageing and the changing safety requirements have been taken into account. This series of first periodic safety reviews highlighted the need for numerous reinforcements, which sometimes led to the replacement of complete units. They notably enabled these licensees to put in place a structured procedure for identifying and giving a hierarchical order to the protection-important components (PIC) of their facilities, contributing to a significant improvement in the control of the effects of ageing, maintenance and control of conformity.

2.3.1. The Orano Cycle reprocessing plants in operation on the La Hague site

In November 2017, Orano Cycle submitted to ASN the periodic safety review file for BNI 118, which comprises the effluent treatment station (STE3), the solvents mineralisation facility (MDS/B) and the sea discharge pipe.

During its examination of the file, ASN called upon the Advisory Committee for Laboratories and Plants (GPU). The GPU shall issue its opinion during 2020.

The periodic safety review file for the UP3-A plant (BNI 116) at La Hague was transmitted to ASN in 2010. At the request of ASN, the IRSN (French Institute for Radiation Protection and Nuclear Safety) assessed this report and presented the results of its analysis to the GPU at six meetings held between mid-2012 and March 2015, and which examined:

- the method and the data used by Orano Cycle to conduct this safety review and the procedure for identifying the safety-important components and its application to the UP3-A plant;
- the operating experience feedback, especially with regard to the incidents which have occurred at the UP3-A;
- the safety measures for the packages for on-site transport of radioactive materials;
- the conformity of BNI 116 with its baseline safety requirements, management of ageing of this facility and safety of maintenance operations;
- the safety reassessment conducted by the licensee, in particular in the light of changing regulations and best practices in safety and radiation protection as well as the lessons learned from operating experience feedback from the facility;
- the programme of measures defined by the licensee to improve the safety of its facility, in order to rule on the level of safety of the UP3-A plant both now and for the next ten years.

On completion of this examination, ASN instructed Orano to make safety improvements through its resolution of 3 May 2016. ASN also considered it necessary to increase the checks of the equipment for concentrating the facility's fission products (the "fission product concentration evaporators"). This equipment is effectively corroding faster than anticipated in its design.

As the maintained integrity of these items has major safety implications, the ASN Commission gave a hearing to General Director of Orano Cycle on 11 February 2016. In its resolution of 23 June 2016, ASN stipulated the conditions to be met by the licensee for continued operation of the fission products concentration evaporators in the La Hague plants. ASN is particularly attentive to the development of the corrosion on these items of equipment; in particular, the evaporator 4120-23 of the T2 unit (UP3-A plant) which is the most severely corroded of the six evaporators in operation, is currently subject to specific commitments on the part of the licensee and tightened surveillance by ASN since it was restarted in December 2019. A request concerning the defining of the evaporator shut down criterion is currently being examined.

Alongside this, Orano submitted in 2019 the authorisation application files for the processes of the six future evaporators of the R2 and T2 units, which will replace the preceding ones, called "new fission product concentrations" (NCPF), with a view to commissioning in 2022-2023. These applications are currently being examined. The civil engineering structures to accommodate these new items of equipment are currently under construction and underwent several inspections in 2019.

Orano submitted the periodic safety review file for the UP2-800 plant in January 2016. This file has been examined unit by unit, and not by technical theme as was the case for the UP3-A plant. Several meetings of the GPU were thus necessary between 2017 and 2019 to examine the entire file.

Orano took advantage of the methodology review and the conclusions of the safety review of the UP3-A plant to improve its process for the safety review of the UP2-800 plant (BNI 117), particularly as regards the identification of the PICs and the associated defined requirements, in compliance with the BNI order. The analysis and conclusions of ASN shall form the subject of prescriptions, a follow-up letter, and an examination report for the minister, which is currently being drafted.

2.3.2. The Orano Cycle Melox MOX fuel fabrication plant

The Melox BNI, situated on the Marcoule site and operated by Orano Cycle, is at present the only nuclear installation in the world producing MOX fuel, which consists of a mixture of uranium oxide and plutonium oxide.

In September 2021, the licensee must file the concluding report for its next periodic safety review, having submitted the safety review guidance file (DOR) in September 2018. One of the main issues of this file concerns the proposal of a new seismic hazard with a safe shutdown earthquake (SSE) response spectrum that is less constraining than the one currently in effect. The Melox plant has experienced production difficulties over the last few years associated with use of uranium obtained from a dry process. The entry into service of a new wet process (NVH) for the production of uranium at Malvési by 2023 should return production to the normal level.

In 2019, ASN observed that the safety situation in the facility is on the whole satisfactory. ASN does however note delays in the commissioning of the new emergency situation management premises planned for under the post- Fukushima works. For the Melox site, the implementation of the provisions called for by the stress tests consisted in putting into service in 2017 remediation means for cooling the material storage areas and making available to the licensee an Emergency Management Building for the site, the construction of which began in 2018 and is currently being completed.

2.3.3. The EDF reactors

2.3.3.1. 900 MWe reactors

After examining, assisted by IRSN, the objectives proposed by EDF and consulting its Advisory Committees of Experts and the public, ASN adopted a position on the objectives of the fourth periodic safety review of the 900 MWe reactors and formulated additional requests in April 2016. In 2018 EDF supplemented its work programme and presented to ASN the measures it is considering to meet these demands. With the support of IRSN, ASN is continuing to examine the generic studies linked to this review. In 2018 and 2019, ASN more particularly obtained the opinion of its Advisory Committees.

In 2020 it will again ask the Committees for their opinion on the results of the generic phase of this periodic safety review.

In September 2018, ASN sent EDF its initial observations on the inspections and modifications EDF intends to implement on its reactors in order to meet the objectives of the periodic safety review. At the end of 2020, ASN will issue a position statement on the conditions for continued operation of the reactors.

In 2019, the Tricastin NPP reactor 1 underwent its fourth ten-yearly outage inspection, which is a major step in its fourth periodic safety review. During this outage, EDF carried out a significant part of the required inspections and will deploy the first safety improvements associated with the review. ASN will issue a position statement on the continued operation of this reactor in 2022, after its position statement on the generic studies and its examination of the periodic safety review concluding report for this reactor, which is to be submitted by EDF in 2020.

For the purposes of this periodic safety review, ASN has been involving the public since 2016 in the drafting of its position statement regarding the objectives proposed by EDF. This approach continued in 2018, under the aegis of the High Committee for Transparency and Information on Nuclear Security (HCTISN), in the form of a consultation on the measures planned by EDF to meet these objectives. ASN will also consult the public at the end of 2020 on the position it will adopt on the generic phase of the periodic safety review. Pursuant to the law, a public inquiry will then be held, reactor by reactor, after submission of the periodic safety review concluding report for each reactor.

2.3.3.2. 1300 MWe reactors

At the beginning of 2015, ASN issued its opinion on the generic aspects of the continued operation of the 1300 MWe reactors beyond 30 years of operation. ASN considers that the steps taken or planned by EDF to assess the condition of its 1300 MWe reactors and manage their ageing up until the fourth periodic safety review are acceptable. ASN also considers that the modifications identified by EDF following this study phase will help to significantly improve the safety of these installations. These improvements particularly concern reinforcing the protection of the facilities against hazards, reducing releases of radioactive substances in the event of an accident, with or without core melt, and preventing the risk of uncovering of the fuel assemblies stored in the spent fuel pit or during handling.

Since 2015, several 1,300 MWe reactors have undergone their third 10-yearly outage. These third 10-yearly outages of the 1300 MWe reactors will span until 2024.

In July 2017, EDF presented a file giving the orientations envisaged for the generic phase of the fourth periodic safety review of the 1300 MWe reactors. In 2019, ASN adopted a position on these orientations, notably by consulting the Advisory Committee for Nuclear Reactors (GPR) on 22 May 2019. ASN considers that the general objectives set by EDF for this review are acceptable in principle. However, following its requests regarding the fourth periodic safety review of the 900 MWe reactors, ASN asks EDF to modify or supplement these general objectives for this safety review, to consider certain baseline requirements for reassessment of the safety of its facilities and to add study topics to its review programme.

2.3.3.3. 1450 MWe reactors

In 2011, EDF transmitted its proposed orientations for the generic study programme of the second periodic safety review for the 1450 MWe reactors. After consulting the Advisory Committee for Nuclear Reactors in 2012, EDF supplemented its generic studies programme with a number of measures and clarified some of its proposals. ASN issued a position statement in February 2015 on the orientations of this second periodic safety review. ASN more specifically considers that the safety objectives to be considered for the second safety review of the 1450 MWe reactors must be defined in the light of the objectives applicable to the new reactors and has asked EDF to study the measures that could meet this requirement as rapidly as possible, so that they can be implemented as of the second periodic safety reviews of the 1450 MWe reactors. Reactor B2 of the Chooz NPP underwent its second 10-yearly outage in 2019; the other 10-yearly outages of the 1450 MWe reactors will span until 2022.

3| CHOICE OF SITE FOR PROJECTED FACILITIES (ARTICLE 6)

1. Each Contracting Party shall take appropriate measures for procedures to be put in place and applied for a projected spent fuel management facility with a view to:

i) assessing all the relevant factors associated with the site which could influence the safety of this facility during its useful life time;

ii) assessing the impact that this facility could have, from the safety point of view, on persons, society and the environment;

iii) to provide the public with information on the safety of this facility;

iv) to consult the Contracting Parties who are neighbours to such a facility, insofar as this facility could have consequences for them and to communicate to them, at their request, general data concerning the facility to enable them to assess its probable impact in terms of safety on their territory.

2. In doing so, each Contracting Party shall take appropriate measures so that such facilities do not have unacceptable effects on other Contracting Parties by choosing their site in accordance with the general safety requirements set out in article 4.

Any spent fuel management facility is a BNI or part of a BNI.

Consequently, any new facility is subject to the general regulations governing BNIs which, as regards the choice of sites, is presented in detail in section E.2. 2.2.

At present EDF if working on a new spent fuel storage pool project with commissioning planned for 2030. The licensee has presented a safety options dossier on which ASN issued a position statement in its opinion of 23 July 2019. Submission of the corresponding creation authorisation application is required by 31 December 2020 under the PNGMDR 2016-2018.

Noting that the deadline set for the end of 2020 would not be met, the ASN Commission gave EDF a hearing regarding its strategy to meet the need for increased storage capacities, the measures envisaged, including for contingencies, and their projected implementation schedule.

EDF presented its forecasts regarding the quantities of spent fuels to store, the updated deployment schedule for a centralised storage pool, and several responses that could be developed to counter the project schedule overruns.

The ASN Commission reminded EDF of the strategic dimension of this centralised storage pool project for the overall safety of the nuclear installations. The Commission emphasised the importance of anticipating the needs and of the ownership of this project in order for it to be designed and carried out in compliance with the safety and radiation protection requirements and controlled time frames.

EDF must moreover detail the solutions it plans implementing to overcome the delays in the centralised storage pool project and demonstrate their conformity with current safety requirements.

4| DESIGN AND CONSTRUCTION OF THE FACILITIES (ARTICLE 7)

Article 7: Each Contracting Party shall take appropriate measures to ensure that:

i) during the design and construction of a spent fuel management facility, appropriate measures are planned to restrict any radiological impacts on persons, society and the environment, including those due to effluent discharges or uncontrolled emissions;

ii) at the design stage, theoretical plans and, depending on the needs, technical provisions for the delicensing of a spent fuel management facility, are taken into account;

iii) the technologies used in the design and construction of a spent fuel management facility are based on experience and tests or analyses.

The technologies used for the design and construction are based in particular on past experience and the implementation of periodic tests or analyses of the facilities, in accordance with legislation and regulations.

The procedures are described in section E.2.2.3, the technical rules in section E.2.2.5 and the rules concerning discharges in section E.2.1. The safety measures taken by the licensees are presented in § G.2. 2.

ASN implements the regulations through the examination of technical files, the analysis of significant events and inspections it carries out in accordance with procedures presented in sections E.2.2.6 and E.2.2.7. ASN's actions concerning the periodic safety reviews performed by Orano, the CEA and EDF are presented in § G.2.3.

Lastly, with regard to the technical measures for delicensing a BNI, the regulations stipulate that the decommissioning plan for the installation, submitted in the BNI creation authorisation application file, must be updated in the BNI decommissioning application file (see section F.6. 1.3.1).

In the case of the EDF's spent fuel storage project mentioned in § G.3, ASN considered in its Opinion 2019-AV-0331 of 23 July 2019 that, insofar as the intended purpose of this facility was to store spent fuel for a period of about one hundred years, its main safety functions had to be guaranteed in the event of a commercial airliner crash. The possible development of flying objects over the period in question must be taken into account.

5| ASSESSMENT OF THE SAFETY OF THE FACILITIES (ARTICLE 8)

Article 8: Each Contracting Party shall take appropriate measures to ensure that:

i) before constructing a spent fuel management facility, a systematic assessment of safety and an environmental assessment as appropriate for the risk presented by the facility and spanning its useful life time are carried out;

ii) before operating a spent fuel management facility, updated and detailed versions of the safety assessment and the environmental assessment are established when deemed necessary to supplement the assessments mentioned in i) above.

The general regulations for BNIs described in section E.2.

The measures taken by the licensees are presented in § G.2.2 which addresses existing facilities.

The regulations concerning the safety evaluation are presented in § E.2.2.3.1, E.2.2.3.2, E.2.2.3.3, E.2.2.4.1, E.2.2.4.2, E.2.2.4.3 and E.2.2.4.4, which focus respectively on the safety assessment, creation authorisations, commissioning authorisations, substantial or notable modifications to the facilities, monitoring of incidents and, lastly, final shutdown and decommissioning of the facilities.

ASN implements the regulations through the analyses and inspections it carries out in accordance with procedures presented in sections E.2.2.6 and E.2. 2.7.

6| OPERATION OF THE FACILITIES (ARTICLE 9)

Each Contracting Party shall take appropriate measures to ensure that:

i) the license to operate a spent fuel management facility is based on the appropriate assessments specified in article 8 and is conditional upon execution of a commissioning schedule demonstrating that the as-built facility complies with the design and safety requirements;

ii) operating limits and conditions resulting from tests, operating experience and the assessments specified in 'article 8 are defined and revised if necessary;

iii) the operation, maintenance, monitoring and surveillance, inspection and testing of a spent fuel management facility are ensured in accordance with the established procedures;

iv) engineering and technological support in all safety-related areas is available throughout the useful lifetime of a spent fuel management facility;

V safety-significant incidents are notified in good time to the regulatory body by the license holder;

vi) programmes to collect and analyse relevant operating experience data are put in place and the results are followed-up when necessary;

vii) plans for the delicensing of a spent fuel management facility are developed and updated as required using the information obtained during the useful lifetime of this facility and are examined by the regulatory body.

6.1. The authorisation process

The general regulations regarding the operating authorisation for BNIs, including spent fuel management facilities, are described in detail in § E.2. 2.

6.2. Practices of the BNI licensees

6.2.1. The CEA's in-service safety practices

Licenses are issued to the CEA in accordance with the procedures described in section E.2. In-service safety is ensured in conformity with the general and particular regulations and forms the subject of periodic safety reviews (see § G.2. 2)

The quality and durability of the technology and engineering support are guaranteed by the quality commitments described in section F.3.2.2 and by the human and material resources described in section F.2.2.2. The delicensing practice is described in section F.6. 2.1.

The baseline safety requirements of the CEA facilities are established when making the commissioning authorisation application and are updated if modifications are introduced or during the periodic safety reviews. They comprise a safety analysis report, general operating rules which are also drawn up by the licensee and approved by ASN, and technical requirements imposed by ASN. These baseline requirements define the operating envelopes authorised by ASN.

These baseline safety requirements documents are supplemented by a set of procedures and operating instructions drawn up by the licensees; they are intended to enable the operational management operations to be applied on the ground consistently with the baseline safety requirements and its operating envelope.

Significant events occurring in the CEA facilities are reported to ASN. These events are then analysed in order to identify their root causes and define the corrective and preventive actions to put in place to prevent them from recurring. The significant event report is produced and sent to ASN within 2 months at the most.

In 1999 the CEA put in place a "central experience file" which enables all the players concerned to have information on the events, and an events analysis guide which has been drawn up to provide uniformity in the drafting of the events reports, to help with their assessment and to codify the results.

The CEA draws on lessons learned from the analysis of the events reports to improve the safety of the facilities, identify the generic weaknesses with regard to safety, define the targeted lines for progress and disseminate them as widely as possible.

6.2.2. Orano's in-service safety practices

Operation is ensured in accordance with the baseline requirements of the facility described in § G.2.2.2. In the context of the periodic safety reviews, an operating practices conformity verification plan is drawn up and implemented. It takes into account the permanent or temporary operating instructions, the main operational procedures, the main maintenance procedures and the operational management instructions for degraded situations. Particular attention is paid to the ergonomics and the availability of the documentation at the work stations and the integration of changes in the operating rules and the organisation. The operating processes relative to the management of deviations, modifications and documents, which contribute to keeping these baseline requirements up-to-date, are described and analysed. Their effectiveness is also assessed.

Outside these review periods, supporting the operators and regularly checking the application or knowledge of any new procedures by the management staff or the head of the facility are vital for the control of the particular situations of the work stations. This support approach is also important on the decommissioning worksites where the environment and the work conditions evolve constantly as the dismantling of the equipment progresses. It effect, the control of risks often rests in part on the operating rules, which must minimise the potential risk of human error. In such cases it is important that the understanding and justification of the operating constraints be perceived at the fair value of the risks by those who are responsible for applying them. Training, skills assessment and information campaigns are implemented at all levels of the hierarchy.

6.2.3. EDF's in-service safety practices

The licenses are issued to EDF in accordance with the procedures described in section E.2. Operation is ensured in conformity with the general and particular regulations as described in § G.2.2.3. The quality and durability of technological and engineering support are guaranteed by the quality provisions described in section F.3.2.4 and by the human and material resources described in section F.2.2.4. The delicensing practice is described in section F.6. 2.3.

6.2.4. ILL's in-service safety practices

The baseline safety requirements of the HFR are established when making the commissioning authorisation application and are updated if modifications are introduced or during the periodic safety reviews. These baseline requirements define the operating envelope authorised by ASN.

These baseline safety requirements are supplemented by a set of procedures and operating instructions drawn up by the licensees, usually by the operators; they are intended to enable the operational management operations to be applied on the ground consistently with the baseline safety requirements and their operating envelope.

Incidents are reported to ASN as rapidly as possible. These incidents are then analysed in order to identify their root causes and define the corrective and preventive actions to put in place to prevent them from recurring. The incident report is drawn up and sent to ASN within 2 months.

The ILL draws on lessons learned from the analysis of the incident reports and all anomalies that have occurred in order to improve the safety of the facilities, identify the generic weaknesses with regard to safety, define the targeted lines for progress and disseminate them as widely as possible.

7| FINAL DISPOSAL OF SPENT FUEL (ARTICLE 10)

If, in accordance with its own legislative and regulatory framework, a Contracting Party has designated spent fuel for final disposal, this is carried out in accordance with the obligations stated in chapter 3 for the final disposal of radioactive waste.

Spent fuels are not at present intended for direct final disposal, with the exception of a few experimental spent fuels. The spent fuels are either reprocessed (UOX), or stored with a view to potential multi-recycling in the current-generation reactors (see Section B 2.4.2) or in a fleet of fourth-generation fast-neutron reactors (MOX and ERU).

For UOX reprocessing and in accordance with the plutonium traffic balancing principle applied by EDF, the annual reprocessing traffic is calculated so as to obtain no more than the precise quantity of plutonium necessary for fabrication of the MOX fuel.

If these fuels were to be reclassified as waste at some time in the future, they would need to be accepted in a deep geological disposal facility (Cigéo project).

On 31 May 2016, ASN issued an opinion on the notion of reversibility of the deep geological disposal facility, entailing adaptability and recoverability requirements. Reversibility is defined in the Act of 25 July 2016 which is now codified in Article L. 542-10-1 of the Environment Code.

The adaptability requirement implies that the facility must take account of possible changes to energy policy or industrial choices, for example leading to direct disposal of spent fuels. Article D. 542-90 of the Environment Code specifies that "the inventory to adopt for the studies and research conducted in view of designing the disposal facility shall include a reference inventory and a reserve inventory". The reserve inventory "takes account of uncertainties, more specifically linked to the deployment of new waste management routes or changes in energy policy".

The PNGMDR 2016-2018 requires that in 2017, Andra proposes the types and quantities of waste to be included in the Cigéo reserve inventory.

Andra submitted this study in June 2017, followed by an update in July 2019. The spent fuel quantities entered in the reserve inventory are calculated considering an "adaptability scenario", which is a variant of the non-renewal scenario adopted in the 2018 issue of the national inventory.

In its opinion of 10 February 2015 concerning the evaluation of the cost of the Cigéo project, ASN had considered that the reserve inventory[1] should be used by Andra as input data for its cost calculations. The PNGMDR 2016-2018 recommends in this respect that Andra submit, when filing the Cigéo creation authorisation application with the Minister responsible for energy, a cost estimate relating to the direct disposal of spent fuels from the operation of the nuclear power reactors and experimental reactors.

Andra has stated that this evaluation will be provided concomitantly with the filing of the Cigéo creation authorisation application, which is scheduled for 2021.

Furthermore, the updating of the total evaluation of the costs of the Cigéo project, approved by the Minister responsible for energy in accordance with Article L. 542-12 of the Environment Code, shall be made public during the Cigéo creation authorisation process, in accordance with the Government and ASN resolution of 21 February 2020 further to the public debate on the 5th PNGMDR.

Study period, which habitually covered ten years, is increased to fifteen years, in order to take account of the time actually observed in the nuclear industry to design and build any new facilities identified as being necessary further to the assessment.

[1] Called adaptability inventory in 2015

SECTION H | SAFETY OF RADIOACTIVE WASTE MANAGEMENT (ART. 11 TO 17)

Each Contracting Party shall take the appropriate measures to ensure that, at all stages of radioactive waste management, persons, society and the environment are adequately protected against radiological and other risks.

In doing so, each Contracting Party shall take the appropriate measures to:

i) ensure that criticality and the removal of residual heat produced during radioactive waste management are suitably taken into account;

ii) ensure that the production of radioactive waste is maintained at the lowest level that can be achieved;

iii) take into account interconnections that exist between the different stages in the management of radioactive waste;

iv) ensure effective protection of persons, society and the environment by applying nationally appropriate methods of protection which have been approved by the regulatory body in the framework of its national legislation, which takes due account of the internationally approved criteria and standards;

V take into account the biological, chemical and other risks that can be associated with radioactive waste management;

vi) try to avoid actions whose reasonably foreseeable effects on the future generations are greater than those accepted by the current generation;

vii) try to avoid imposing excessive constraints on future generations.

1| GENERAL SAFETY REQUIREMENTS (ARTICLE 11)

1.1. ASN requirements

The basic nuclear installations (BNI) that produce or manage waste are subject to the general provisions of the BNI system and to the provisions of chapters III, V, VI of title IX of book V and the provisions of chapter II of title IV of book V of the Environment Code and the Order of 7 February 2012. Articles 1.2, 3.4 and 6.1 of the Order of 7 February 2012 stipulate respectively that:

- "*the licensee must ensure a level of risks and adverse effects mentioned in Article L. 593-1 of the Environment code that is as low as possible under economically acceptable conditions for its activities of design, construction, operation, final shutdown and decommissioning, maintenance and monitoring of its basic nuclear installations, given the state of knowledge, practices and environmental vulnerability*";
- *"control of the nuclear chain reactions, the removal of thermal power, the containment of radioactive substances, the protection of persons and the environment against ionising radiation must be taken into account in the safety case*";
- "*the licensee shall take all necessary measures from the design stage to prevent and reduce, particularly at source, the production and the harmfulness of the waste produced in its installation*".

With regard to radioactive waste, Article L. 542-1 of the Environment Code stipulates that:

- "*the sustainable management of radioactive material and waste of any kind (…)is ensured in such a way as to protect individual health, safety and the environment";*

- "*the search for and the deployment of the means necessary for the definitive safeguarding of radioactive waste are undertaken in order to prevent or limit the costs that will be borne by the future generations*".

To this end, Article L. 542-1-2 of the Environment Code stipulates that a National Plan for the Management of Radioactive Material and Waste (PNGMDR) shall be drawn up, defining the "*general objectives, the main time frames and the schedules for meeting these time frames while taking into account the priorities it defines*".

This same article stipulates that "*the reduction in the quantity and harmfulness of the radioactive waste is sought in particular by reprocessing the spent fuels and treating and packaging the radioactive waste".*

The Environment Code and the Order of 7 February 2012 also lay down requirements in this area:

- article R. 593-17 of the Environment Code stipulates that the file submitted by the licensee for the BNI creation application must include an impact assessment whose scope comprises:
  - proof of the compatibility of the installation "*with the radioactive waste intended to be produced by the installation, or stored or disposed of in it, with the decree that establishes the requirements of the National Plan for the Management of Radioactive Material and Waste (PNGMDR*) *provided for by Article L. 542-1-2",*
  - "*the* solutions *chosen to minimise the volumes of waste produced and its radiological, chemical or biological toxicity"*.

- articles R. 593-66 and R. 593-67 of the Environment Code also stipulate that, under the final shutdown and decommissioning procedures for BNIs, the waste management plan must be updated and supplemented;

- article 6.7 of the Order of 7 February 2012 stipulates in addition that "*the packaging of the waste intended for the radioactive waste disposal facilities currently being studied […]that does not have acceptance specifications is subject to the agreement of ASN";*

- pursuant to Article 6.8 of the Order of 7 February 2012, the licensees must check, during the packaging of "their waste […],the compatibility of the waste packages produced with the conditions planned for their subsequent management". In this way the licensees take into account the interconnections that exist between the different stages in the management of radioactive waste.

The obligations of licensees of BNIs or future BNIs with regard to the control of safety for the management of radioactive waste are thus defined by acts, decrees and ministerial orders, as well as by resolutions and prescriptions issued by ASN (see E).

ASN has thus published resolutions:

- in 2013: relative to control of detrimental effects and the impact of BNIs on health and the environment,

- in 2015:
  - relative to the content of the safety analysis report,
  - relative to the waste management study and the assessment of the waste produced in the BNIs,

- in 2016: relative to modifications to the resolution of 2013 on the control of detrimental effects and the impact of BNIs on health and the environment;

- In 2017: relative to the packaging of radioactive waste and the conditions of acceptance of the radioactive waste packages in the disposal BNIs;

- in 2020: relative to modifications to the resolution of 2015 on the study of waste management and the assessment of the waste produced in the BNIs.

In 2021, ASN should finalise the resolution relative to the safety requirements applicable to the various operating phases of radioactive waste disposal facilities.

Complementing this, the ASN guides (see section E.2.2.5.2) make recommendations and describe practices that ASN deems satisfactory to achieve them.

In 2016, ASN also published a guide (No. 23) to the establishing and modification of the waste zoning plan of the installations to detail the conditions of application of its resolution 2015-DC-0508 of 21 April 2015 on the management of waste and the assessment of the waste produced in the BNIs.

1.2. Measures taken by the BNI licensees

1.2.1. Measures taken by the waste producers CEA, EDF, ILL and Orano

Management of the waste in the BNIs comprises the following main phases:

- "waste zoning" (see section B.5. 2.1);
- collection;
- sorting;
- characterisation;
- processing and packaging;
- storage;
- shipping.

Collection and sorting are sensitive waste management phases in the BNIs.

The waste is collected selectively, either directly during normal operation or by the personnel on the worksites.

The waste is sorted according to its nature (physical-chemical state) and, if applicable (for radioactive waste), according to its radiological characteristics (activity and half-life of the radionuclides contained in the waste). These criteria will determine the corresponding management route. Once sorted, the waste undergoes qualitative and quantitative characterisation: weight, properties and physical-chemical composition, radioactive content if applicable. This characterisation is necessary in order to comply with the applicable regulatory requirements and the technical specifications set by the processing and disposal routes in terms of treatment, packaging, elimination or reuse.

The waste is directed towards industrial processes that are duly authorised to receive such waste for elimination or reuse. The aim is for the waste to be removed to these processes in order to limit interim storage on the production sites. The radioactive waste is transported in accordance with the regulations in force (ADR).

The traceability of the waste management stages from their origin (waste zoning) to their place of disposal or reuse is ensured. For radioactive waste, this traceability is materialised in particular by the constitution of the package file which contains all the information relative to the manufacture of the waste package, from production of the waste through to removal of the package. The traceability of conventional waste is based essentially on information provided on the tracking sheet.

Lastly, the "waste management studies", required by the regulations until the publication of the Decree 2019-190 amending and codifying the requirements of Decree 2007-1557, which are conducted by the majority of the production sites, present the management conditions for all types of waste, analysing the performance with regard to the best techniques available in order to determine whether avenues of improvement or optimisation must be sought.

These "waste management studies" conducted by the CEA, EDF, ILL and Orano are regularly updated and submitted to ASN. Since the publication of Decree 2019-190, the description of the conditions of waste management shall be partly integrated in the impact study of each facility, therefore it is due as soon as the creation authorisation application is filed, while the other requirements have to be integrated in the baseline operating requirements.

Furthermore, each licensee establishes an annual assessment of its waste management in a form specified in the ASN "waste" resolution. It transmits this assessment to ASN and the competent regional authorities.

Lastly, each year, in application of Article L. 125-15 of the Environment Code, the CEA, EDF, ILL and Orano establish reports on the measures taken with regard to safety and radiation protection, events, measurements of the discharges into the environment and the waste stored in their BNIs.

1.2.2. Process for removing waste to CENTRACO and to Andra's disposal facilities

The setting up and tracking of the radioactive waste shipping schedules are established after discussion between all the entities concerned and notifying the carriers, given the different removal routes available: melting and incineration at CENTRACO, disposal at the CSA repository, disposal at the Cires facility. The quality of the transport operations is monitored.

1.2.3. Measures taken by Andra

The radiation protection objectives chosen by Andra are described in section F.4. 2.1.1.

Regarding the risks associated with the chemical toxicity the waste can potentially present, and in accordance with Basic Safety Rule RFS III. 2.e and the safety guide on the deep geological disposal of radioactive waste, Andra asks the waste producers to quantify the presence in the waste of elements covered by the regulations applicable to hazardous waste or the regulations concerning water quality. These elements are integrated in the disposal facility impact studies. Specific actions are also undertaken to reduce their quantities in the delivered packages, for lead in particular.

The reduction of the volume of waste delivered is a joint objective of the waste producers and Andra. It enables the disposal surface area footprint to be limited. It is achieved in particular by efficient conditioning processes (compacting, incineration) and control of the equipment introduced into the facilities in regulated areas. The graph below shows the trend for deliveries of low- and intermediate-level short-lived waste packages since 1969.

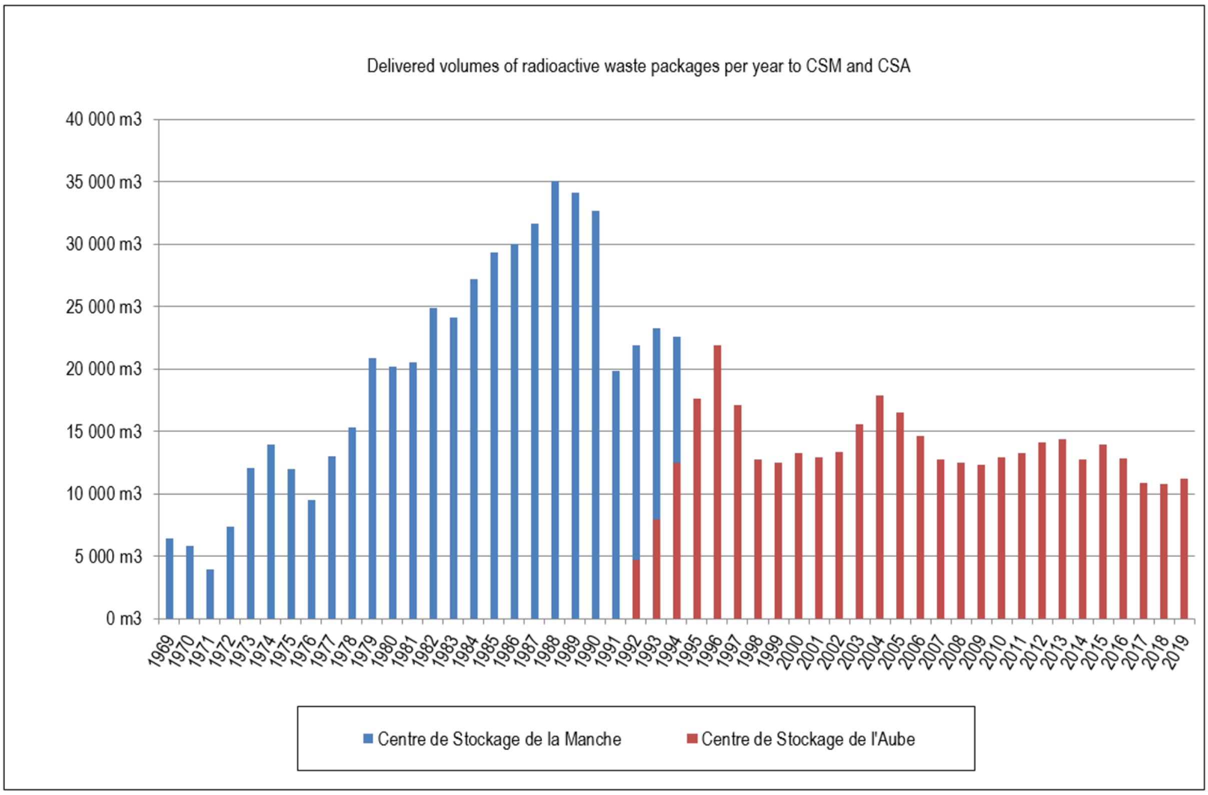


Figure 14: Trend for deliveries of low- and intermediate-level short-lived waste packages since 1969

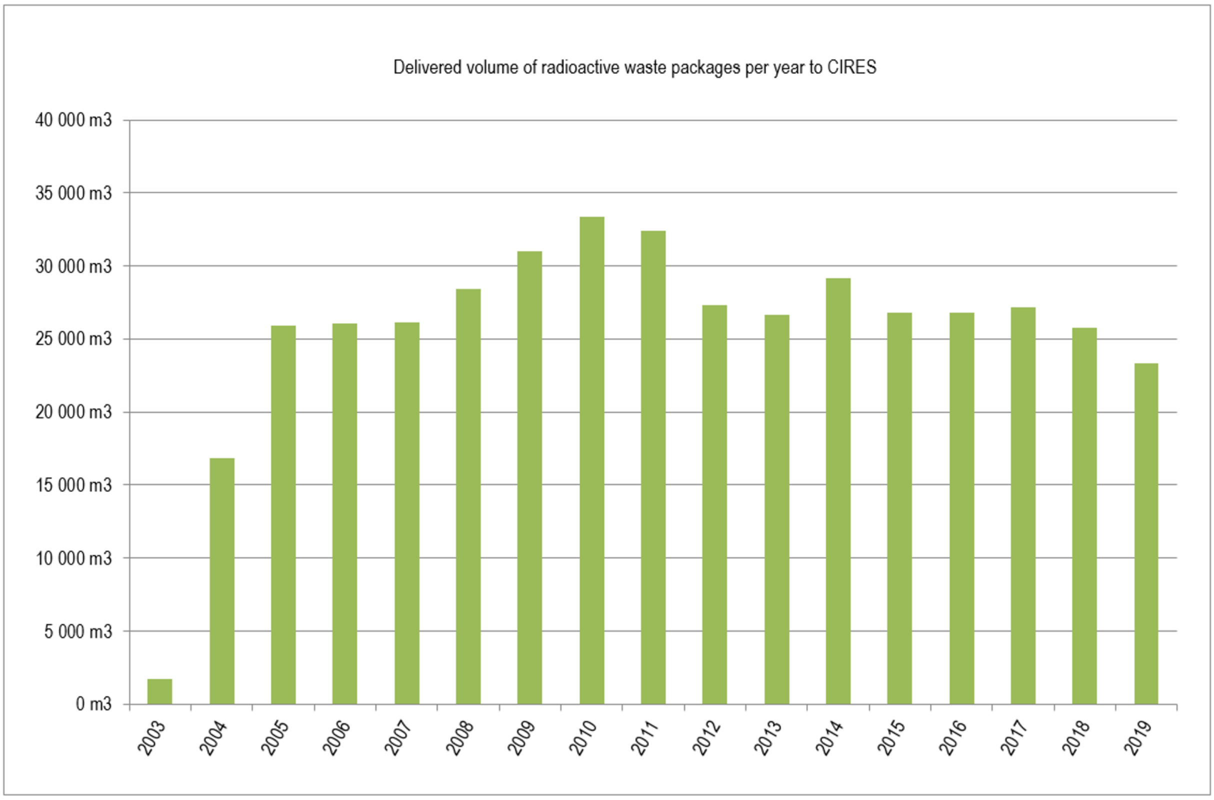


Figure 15: Trend for deliveries of very Low-Level waste packages

Controlling the short-, medium- and long-term safety of waste disposal facilities necessitates control of the quality of the waste packages accepted by these facilities. This quality is described in specifications which set the conditions that the waste and waste packages must satisfy to be able to be accepted in the disposal facility. These specifications constitute a baseline for the nuclear licensees who produce the waste packages. They focus in particular on the prevention of radiological, chemical, fire and criticality risks. During operation of the disposal facility, an acceptance process called "approval process" conducted by Andra is carried out for each type of waste package proposed by the producer to guarantee that the type of packages meets Andra's specifications.

A similar but adapted process is applied for the Cires facility.

For the high- or intermediate-level long-lived waste that is subject to research for a deep geological disposal route, the waste packages are designed in reference to the safety guide relative to the deep geological disposal of radioactive waste. Pursuant to the ASN "packaging" resolution, Andra is also responsible for giving the administrative authorities an opinion on the new packaging projects.

For the near-surface disposal project for radium-bearing waste, graphite waste and certain other types of low-level long-lived waste that is not yet packaged, Andra is studying – with the nuclear licensees who own the waste – the most appropriate methods of packaging at the same time as it defines the disposal concepts.

The principles listed earlier, as much for the packages intended for the disposal facilities in operation as for those intended for the projected disposal facilities, shall be taken up in an ASN resolution and guide.

1.3. ASN analysis for the BNIs

ASN oversees the measures taken by the licensees to meet the legislative and regulatory requirements (see section E and § H.2 to § H.7). This oversight concerns all their obligations concerning protection of persons and the environment. Under Article 1.2 of the Order of 7 February 2012, this oversight covers the licensees' activities associated with all the stages in the life of the facilities (design, construction, commissioning, operations, final shutdown, decommissioning, maintenance and monitoring and surveillance for the disposal facilities).

It applies to the existing and projected facilities, as well as to the methods of waste conditioning and packaging:

- ASN examines the technical aspects of the files and supporting documents provided by the licensee, particularly with respect to the Environment Code (creation authorisation application file, decommissioning, closure and monitoring and surveillance file, modifications, periodic safety review files, etc.) ;
- ASN conducts inspections on site or in the licensee's departments and services. This includes inspections at Andra to check application of the processes for issuing approvals for the packages that are to be delivered to its disposal facilities.

The inspections can lead to requirements, follow-up letters, complementary assessments, administrative and penal enforcement actions (see section E.2).

ASN also examines the licensees' assessments, studies and proposals to meet the requirements of the decrees laying down the requirements of the PNGMDR, issued in application of Article L. 542-1-2 of the Environment Code. ASN should thus issue several opinions in 2020 concerning the studies submitted in application of the PNGMDR 2016-2018, in preparation for the 5th issue of the PNGMDR, on the management of VLLW, LLW-LL, HLW and ILW-LL waste, the former mines, the legacy situations, the waste necessitating specific work and the reusable nature of radioactive materials.

ASN can also present its recommendations to the Government. In 2015 it thus published an opinion relative to the cost of the implementation of long-term management solutions for high-level and intermediate-level long-lived radioactive waste after examining the file submitted by Andra. This subject was subsequently taken up in the order of 15 January 2016 on the cost of the Cigéo project. Likewise, ASN made a statement on the reversibility of deep geological disposal of radioactive waste in its opinion of 31 May 2016, a subject which was addressed by the act of 25 July 2016 supplementing Article L. 542-10-1 of the Environment Code on the subject.

In addition to this, ASN considers it important to examine the overall policy and strategy of each of the major nuclear licensees for the management of radioactive waste and decommissioning (see sections F.6.3.1 and G.1.3 concerning the licensees' decommissioning policy and strategy and the overall consistency of the cycle). EDF, the CEA and Orano are thus asked periodically to produce a file setting out their policy and strategy so that ASN can:

- have an overall and forward-looking view of their strategy that goes beyond 10 years;
- check the coherence of these strategies and the degree to which the licensees anticipate the necessary actions to implement them under optimum conditions.

A revision of EDF's file on its waste management policy was transmitted to ASN which examined it in 2014. The file was then examined by the Advisory Committees of Experts in 2015. This file was examined at the same time as that concerning EDF's decommissioning strategy (see section F.6.3.1.3). In 2015, ASN also asked EDF for an overall revision of the "Cycle Impact" file to be carried out for 2016 in order to present the way in which the changes in fuels or the management of irradiated fuels will be taken into account in the next fifteen years for, among other things, the medium and long-term management of waste (see section G.1. 3).

With regard to the Orano group, the waste management strategy of the La Hague site was examined by the Advisory Committee of Experts brought together by ASN in 2005. In January 2006, ASN issued a position statement on this strategy. The waste management strategy over the perimeter of the Orano Cycle DBNI at Tricastin was also examined in 2012 by the safety commission for laboratories, plants and waste brought together by ASN. In December 2012, ASND informed Orano Cycle of its position concerning this strategy. In June 2014, ASN and ASND asked Orano to send them its national strategy concerning waste management and decommissioning. The file was received in June 2016 and is currently being examined.

The Advisory Committee of Experts reviewed the CEA's strategy and issued its opinion in February 2012. It focuses in particular on the CEA's organisation for managing the radioactive waste produced by its facilities (including legacy waste) and the corresponding resources: projects for new waste treatment or storage facilities, renovation of existing facilities, development of conditioning/packaging processes and the development of transport packagings. The progress with respect to the preceding review in 1999 was noted. Nevertheless, very significant increases in the projected duration of decommissioning operations and the quantity, the non-standard nature and difficulty in characterising certain substances or waste that will be produced by these operations have led ASN and ASND to jointly ask for an overall review in 2016 of the decommissioning and waste management strategies for the next 15 years. This report was received in December 2016 and ASN and ASND issued an opinion on it in May 2019 (see section F 6.3.3.1).

Lastly, in the context of Decree 2007-243 of 23 February 2007, ASN gives the DGEC its opinion on the three-yearly reports and annual updating notes on the long-term financing of nuclear expenses submitted by the licensees (see sections B.1.7 and F.2. 3.2).

1.4. Case of the ICPEs and mining waste

As was indicated earlier in this report, the radioactive waste - apart from naturally occurring radioactive material (NORM) – coming from the ICPEs is managed via the same routes as the waste from the BNIs. The safety of management is therefore identical.

The last uranium mine in France closed in 2001. The mining industry therefore produces no new waste and the public and environment must be protected from the waste produced in the preceding years, particularly the mining waste rock and the ore treatment residue disposal facilities (facilities classified as ICPE). With regard to the mining waste rock, the circular of 22 July 2009 explicitly asks the licensee to inventory the mining waste rock reused on public land. After establishing this inventory, the licensee must verify that the land uses are acceptable from the environmental and health aspects. In the event of incompatibility, remediation measures are implemented in relation with the public authorities. The Ministry of Ecology issued an instruction on 8 August 2013 with respect to its regional services within the DREAL (Regional Directorate for the Environment, Planning and Housing), through the Prefects, in order to regulate this operation. This instruction regulates the process for establishing the inventory and removing the mining waste rock reused on public land. It more particularly specifies the conditions for informing the public of the results of the inventory, defines the methodology for performance of the works and specifies the means of preserving a land use record (memory). This action is borne by the administrative authority (Prefect), assisted by the DREALs in collaboration with ASN and the local Regional Health Agencies (ARS).

1.5. Case of industrial activities outside the nuclear sector, research activities and medical activities

The case of industrial activities outside the nuclear sector, namely research activities and medical activities, are addressed in section B.6.

2| EXISTING FACILITIES AND PRIOR PRACTICES (ARTICLE 12)

Each Contracting Party shall take appropriate and timely measures to examine:

i) the safety of any radioactive waste management facility in existence when the Convention enters into effect for that facility and to ensure that, if necessary, all improvements that can be reasonably made to the facility to increase its safety are introduced;

ii) the consequences of prior practices in order to determine whether an intervention is necessary for radiation protection purposes, without losing sight of the fact that the reduction in damage resulting from the reduction in dose should be sufficient to justify the negative effects and the costs associated with the intervention, including the social costs.

2.1. Requests from the regulatory authorities

The BNIs undergo a periodic safety review every 10 years at least (see section E.2. 2.3.1).

When necessary, ASN asks the licensee to take measures to improve safety. This is notably the case with certain old storage facilities. The Orano group, the CEA and EDF have stored radioactive waste on certain sites (such as La Hague, Saclay, Marcoule, Cadarache, Saint-Laurent-des-Eaux) in accordance with the regulations and the rules of good practice prevailing at the time. The lack of, or the age of the packaging of the stored waste and the initially planned life time of the storage facilities, combined with the increased safety requirements since then, have made it necessary to implement measures to improve safety. Under these conditions, it is usually advisable to retrieve and package this legacy waste so that it can be transferred either to existing disposal facilities or to interim storage facilities having a satisfactory standard of safety.

Article L. 542-1-3 of the Environment Code stipulates in this respect that the owners of intermediate-level long-lived waste produced before 2015 must have packaged this waste by 2030 at the latest.

In its Resolution 2014-DC-0472 of 9 December 2014, ASN prescribed provisions concerning Orano Cycle's legacy waste retrieval and packaging (WRP) operations on its La Hague site. This resolution sets some sixty milestones governing the WRP operations for the projects concerned. ASN also conducted an in-depth inspection of the WRP projects in October 2016, focusing on the licensee's organisation and the progress of the top priority projects. ASN noted a number of points hindering the progress of the operations. In 2019, in view of the delays observed in the implementation of the retrieval projects (those containing the greatest potential source terms in the event of an accident), ASN began an exploratory approach for monitoring the progress of the waste retrieval and packaging projects (see section F.6.3.3)

In some cases, the time frames of the WRP operations and the level of safety of storage are such that ASN is obliged to demand that the safety of the installation be reinforced (as was the case for the Saint-Laurent silos, for example).

Along with this, Orano, the CEA and EDF have, under the PNGMDR 2016-2018, continued investigations to look for legacy disposal sites containing radioactive waste. This primarily concerns:

- thirteen conventional waste disposal facilities which had received VLL waste from conventional or nuclear industries;
- waste in disposal sites near BNIs, DBNIs or SIENIDs (experimental nuclear installations concerning defence);
- waste depots with high natural radioactivity which are not subject to the regulations of classified installations.

The PNGMDR 2016-2018 asked for the completion of the investigations into the search for legacy disposal sites containing radioactive waste within or near the perimeters of nuclear installations and a substantiated presentation of the management strategies for the identified disposal sites.

Article 19 of the Order of 23 February 2017 thus prescribed that the investigations by Orano, the CEA and EDF are in the areas with confirmed or suspected presence of legacy disposal sites. The studies submitted by the three licensees concern the inventory of legacy disposal sites and the presentation and justification of the management strategies envisaged for each legacy disposal site.

In the majority of cases, the licensees propose in-situ management of these legacy disposal sites. ASN and ASND are analysing their proposals.

2.2. Measures taken by the BNI licensees

2.2.1. Measures taken by Andra

The Manche repository (CSM) was operated from 1969 to 1994. During this period, the safety regulations and principles evolved. In effect, the first issues of the Basic Safety Rules RFS I.2 and III.2.e date from 1982 and 1985. Andra endeavoured to adapt its modes of operation to the changes in the regulations. When past practices no longer correspond to the regulations in force at a given time, Andra verifies during the periodic safety reviews that they remain compatible with the safety objectives. The measures concerning the Manche repository are detailed more particularly in section D.3.2.2.1 and § H.7.

2.2.2. Measures taken by the CEA

The legacy waste originates from diverse practices dating from a time when the current waste management routes were not available. They are often similar to today's waste but, given the diversity of their storage sites and the changes in the waste management methods, they pose specific retrieval, characterisation and treatment problems. This primarily concerns:

- liquid aqueous and organic wastes contained in tanks, cylinders or drums;
- solid wastes, usually placed in drums stored in wells, vaults or pits;
- solid wastes buried in open ground in diverse forms (in bulk in vinyl bags, in metal drums, in concrete shells).

The aim of the CEA is to retrieve and condition these wastes using appropriate treatments so that they can be directed to management routes that either exist already or are being created.

In this approach, as is the case for decommissioning (see § F.6.2.1), priority is given to the retrieval of legacy waste on the basis of a reduction in the potential source term (TSM).

After sorting and suitable conditioning and packaging, this waste is either transferred to the Aube repository (CSA) or to Andra's Cires facility, or stored in the centres pending the availability of disposal facilities for the HLW, ILW-LL and LLW-LL waste, which are still being studied. The modes of conditioning and packaging may yet, in some cases, change according to the finalised acceptance specifications of the disposal centres being studied.

Alpha-contaminated waste for example, is conditioned in cemented packages and stored in BNI 164 (CEDRA). It is planned to store the highly irradiating waste as from the end of 2022 in the Marcoule centre in a dedicated facility (DIADEM), whose commissioning authorisation application is expected in June 2021. The CEA will acquire specific complementary units for packaging the primary LLW-LL and ILW-LL waste packages directly in storage containers and ship them to the future disposal centres.

The waste retrieval programme is continuing on the CEA sites of Marcoule (UP1 Plant), Fontenay-aux-Roses, Saclay and Cadarache, and will extend over several decades. In the context of the Grenoble Centre "delicensing" programme, for example, all the legacy waste stored on this site has been characterised, retrieved and removed, and all the nuclear installations have been delicensed.

2.2.3. Measures taken by Orano: retrieval of the legacy waste on the La Hague site

Part of the waste produced during operation of the UP2-400 plant was stored on the La Hague site pending the opening of disposal centres suited to the radiological and physical-chemical characteristics of this waste. This waste is covered by a waste retrieval and packaging (WRP) programme with a view to its subsequent removal. Project ownership for the final shutdown/decommissioning and WRP operations is ensured by the Waste and Decommissioning Project Ownership Department (DM2D), which delegates operational management to the Decommissioning & Services Business Unit (D&S BU). The major developments intended for legacy waste retrieval are managed by DM2D through the Major Projects Department (DGP).

The waste from the UP2-400 facility shall be treated and packaged either in the existing facilities (UP2-800/UP3-A), which are already in service, or in new facilities yet to be created.

Today, virtually all the fission products (FP) are vitrified. The vitrification of the FP solutions with a high molybdenum content which are incompatible with the existing hot-crucible vitrification process (corrosion aspect), was initiated in early 2013 thanks to an innovative cold-crucible verification process (see section B.6.1.3). At present, the majority of these solutions are vitrified.

The retrieval of contaminated technological waste stored in steel drums in building 119 was completed in 2015. This legacy waste from the UP2-400 plant was transferred to the UCD (Alpha waste conditioning unit) to undergo a mechanical treatment (sorting and conditioning) and/or chemical treatment (decontamination by leaching) then to AD2 (waste packing facility) to be packaged in cemented packages. The most recent waste from the Orano Cycle Melox plant and the ATPu of Cadarache has been transferred to the STE3 station pending treatment.

The sludge stored in the STE2 station should be retrieved as of 2027 to be treated by a new process currently being studied and substituting for the bituminisation process initially planned.

In this context, Orano is developing an alternative solution favouring the earliest possible retrieval of the sludge in cans after centrifuging. These cans will be transferred to an existing storage facility with appropriate monitoring and surveillance.

The waste contained in the HAO silo will, when retrieved, be sorted in a new unit under construction; the structural waste (hulls and end-pieces) will be transferred to the ACC unit for compacting; the technological waste (aluminium covers) will be cut up and stored in metal container type package in the pools of the SOC (organised hulls disposal facility) before being packaged in CBF-K (fibre-concrete package); the fines and resins will be retrieved and transferred to a new cementation unit, adjacent to the retrieval unit, to be cemented in drums. The "curseur" drums stored in the SOC pools will be transferred to the retrieval and sorting unit of the HAO silo where the hulls and endpieces they contain will be emptied from them to follow the same treatment route as the structural waste from the HAO silo. Technological waste (empty drums, covers, etc.) will be cut up and decontaminated if necessary, then packaged in CBF-K packages.

The gas-cooled reactor (GCR) waste from silos 115, from the SOD and from silo 130 shall be retrieved under a scenario favouring sorting and treatment in appropriate routes.

Retrieval of the GCR waste from silo 130 began in 2019 in a new facility annexed to silo 130.

2.2.4. Measures taken by EDF

2.2.4.1. Conditioning and removal of waste from EDF sites in operation

Each nuclear power plant has the facilities and equipment necessary to manage the different types of conventional and radioactive waste it produces.

Once collected and sorted, the waste thus undergoes treatment or conditioning with the aim of:

- reducing the volume: compaction, chopping-up/crushing;
- conditioning to reduce the harmfulness (if necessary) and make the waste compliant for removal to the appropriate disposal route: packaging in concrete shell in a matrix for intermediate-level short-lived process waste, packaging in metal or plastic drums for low-level technological waste or placing in skip for conventional waste, etc.

When areas for improvement are identified (sub-standard conditioning/packaging with respect to the best technologies available, identified risks as regards the availability / capacity of the management route), steps are taken to have an optimised route.

With regard to the storage of waste packages:

- conventional waste is stored on dedicated outdoor areas (called transit areas);
- packages of LLW/ILW-SL waste intended for the CSA (Aude repository) are stored in premises designed for this purpose (packaging auxiliaries building or effluent treatment building, depending on the plant series);
- packages of VLL waste intended for Cires are stored on regulated outdoor areas (VLLW areas) commissioned in the early 2000s and specially designed for the storage of this waste pending its removal.

In addition to this, the EDF nuclear power plants have to store other types of waste in non-packaged form, because certain management routes are not yet available. This is the case in particular for activated operational waste (intermediate-level long-lived waste), which is stored in cooling pools and for which the ICEDA (Activated Waste Packaging and Interim Storage Facility) commissioning application has recently been reviewed and the commissioning authorization was issued in July 2020.

The waste management process (control of the storage areas and availability of management routes) has been considerably improved thanks to the commissioning of the CENTRACO plant operated by Cyclife France (see section B.6.1.1), of the Cires facility operated by Andra and the policy of on-line waste removal adopted by EDF.

Various actions have led to tangible results:

- a reduction in the quantities of concrete shells and drums, thanks to the optimisation of the entire "shipping" process and removal as early as possible to the CSA repository and CENTRACO;
- a reduction in package non-qualities, which can be the cause of shipping delays. Alongside this, a metal box-type package suitable for the repackaging of concrete shells suffering defects has been developed;
- at-source limitation of certain types of waste (ion exchange resins, water filters, technological waste) thanks to the optimisation of operation of the channels;
- highly selective sorting of the technological waste when the dose rate is less than 2 mSv/h, which enables a maximum amount of this waste to be directed to incineration (reduction in volume) or to the Cires facility (reduction in harmfulness);
- optimisation of waste zoning and examination of the files for downgrading potential nuclear waste production zones (ZppDN) to conventional waste zones (ZDC) which avoids the production of radioactive waste (conservation of disposal capacities).

These actions are continuing and are consistent with the sites' application of the operating rules associated with the management of waste in their facilities.

2.2.4.2. Packaging and removal of waste from EDF sites undergoing decommissioning

The waste from the decommissioning operations is managed in the same way as operational waste from the NPPs in service. The waste is characterised, sorted and packaged, then transported to the appropriate disposal facility according its nature or to the CENTRACO melting and incineration facilities.

The ILW-LL waste will be stored pending the availability of a deep geological disposal facility planned for by the waste act.

The dismantling of the 11 BNIs comprising nine shut down reactors and the graphite sleeve storage facility at Saint-Laurent-des-Eaux (see section F.6.2.3) will produce, according to current studies, a total of about one million tonnes of waste, of which about 20% (by weight) will be radioactive waste:

- 800,000 tonnes of "conventional" waste, containing no radioactive elements: the large majority of this waste will be remediated concrete and gravel which will be used essentially to fill in the voids created on the site by the destruction of the facilities;
- 250,000 tonnes of radioactive waste, mainly short-lived, intended for disposal after packaging and for which the disposal routes either exist or are to be created.

This radioactive waste will be broken down as follows:

- the "very low-level" waste consisting mainly of metals, soils and rubble will represent about 150,000 tonnes and will be disposed of at the Cires facility;
- the low-level/intermediate-level short-lived waste (LLW/ILW-SL), consisting essentially of equipment having contained or carried radioactive fluids (pipes, valves, tanks, etc.) represents about 53,000 tonnes. This waste also has a safe and definitive disposal solution, namely the CSA repository for LLW/ILW-SL waste operated by Andra;
- the LLW-LL waste, consisting essentially of graphite waste from the GCR power plants (about 17,000 tonnes), for which the "waste" act provides for the commissioning of a disposal centre. This concerns firstly the graphite sleeves currently in storage, and secondly the graphite structures, particularly the stacks, which are still in place in the old GCR reactors;

- the ILW-LL waste consisting of metal parts which have been rendered radioactive by the neutrons emitted from the reactor core (about 120 tonnes). In the interim period until the Cigéo project becomes operational, EDF plans to package and store this ILW-LL waste in ICEDA (Activated Waste Packaging and Storage Facility) on the Bugey NPP site (Ain *département*). This waste will then be transferred to the Andra's deep geological repository once it is available.

The sodium from the Creys-Malville NPP (about 5,900 tonnes of sodium from the reactor pressure vessel and the non-radioactive secondary systems) has been transformed into soda using an industrial process developed by the CEA, then safety conditioned and packaged by incorporating the soda in concrete. The corresponding very low-level concrete blocks (about 67,000 tonnes) will be stored on the site for about 30 years, where they will reach a level of activity close to that of naturally occurring radioactivity.

2.3. ASN analysis for the case of BNIs

2.3.1. The existing facilities

As indicated above, the existing facilities undergo a periodic safety review. Pursuant to Article L. 593-19, after each periodic safety review, the licensee sends ASN a concluding report indicating, where applicable, the measures it is considering to remedy the observed anomalies and improve the safety of its facility. ASN informs the Minister responsible for nuclear safety of its opinion on this report and issues a position statement on the continuation of operation. It sends the licensee any particular demands with a schedule for the expected responses. New requirements may be laid down for implementation by the licensee. ASN also carries out inspections which are followed up by a letter to the licensee concerned. In 2020, six periodic safety reviews of facilities involved in radioactive waste management were being examined by ASN, including the two disposal BNIs for LLW/ILW-SL waste.

2.3.2. Legacy waste

The majority of the waste produced today is packaged in packages. However, some legacy waste is not packaged or has been inadequately packaged (deterioration of the containers for example) and is not compatible with the subsequent management procedures as required by Article 6.7 of the BNI order of 7 February 2012.

Although progress has been observed in legacy waste retrieval, ASN has been obliged to ask the licensees to increase their efforts to meet the deadlines imposed by the safety of the legacy waste storage areas and to achieve the targeted date of 2030 set by Article L. 542-1-3 of the Environment Code for completion of packaging of the ILW-LL waste produced before 2015.

Some significant examples are detailed below. These being:

- graphite sleeves stored by EDF (Saint-Laurent-des-Eaux);
- sludge from the treatment of effluents from the UP2-400 plant at La Hague (Orano La Hague);
- waste from BNI 56 (CEA Cadarache);
- waste from BNI 72 and BNI 35 (CEA Saclay).

Despite the substantial efforts deployed, it is probable that this deadline of 2030 will not be met. ASN is working accordingly on the development of an approach for monitoring complex projects in order to identify the critical factors as early as possible and allow more effective supervision of these projects (see section F.6.3.3).

2.3.2.1. *The graphite sleeves stored by EDF*

This is structural waste from the fuels used in the former graphite-moderated gas-cooled reactors. The long-term management of this waste is studied by EDF and Andra under the disposal facility project for LLW-LL waste (see section B). In the meantime, this waste is stored mainly in the Saint-Laurent-des-Eaux silos. This represents about 2000 tonnes (in comparison with the 970 tonnes stored on the La Hague site and 760 tonnes at the Marcoule centre). The Saint-Laurent-des-Eaux silos are made up of two semi-buried reinforced concrete bunkers with a steel lining. Their filling capacity was reached in 1994.

In view of the delays in the graphite waste disposal project and in response to ASN's request to improve the safety of the Saint-Laurent silos, in July 2007 EDF presented a solution that consisted in installing a containment barrier around the silos. After examination by ASN, followed by complementary information requests and then approval, the work to install a geotechnical containment acting as a barrier was carried out in 2010. The licensee submitted the periodic safety review file in early 2010, the examination of which focused in particular on the data relative to this containment and the associated equipment.

ASN then informed EDF that it could continue using the thus-reinforced and monitored facility (it has been monitored since 1994) on condition that it meets its commitments made during the examination of the periodic safety review file.

Operation of the site used for storage is limited to monitoring and maintenance measures. In 2015, ASN finished examining the commitments made by EDF in the context of the periodic safety review of the installation which ended in 2014 and is waiting for additional studies requested in July 2015 on completion of the examination. The file relative to the stress tests gave rise to a follow-up letter in November 2017, which asked for a re-assessment of the hazard levels at the next periodic safety review. The periodic safety review file was received in December 2019. The admissibility examination will serve in particular to verify integration of the requests of the letters of 28 July 2015 and November 2017.

In the context of its new decommissioning strategy for the gas-cooled reactors (GCR), EDF has announced its decision to start removing the graphite from the silos without waiting for the graphite waste disposal route to become available. In December 2019, EDF presented the preliminary technical and safety guidelines for the storage of the graphite sleeves and their possible adaptation for storage of the graphite from the stacks. EDF plans starting the silo emptying operations in 2029. This study is currently being examined by ASN.

2.3.2.2. *Sludge from the treatment of effluents from the UP2-400 plant at La Hague*

From 1966 until the end of the 1990s, the effluents from the UP2-400 plant were treated in the STE2 facility by chemical co-precipitation. The sludge resulting from this process (a volume of 9,300 m^3 representing about 3,400 tonnes of salts) was stored in buried silos as and when it arrived.

The main risk is of dissemination of radioactive substances, given that there is only one containment barrier made up by the walls of the silos, whose current condition is poorly known and future development is difficult to predict.

Over the last few years the licensee has defined and tested methods of sludge retrieval and transfer prior to any treatment and packaging.

The scenario presented in 2010 for the retrieval and packaging of sludge from the STE2 building involved three steps:

- retrieval of the sludge stored in the silos at STE2 (BNI 38);
- transfer and treatment by drying and compacting at STE3 (BNI 118);
- packaging of the resulting pellets in "C5" packages for deep geological disposal.

ASN authorised the first phase of the sludge retrieval work on STE2 in 2015.

The creation authorisation decree for effluent treatment station STE3 was modified by decree of 29 January 2016 to allow the implementation of the STE2 sludge treatment process. Through a resolution of 4 January 2011, ASN also subjected to its prior agreement the acceptability of the C5 package for deep geological disposal:

- on the demonstration that the integrity of the package is maintained during the period of deep disposal reversibility with regard to the risks of corrosion and hydrogen release;
- on the production of complementary elements for analysing the acceptability of the package in deep disposal, particularly with regard to:
    - the feasibility of its integration in the disposal project,
    - its behaviour in a disposal situation, particularly with respect to the release of radioactive substances and its impact on the performance of the other components of the storage system.

Orana informed ASN however, at the end of 2016, that the process adopted for the treatment of the sludge in STE3 renders the conditions of operation and maintenance of the facilities more complex. The licensee is considering an alternative scenario.

In 2017, Orano proposed a new scenario based in particular on centrifuging the sludge before storing it in cans. Some aspects concerning effluent management, control of the sludge reactivity and the conformity of the facilities with the new operating conditions remain to be consolidated. The safety options dossier is currently being examined by ASN. The currently envisaged time frame for starting retrieval of this sludge is beyond 2026.

2.3.2.3. Other legacy waste at Orano

Unlike the direct on-line packaging of the waste generated by the new UP2-800 and UP3-A plants at La Hague, most of the waste generated by the first UP2-400 plant was stored in bulk without permanent packaging. The operations to retrieve this waste are technically delicate and necessitate substantial means.

The difficulties associated with the age of the waste, in particular the need for characterisation prior to any retrieval and processing, require the licensees to assess, for any project, the corresponding production of waste and plan for processing and packaging as and when the waste is produced. The recovery of the waste contained in the old storage facilities on the Orano La Hague site is also a precondition for the decommissioning and clean-out of these storage facilities.

ASN therefore monitors the retrieval of legacy waste from the La Hague site with particular attention because of the strong safety and radiation protection implications associated with it. Furthermore, it is an important commitment of the Orano group.

The initially-planned calendar for the retrieval of this waste has drifted off target in the last few years. ASN considers that the deadlines must no longer be pushed back because the buildings in which this legacy waste is stored are of an old design and do not comply with current safety standards. ASN considers in particular that Orano must retrieve the legacy waste produced by operation of the UP2-400 facility as quickly as possible. In addition to the sludges stored in the STE2 silos, this includes the waste from the HAO and 130 silos and the fission product solutions stored in the SPF2 unit.

ASN has regulated all the legacy waste retrieval and packaging programmes by a resolution of 9 September 2014. This resolution defines the priorities of the WRP operations in terms of safety and sets milestones for each programme concerned. In addition, ASN has initiated an exploratory approach for monitoring the management of WRP projects, supported for the financial aspects by the Ministry responsible for energy, and has thus identified a number of fundamental improvements in the project baseline requirements and support organisations which Orano must implement as soon as possible (see section F.6.3.3).

2.3.2.4. The legacy waste of CEA Cadarache

The CEA Cadarache centre's legacy waste is stored in BNI 56, the "Parc d'entreposage" (Storage yard). Part of this facility is made up of 5 trenches filled between 1969 and 1974 with varied types of solid waste of low and intermediate level activity, then covered with earth. At the time this was an experimental waste disposal facility.

The ILW-LL waste comes from the operation or decommissioning of CEA installations and cannot be disposed at the CSA. The installation also comprises storage areas of legacy very low level (VLL) waste compatible with disposal at the Cires facility.

The waste present on the installation must be retrieved as soon as possible, packaged and stored in appropriate facilities (CEDRA in particular). Retrieval of the waste from the pits and trenches requires the setting up of new processes. The VLL waste is characterised and packaged in the STARC ICPE before being transferred to Cires.

The CEA submitted the concluding report of the periodic safety review of the facility to ASN in March 2017.

The procedure for registering the BNI perimeter of the facility was carried out in parallel with the safety review and culminated in 2019. The decommissioning file for the facility submitted in 2018 is currently being examined.

Delays are noted in the waste retrieval and packaging projects linked to project management and the development of retrieval solutions that take into account all the requirements concerned. All the CEA's waste retrieval and packaging projects were re-prioritised when the CEA's decommissioning and waste management strategy file was submitted (see section F.6.3.1.1). BNI 56 was identified as the first priority among the CEA's civil facilities, along with solid waste management zone (ZGDS, BNI 72). Among the waste retrieval projects, the one concerning the moderately irradiating drums – some of which are corroded - placed in bulk in wells, has been identified as particularly high on the list of priorities. This file is currently being examined.

2.3.2.5. The legacy waste of CEA Saclay

Solid waste management zone (BNI 72)

BNI 72 is used for the storage, characterisation and packaging of the waste produced at the Saclay centre. The installation also retrieves the CEA sources that are surplus to requirements. The legacy waste and the spent fuels are stored there in wells, pools or blocks.

The final shutdown and decommissioning application file was sent to ASN late December 2015. As from 2018 and until the decommissioning decree is issued, the operations carried out consist in the continuation of the removal from storage operations (waste, fuel), making the arrangements necessary for the construction of the EPOC cell, and the rehabilitation of the HA cell so that its contents can be removed. A request to continue accepting irradiating waste from the centre's BNIs pending the installation of equipment for direct removal to the outlets has been submitted to ASN.

The periodic safety review of the facility has been carried out in parallel with the examination of the decommissioning file. The meeting of the Advisory Committee of Experts concerning the examination of the decommissioning file and the facility safety review file was held on 19 February 2019.

The commitment "to remove the fuels contained in blocks and pools" from BNI 72 has been only partially fulfilled. A new schedule for removing the fuels from BNI 72 was drawn up in early 2017 and submitted to ASN. A request to push back the deadline for emptying the blocks and pool of BNI 72 (ASN Resolution 2010-DC-0194) has been submitted to ASN. This is because, as part of the post-2017 irradiating waste management strategy for Saclay, the CEA has decided to make the producing facilities independent. To make the bridge between 2017 and the commissioning of the waste packaging means on these facilities, BNI 72 is required to receive irradiating waste, in a regulated manner, in order to ensure continued operation of these facilities.

Another technical prescription for BNI 72 requires the retrieval of the waste drums from the area of the 40 undrained and unventilated wells of building 114 before 31 March 2019. This deadline will have to be revised in view of the concomitant activities for the various WRP projects and the rate of drum retrieval.

With regard to the retrieval of the fuel-containing bins stored in wells, a specific projects (baptised "EPOC") has been created. The drums will be retrieved from the wells of BNI 72 then directed to a shielded cell (to be built) by a specific lifting tool placed under biological protection. The fuels and wastes present in the drums will be sorted in the shielded cell. At present it is planned to transfer the fuels to STAR.

Liquid effluents management zone (BNI 35)

The liquid effluents management zone (ZGEL) constitutes BNI 35. Declared by the CEA by letter of 27 May 1964, this installation is dedicated to the treatment of radioactive liquid effluents. CEA was authorised by a decree of 8 January 2004, to create "Stella", an extension in the BNI for the purpose of treating and packaging low-level aqueous effluents from the Saclay centre. These effluents are concentrated by evaporation then immobilised in a cementitious matrix in order to produce packages acceptable by Andra's above-ground waste disposal centres.

In addition, the decree of 8 January 2004 authorising the creation of Stella also stipulated that the CEA must remove the legacy waste stored in the eight MA500 tanks and the HA4 tank of BNI 35 within ten years. Due to the technical difficulties encountered in the retrieval and packaging of this waste, the CEA was unable to meet this deadline[1] and requested its extension. Through a resolution of 15 July 2014, ASN prescribed new retrieval deadlines for these effluents and obliged the CEA to have them removed by the end of 2018, with intermediate deadlines at the end of 2014, 2015 and 2016. At the end of 2018, tank HA4 and 7 of the MA500 tanks were empty. With regard to the last tank called "MA507", due to technical and organisational difficulties and operating contingencies, the CEA asked that the deadline for emptying it to be pushed back to 30 June 2020. ASN prescribed this new deadline through a resolution dated 6 January 2020.

In November 2018, the CEA submitted to ASN a file presenting the management strategy for the liquid radioactive effluents from the CEA Île-de-France and the overall strategy concerning BNI 35. In this file the CEA has set deadlines for the cementation of the legacy concentrates stored on the site, which is a priority for the facility. ASN is currently examining this strategy.

2.3.2.6. ASN conclusions on the legacy waste

The various examples above illustrate the difficulties inherent to the retrieval and packaging of legacy waste. The problems encountered include in particular:

- the data relative to the legacy waste are incomplete. At the time this waste was stored, traceability and quality assurance were not practised in the way they are now. Pre-retrieval characterisation of the waste is therefore based on the available history of its production, the taking of a few samples and, if necessary, calculations, and it can only be done in detail once the waste has been retrieved for treatment and packaging;
- the legacy waste is often heterogeneous (this is case of the waste in silos 115, 130 and HAO, for example);
- the licensees must cope with problems of treating and packaging this waste and often have to develop specific processes in a context rendered difficult by the fact that the acceptance specifications for the projected disposal routes have not yet been defined;

[1] In effect, only half of the initial source term had been removed (19,256 GBq in 2004) by the 8th January 2014. Nevertheless, all the radioactive organic effluents contained in tank HA4, which presented the greatest risks for safety, had been removed by the end of 2013.

- the licensees must cope with technical difficulties with retrieval;
- the licensees implement industrial strategies which have been subject to turnarounds and these issues have not been suitably prioritised in the licensees' overall strategy.

These combined difficulties often lead to schedule slippages and extra costs. Resolving the difficulties relating to the legacy waste and its storage requires them to be taken into consideration very early in the projects and to be specially monitored by ASN.

ASN is particularly attentive to compliance with the deadlines for the licensees' waste retrieval and packaging programmes.

The challenges for the three major licensees are as follows:

- For EDF, the main challenge is the management of graphite waste. Given the new decommissioning strategy for the GCR reactors, EDF has started the WRP operations on the graphite sleeves of the Saint-Laurent-des-Eaux silos and is considering building a storage facility;
- For Orano, retrieval of the legacy waste represents a strong commitment. The initially planned schedule has slipped and the deadlines can no longer be pushed back because the buildings in which the waste is stored are old and their standard of safety leaves no margins with respect to current safety standards. ASN, through its resolution on the waste retrieval and packaging (WRP) programme, has regulated the progress and execution of Orano's WRP programme according to the safety implications of the operations. In addition to this, ASN has undertaken, with the support of the DGEC for the financial aspects, an exploratory approach to the monitoring of Orano's WRP projects (see section F.6.3.3);
- For CEA, the two main challenges are, on the one hand, the implementation of new waste treatment and storage facilities within time-frames compatible with the shutdown programme of the old facilities for which the level of safety no longer meets current requirements and, on the other, to run projects to remove legacy waste from storage. ASN observes that the CEA has difficulty in managing these two challenges, even if some projects have moved forward. ASN thus issued a position statement in 2019 on the CEA's decommissioning and waste management strategy (see section F.6.3.3.1).

The decree of 27 December 2013 laying down the prescriptions of the PNGMDR 2013-2015 required EDF, Orano and the CEA to present the state of progress of characterisation of the ILW-LL waste and the consolidated design options for new packages appropriate for the envisaged disposal route by 31 December 2014. The PNGMDR 2016-2018 requires the continuation of these studies on the packaging of the ILW-LL waste and their compatibility with the disposal facility being studied. The studies submitted by the CEA, EDF and Orano in December 2017 present an analysis of the acceptability in Cigéo of the packages of radioactive waste which had been packaged at this date, in the light of the preliminary version of the preliminary acceptance specifications for Cigéo transmitted by ANDRA: ASN will issue a position statement on these studies in 2020.

ASN and ASND (for the licensees of national defence facilities) shall be attentive to the fact that the strategies proposed by the CEA, EDF and Orano assign the necessary resources to the retrieval of the ILW-LL waste mentioned in § H.2.3.2 before 2030. Difficulties are nevertheless encountered.

2.3.3. Tritiated waste

The majority of the tritiated waste produced in France is operational and decommissioning waste from facilities associated with the CEA's military applications (98%), while the remainder comes from small producers other than nuclear power production (research, pharmaceutical and hospital sector, etc.). At the end of 2018, the volume of tritiated waste represented some 5,775 m^3. A significant increase in the inventory of tritiated waste produced in France is projected, associated with the commissioning of the ITER fusion facility. Thus, for the producers as a whole, the inventory of tritiated waste requiring storage before disposal is forecast to reach a volume of about 30,000 m3 by 2060, for a tritium radiological activity of about 35,000 TBq. However, commissioning of ITER is falling behind schedule, pushing back the production of waste to the same extent.

The operational solutions for the long-term management of tritiated waste are:

- currently limited in terms of storage capacity: the majority of the waste is stored on the CEA sites, particularly Valduc and Marcoule;
- complex, involving, depending on the case:
  - a heat treatment by melting for the metallic waste and baking for the organic waste on the Valduc site,
  - incineration of the liquid waste at CENTRACO,
  - decay storage for the waste which cannot be accepted at the CENTRACO or Andra centres,
  - disposal for the tritiated waste emitting little gas.

As a complement to the storage on the Marcoule and Valduc sites, a storage facility project - Intermed - associated with the ITER project is currently being studied (see section B.6.1). A safety options dossier was produced for this facility and filed with ASN in 2014, which issued its opinion on it in November 2016. The estimated date of commissioning of this facility is 2035, in relation with the ITER schedule.

With regard to the defining of management routes, the PNGMDR 2016-2018 required Andra, SOCODEI (which has become Cyclife France) and the CEA to present an analysis of the various options (direct disposal, storage, incineration with or without storage) by the end of 2017, so that the next PNGMDR can adopt a position in this respect. The submitted study is being examined by ASN.

For the waste from small producers outside the nuclear power industry, the chosen solution is mutualised storage in Intermed.

Pending the commissioning of Intermed, Andra – jointly with the CEA - has put in place a management route enabling the waste from the small producers to be stored at the Valduc centre. This route is now operational and can accept highly tritiated waste from the small producers who so request, without calling into question the main intended purpose of the CEA Valduc facilities. This waste will be removed from storage and transferred to operational routes as soon as their radioactivity level so permits, or to the Intermed facility once it is commissioned.

2.3.4. Technological alpha-emitting waste from Orano and the CEA that is not acceptable for above-ground disposal

The technological alpha-emitting waste from Orano comes mainly form the La Hague and Melox plants. Pursuant to an ASN resolution dated 23 February 2010, Orano has presented the progress of its work to define an alternative package to the compacted waste package. The new method of treating and packaging this waste is based on an incineration/melting/vitrification process, allowing the manufacture of packages applying principles that enhance the safety of their storage and disposal.

In application of the provisions of the Order of 23 February laying down the prescriptions of the PNGMDR 2016-2018, Orano submitted an interim report presenting the state of progress at the end of 2018 of the work on the development of the incineration / vitrification process ("PIVIC") for conditioning the organic ILW-LL waste rich in alpha emitters. This report indicates that the industrial implementation of a PIVIC process will not be possible before at least 2038 and that the demonstration of feasibility of the PIVIC process on a scale-1 prototype is expected in 2020. This study is currently being analysed by ASN.

2.4. The case of legacy waste from non-BNI sources

The policy and practices in effect concerning this waste were presented in the general context in sections B.5 and B.6.

More specifically, the case of mine tailings is addressed in section B.6.3 and that of waste from non-nuclear power industries in section B.5.2.2.

The inventory of sites contaminated by radioactivity is mentioned in section D.3.1.4.

The public authorities have devoted continuous efforts to the management of contaminated sites for several years now.

Articles R. 1333-95 of the Public Health Code describe the administrative procedures applicable to the management of contaminated radioactive sites coming under the ICPE system or the Public Health Code system, whether the responsible entity is solvent or not.

Sites contaminated by radioactive substances are managed on a case-by-case basis, requiring a precise diagnosis of the site and the contamination. Article L.125-6 of the Environment Code, amended on 26 March 2014, provides for the State to create Soil Information Sectors (SIS) in the light of the information at its disposal. These must comprise land for which (more specifically in the case of a change in usage) the available soil contamination data warrants the performance of soil surveys and contamination management measures in order to protect public health and safety and the environment. The decree of 26 October 2015 defines the conditions of application. The Regional Directorates for the Environment, Planning and Housing (DREAL) coordinate the SIS development process under the authority of the Prefects. The ASN regional divisions contribute to the process for the sites they know to be contaminated by radioactive substances.

The rehabilitation project is approved by the Prefect on the basis of the opinions of ASN and the Classified Installations Inspectorate (if classified facilities are concerned). Implementation of the rehabilitation measures is governed by Prefectoral order. If residual contamination remains after the work, the Prefect can introduce restrictions on use. For the sites requiring radiation protection oversight, active institutional controls may be introduced by the Prefect under Article R. 1333-97 of the Public Health Code as of 1 July 2018.

Management of sites and soils contaminated by radioactivity is governed firstly by the methodological guide to the management of industrial sites potentially contaminated by radioactive substances, published in 2011, and secondly by the ASN doctrine defined in 2012 detailing the fundamental principles (see https://www.asn.fr/Informer/Dossiers-pedagogiques/Les-sites-et-sols-pollues-par-des-substances-radioactives - Basic principles of the ASN doctrine for the management of sites contaminated by radioactive substances).

The methodological guide describes how to deal with the various situations liable to be encountered when rehabilitating sites potentially contaminated by radioactive substances. It aims at providing the parties concerned with a common methodological basis for the simultaneous and concerted management of all the risks presented by such a site. It specifies in particular the substantiating elements the person responsible for site rehabilitation must present to the competent authorities. In accordance with the radiation protection principles detailed in Article L. 1333-1 of the Public Health Code, the cost-benefit trade-off mentioned in chapter 5 of the guide must primarily aim to reduce as much as is reasonably possible the exposure of persons to ionising radiation as a result of using the site and the rehabilitation operations. This cost/benefit trade-off must also take into consideration the robustness of the envisaged management solutions and the reference level to which a person can be exposed over one year (1 mSv) in accordance with Article R. 1333-96 of the Public Health Code.

In the case of a defaulting responsible entity, the site can be cleaned up by the public authorities via the general interest mission devolved to Andra.

Andra then coordinates the clean-up of the contaminated sites under a mandate from the Prefects of the regions in which the sites are situated. A National Commission of Radioactivity Aids (CNAR) chaired by a qualified person gives an opinion on Andra's proposals for the clean-up scenarios to be implemented and on the use of public funds to assist them. This commission comprises representatives from the Ministries responsible for ecology and from ASN, IRSN, environmental protection associations, competent personalities and an elected official. The composition of the commission is set by Article D. 542-15 of the Environment Code.

3| CHOICE OF SITE FOR PROJECTED FACILITIES (ARTICLE 13)

1. Each Contracting Party shall take appropriate measures for procedures to be put in place and applied for a projected radioactive waste management facility with a view to:

i) assessing all the relevant factors associated with the site which could influence the safety of this facility during its useful life time and that of an ultimate disposal facility after its closure ;

ii) assessing the impact that this facility could have, from the safety point of view, on persons, society and the environment, considering the possible evolution of the state of the site of the ultimate disposal facilities after their closure;

iii) to provide the public with information on the safety of this facility;

iv) to consult the Contracting Parties who are neighbours to such a facility, insofar as this facility could have consequences for them and to communicate to them, at their request, general data concerning the facility to enable them to assess its probable impact in terms of safety on their territory.

2. In doing so, each Contracting Party shall take appropriate measures so that such facilities do not have unacceptable effects on other Contracting Parties by choosing their site in accordance with the general safety requirements set out in Article 11.

3.1. Legal framework for the projected BNIs and ASN requirements

The procedure for choosing a BNI site is indicated in section E.2.2.2.

Concerning more specifically the location of a disposal site, ASN has published the following basic safety rule (RFS) and safety guide:

- RFS I-2 (published in 1982 and revised in 1984), for above-ground disposal facilities for low and intermediate-level short-lived waste;
- the safety guide published in February 2008 for the deep geological disposal of high-level and intermediate-level long-lived (HLW/ILW-LL) radioactive waste.

For the low-level long-lived waste (LLW-LL), ASN published general safety guidelines in June 2008 with a view to seeking a disposal site for this waste, which should be revised in the near future.

These documents, the purpose of which is indicated in E.2.2.5.2, define the objectives that must be adopted for radioactive waste disposal sites, as from the site investigation and facility design phases in order to ensure safety after closure. They address in particular the geological environment and site technical selection criteria.

To set up a new disposal facility, a legislative framework may be necessary. This is the case in particular with deep geological disposal and its precursor, the underground research laboratory. The Act of 30 December 1991 obliged any underground laboratory project to undergo a consultation mission with the elected officials and local populations. This mission was set by decree. According to this same act, the construction and operating authorisation for an underground laboratory should be given by decree on the basis of a technical file prepared by Andra after holding a public inquiry and obtaining the opinions of the various stakeholders. In practice, three files corresponding to three different sites were submitted by Andra in 1996. Only one of these - the Bure laboratory - was authorised for creation in 1999.

Article L. 542-10-1 of the Environment Code stipulates that an application for creation of a deep geological disposal centre must concern a geological layer that has been studied by means of an underground laboratory.

The procedures concerning any BNI creation authorisation application are indicated in sections E.2.2.3.1 and E.2.2.3.2. They are detailed and supplemented by article L. 542-10-1 of the Environment Code for the deep geological disposal authorisation, procedures which were clarified by the Act of 25 July 2016 defining the notion of reversibility and introducing more specifically the concept of industrial pilot phase.

Filing of the creation authorisation application for the centre is thus preceded by a public debate as defined in article L. 121-1 on the basis of a file produced by Andra. The creation authorisation application for the centre also gives rise to a report from the national commission mentioned in Article L. 542-3, to an ASN opinion and the gathering of the opinions of neighbouring regional authorities.

This application is then sent to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST), which assesses it and reports on its work to the competent commissions of the National Assembly and the Senate.

The authorisation sets the minimum period during which reversibility of disposal must be ensured as a precautionary measure. This period cannot be less than one hundred years. The creation authorisation for the centre is delivered by decree in Conseil d'Etat (Council of State).

The commissioning authorisation is limited to the pilot industrial phase, for which the results give rise to a report at Andra, an opinion from the commission mentioned in Article L. 542-3, an opinion from ASN and opinions from the neighbouring regional authorities. These documents are sent to the OPECST which assesses them and reports on its work to the competent commissions of the National Assembly and the Senate.

The Government then presents a bill adapting the conditions of exercise of disposal reversibility taking into account, if applicable, the OPECST's recommendations, and ASN issues the complete commissioning authorisation for the facility.

The Environment Code indicates in addition that "*the creation authorisation for a facility that could discharge radioactive effluents into the surrounding environment cannot be granted until the opinion of the European Community Commission has been obtained in application of Article 37 of the Treaty instituting the European Atomic Energy Community or, in the absence of such an opinion, after expiry of a period of six months following referral to the Commission*".

3.2. Measures taken by the BNI licensees

3.2.1. Measures taken by Andra

In the context of research carried out in accordance with the *waste Act*, Andra is responsible for the research and development programme with a view to building a deep geological repository, whose construction is scheduled to start in 2025, subject to creation authorisation. It follows on from the research and studies conducted under the Act of 30 December 1991, the results of which were compiled in the "dossier argile 2005" (Clay File 2005) published by Andra (available at http://www.andra.fr). This file contains in particular the knowledge acquired at and around the Bure underground laboratory site, and the deep geological repository design studies conducted up until then (including the reversibility aspects). The results of the research carried out in this research laboratory enabled the feasibility of deep disposal of high-level and intermediate-level long-lived waste in the studied Callovo-Oxfordian argillite layer.

In 2009, Andra presented safety, reversibility and design options. They were examined in 2010 by ASN and its technical support organisation, IRSN, notably identifying the main points requiring further information for the creation authorisation application.

In 2010 Andra conducted an in-depth geological survey of the area studied for the installation of the repository with means for conducting a three-dimensional seismic investigation of the sub-soil. In its assessment report of November 2011, the National Assessment Commission (CNE) underlined that the new seismic campaign confirms the excellent homogeneity of this area. The CNE also considers that Andra now has a geological model justifying the transposition of the data produced from the information acquired in the underground laboratory to the area studied for the location of the repository.

In 2012 Andra began the industrial design studies of the repository. These studies are based on the broad principles adopted after 20 years of research to ensure the long-term safety of the repository. The results of these outline studies were assessed in 2013 by ASN and the CNE and presented during the public debate. Andra's follow-up to the public debate and the assessors' recommendations shall be taken into account in the remainder of the studies. After having drawn up a Preliminary Design Study in 2014-2015, ANDRA submitted a safety options dossier and a retrievability technical options file to ASN in 2016 in preparation for the examination of the Cigéo creation authorisation application. An international peer review mandated by ASN was held under the aegis of the IAEA at the end of 2016: a team of 9 international experts from the safety authorities of various countries examined the safety options dossier and formulated opinions and recommendations. ASN finally issued a position statement on Andra's safety options dossier on 11 January 2018. On the basis of the feedback from the examination of this file and studies of the final design study, Andra has announced that the creation authorisation application will be finalised in 2021.

In accordance with the provisions of the Euratom treaty, the European Commission will issue an opinion. More specifically, Andra must submit to the European Commission a file concerning the radioactive effluent discharges; the Cigéo creation authorisation cannot be granted until the Commission has issued an opinion on this file.

Andra is also in charge of the disposal project for LLW-LL waste, such as graphite waste (stacks and liners) and radium-bearing waste, for which there is no management route at present.

In 2008, the search for a disposal site capable of taking LLW-LL type waste was unsuccessful. Further to the guidelines given by the PNGMDR 2010-2012 and the recommendations of the High Committee for Transparency and Information on Nuclear Safety (HCTISN) which produced a synthesis of the experience feedback from the procedure to find potential sites, Andra submitted proposals for project continuation to the Government in 2012. In 2013, the Minister responsible for ecology asked Andra to continue looking for a site, as much among the sites already accommodating nuclear facilities as in the regions where municipalities volunteered to host such a site in 2008, as recommended by the HCTISN. In 2013, geological investigations were carried on the land situated near the Andra's existing repositories in the Aube département, in consultation with the local players. In mid-2015, ANDRA gave the Government its interim report on the near-surface disposal of LLW-LL waste for the investigated site. This report enabled the lessons to be drawn from the first geological investigations and from the progress in the studies and research into waste conducted by Andra and the producers. ASN issued a position statement on this report in 2016, pointing out that "*it will be difficult to demonstrate the feasibility, in the investigated zone, of having a disposal facility with the capacity for all the LLW-LL waste retained by Andra*".

To follow on from the report submitted in 2015, the PNGMDR 2016-2018 asks Andra to submit an overall industrial scheme for the management of all the LLW-LL waste. This scheme must integrate new input data obtained since 2015: opinion of ASN on the 2015 report, request to take new waste into account in the project inventory, change of the producers' decommissioning and clean-out strategies, with in particular the announced schedule push-backs. To produce the industrial scheme, Andra conducted complementary geological investigations between 2017 and 2018 in the area of interest proposed in 2015. It is also continuing, with the waste producers, studies of the radiological inventory of the waste and to control its behaviour in a disposal situation. Alongside this, Andra's reflections have included thoughts on the possibility of creating - on the future site dedicated to LLW-LL waste - a disposal area for very low-level (VLL) waste. This is because in view of the forecast volumes of VLL waste resulting from the future decommissioning operations, new disposal capacities must be prepared for as of now, and synergies with the existing Andra centres in the Aube département, could be created. The report is now announced for the end of 2020 by Andra.

3.2.2. Measures taken by the CEA

The CEA only builds its new nuclear facilities on the sites of its centres that already accommodate other nuclear facilities. In practice, Cadarache and Marcoule are now virtually the only sites accommodating new facilities, and they are situated far from urban areas. Projects for new facilities can occasionally be undertaken at the Saclay centre, but these either involve the replacement of old facilities which have become difficult to maintain to current safety standards (as was the case with the Stella liquid effluent treatment facility at Saclay), or facilities with a low potential impact dedicated to the radioactive remediation of shut down facilities on the site.

The CEA's general waste management strategy therefore aims, after a summary conditioning treatment on their site of production, at directing to Cadarache or Marcoule the waste that requires complex conditioning treatment - as reversible as possible pending disposal acceptance specifications, and possible interim storage pending the opening of a disposal route. The corresponding facilities are built in compliance with the regulations and form the subject of information campaigns and consultation with the neighbouring populations, notably through public inquiries. In 2016, on completion of the public inquiry, the CEA thus obtained the decree authorising the creation of the DIADEM storage facility for irradiating waste on the Marcoule site.

3.3. ASN analysis for the case of BNIs

ASN checks regulatory compliance by examining the files submitted by the licensees and by conducting inspections.

With regard to the deep geological repository project, ASN has given the following opinions to the Government over the last few years:

- in 2010, a favourable opinion on Andra's proposal relative to an area of interest propitious to the installation of such a repository and in which complementary geological investigations would be carried out;
- in May 2011, an opinion confirming the interest of continuing the research and experimentation work in the Meuse/Haute-Marne underground laboratory;
- in July 2011, an opinion on the file submitted at the end of 2009 by Andra, presenting more specifically an update of the safety and reversibility options for the repository and the waste inventory considered for the design of the facility;
- in May 2013, an opinion on the documents produced by Andra since 2009. In this opinion, ASN points out a number of principles that Andra, in charge of the project, must adhere to, such as the need to maintain the lowest radiological impact that can be achieved given acquired scientific knowledge, the state of the art and economic and social factors. While underlining the quality of Andra's work, ASN also makes a number of recommendations for the future work and studies. ASN specifies principles that it adopts for the waste inventory, in view of the examination of the future creation authorisation application file for the repository and any modification applications that might be made during operation of the facility;
- in February 2015, an opinion on the project cost evaluation; further to this opinion, on 15 January 2016 the Minister responsible for energy set the reference cost of the project at €25 billion (cost as at 31 December 2011);
- in February 2016, an opinion on the management of HLW/ILW-LL waste under the PNGMDR 2016-2018 asking the licensees to study the consequences of pushing back the commissioning of Cigéo beyond the planned date of 2030;

- in May 2016, an opinion on reversibility taken up in the Act of 25 July 2016;
- in January 2018, an opinion on the Cigéo safety options dossier, which had also undergone an international peer review organised by the IAEA from 7 to 15 November 2016; this opinion includes several recommendations concerning the radioactive waste inventory to consider, the disposal of bituminised waste packages and certain subjects that could lead to design changes (justification of the repository architecture, dimensioning of the facility to withstand hazards, monitoring and surveillance of the facility and post-accident situations).

Lastly, ASN has published several position statement letters addressed to Andra:

- in December 2013, following the examination of a file entitled "Cigéo-Outline Project Jesq03 (2012)" giving a synopsis of the overall architecture adopted for the design studies and indicating in particular the design development of the project and their impacts on safety compared with the file submitted at the end of July 2009;
- in October 2014, on the closing engineering structures;
- in December 2014, on the requirements of the project safety options dossier;
- in April 2015, on the control of risks in operation;
- in June 2016, on the project development plan;
- in January 2018, on the Cigéo safety options dossier.

3.4. Case of the ICPEs and mine tailings

The acceptability for the environment is a founding principle of the ICPE regulations.

In the case of facilities subject to authorisation, in agreement with the European directives, the authorisation application must include a study (impact assessment or, failing this, an environmental impact assessment) the purpose of which is to analyse the impact of the project on the environment. Its content must be in relation with the scale of the projected works and their foreseeable impacts. The impact assessment must include:

- an analysis of the initial state of the site and the environment, focusing in particular on the natural resources, the material assets and the cultural heritage that could be affected by the project;
- an analysis of the direct and indirect effects of the facility, whether temporary or permanent, on the environment;
- an analysis of the cumulative effects on the environment of this project combined with other projects;
- the reasons, particularly with regard to the environmental concerns, for choosing this project among the envisaged solutions;
- the measures envisaged by the applicant to avoid, reduce and if possible compensate for the drawbacks of the facility.

The authorisation application must also include a hazards assessment. It includes a description of the accidents that could occur, particularly under the effect of the external causes that can be envisaged in view of the planned location, and a presentation of the hazards the facility could represent in the event of an accident.

The content of the hazard and impact assessments and all the elements of the authorisation application file are made public and submitted to the populations concerned by the project through a public inquiry.

In accordance with the decree of 2 June 2006, chapter VI "ionising radiation", a management plan for these deposits must be established and indicate the measures taken to limit their radiological impact on the environment.

These deposits must be monitored by the licensee until it is observed that their radiological impact on the environment is acceptable.

4| DESIGN AND CONSTRUCTION OF THE FACILITIES (ARTICLE 14)

Article 14: Each Contracting Party shall take appropriate measures to ensure that:

i) during the design and construction of a radioactive waste management facility, appropriate measures are planned to restrict any radiological impacts on persons, society and the environment, including those due to effluent discharges or uncontrolled emissions;

ii) at the design stage, theoretical plans and, depending on the needs, technical provisions for the delicensing of a radioactive waste management facility other than an ultimate disposal facility, are taken into account;

iii) at the design stage, technical provisions are developed for the closure of an ultimate disposal facility;

iv) the technologies used in the design and construction of a radioactive waste management facility are based on experience and tests or analyses.

4.1. Case of BNIs

A description of the general regulations governing the design and construction of BNIs is presented in section E.2.2.3 for the procedures, section E.2.2.5 for the technical rules and section E.2.1 for the discharges. In addition to the requirements of the general regulations, ASN can issue prescriptions, especially technical prescriptions, for the design, construction or operation of the projected facility. In such cases, these prescriptions supplement the facility creation authorisation decree.

In the case of a disposal facility, and in accordance with Article 8.5.1 of the BNI Order of 7 February 2012, "*the choice of geological environment, the design and construction of a radioactive waste disposal facility, its operation and its entry into the monitoring and surveillance phase are defined so as to protect persons and the environment against radioactive substances and toxic chemicals contained passively in the radioactive waste. This protection must not require intervention beyond a limited monitoring and surveillance period, determined according to the emplaced radioactive waste and the type of repository. The licensee must prove that the chosen design meets these objectives and demonstrate its technical feasibility.* ».

The technologies used in the design and construction of a radioactive waste management facility must be based on experience and tests or analyses. This is the case in particular with deep geological repository project, through the Bure underground research laboratory. It is also the case with the BNIs for the treatment, conditioning, packaging, storage or disposal of waste, in which the processes and equipment corresponding to the protection-important components must be based on tried and tested technologies or, in the case of a prototype, be covered by qualification files and for which tests are systematically performed in the facility before it is commissioned.

For BNIs other than disposal facilities, the licensee must, at the design stage, take the necessary measures to facilitate decommissioning of the facility and limit the corresponding waste production. In application of Article L. 593-7 of the Environment Code, the licensee must, as soon as it files the creation authorisation application, demonstrate that the general principles proposed for decommissioning or - in the case of radioactive waste disposal facilities - for their monitoring and surveillance after closure, are such as to prevent and limit the risks or drawbacks that the facility represents. The Environment Code requires a decommissioning plan to be drawn up as soon as the creation authorisation application is filed. This plan must present the principles and the steps envisaged for decommissioning and rehabilitating the facility and the subsequent monitoring and surveillance of the site. It must provide justification for the envisaged time frame between final operational shutdown of the facility and its decommissioning.

In agreement with the international standards (IAEA, WENRA), ASN considers that the following points are particularly important in the design and construction of a new facility:

- the choice of materials;
- the constructional measures to facilitate the decommissioning work;
- the provisions relative to the system to avoid active deposits and limit extension of contamination and facilitate decontamination of the premises and equipment, and cutting off the electrical power supply of the buildings;
- the collection and archiving of the required documents and data.

In the past, the measures taken at the design stage to facilitate decommissioning and limit the resulting production of waste were described relatively succinctly. Nowadays, for new BNIs they are described in more detail on account of the new regulatory requirements (decommissioning plan and waste studies).

For a waste disposal facility, Article R. 593-75 of the Environment Code stipulates that, when the creation authorisation application if filed, the decommissioning plan is replaced by a decommissioning, closure and subsequent monitoring and surveillance plan for the facility. This plan must include:

- the envisaged durations of decommissioning and of the facility monitoring and surveillance phase;
- the methods envisaged for decommissioning and the facility monitoring and surveillance phase;
- the methods envisaged for the conservation and transmission of the memory of the facility during and after the monitoring and surveillance phase;
- a preliminary version of a file called the "facility memory summary file", describing the as-built facility and including the inventory of the waste it contains, indicating the locations of the different types of waste and their physical, chemical and radiological properties;
- a description of the engineering structures in place for closure;
- a description of the various work steps necessary for the accomplishment of all the closure preparation operations and subsequent monitoring and surveillance, justifying their respective durations.

4.2. Case of ICPEs

For radioactive waste management facilities, which are ICPEs, the general regulations for ICPEs are applicable and their design and construction aspects are described in section E.2.3.1.

The regulatory authority (the Prefect of the *département*) checks implementation of the regulations through analyses and inspections it carries out in accordance with procedures presented in sections E.2.3.2.

5| ASSESSMENT OF THE SAFETY OF THE FACILITIES (ARTICLE 15)

Article 15: Each Contracting Party shall take appropriate measures to ensure that:

i) before constructing a radioactive waste management facility, a systematic safety assessment and an environmental assessment are carried out as appropriate for the risk presented by the facility and spanning its useful life time;

ii) in addition, before building an ultimate disposal facility, a systematic safety assessment and an environmental assessment for the period following closure is carried out and that the results are judged against criteria established by the regulatory body;

iii) before operating a radioactive waste management facility, updated and detailed versions of the safety assessment and the environmental assessment are established when deemed necessary to supplement the assessments mentioned in i) above.

5.1. Legal framework and ASN requirements

The general regulations of basic nuclear installations (BNI) apply to the radioactive waste management facilities that enter into this category of installations defined by decree on account of their radiological content.

The safety assessment requirements and conditions are described in section E. The general principles are reiterated below.

When filing the creation authorisation application for a facility, the licensee must provide a certain amount of information and studies (see section E.2.2.3.2). The content of the file is detailed in Article R. 593-16 of the Environment Code All the phases of the facility's life cycle must be studied (including its decommissioning or, in the case of a repository, the period following its closure). ASN examines the preliminary safety analysis report then submits a proposal to the Ministers for the drafting of the creation authorisation decree for the facility.

The main requirements concerning the preliminary safety analysis report are defined by Article R. 593-18 of the Environment Code. Title III of the Order of 7 February 2012, sets the principles and conditions of the safety case. The licensee must in particular apply the principle of defence in depth. The safety case must be based on a cautious deterministic approach and present the way in which the following functions are ensured:

- control of nuclear chain reactions;
- evacuation of the thermal power produced by the radioactive substances and nuclear reactions;
- containment of radioactive substances;
- protection of people and the environment against ionising radiation.

ASN defines the requirements regarding the BNI safety analysis report in its resolution of 17 November 2015. This resolution indicates, among other things, the information to be included in the safety analysis report. Furthermore, as indicated in § H3.1, ASN has issued basic safety rules and safety guides to define the objectives which must be decided upon as early as possible to ensure the safety of the facility, including after closure in the case of a disposal facility.

Even before initiating the authorisation procedure, a licensee may ask ASN for an opinion on some or all of the options it has adopted to ensure the safety of its facility. This preparatory procedure does not substitute for the subsequent regulatory examinations but aims at facilitating them (see section E.2.2.3.1).

On completion of construction and for the purpose of commissioning, that is to say the first introduction of radioactive substances, the licensee must send ASN a file as indicated in section E.2.2.4.1 and detailed in Article R. 593-30 of the Environment Code.

If the examination finds the file to be satisfactory, ASN authorises commissioning of the facility. The ASN resolution then sets the deadline for the licensee to submit an end-of-start-up file for the facility.

The authorisations granted are not limited in time. Nevertheless, periodic safety reviews are held every ten years (the authorisation decree can set a different frequency if the particularities of the facility justify this) and ASN can suspend the authorisation in case of imminent danger.

Some details concerning the safety assessment and the environmental assessment of the disposal facilities for the period following closure are given below. Two situations must be considered:

- the reference situation based on a scenario involving normal development of the disposal facility;
- "altered" situations resulting from uncertain events of varying degrees of plausibility, whether natural or linked to human actions.

The impact calculation under normal development must be based on an essentially deterministic approach using reasonably conservative models and parameters. Uncertainty studies must be carried out. If the calculation gives a value exceeding 0.25 mSv/year, it is necessary either to reduce the uncertainties through an appropriate research programme or to revise the design of the facility. For deep geological disposal, the value of 0.25 mSv/year is kept as a reference value for the period extending beyond 10,000 years.

In the case of altered situations, the calculations can lead to exposures exceeding the value of 0.25 mSv/year. As indicated in section D.3.2.2.2, the criteria for judging whether the impact is acceptable are essentially the mode and duration of exposure, along with the penalising aspect of the hypotheses considered for the calculation.

For example, for the stress tests, the altered scenarios are as follows, at the end of the monitoring and surveillance period (300 years):

- conventional intrusion scenarios leading to airborne transfer (road works, residence, children's games);
- various scenarios leading to transfer by water in the aquifer (barrier break, water supply well).

With regard to the project for deep geological disposal of radioactive waste, its procedures are governed by Article L. 542-10-1 of the Environment Code (see § H.4.1 for the regulatory details) which prescribes a pilot industrial commissioning phase prior to operation. Furthermore, the ASN guide on the deep geological disposal of radioactive waste considers that there will be an initial period of 500 years corresponding to the conservation of the memory of the disposal facility, enabling human intrusion into the disposal area to be rendered extremely unlikely.

5.2. Measures taken by the BNI licensees

5.2.1. Practices of Andra

For the creation of the Aube repository (CSA), the safety assessment and the environmental assessment focus not only on the operating phase but also on the monitoring and surveillance phase of about 300 years and on the "post-monitoring and surveillance" safety phase which is based on the implementation of passive safety measures. The design of the disposal structures and the specifications applicable the CSA waste packages take into account the safety requirements for all the repository life cycle phases mentioned above. Moreover, the preparation for closure of the Manche disposal centre (CSM) was carried out applying the same measures as for the creation of a new BNI in accordance with the practices in effect at the time of the request.

With regard to Cires which is comes under the ICPE regulations and not the BNI regulations, a comparable scheme was followed with production of safety assessments and environmental impact assessments addressing not only construction and operation but also the long-term outcome of the facility after its closure. These assessments are updated each time the facility is modified.

5.2.2. Practices of the other licensees - CEA, Orano and EDF

The practices of the CEA, Orano and EDF are identical to those applied for the spent fuel management facilities which are described in section G.2.2.

5.3. ASN analysis for the case of BNIs

The deep geological repository project is still in a phase preceding the creation authorisation application. ASN's analysis is described in section H.3.3.

As for the existing disposal facilities, they undergo periodic safety reviews.

Andra sent ASN the periodic safety review file for the CSA in August 2016. The file is currently being examined with the aim in particular of assessing the safety of the facility with regard to the planned development of its activities over the next ten years. It also consists in detailing the strategy for decommissioning, closing and monitoring and surveillance of the facility once it has stopped receiving waste.

In 2019 Andra authorised commissioning of the package inspection facility aiming to give the site more efficient means for checking the quality of the packages received at the CSA (see § H.6.3).

Andra finally submitted the periodic safety review file for the CSM to ASN in April 2019 (see § H.7.1), and ASN is currently examining it.

5.4. Case of the ICPEs and mining waste

The licensee's assessments of the design choices and of the impacts and hazards associated with an ICPE subject to authorisation or a mining waste disposal facility are analysed when examining the impact assessment and the hazards assessment (see section E.1.2 and H.3.4).

The objective of the licensees and the officials tasked with administrative surveillance was to detail the post-mining organisation by defining requirements proportionate to the risks and hazards for the long-term monitoring and surveillance of the sites.

6| OPERATION OF THE FACILITIES (ARTICLE 16)

Each Contracting Party shall take appropriate measures to ensure that:

i) the license to operate a radioactive waste management facility is based on the appropriate assessments specified in article 15 and is conditional upon execution of a commissioning schedule demonstrating that the as-built facility complies with the design and safety requirements;

ii) operating limits and conditions resulting from tests, operating experience and the assessments specified in 'article 15 are defined and revised if necessary;

iii) the operation, maintenance, monitoring and surveillance, inspection and testing of a radioactive waste management facility are ensured in accordance with the established procedures; In the case of an ultimate disposal facility, the results are used to verify and examine the validity of the proposed hypotheses and to update the assessments specified in article 15 for the post-closure period;

iv) engineering and technological support in all safety-related areas is available throughout the useful lifetime of a radioactive waste management facility;

V radioactive waste characterisation and separation procedures are applied;

vi) safety-significant incidents are notified in good time to the regulatory organisation by the license holder;

vii) programmes to collect and analyse relevant operating experience data are put in place and the results are followed-up when necessary;

VIII. plans for the delicensing of a radioactive waste management facility other than an ultimate disposal facility are developed and updated as required using the information obtained during the useful life time of this facility and are examined by the regulatory body.

ix) plans for the closure of an ultimate disposal facility are developed and updated as required using the information obtained during the useful life time of this facility and are examined by the regulatory body.

6.1. Legal framework and ASN requirements

The requirements of Article 16 of the Joint Convention are included in the requirements of the French regulations.

The authorisation to operate a radioactive waste management facility can only be granted at the end of the procedure indicated in section E.2.2.4 and reiterated in § H.5.1.

The general operating rules (RGE) established by the licensee in accordance with the BNI procedures decree must define the limits and conditions of operation of the facility in question. The RGEs are revised periodically to take account of the development of the facility and acquired experience.

The quality assurance rules define the requirements regarding the quality of operation, maintenance, monitoring and surveillance and inspection (see title II of the Order of 7 February 2012). More specifically, the licensee must have all the skills necessary for performance of the safety-related activities. It may nevertheless call upon third-party engineering and technological assistance in all safety-related areas.

In accordance with the Environment Code and Article 2.6.4 of the Order of 7 February 2012, incidents or accidents significant for safety or radiation protection must be reported to ASN without delay and to the State representative in the département in which the incident or accident occurred (see sections E.2.2.4.3 and E.2.2.7.2).

Article 2.6.3 of the Order of 7 February 2012 stipulates that the licensee must provide a detailed report containing the technical analysis, a human factors section and the fault tree. ASN checks its exhaustiveness and uses it to perform a cross-analysis between the various licensees.

Furthermore, in application of the order of 7th February 2012, the licensee must maintain a continuous improvement approach. Articles 2.7.1 and 2.7.2 of the abovementioned order thus stipulate respectively that:

- in addition to the individual handling of each deviation, the licensee periodically reviews the deviations to assess the cumulative effect of as-yet uncorrected deviations on the facility, and to identify and analyse trends concerning the recurrence of similar deviations;

- the licensee takes all necessary measures, including with respect to outside contractors, to systematically collect and analyse information that could enable it to improve the protection of the interests mentioned in article L. 593-1 of the Environment Code, whether the information results from the experience of the activities mentioned in Article 1.1 on its own installation or on other installations - similar or not - in France or abroad, or from research and development activities.

The licensee must provide a decommissioning plan as soon as it files the application for authorisation to create a BNI other than a radioactive waste disposal facility (see § H.4.1). For a disposal facility, the decommissioning plan is replaced by a decommissioning, closure and monitoring and surveillance plan (see § H.4.1).

Packaging is an essential aspect of radioactive waste management because the package is the first of the three containment barriers in a disposal facility, and in the case of a storage facility it plays an important role as a means of containment and of providing the possibility of retrieval.

In application of Article L. 542.12 of the Environment Code, Andra is tasked with producing the specifications for the disposal of radioactive waste and for giving the competent administrative authorities an opinion on the waste packaging specifications.

The BNI order indicates the following points:

- the radioactive waste intended for facilities having acceptance specifications provided for in Article L. 542-12 of the Environment Code is packaged in accordance with these specifications.
- the packaging of radioactive waste intended for facilities still being studied and which do not have acceptance specifications is subject to ASN approval.

ASN Resolution 2017-DC-0587 of 23 March 2017 relative to the packaging of radioactive waste and the conditions of acceptance of radioactive waste in the disposal BNIs details the radioactive waste packaging requirements figuring in the BNI Order.

For the CSA repository, Andra has put in place a battery of measures (specifications, approval procedures, computerised verification and tracking, visual inspection and dose rate on arrival, audits and inspections on the waste production sites, destructive and non-destructive tests of packages on delivery to the disposal centres, nonconformity processing procedures). As indicated in section D.3.2.2.2, the criteria for accepting packages at the centre result from the in-service and long-term safety assessments. Each producer designs and develop its treatment/packaging projects (by type of end package) and submits them to Andra for examination of conformity with Andra's specifications and ultimately to obtain its approval. Reminder: the CSA repository can only accept packages approved by Andra.

For some types of radioactive waste, especially high-level and intermediate-level long-lived waste, disposal is currently being studied in the context of the Cigéo project and should not be commissioned (industrial pilot phase) until 2030, on condition that the required authorisations are obtained. In the context of the PNGMDR 2016-2018, Andra was asked to draw up as soon as possible a preliminary version of the Cigéo facility acceptance specifications so that the producers can assess the acceptability of their waste. This preliminary version of the specifications was submitted by Andra in April 2016, then updated in July 2017.

In the meantime - as is the case for the other disposal facilities being studied - the production of waste packages they will receive is subject to ASN authorisation, after packaging approval on the basis of a file called "Packaging baseline requirement" demonstrating that on the basis of existing knowledge, and backed up by an opinion from Andra, there is nothing to prevent disposal of the packages on site.

Orano Cycle thus produces "production specifications" for the waste packages produced in the La Hague plant since 1991.

In November 2015, EDF submitted an approval application file for packaging ILW-LL waste in C1PGSP packages in the ICEDA facility file to ASN. This file has been reviewed and the commissioning authorization was issued in July 2020.

At the end of 2015 the CEA submitted a packaging approval application file for the packages of BNI 37 A, and an application for the packaging of packages containing disused sealed sources. These files are currently being examined.

6.2. Measures taken by the BNI licensees

6.2.1. Andra's in-service safety practices

For its facilities, Andra follows the procedures described in section E.2.2 which apply in particular to the commissioning of the facilities and the reporting of significant safety events.

The general operating rules (RGE) and the general surveillance rules (RGS) define the normal operating envelope of the centres. They are drawn up by Andra in conformity with the general regulations, the regulations specific to each facility (creation decree in particular) and the technical requirements indicated by ASN. The RGEs and RGSs are subject to formal approval by ASN.

Andra also draws up environmental monitoring plans. They indicate the measures (qualitative and quantitative) and their frequency implemented at the centres and in their vicinity to meet the objectives of the decree for entry into monitoring and surveillance phase and the discharge authorisation order. They are subject to a critical review and approval by ASN before being applied.

These measures are implemented not only at the Aube repository (CSA) , which is in service, but also at the Manche repository (CSM).

For the Cires facility, Andra complies with the requirements of the regulatory framework of the ICPEs, as described in section E.1.3.

As a general rule, all Andra's activities, and more specifically the operation, maintenance, monitoring and surveillance of the disposal centres, are carried out following established procedures in accordance with the quality system in place at Andra (see section F.3.2.1).

Andra's organisation aims at maintaining the necessary scientific and technical skills in all areas relating to the safety of its facilities (see section F.2.2.1).

6.2.2. Practices of the CEA, Orano and EDF

Radioactive waste management facilities are BNIs, like the spent fuel management facilities. Consequently, the practices of the CEA, Orano and EDF are identical to those applied for the spent fuel management facilities which are described in section G.6.2.

6.3. ASN analysis for the case of BNIs

As indicated above, the provisions set out in section E.2.2 concerning the BNI regulations aim at achieving the objectives of Article 16 of the Convention. The monitoring of the measures taken by the licensee, particularly through frequent inspections and periodic safety assessments, serves to verify that the regulations are applied.

In 2011, ANDRA submitted a request for modification of the CSA to allow X-ray imaging inspections, tritium degassing checks and destructive tests (core sampling of low level packages) on the site, in addition to the non-destructive checks already carried out (visual, radiological, dimensional, gamma spectrometry checks). ASN is in favour of Andra acquiring its own high-performance inspection resources to ensure the quality of the packages received in its facilities, by sampling inspections in certain cases. The construction of this facility received the agreement of ASN in mid-2013. The construction work was completed in 2015 and commissioning was authorised in September 2019.

In addition, ASN receives annual assessments established by Andra on the quality of the packages received at the CSA from each of the main producers. ASN conducts inspections to verify the satisfactory functioning of the system implemented by Andra.

6.4. Case of the ICPEs and mining waste

In the case of ICPEs, the requisite measures with regard to operation, maintenance, monitoring, and possibly at cessation of activity, are set by the technical requirements laid down in the Prefectoral Order (see section E.1.3) in application of the Environment Code, particularly Book V, as described in annex L. With regard to mining waste, as all the facilities have stopped operations, the practices relating to the closure and monitoring are presented in § H.7.2.

7| INSTITUTIONAL MEASURES AFTER CLOSURE (ARTICLE 17)

Each Contracting Party shall take appropriate measures to ensure that, after the closure of an ultimate disposal facility:

i) the files required by the regulatory body concerning the location, the design and the content of this facility are kept;

ii) the institutional controls, whether active or passive, such as monitoring and surveillance or access restrictions, are ensured if necessary;

iii) if an unscheduled emission of radioactive substances into the environment is detected during any period where active institutional controls are in place, response measures shall be implemented if necessary.

7.1. Waste from BNIs or ICPEs

7.1.1. The legislative framework

The legislative framework applicable to radioactive waste disposal BNIs for the period following their closure is governed by Article L. 593-31 of the Environment Code which stipulates that:

- the prescriptions applicable to the phase after closure of the installations, qualified as monitoring and surveillance phase, are defined by the decommissioning decree;
- the delicensing decision can be made once the installation has entered the monitoring and surveillance phase.

The Environment Code indicates that the decommissioning file includes in particular:

- the duration and envisaged methods for the phases of decommissioning, closure and monitoring and surveillance of the facility;
- a description of the engineering structures in place for closure;
- a description of the various work steps necessary for the accomplishment of all the closure operations and subsequent monitoring and surveillance, justifying their respective durations;
- the general monitoring and surveillance rules;
- a detailed file on the memory of the facility;
- and, if necessary, active institutional controls that the administrative authority can apply under Article L. 593.5 of the Environment Code.

Lastly, the Order of 7 February 2012 provides in particular that the protection of the interests mentioned in Article L. 593.1 of the Environment Code (i.e. public health and safety, protection of nature and the environment) must be ensured passively and not require human intervention beyond a limited monitoring and surveillance period, stipulating that the licensee must provide justification for the chosen design and the technical feasibility of meeting these requirements.

The closure of the facilities and entry into monitoring and surveillance phase are subject to the prior consent of ASN which rules in the light of the decommissioning file and, more specifically, the demonstration of the effectiveness of the planned monitoring measures.

7.1.2. The Manche disposal centre (CSM).

The CSM stopped accepting waste on 30 June 1994. In application of Decree 2016-846 of 28 June 2016, under the responsibility of Andra, the CSM is considered as being in the decommissioning phase (operations prior to its closure) until the end of installation of the definitive cover, allowing protection over a period covering the monitoring and surveillance phase and the post-monitoring and surveillance phase. An ASN resolution shall specify the date of closure of the repository (entry into monitoring and surveillance phase) and the minimum duration of the CSM monitoring and surveillance phase.

The various aspects relative to closure of the CSM are described in section D.3.2.2.1, while those for effluents are described in section F.4.2.1.3.

The monitoring and surveillance phase is the period during which the repository must be controlled (access restrictions, surveillance and repair work if necessary). This monitoring and surveillance phase will last at least 300 years, on the understanding that the required actions should decrease over time. The Decree of 10 January 2003 provides that, during this period, the monitoring and surveillance pan is revised every 10 years at the same time as the safety analysis report, the general operating rules and the contingency plan. These documents are submitted to ASN for examination. They must take experience feedback into account. For the CSM this is therefore a gradual and cautious approach.

During the procedure that led to the authorisation for the CSM to enter the decommissioning phase, a number of recommendations were issued, notably by the "Turpin Commission" (1996) for assessing the situation of the Manche repository, such as:

- evaluate the durability of the cover in place and estimate the benefits of replacing it by a new cover facilitating the inspection programme;
- optimise the inspection programme so that monitoring and surveillance becomes increasingly passive;
- transmit the necessary information to the future generations (plans, data, summary file and detailed file, transmission medium, etc.) ;
- inform and involve the public during the monitoring and surveillance phase.

With regard to the durability of the cover, during the last periodic safety review in 2006, ASN considered that Andra should continue its efforts to reinforce the stability of the cover and resolve the problems of stormwater infiltrations. In accordance with the commitment made during this safety review, on 16 February 2015 Andra sent ASN an interim review of the work carried out on the repository cover. Technical complements were requested in September 2016 and will in particular enable the requirements concerning the dimensioning of the long-term cover to be clarified. These factors will also be addressed in the ongoing examination of the periodic safety review, for which the file was submitted in 2019. Nevertheless, in application of the Decree of 28 June 2016 following on from the TECV act, the CSM is administratively considered to be in the decommissioning phase and not in the monitoring and surveillance phase, as the closure operations have not all been carried out. ASN has asked Andra to indicate the duration of the long-term cover installation operations before the CSM is closed and enters the monitoring and surveillance phase. On the basis of this information, ASN will issue a resolution setting the date of submission of the closure application file and entry into the monitoring and surveillance phase, and the duration of the CSM monitoring and surveillance phase.

Andra submitted the periodic safety review guidance file (DOR) in July 2016, and ASN issued an opinion on it in December 2017. In April 2019, Andra finally submitted the CSM periodic safety review file presenting the envisaged strategy for the installation of the definitive cover. This file is currently being examined by ASN.

The years of operation of the CSM repository were marked by tritium contamination of the water table discovered in 1976. The waste that caused this contamination was removed in 1977 and 1978, but the groundwater contamination is still significant. In 2016 Andra continued taking tritium activity measurements in the water table at the CSM. These measurements reveal a reduction in the average tritium-marking of the water table which is consistent with the radioactive half-life of tritium. In its Opinion of 23 February 2016, ASN considers that the regulatory monitoring and surveillance plan for the CSM is appropriate for monitoring the tritium contamination of the ground and surface waters. Andra will continue taking five-yearly measurements of the tritium stratification in the piezometers of the initial study and in new sectors to consolidate the observed trends and map the various sectors of the CSM. These data should provide a better understanding of the hydrogeological mechanisms at the CSM.

Archival

Long-term archival of the information is an important point. The technical prescriptions issued by ASN for the monitoring and surveillance phase list the information that must be archived over the long term.

In order to conserve the memory of the CSM and foster its transmission over several centuries, Andra has put in place several mechanisms which were mentioned in section D.3.2.2.1 and are detailed below.

Andra has set up a so-called "passive" memory comprising a detailed memory and a summarised memory. This is a long-term memory (spanning a time scale of a few centuries to a thousand years):

- all the documents constituting the detailed memory are printed on permanent paper in two copies, one kept on the site, the other in the National Archives. In accordance with the recommendations of the "Turpin Commission", Andra produced an intermediate version of the "summarised memory" in 2008 intended to conserve the essential information concerning the CSM for the future generations. Following an exercise carried out in 2012 to examine the relevance of the data contained in the detailed memory, Andra prioritised the data figuring in it in 2016. Andra submitted a consolidated version in its periodic safety review file in April 2019;
- the summarized memory is contained in a single volume. It is intended to be distributed to decision-makers, whether local (prefects, mayors, notaries, etc.) or national (ministries, etc.) and to broader audiences (associations, national and international bodies (NEA, IAEA, etc.) and the general public). It provides a record of the most important information on the disposal facility to enable decisions to be taken with full knowledge of the facts.

Ultimately, Andra also envisages producing a simplified memory (some thirty pages) and an ultra-simplified memory (1 page printed on both sides)

Furthermore, the existence of the disposal centre is recorded in the land registry so that any possible future utilisation of the site and the neighbouring land is done knowledgeably.

In addition, Andra also deploys an "active" memory based on communication with the public and regular relations with the Local Information Committee (CLI) and based on a short and medium-term memory (spanning from a few decades to about a century).

It is based on two principles:

- informing the public (site newsletter, receiving visitors, website, etc.) in order to make the memory last as long as possible after the end of operation of the facility;
- keep track of the functioning of the centre and inform the local populations through the CLI.

The memory project

With Cigéo, Andra wants the time scale of the memory to cover several thousand years.

Consequently, in 2010, Andra decided to launch a memory project with a two-fold goal:

- increase the robustness of the reference solution;
- and develop the reflections and studies on the several-thousand-year memory.

For each of the three components that constitute the memory (message, physical medium and relaying mechanism), Andra is conducting complementary research combining landscape archaeology, linguistics, ageing of materials, archival, and social sciences and the humanities.

Scientific studies into the ageing of materials consisted in testing the ink/paper combination by means of standardised tests. This must still be consolidated by an international laboratory. Durability studies on other media for the longer term are currently being defined. They will concern non-paper media for writing and engraving, in particular studies of surface markers to be installed on the cover over the centres and the production of sapphire disks as demonstrators for a memory medium, the longevity of which could be up to a million years.

Studies of another type have also been initiated on the following subjects:

Long-term durability:

- languages and symbols, in order to determine for what reasonable time current or dead languages can be known and what the communication solutions could be once these languages cease to be known;
- of institutional conservation of written works, sounds, images, objects, etc. by specialised French and international organisations, to analyse the preventive measures taken to limit deterioration over time and encourage assimilation and transmission by future generations;
- long-term digital archival, more specifically by organising an intelligence watch in this field, which is beginning to become organised and which, within the next few decades, could open up new prospects for the long term.

Temporality and vestiges:

- the archaeology of techniques and landscapes, incorporating man-made changes and geodynamic changes, as well as the possibilities of memory within human creations (using the backfilling material of surface-to-underground links as a memorisation tool);
- the memory of “legacy” repositories not managed by Andra, which exist in various places in France (uranium mines, nuclear tests, etc.);

The societal dimension of the issue:

- the perception of long time scales (several thousand years and more) by the public, within the framework of a grouping of human and social sciences laboratories;
- possible societal developments in science, technology, the humanities, etc. broken down into three broad lines (regression, stagnation, progression);
- the inclusion of preservation of the memory of repositories in teaching programmes on nuclear energy, heritage and memory;
- the transmission of memory between generations via social networks on the Internet to provide global information on the memory of the repositories.

7.2. Case of uranium ore processing residues

The uranium mines, their annexes and their conditions of closure are covered by the Mining Code. The disposal facilities for radioactive mining tailings are governed by section 1735 of the ICPE nomenclature.

A plan of action was also defined in 2009, comprising the following themes:

- monitor the former mining sites;
- improve the understanding of the environmental and health impact of the former uranium mines and their monitoring;
- manage the mining tailings;

- reinforce information and consultation.

Generally speaking, any mining site must, after stopping its activity, undertake works in conformity with the Prefectoral decision in order to control the long-term risks by choosing robust and lasting structures.

The Prefect asks firstly for the implementation of an active monitoring system to confirm that the impact remains acceptable.

On the basis of the feedback from this monitoring, active monitoring and surveillance may be relaxed and replaced by passive monitoring and surveillance. The long-term acceptability is examined in the light of degraded situation scenarios (loss of embankment impermeability, deterioration of the cover, mining work, dwellings, etc.).

A major aspect of the monitoring and surveillance system is based on an institutional control which aims to ascertain that the possible modifications to the land will not affect the control of the risks. This institutional control relative to the soils and waters consists in:

- restrictions on the occupancy or utilisation of the site (irrigation, crops, livestock, dwellings, swimming, etc.) ;
- obligatory measures (monitoring and surveillance, maintenance, etc.);
- precautions to take (excavation work, installation of pipes, etc.);
- access restrictions.

The information is available to the public and in the notarial deeds. If there is a major risk, the Prefect may to put in place a "mining risks prevention plan" (PPRM).

The radionuclides present in the mining waste treatment residues and the associated radon are taken into account in the impact assessments and for site monitoring.

The redevelopments of mining sites have been designed and carried out so that after a few years of active monitoring and surveillance, site monitoring can be reduced to a minimum. The aim of the licensees and the officials tasked with administrative surveillance was to avoid having excessive site monitoring or maintenance requirements subsist over the long term.

Nevertheless, verifications and even redevelopments were found to be necessary in the uranium ore treatment residue and mining waste rock disposal sites. Some actions are still in progress (see section B.6.3).

Studies on the long-term behaviour of the mine tailings disposal sites were submitted as soon as the French National Radioactive Material and Waste Management Plan (PNGMDR) was put in place in 2007 and shall be continued in the various successive PNGMDRs in order to assess the long-term environmental and health impact of the management of the former uranium mining sites.

SECTION I | TRANSBOUNDARY MOVEMENTS (ART. 27)

1. Each Contracting Party concerned by a transboundary movement shall take appropriate measures to ensure that this movement takes place in conformity with the provisions of this Convention and the relevant legally binding international instruments.

In doing so:

- *a Contracting Party which is a State of origin takes appropriate measures to ensure that this transboundary movement in only authorised and only takes place after notifying the destination State and having received its consent;*
- *the transboundary movement through the States of transit is subject to the relevant international obligations for the particular modes of transport used;*
- *a Contracting Party that is a destination State shall only consent to a transboundary movement if it has the administrative and technical means and the regulatory structure necessary to manage the spent fuel or radioactive waste in compliance with this Convention;*
- *a Contracting Party that is a State of origin shall only authorise a cross-border movement if it can ascertain, in accordance with the consent of the destination State, that the requirements set out in iii) are satisfied prior to the cross-border movement;*
- *a Contracting Party that is a State of origin shall take appropriate measures to authorise the return onto its national territory if a transboundary movement is not or cannot be carried out in accordance with this article, unless another arrangement can be reached.*

2. A Contracting Party shall not deliver a license to ship its spent fuel or radioactive waste for storage or final disposal to a destination situated south of the latitude 60 degrees south.

3. No provision of this Convention prejudices or affects:

i) the exercising, by the ships and aircraft of all the States, the rights and freedoms of maritime, inland waterway and air navigation such as they are provided for by international law;

ii) the rights of a Contracting Party to which the radioactive waste is exported for treatment, to return the radioactive waste and other products after treatment to the State of origin or to take measures to this effect;

iii) the rights of a Contracting Party to export its spent fuel for the purpose of spent fuel reprocessing;

iv) to the rights of a Contracting Party to which the spent fuel is exported for reprocessing, to return the radioactive waste and other products resulting from the spent fuel reprocessing operations, to the State of origin or to take measures to this effect.

1| AUTHORISATION FOR TRANSBOUNDARY TRANSPORT OPERATIONS

France is attached to the principle whereby each nuclear installation licensee is responsible for the waste it produces. This principle is transcribed in the Environment Code which prohibites the disposal in France of radioactive waste from foreign countries and the disposal of radioactive waste resulting from the reprocessing of spent fuels and radioactive waste from foreign countries. Furthermore, the introduction onto the national territory of radioactive waste or spent fuel for the purpose of processing or reprocessing is subject to the prior conclusion of intergovernmental agreements, setting a date limit for the return of the ultimate waste to the country of origin (see section B.1.4). In addition, France obliges the disposal on French territory of the radioactive waste produced on French territory.

The radioactive waste is packaged in a form that can guarantee its transport and storage in the safest possible manner for the environment and public health. France ascertains that the waste destination countries comply with the obligations of Article 27 of the Joint Convention.

With regard to the organisation of transboundary movements, France applies the international, European and nationals standards for safety, transport, security, physical protection and law enforcement. More specifically it applies the provisons of Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel, transposed into French law by Decree 2008-1380 of 19 December 2008 codified in Articles R. 542-34 to R. 542-66 of the Environment Code.

The transboundary movements of spent fuel and radioactive waste between France and third-party countries mainly concern the spent fuel reprocessing operations carried out in the La Hague plant for foreign customers.

Transboundary movements with European countries are made chiefly by rail. Maritime transport is used for Japan and Australia, as port infrastructures with the required nuclear safety level have been provided on both sides. No significant incident calling into question security, safety or radiation protection has been reported in these transport operations over the last few years.

In accordance with Article 27 of the Joint Convention, France has never authorised the shipping of spent fuel or radioactive waste to a destination situated south of latitude 60 degrees south.

France adds to these requirements, on a voluntary basis, the implementation of a policy of transparency comprising the exchange of information and communication, particularly with the general public and civil society. It applies more particularly these provisions in the area of maritime transport with respect to the coastal Statse on maritime routes, supplemented by diplomatic information initiatives.

2| OVERSIGHT OF THE SAFETY OF TRANSPORT OPERATIONS

2.1. Organisation of the oversight of the safety of transport of radioactive substances

ASN is tasked with oversight of the safety of transport of radioactive and fissile materials for civil use. Its attributions in this area are mentioned in the Environment Code (Articles L. 592-19, L. 595-1 and R. 595-1 in particular) and the Transport Code. It should be noted that the regulations governing the transport of radioactive substances have two distinct objectives:

- security, or physical protection, consists in preventing losses, disappearances, thefts and hijacking of nuclear materiasl (materials that can be used to produce nuclear weapons); the Defence and Security High Official (HFDS) of the Ministry responsible for ecology, is acting authority by delegation from the Ministries of Defence and of Energy;
- safety, which consists in controlling the risks of irradiation, contamination and criticality presented by the transport of radioactive substances, so that humans and the environment do not suffer the adverse effects. Oversight of safety is the responsibility of ASN. Since 2016 ASN has been responsible for oversight of the security of transport of radioactive sources when nuclear materials are not involved, and the oversight system is becoming progressively established.

In application of the Defence Code, oversight of the transport of radioactive substances concerning national defence is the responsibility of the Delegate for Nuclear Safety and Radiation Protection for the activities and facilities concerning defence (DSND).

In the oversight of the safety of transport of radioactive and fissile substances, ASN is tasked with:

- contributing to the preparation of the technical regulations and monitoring their application;
- carrying out the licensing procedures (approval of certain package models and organisations);
- receiving the notifications prior to the shipping of higher-risk radioactive substances and receiving the notifications from companies whose activity involves the transport of radioactive substances;
- organising and supervising inspections;

- taking enforcement measures (serving compliance notices, financial deposit, compulsory work performance, suspension of transport, etc.) and the necessary sanctions;
- contributing to informing the public.

In addition, ASN provides the public authorities with technical support in the event of accidents involving radioactive substances.

2.2. Regulation of the transport of radioactive substances

Unlike the technical regulations governing the safety of installations, which are specific to each country, international bases have been developed by the IAEA for the safety of transport and constitute the regulations for the safe transport of radioactive material, reference SSR-6 (of which the last issue dates from 2018).

It must be noted that the term "radioactive material" used in the regulations specific to transport designates all radioactive substances, including waste. The IAEA bases are taken up in the international modal regulations:

- the ADR agreement (European Agreement concerning the International Carriage of Dangerous Goods by Road) which governs road transport;
- the RID regulations (Regulations concerning the International Carriage of Dangerous Goods by Rail) which governs rail transport;
- the ADN agreement (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) which governs inland waterway transport;
- the IMDG (International Maritime Dangerous Goods) code which governs maritime transport;
- the technical instructions of the ICAO (International Civil Aviation Organisation) which govern air transport.

These modal regulations are integrally transposed into French law and rendered applicable by European or French legislation (Directive 2008/68/EC, Commission Regulation (EU) 965/2012, TMD Order of 29 May 2009 amended, RSN Order of 23 November 1987 amended, etc.). To this end, ASN is in contact with the Administrations responsible for the various modes of transport (General Directorate for Risk Prevention (DGPR), General Directorate for Infrastructure, Transport and the Sea (DGITM), General Directorate for Civil Aviation (DGAC) and sits on the Interministerial Commission on the Transport of Hazardous Materials (CITMD).

Safety of transport is based on the principle of defence in depth and three complementary levels of protection:

- the robustness of the package, which maintains the safety functions (case of type-B packages in particular) in the event of a severe accident;
- the reliability of the transport operations, which reduces the occurrence of anomalies, incidents and accidents;
- emergency situation management, which mitigates the consequences of incidents and accidents.

IAEA safety standard SSR-6 specifies package performance criteria and the safety functions (containment, radiation protection, control of thermal risks and criticality) that it must fulfil. For each type of package (excepted packages, industrial packages, type-A, type-B and type-C packages, etc.), the regulations define the safety requirements which aim to maintain the safety functions when the package is subjected to certain test conditions, the severity of the requirements being proportional to the hazard level of the radioactive content of the package.

ASN participates in the drafting of the technical regulations and verifies their application. ASN endeavours to be involved as early as possible in the preparation of the regulations, in collaboration with IRSN, notably by participating in the various international or multinational working groups for the transport of dangerous goods and radioactive materials.

Thus, ASN is a member of:

- the IAEA TRANSSC (Transport Safety Standards Committee) and is represented in numerous working groups relative to the transport of dangerous goods, as an expert when the case of radioactive substances is addressed;
- the European Association of Competent Authorities (EACA).

With regard to spent fuel and waste transport operations, the French regulations impose the same safety rules whether the transport operations involve border crossings or not. All these transport operations must therefore comply with the international modal regulations, in particular the ADR agreement for transport and the RID agreement for rail transport.

As regards safety, the Defence Code contains provisions aiming to prevent the theft of nuclear material during transport or malicious acts directed against them. This applies in particular to spent fuel and high-level waste transport operations.

To this end, the Defence Code stipulates that the carriers must obtain an authorisation from the HFDS (Defence and Security High Official). They are required in particular to take measures to protect the items they collect or transport and to comply with the inspection requirements.

The HFDS relies on the assistance and technical expertise of the IRSN in the accomplishment of this task.IRSN is more specifically tasked with monitoring nuclear transport operations.

In this context, a duly authorised carrier must provide IRSN with a notice describing the conditions of each transport operation: nature and quantity of material transported, places of departure and arrival, itinerary and schedule, border crossing points. On the basis of this file, IRSN or the HFDS, as the case may be, will issue a license to carry out the transport operation or not.

The transport operation itself is supervised by IRSN. To this end, the carrier ensures contact between the convoy and IRSN to keep the latter it informed without delay of any event that could delay or compromise the operation and thus inform the HFDS of it.

For the transport of radioactive substances that are not nuclear materials, the general security provisions of the international modal regulations are applicable. Moreover, the Order of 29 November 2019 relative to the protection of ionising radiation sources and batches of radioactive sources of categories A, B, C and D against malicious acts lays down requirements aiming to reinforce the security of transport of the most dangerous sealed radioactive sources (that is to say high-activity sealed sources within the meaning of European Directive 2013/59/Euratom setting the basic standards relative to protection of health against the hazards resulting from exposure to ionising radiation), with gradual entry into force.

2.3. Inspection of the transport of radioactive substances

Each year ASN conducts about one hundred inspections in the transport of radioactive substances, relying in particular on its regional divisions, as it does for the BNI inspections.

Good coordination - from the regulatory and practical aspects – is sought with the other oversight authorities responsible in particular for inspection of the means of transport, labour inspection in the transport sector and the protection of nuclear materials.

The ASN inspections give rise to follow-up letters addressed to the inspected entities. ASN renders the follow-up letters accessible to the public on its website.

2.4. Radioactive substance transport events

Recording and analysing the significant transport events has a dual purpose:

- ensure that the companies involved in a particular event have conducted an analysis in order to learn all the relevant lessons from it;
- enable ASN to establish an overall view in order to highlight recurrent safety problems encountered by the transport players, practices that must be improved or questioning on the needs to make changes to the regulations.

In accordance with the provisions of the TMD order of 29 May 2009 and the requirements of the international modal regulations and the Environment Code, any deviation from the regulations or requirements of the safety cases, and any event actually or potentially affecting safety, must be reported to ASN within a matter of days following its detection (save in an emergency in which case the public authorities must be informed immediately). In addition to this notification, a detailed report of the incident must be sent to ASN within two months. ASN Guide N. 31, updated in 2017, defines the classification criteria for events involving transport and the conditions of their notification to ASN. It is available on the ASN website. In the area of radioactive substance transport, 84 events rated level 0 and 5 events rated level 1 on the INES scale were reported to ASN in 2019.

SECTION J | DISUSED SEALED SOURCES (ART. 28)

1. Each Contracting Party shall take, in national law, appropriate measures to ensure that the possession, repackaging or final disposal of disused sealed sources is carried out safely.

2. A Contracting Party authorises the return onto the national territory of disused sealed sources if, under natonal law, it has accepted that such sources be reshipped to a manufacturer authorised to receive and possess disused sealed sources.

1| THE REGULATORY FRAMEWORK

The general regulation framework for sources is described in section E.2.1. Any user is obliged to have its suppliers take back the sealed sources it has been delivered as soon as the user has no further use for them and at the latest within 10 years following the date of the first approval signature placed on the source supply requests. These provisions relative to the talking back of sources and those relative to the financial guarantees have been applicable in France since the early 1990s.

Disposal solutions for disused sources are being studied in the context of the PNGMDR.

ASN has authorised the disposal in the CSA of sealed radioactive sources with a half-life less than that of caesium-137, that is to say about 30 years, with activity limits per source and per package of sources. This disposal route, which concerns about 10% of the disused sources, will not however permit the long-term management of all the sources. In 2019, ASN authorised the disposal of high-activity Cobalt-60 sources and discards from the CEA on the basis of an acceptable assessment of the associated impacts, with a normal development scenario and a human intrusion scenario.

In order to control and limit the number of sealed radioactive sources that must be taken back, extension of the life of certain sources is envisagd. An ASN technical resolution detailing the requisite conditions for a source to be granted such an extension was approved by Order of 23 October 2009 (ASN Resolution 2009-DC-0150). The possibility of life extension is to be assessed in particular on the basis of the source construction process, the quality of manufacture, the conditions under which it has been used, and the possibility of checking the condition and sealing of the source. The results of the periodic technical checks required by the regulations throughout the source utilisation period are also examined.

2| THE ROLE OF THE CEA

Under French regulations, since 1989, sealed source suppliers are responsible for taking back disused sealed radioactive sources (DSRS) if requested by the user. This obligation now figures in the Public Health Code (Article R.1333-52 III).

The CEA and CISBIO, its former subsidiary, were major manufacturers and suppliers of a very large variety of sealed sources (all isotopes, all applications). Taking back the DSRS's is therefore a statutory obligation for the CEA, resulting from its past activities as a sealed source supplier. Furthermore, given the special status of the

CEA with regard to the management of its own sources until April 2002, the CEA manages the DSRS's acquired before that date, whoever the initial supplier was.

It is in this context that the CEA has set up a system for collecting and storing DSRS's and is seeking disposal routes. This system was finalised in 2008/2009 with the creation of:

- the HA sources GIP (high-activity sources Public Interest Grouping), between CEA and CISBIO, for the retrieval of high-activity cobalt and caesium sources;
- the Sources Mission, responsible for strategic coordination of the entire DSRS programme.

The programme scope includes:

- collection and management through to disposal of DSRS's which were supplied by the CEA or CISBIO and all the DSRS's used by the CEA and acquired before April 2002;
- management of the sources already retrieved in the past by the CEA or CISBIO through to their disposal;
- collaboration with the IAEA in international operations to retrieve or make safe radioactive sources within the framework of the agreement signed by France and the IAEA in 2011 ("support-plan").

At the end of 2008, Andra issued a study on the sustainable management of disused sealed radioactive sources under the waste act, and the 2009 version of the PNGMDR took the management of DSRS's into account. The CEA used these bases to revise its DSRS management strategy in order to systematically include not only their retrieval and storage but also their disposal. This strategy was approved by ASN in the first half of 2012.

The CEA and CISBIO have stopped their sealed source supply activities (CEA in 1999 and CISBIO in 2006). Consequently, the CEA's DSRS management programme aims at achieving its objectives within a limited time frame. The end of the regulatory obligations of the CEA (and CISBIO) resulting from their statuses as former suppliers and manufacturers of sealed sources, which is the fundamental objective of the Sources Mission, implies:

- keeping the various retrieval routes available for the time necessary to finalise the collection of disused or still-used sources;
- creating disposal routes and keeping them available for the time necessary to ensure the disposal of the stocks of sources already retrieved and those still to be retrieved;
- close or transfer to Andra the developed disposal routes by 2026.

3| DISPOSAL OF DISUSED SEALED SOURCES

3.1. Stocks of disused sealed sources

In late 2011, Andra updated the inventory of the stocks of disused sealed sources considered as waste, together with the entities in possession of them, pursuant to Decree 2012-542 of 23 April 2012 laying down the requirements of the PNGMDR 2010-2012. 3.5 million disused sealed sources have been declared to Andra. The companies in the French grouping of electronic fire safety industries (GESI) hold about 74% of all disused sealed sources (smoke detectors), the French armed forces hold about 23% (scrapped military equipment such as compasses, instrument dials, etc.)and industrial and medical sources represent about 3% (includuing the sources of the CEA, the LEA (Laboratory of Activities Standards), EDF, etc.).

3.2. Overview of the conditions of disposal of sealed sources

On account of their properties, disused sealed sources lie within the categories of radioactive waste that require special management routes.

The specificity of sealed sources is their concentrated activity and their potential attractiveness. In the event of human intrusion following the loss of all recorded memory of a repository, this attractiveness could lead to disused sealed sources being retrieved by individuals unaware of the hazards. If the impact that would result from this retrieval were considered to be excessive, the disused sealed sources would not be considered acceptable in the repository. Consequently, the repository acceptance conditions for sources are the subject of specifications, on the one hand with an activity criterion concerning the packages and structures, called “specific activity limit” (SAL) and on the other an activity criterion per radionuclide in each source, called the “source activity limit” (LAS). The source activity limit (LAS) is estimated in order to limit exposure in the event, for example, of a package falling during operation of the repository, or persons intruding after the monitoring and surveillance period and taking away a disused sealed source (scenarios considering the potentially attractive nature of the source).

The CSA today, and the Cires since 2015, have acceptance specifications for the disposal of radioactive packages containing sealed sources.

The CSA accepts sources comprising a single radionuclide whose half-life is less than that of caesium-137, that is to say 30 years, and with activity levels below given thresholds[1]. Lastly, mixed packages containing both disused sealed sources and waste are not authorised. The sources accepted at Cires are those whose activity will be less than 100 Bq 30 years after their arrival, this criterion being reduced to 10 Bq after 30 years for sources with alpha emitters or decay products. This will permit, for example, the management of old, totally decayed sources, or sources used in nuclear medicine e.g. cobalt-56 or germanium-68).

For sources that do not satisfy these acceptance criteria, Andra has examined the possibilities of disposal via the low-level long-lived waste (LLW-LL) route. These acceptance criteria are yet to be established for a future LLW-LL waste repository. Disused sealed sources not acceptable in above-ground or near-surface repositories will be routed to deep geological disposal, along with ILW-LL waste for disused sources with low exothermal properties and with HLW waste for the most exothermal disused sources.

In the context of the PNGMDR 2013-2015, on the basis of the preceding PNGMDRs, a working group – the "Sources WG" – chaired jointly by the Director General for Energy and the Climate and the Director General for Risk Prevention or their representatives, has continued analysing the situation and the needs in order to define the conditions of management of disused sealed sources if they are intended for recycling or considered as waste. The CEA, which is a stakeholder in the management of disused sealed sources and ensured the secretariat of the working group, submitted the WG recommendations in a report issued on 19 December 2014.

The PNGMDR 2016-2018 thus recommends primarily that Andra:

- examines the possibility of reassessing the acceptance criteria for the Cires and the CSA;
- develops, as part of the project for a disposal facility for LLW-LL waste currently under design, preliminary acceptance criteria for disused sealed sources;
- integrates, for the HLW and ILW-LL waste, the case of disused sealed sources in the preparation of preliminary acceptance specifications for the Cigéo project transmitted as part of the project safety options;

[1] Activity per source < source activity limit (SAL), depending on the radionuclide concerned; maximum activity of package < 270 TBq; Specific activity of package < 1/10 of the maximum acceptable limit (MAL).

- presents at the end of 2017 a track record for the deployment of the management routes for disused sealed sources considered as waste in order to assess the implementation of the preceding recommendations.

In July 2018 Andra submitted a study in which it proposes changes concerning the acceptance of sources at the Cires and the CSA.

The increase in the "source activity limit" (LAS) acceptance criterion to 10 Bq after 30 years for sources with alpha emitters or decay products, and to 100 Bq for the other sources, is applicable since 1 January 2019.

With regard to the CSA, the proposed change in Andra's acceptance specifications, except for sources containing tritium in liquid or gaseous state, is being examined by ASN as part of the periodic safety review of the facility. Alongside this, the CSA was authorised on 13 August 2019 to accept a finite batch of high-activity Cobalt-60 disused sealed sources and their fabrication discards which include the isotopes 59 and 63 of nickel, after demonstrating the absence of unacceptable impacts in a human intrusion scenario.

With regard to Cigéo, the source acceptance specifications shall be defined in the years to come.

3.3. Retrieval of disused sealed sources

The holders of sealed sources are required under article R. 1333-52 of the Public Health Code to have their sources taken back after ten years of possession, unless a possession extension authorisation is issued.

The supplier of sealed radioactive sources is, for its part, obliged to collect any sealed source it has distributed, unconditionally and whenever requested (Article L.1333-15 of the Public Health Code). Article R.1333-161 provides for the possibility of retrieval of sealed radioactive sources by any supplier (and no longer only the original supplier or its takeover firm) and, as a last resort by Andra, if and only if it has been impossible to identify the original supplier or if there is no possibility of recycling the disused sealed radioactive sources under the technical and economic conditions prevailing at the time.

The PNGMDR 2016-2018 asks Andra to assess the deployment of management routes for disused sealed sources considered to be waste and to continue to examine source disposal needs with the holders concerned.The study submitted by Andra is currently being analysed. The work on this subject will be continued in the context of the fifth issue of the PNGMDR.

Section K | Measures to improve safety

1| NATIONAL MEASURES

To guarantee and maintain a high level of nuclear safety in nuclear facilities in France, the French authorities base the exercise of their missions on various principles. Among these principles, the continuous improvement of nuclear safety using the best available techniques is a priority.

1.1. ASN objectives

Under article L. 592-1 of the environment code, ASN participates in the oversight of nuclear safety and radiation protection and informing the public in these areas see section E.3.1).

ASN is involved in all aspects of radioactive waste management, fuel management and decommissioning, either directly as the installations oversight authority or within the framework of the PNGMDR.

1.1.1. Objectives concerning the regulatory framework

Continuation of the overhaul of the regulatory framework applicable to BNIs

Since 2017 ASN has been pursuing its overhauling of the regulatory framework applicable to BNIs.

The regulatory part of the Environment Code more specifically concerning ASN, BNIs, the transport of radioactive substances and the system of oversight and sanctions with respect to these installations and activities was created by Decree 2019-190 of 14 March 2019 amending and codifying the provisions applicable to basic nuclear installations, to the transport of radioactive substances and to transparency in nuclear matters.

The decree codifies:

- decree 2007-830 of 11 May 2007 amended relative to the nomenclature of basic nuclear installations;
- decree 2007-831 of 11 May 2007 setting the appointment and certification procedures for nuclear safety inspectors;
- decree 2007-1368 of 19 September 2007 relative to the part-time seconding of certain State civil servants to ASN;
- decree 2007-1557 of 2 November 2007 amended, relative to basic nuclear installations and to regulation of the transport of radioactive substances in terms of nuclear safety;
- decree 2007-1572 of 6 November 2007 relative to technical inquiries into accidents or incidents concerning a nuclear activity;
- decree 2008-251 of 12 March 2008 relative to Local Information Committees for basic nuclear installations.

- decree 2008-1108 of 29 October 2008 relative to the composition of the High Committee for Transparency and Information on Nuclear Security (HCTISN).
- decree 2010-277 of 16 March 2010 relative to the High Committee for Transparency and Information on Nuclear Security (HCTISN).

This decree amends the regulatory procedures concerning BNIs in order, among other things, to tie them in with the new regulatory requirements linked to the environmental assessment of projects resulting from the Ordinance of 3 August 2016 and its implementing decree of 11 August 2016 which transposes European Council Directive 2011/92/EU of 13 December 2011 as amended by European Parliament and Council Directive 2014/52/EU of 16 April 2014.

Furthermore, the decree:

- supplements the provisions relative to the Local Information Committees (CLI) with the aim, if the BNI site is located in a département which borders another country (or countries), of including representatives from the country or countries concerned in the relevant CLIs;
- defines the conditions of renewal of half of the members of the ASN Commission, other than its chairperson, every three years in application of Act 2017-55 of 20 January 2017 introducing the general status of the independent administrative authorities and the independent public authorities;
- defines the functioning of the ASN sanctions commission and details the procedures giving rise to administrative fines;
- clarifies the system applicable to BNIs with equipment or facilities coming under Directive 2010/75/EU of 24 November 2010 relative to industrial emissions (called the "IED directive"), and the BNI system coming under Directive 2012/18/EU of 4 July 2012 concerning the control of hazards associated with major accidents involving substances (called the " SEVESO 3 directive").

ASN also continued its work drawing up ASN regulations and guides giving recommendations and practices that ASN considers satisfactory. An exhaustive list of the published guides is provided in appendix L.5.2.

ASN continued this work in 2017, applying Guide No. 25 published in 2016 on the conditions for consulting stakeholders and the public in the preparation of ASN regulations and ASN guides.

In 2017 ASN finalised the resolution relative to the packaging of radioactive waste and will produce draft resolutions relative to radioactive waste disposal and storage facilities.

ASN has started producing a safety guide relative to the disposal of low-level long-lived radioactive waste. A pluralistic working group was set up for this purpose in 2019 and IRSN will publish its conclusions in 2020.

Transposition of Directive 2013/59/Euratom of 5 December 2013 setting the basic radiation protection standards

ASN has been actively participating since 2013 in the transposition of Directive 2013/59/Euratom of 5 December 2013 setting the basic radiation protection standards. This transposition has led to the publication of:

- the Ordinance of 10 February 2016 relative to nuclear activities;
- the Decree 2018-434 of 4th June 2018 introducing various provisions concerning nuclear activities;
- Decree 2018-437 of 4th June 2018 relative to the protection of workers against the hazards of ionising radiation

These texts have modified the Public Health Code, the Labour Code, the Environment Code and the Defence Code.

ASN is strongly involved in the drafting of the implementing texts provided for by these decrees.

Involvement in international working groups

Lastly, ASN will remain strongly involved in international work by maintaining its active participation in international working groups.

More specifically, ASN participates in:

- the WASSC (Waste Safety Standards Committee) of the International Atomic Energy Agency (IAEA), whose role is to draw up international standards, particularly concerning radioactive waste management;
- the meetings of the International Working Forum on Regulatory Supervision of Legacy Sites (RSLS) organised by the IAEA to discuss the management and prevention needs of legacy sites;
- other projects such as SITEX-II[1] conducted with the European Union, or GEOSAF-Part II[2] and HIDRA[3] of the IAEA;
- the WGWD (Working Group on Waste and Decommissioning) of WENRA (Western European Nuclear Regulators Association) tasked with developing reference levels relative to the management of radioactive waste and spent fuels;
- the Working Group 2 (WG2) of ENSREG (European Nuclear Safety Regulators Group) tasked with subjects relating to the management of radioactive waste;

1.1.2. Objectives concerning radioactive materials and waste

1.1.2.1. The findings

ASN considers that the French radioactive waste management system, built around a specific body of legislative and regulatory texts, a national radioactive materials and waste management plan (PNGMDR) and an agency dedicated to the management of radioactive waste (Andra), is capable of regulating and implementing a structured and coherent national waste management policy. All waste must ultimately have safe management routes, and more specifically a disposal solution. ASN will keep track of the progress of the work submitted under the PNGMDR 2016-2018, more specifically within the PNGMDR working group which it chairs jointly with the DGEC.

1.1.2.2. The issues and implications

Deep geological disposal of high- and intermediate-level, long-lived waste

With regard to the Cigéo project for the disposal of high- and intermediate-level, long-lived waste, 2017 was marked by ASN's examination of the Cigéo safety options file submitted by Andra in 2016 and containing more specifically the project’s safety options, the technical retrievability options, a preliminary version of the waste acceptance specifications and a project development plan. This file constitutes the first overall safety file for the facility since 2009. It underwent an international peer review under the aegis of the IAEA in November 2016. The ASN opinion on the DOS (safety options dossier) published on 11 January 2018, after examination by the Advisory Committee on Waste and the IAEA experts, underlined the satisfactory technological readiness achieved at the DOS stage and put forward several recommendations. These recommendations concern the radioactive waste inventory to consider, the disposal of bituminised waste packages and certain subjects that can lead to design changes (justification of the disposal facility architecture, hazard-proofing the facility, monitoring and surveillance of the facility and post-accident situations). In this opinion ASN has also specified

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[1] "*Sustainable network for Independent Technical EXpertise of radioactive waste disposal - Interactions and Implementation*", Projet Horizon 2020

[2] "*GEOSAF Part II provides a forum to exchange ideas and experience on the development and review of an integrated operational and post-closure safety case for geological disposal facilities. It also aims to provide a platform for knowledge transfer.*"

[3] "*Human Intrusion in the context of Disposal of Radioactive Waste*"

its expectations regarding the content of the Cigéo creation authorisation application that Andra plans submitting in 2021.

ASN underlines the importance it attaches to the progress that the waste producers must make in packaging their waste, particularly the waste resulting from waste repackaging operations and notes that the preparation of a preliminary version of waste acceptance specifications for Cigéo by Andra submitted in April 2016 and updated in July 2017 enables the requirements concerning the future waste packages to be detailed.

Disposal of low-level, long-lived waste (LLW-LL)

The LLW-LL waste essentially comprises graphite waste from the gas-cooled reactors, radium-bearing waste and bituminised waste from the treatment of radioactive liquid effluents on the Marcoule site. ASN considers it vital to move forward in the setting up of management routes for this waste. The analysis of the file submitted by Andra in 2015 has shown that it will be difficult to demonstrate the feasibility of having a disposal facility for all the LLW-LL waste in the investigated area of the municipality of Soulaines. In its opinion of 29 March 2016, ASN asked Andra to submit by mid-2019, a report presenting the technical and safety options for this disposal facility, the inventory of the waste likely to be stored in it and an industrial scheme for managing the LLW-LL waste established through consultation with the producers of this waste. A report on the various management options that are compatible with the diversity of LLW-LL waste is finally to be submitted by the end of 2020.

The public debate preceding the production of the fifth issue of the PNGMDR, which ran from April till September 2019, confirmed the difficulty in finding a "one-stop" management solution given the heterogeneity of this waste, and highlighted the need for complementary technical expert assessments before defining the management solutions, which will have to better integrate the regional issues. Faced with these uncertainties concerning the management route for LLW-LL waste as a whole, the Minister responsible for energy and ASN have indicated in a joint resolution published on 21 February 2020, that the next national plan will provide for the continuation of the work following on from the PNGMDR 2016 - 2018, with the defining of a management strategy that takes into account the diversity of the LLW-LL waste. This strategy will integrate the characterisation of the safety issues and the environmental and regional issues of the various management solutions, define the possible role of the Soulaines-Dhuys site, and plan for the defining of a definitive management solution for the waste - legacy waste in particular - of the Orano Malvési plant.

Conditioning and packaging the waste, and legacy waste in particular

ASN considers that research must be continued and intensified in the coming years in order to define and implement appropriate packaging methods for irradiating ILW-LL waste containing organic matter and for legacy waste, so that the waste produced before 2015 is packaged before 2030 in accordance with law.

As the level of safety of certain legacy waste storage facilities is unsatisfactory, ASN asks the licensees concerned to carry out the waste retrieval and packaging (WRP) operations as soon as possible with a view to storing this waste in safe facilities. In this respect, an ASN resolution concerning the retrieval and packaging of the legacy waste at the La Hague site was issued on 9 December 2014.

Due to the significant slippages in Orano's schedules and its failure to meet numerous deadlines, ASN has initiated an approach for monitoring the management of waste retrieval and packaging projects (see section F.6.3.3).

ASN will also give an opinion on the studies and the strategies demanded of the licensees under the PNGMDR for the retrieval and packaging of waste produced before 2015 to be packaged before 2030.

The radioactive waste management strategies

ASN and ASND periodically assess the strategies implemented by the licensees to ensure that each type of waste has an appropriate management route and that the various routes are mutually coherent. More particularly, ASN and ASND remain attentive to ensuring that the licensees have the necessary treatment or storage capacity to manage their radioactive waste and anticipate sufficiently far in advance the construction of new facilities or renovation work on older facilities.

On this account, Orano has revised its waste management strategy, submitting the update in mid-2016, while the CEA has also updated its strategy and submitted it at the end of 2016.

ASN and ASND should give their opinion on Orano's strategy in 2020.

The CEA's strategy is detailed in section F.6.2.1 and the opinion of ASN and ASND is presented in section F.6.3.1.1.

ASN and ASND ensure that the main recommendations of the PNGMDR are implemented by the radioactive waste producers and the material owners. The general objectives of these recommendations are to:

- reinforce the management route approach by recommending the setting up or the updating of associated overall industrial schemes by checking, more specifically, the coherence of the waste management strategy with the decommissioning programmes;
- consolidate the radioactive waste production forecasts, particularly for very low level waste, and reduce the waste produced at source;
- adopt an approach considering the long-term harmfulness of the radioactive waste in a global environmental perspective;
- reinforce the prospects for long-term reutilisation of certain radioactive materials, or the storage strategies adopted by the licensees until final management solutions are found.

The other examination actions

In 2018 ASN authorised the commissioning of the ECRIN waste storage BNI at Malvési (Orano), which allowed commencement of the work to put in place a cover ensuring the containment of the treatment residues for a 30-year period pending the availability of a near-surface disposal facility dedicated to this waste.
The commissioning application for EDF’s ICEDA activated waste (medium level, long-lived waste) conditioning and storage facility has recently been reviewed and the commissioning authorization was issued in July 2020.
ASN also started examining the commissioning authorisation application for the DIADEM storage facility in Marcoule (CEA).
In 2020 ASN continued examining the periodic safety review of Andra's CSA disposal facility and started examining the periodic safety review files of several CEA treatment, storage and packaging facilities.

Management of the former uranium mining sites and polluted sites and soils

With regard to the former uranium mining sites, in 2020 ASN will endeavour to address the concerns of the DREALs (Regional Directorates for the Environment, Planning and Housing) regarding the Orano Mining action plan for the management of mining waste rock situated on public land. Its action will be directed in particular towards the management of potentially sensitive cases, particularly with respect to the risk of radon of natural origin (as Orano Mining's actions to remediate the radon of anthropogenic origin will be completed in 2020). It will see to it that these actions are carried out completely transparently by involving the local players and it will continue its work in collaboration with the Ministry responsible for the environment.

As far as polluted sites and soils are concerned, ASN will continue to issue statements on the polluted site rehabilitation projects which concern polluted sites and soils situated in BNIs and those coming under the Public Health Code. In the other cases, particularly those coming under the ICPE system, ASN may be required to issue an opinion at the request of the Prefect or the DREAL. When ASN issues an opinion it does so on the basis of the principles of its doctrine published in 2012.

1.1.3. Objectives concerning decommissioning

In 2019, thirty-five nuclear installations of all types (power and research reactors, laboratories, fuel reprocessing plants, waste treatment facilities, etc.) were shut down or undergoing decommissioning in France, which corresponds to about one third of the BNIs in operation other than the power reactors. The decommissioning operations are usually long and costly, involving the removal of massive amounts of waste and representing challenges for the licensees. The current size of the French nuclear fleet, of which the oldest plants and research installations are today definitively shut down or undergoing decommissioning, makes this stage in the life of an installation a major challenge for the future.

ASN's main actions in 2020 will concern the monitoring of the examination and progress of the decommissioning projects (examination of the decommissioning files for: UP2-400, STE2, ATUE, RAPSODIE, the SUPPORT and PROCÉDÉ BNIs, the CEA's solid radioactive waste management zone (ZGDS) at Saclay and the PARC BNI at Cadarache) which will be carried out consistently with the appropriate waste management strategies. ASN will examine with particular attention the legacy waste retrieval and packaging projects of the CEA and Orano, which are significantly behind schedule. ASN will also continue its examination of EDF's request to change the decommissioning strategy for its GCR reactors and Orano's decommissioning and waste management strategy.

The periodic safety reviews of the facilities undergoing decommissioning, for which the majority of the concluding files will be submitted by the licensees in 2017, also undergo examinations tailored to the risks and inconveniences the facilities represent. Some of them have already formed the subject of ASN position statements.

ASN will also continue its oversight actions to get the licensees to devote the necessary means to ensure decommissioning in as short a time as possible and achieve a final state in which as much of the hazardous substances as possible, radioactive substances included, has been removed; ASN will in particular continue its exploratory approach to the monitoring of progress of decommissioning and WRP projects, which was initiated in 2019 (see section F.6.3.3).

1.1.4. Objectives concerning the fuel cycle

Cross-disciplinary aspects

ASN will continue its review of several of the Orano Cycle group and Framatome BNIs and will extend this process to new facilities at La Hague and the Framatome site at Romans-sur-Isère in particular, but also on EDF's inter-regional fuel stores (MIR) for storing fresh fuel with enriched natural uranium (at Chinon and Bugey).

ASN will continue to monitor the additional safety measures requested following the stress tests (see section A.3).

With regard to the splitting of the former Areva group between Orano and Framatome, ASN remains attentive to ensuring that the BNI licensees resulting from this split are in full possession of the capabilities necessary to exercise their responsibilities. These two groups remain interdependent in several aspects, such as the conduct of the periodic safety review and emergency management. They have set up agreements to govern their joint actions which have undergone ASN inspections.

Consistency of the cycle

In 2016 ASN started examining the updated "Cycle Impact" file covering the 2016 - 2030 period which aims at looking ahead to the various emerging needs to control the nuclear fuel cycle in France. ASN is focusing in particular on monitoring the level of occupancy of the spent fuel underwater storage facilities (Orano and EDF). It has asked EDF, as overall ordering customer, to examine the impact of the shutdown of a reactor or a possible change in the spent fuel reprocessing streams on the forecast saturation dates for these storage facilities, along with solutions for pushing back these dates. The examination of the "Cycle Impact" file submitted in 2016 resulted in the issuing of an ASN opinion on 18 October 2018.

Tricastin site

ASN has examined the SOCATRI facility modification within the framework of the Trident project, whose commissioning authorisation is currently being examined. ASN has examined the reorganisation of the site for the management of nuclear waste pending construction of the Trident facility which should begin in 2021, after having been delayed by several years.

ASN has authorised commissioning of the ATLAS facility which has replaced several outdated laboratories at Tricastin and has conducted several inspections in this context.

ASN has authorised the reorganisation of the Tricastin platform to ensure that these major organisational changes have no impact on the safety of the various BNIs on the site. Thanks to this process, the Tricastin platform is operated by a single entity.

ASN, jointly with ASND and the Minister responsible for nuclear safety, shall define the final breakdown into BNIs resulting from the ongoing delicensing of the site's DBNI, a large part of which will be transferred to the civil authorities on 1 January 2021. This process is more broadly intended to revisit the breakdown of the site's facilities to group them consistently with the function they fulfil.

ASN will proceed with the safety review of the centrifugal enrichment plant whose report must be submitted in 2022.

ASN is currently examining two requests for new facility projects at Tricastin, the first concerning a new storage yard for uranium resulting from the "'FLEUR" reprocessing process, which is to be commissioned in 2021, the second concerning a new uranium container maintenance shop which should be commissioned late 2024.

Melox plant

ASN will continue monitoring compliance with the licensee's commitments and the prescriptions it issued further to the periodic safety review of the plant carried out in 2011, particularly with regard to the fire risk and the monitoring of outside contractors.

In addition, the changes in fuel management for power reactors, which will necessitate adaptation of the characteristics of the MOX fuel, will be a subject of interest for ASN. Orano will effectively have to demonstrate that these changes have no impact on the safety of the facility and it will, if need be, submit the necessary modification files.

The prospects of using MOX fuels in the 1300 MW reactors should result in modifications to the plant which at present does not produce any fuels as large as this. In addition, the licensee intends manufacturing experimental objects as part of the multirecycling in PWRs project.

La Hague site

ASN will remain particularly attentive to the development in the corrosion of the fission product evaporator-concentrators until they are replaced. The methods of inspecting these equipment items and forecasting the development of their corrosion have been perfected by Orano which has moreover started replacing them, with commissioning planned between 2022 and 2023. ASN will examine the applications in question.

Following the periodic safety review of the UP3-A plant, ASN will continue to monitor the plant safety improvement work and compliance with the requirements of the resolution of 3 May 2016. Among these requirements, application of the methodology for identifying protection-important equipment and reassessing control of the fire-related risks shall continue to receive particular scrutiny. The examination of the periodic safety review file for the UP2-800 plant will lead to an ASN resolution in 2021.

With regard to the forthcoming process changes in the La Hague facility, ASN attaches particular importance to the special fuels reprocessing (TCP) project, which will make it possible to process several fuel assemblies which at present cannot be processed.

ASN will moreover remain attentive to ensuring that all the spent fuels received at the Orano Cycle plant are received for reprocessing in accordance with the plant's authorisation decrees.

With regard to the legacy waste retrieval and packaging, the projects are technically complex, which partly explains the schedule slippages despite the efforts made by Orano. ASN considers that the efforts must be continued and that the baselines of the licensee's projects must be improved in order to remedy the numerous accumulated delays and the failure to meet the deadlines figuring in the ASN authorisations and the decrees.

Romans-sur Isère site

Following the periodic safety review of its plant, Framatome must review the consideration of the risk relating to hazardous substances in its safety case.

Framatome wants to increase its enriched reprocessed uranium fuel production capacity to 300 tonnes per year. ASN will examine this request as from 2021.

Framatome has carried out extensive compliance work on several buildings.

Given this substantial work and the measures put in place to increase the operating rigour of the site, ASN has lifted the tightened surveillance of the site. The reports presenting the conclusions of the ten-yearly periodic safety reviews carried out on BNIs 63 and 98 have been examined and ASN has issued its opinion on the conditions for authorising continued operation of these facilities for the next ten years.

1.2. Objectives of the licensees

1.2.1. Objectives of Andra

The Waste Act and putting in place the PNGMDR have extended and reinforced the remit of Andra, which acts as a State operator. A contract defining Andra's objectives for the period from 2017 to 2021 was signed with the State in 2018.

The objectives contract covers the 2017-2021 period and is intended to constitute a genuine strategic coordination tool for Andra. It is divided into six cross-cutting strategic priorities covering all of Andra's activities, and defines its objectives and broad lines of action within the scope of its various missions:

- leading the transformation of Andra;
- placing the environment and communication with society at the core of its action;
- making a collective success of Cigéo;
- confirming the industrial excellence of Andra and contributing to that of the sector;
- developing, capitalising on and transmitting knowledge;
- consolidating the model of a public agency for the safe management of waste in a manner proportionate to the issues.

The strategic priorities result from a collective construction approach conducted over more than nine months with Andra's senior management and shared within the organisation by all the personnel. This approach was enriched by listening to outside stakeholders: producers, assessors, partners and NGOs.

1.2.2. The objectives of the CEA

Maintaining its BNIs at the optimum level of safety remains a major priority for CEA.

On this account, the CEA performs safety reviews of its facilities with a 10-yearly frequency. The lessons drawn from the accident that hit the Fukushima-Daichii nuclear power plant in Japan in 2011 have also given rise to a plan of actions to reinforce the protection of the facilities against natural phenomena of high intensity, not considered in the design basis due to their very low probability of occurrence.

The CEA is also conducting a major programme to renovate its transport packagings to meet its needs and the changes in regulations.

Training and awareness-raising actions continue to be implemented to reinforce the security, radiation protection and nuclear safety culture of the personnel. Likewise, the entire chain of command is mobilised in the progress approach on which the safety policy of the installations is founded, and which implies its commitment and accountability as regards defining objectives and allocating resources.

In the area of radiation protection, the CEA, which considers the health of its personnel and outside contractors a priority, is stepping up its action for the reduction and forward-looking management of exposure, in which the employees concerned are fully involved.

The CEA is implementing a major radioactive clean-out and decommissioning programme on those of its installations whose maintained operation is no longer justified, whether this is because they no longer meet CEA's R&D requirements or because they do not meet current safety standards. In this programme, the CEA is endeavouring to minimise the resulting waste production and ensure that the waste is correctly categorised to avoid overloading existing management routes as a result of systematic conservative classification.

The CEA also contributes to the studies called out in the PNGMDRs, particularly in the areas of waste disposal, storage and packaging, the management of disused sealed sources and the recycling of radioactive waste.

1.2.3. The objectives of EDF

EDF aims at having optimised management routes for all its waste and is working, within the framework of the PNGMDR and in collaboration with Andra and the other waste producers, on the development of these routes through its technical and financial participation.

EDF is also setting itself the target of optimising the use of the disposal centres currently in operation to extend their operating life by limiting the volumes to stock.

With regard to the projected disposal centres, EDF and the other waste producers finance all Andra's actions concerning HLW and ILW-LL waste.

1.2.4. The objectives of Orano Cycle

Each year, lines of improvement in the various areas of safety and waste management are identified for each installation and action plans are established.

These actions can concern:

- physical modifications of the installations by applying techniques identified within the framework of the safety reassessment of a periodic safety review;
- taking into account an event and the lessons learned from it, which can result in modifications to the installations or equipment or changes in work methods and procedures;
- reducing worker dosimetry by optimising or reorganising the working environments;
- integrating regulatory changes;

- improving prevention of the criticality risk by checking the effectiveness of the measures taken, by upgrading the computerised management systems and by improving the ergonomics of the human/machine interfaces;
- the players, taking into account, for example, the analysis of risks associated with the organisational and human factors in the safety-related activities and the decommissioning activities;
- the collective work approach by developing or simplifying the organisational structures;
- training courses and skills development, notably to fulfil a work function;
- dissemination of the safety culture using collective self-assessment tools;
- reductions in consumption and the production of waste, such as studying the implementation of additional management routes or treatment methods that reduce the environmental and radiological impacts of radioactive waste management, reductions in energy consumption and the production of conventional waste and the optimisation of reuse by material recycling;
- measures to enhance transparency and communication of information, particularly with the local authorities and local players.

Furthermore, with the industrial commissioning of new conversion plants in 2018, the Orano group is continuing the renewal of its industrial plant and its investments in:

- waste treatment units;
- the renovation and compliance upgrading of facilities and equipment;
- waste retrieval and packaging, and in decommissioning and the management of waste from shut down facilities;
- the implementation of emergency situation management and mitigation measures defined within the framework of the post-Fukushima stress tests;
- R&D actions to develop new processes and more resistant materials, to use less polluting reagents and acquire a better understanding of certain risks and phenomena.

2| INTERNATIONAL COOPERATION ACTIONS

2.1. Institutional cooperation

2.1.1. ASN cooperation actions

ASN's international activities are carried out within the legislative framework defined by Article L. 592-28 of the Environment Code.

ASN also aims to promote a high level of safety and the reinforcement of the nuclear safety and radiation protection culture across the world. ASN also considers that international relations should enable it to consolidate its skills in its areas of activity.

2.1.1.1. ASN activities at European level

Europe constitutes a priority field of international action for ASN, which thereby intends contributing to the construction of a European hub on the subjects of nuclear safety, safety of spent fuel and radioactive waste management, and radiation protection. ASN is heavily involved in the work of the associations WENRA and HERCA, which focus on nuclear safety - including waste management, and radiation protection respectively.

ASN has invested itself in the work of WENRA, whose missions include developing reference safety levels in order to harmonise nuclear safety practices in Europe. Working groups were set up in 2002 to develop these reference levels. One of these groups, the WGWD (Working Group on Waste and Decommissioning) was tasked with developing reference levels relative to the safety of radioactive waste and spent fuel storage facilities, of radioactive waste disposal facilities and of decommissioning operations. The WENRA member countries must produce national action plans for the transposition of these reference levels. In 2017 ASN initiated a working group on the analysis of the technical anomalies detected in nuclear pressure equipment (NPE). In November 2019, the ASN Director-General was appointed Chair of the association. Under this Chairship, ASN will actively participate in WENRA's reflection on the implementation of its new strategy for the 2019-2023 period.

In the area of radiation protection, ASN is a member of the association HERCA. Six working groups are currently working on the following themes: emergency situation preparedness and management, medical applications, veterinary applications, radioactive sources and practices in the industrial and research sectors, natural sources of radiation and lastly, education and training in radiation protection. Cross-disciplinary networks have also been developed on dedicated themes such as collective dose monitoring.

ASN also participates in projects under the 7th Euratom R&D Framework Programme, such as the SITEX project (dedicated to the technical support expectations and needs of a nuclear safety authority in the examination of a file concerning a deep geological disposal facility) and the PREPARE project (concerning emergency situations and post-accident management in the transport of radioactive substances).

2.1.1.2. Relations with the IAEA

ASN actively participates in the work of the IAEA Commission of Safety Standards (CSS) which draws up international standards for the safety of nuclear installations, waste management, radioactive substance transport and radiation protection. It is a member of the four safety standards committees (NUSSC for the safety of nuclear installations, RASSC for radiation protection, TRANSSC for the safety of radioactive material transport and WASSC for the safety of radioactive waste).

It also participates in GEOSAF (IAEA project on the safety of a deep geological repository during the operating phase) and HIDRA (IAEA project on the unintentional impacts of human activities on deep geological repositories once the memory of the repository has been lost. The discussions on this theme, which explores time scales of up to a million years, go beyond the bounds of conventional technical subjects and address issues such as the societal impacts).

ASN is also a member of the International Decommissioning Network (IDN) coordinated by the IAEA and as such keeps itself informed of the international projects. It has contributed in particular to the CIDER (Constraints to Implementing Decommissioning and Environmental Remediation programmes) project, which aims to identify and develop aids to overcome the difficulties that member countries can encounter in site decommissioning and rehabilitation projects, and which held its first plenary meeting in March 2013. ASN is also involved in the COMDEC (completion of decommissioning) project, where it participates alongside IRSN in the working groups that aim to better oversee and regulate decommissioning and delicensing (WG1 and 3), while IRSN participates in WG2 which aims at making a technical assessment of the risks of these situations.

ASN is also active on the international scene to learn lessons from international experience feedback and from the best international practices (IRRS, joint safety convention, peer reviews, etc.).

2.1.1.3. Relations with the NEA

Within the NEA, ASN participates in the work of the Committee on Nuclear Regulatory Activities (CNRA). ASN also participates in the work of the Committee on Radiation Protection and Public Health (CRPPH), the Radioactive Waste Management Committee (RWMC) and a few working groups of the Committee on the

Safety of Nuclear Installations (CSNI). ASN also participates in the work of the Committee on Decommissioning and Legacy Management (CDLM) created in 2018.

2.1.1.4. Bilateral relations

Bilateral relations between ASN and its foreign counterparts represent an essential vector for international actions. They allow interactions on topical subjects and the rapid implementation of cooperation measures, which are useful in particular for informing the countries concerned if events occur on nuclear installations situated close to national borders.

2.1.1.5. Peer reviews

IRRS

ASN hosted an IRRS – Integrated Regulatory Review Service – mission in November 2014.

ASN was peer-reviewed for the first time in 2006, at the time of its creation as an independent authority. This mission covered all the areas of nuclear safety and radiation protection. A follow-up IRRS mission was organised in 2009. In 2009, the obligation to undergo such an audit at least once every ten years was instituted by the European directive on nuclear safety.

The good practices identified by the IRRS team in its 2014 mission are detailed in E.3. 1.3.2.

The mission's final report was submitted to the French Government within a period of three months. This report was made public. The follow-up mission was held from 1 to 9 October 2017 and concerned all the activities under ASN oversight.

The reports of the IRRS mission can be consulted via the link https://www.asn.fr/Informer/Actualites/Rapport-international-IRRS-de-l-AIEA-en-ligne.

ARTEMIS

At the request of France, an ARTEMIS mission - the IAEA's integrated peer review service for radioactive waste and spent fuel management, decommissioning and remediation – was conducted from 14 to 24 January 2018. ASN was closely associated with the hosting of the mission, which was coordinated by DGEC.

NF EN ISO/IEC 17020 accreditation

Since 1 July 2013, the ASN has been accredited in accordance with standard NF EN ISO/IEC 17020 as a type an organisation for performing inspections in the area of manufacturing inspection and in-service monitoring of nuclear pressure equipment (No. 3-1018 available from the COFRAC site). This accreditation does not result from a regulatory requirement but from a recommendation made by the IRRS mission conducted late 2006.

2.1.2. IRSN's cooperative actions

The international relations of IRSN in the area of radioactive waste management safety and spent fuel management safety hinge primarily around the following lines of development:

- understanding of the processes governing the transfers of radioactive materials in the geological environments and development of states of the art and doctrines on scientific and technical issues;
- research into deep earthquakes and their consequences on the fracturing of rocks and underground water circulation and studies on the prediction of seismic movement;
- studies on the applicability of means of instrumentation, notably techniques of investigating disposal sites and of sounding the behaviour of underground engineering structures;
- modelling all the phenomena important for the safety of disposal facilities and the potential dosimetric impacts of these facilities;

- specific studies of the risks associated with the operation of a geological disposal facility for high and intermediate-level waste;
- studies relative to the safety of fuel reprocessing and the management of waste in scenarios concerning the development of a fourth-generation reactor fleet;
- assistance to the nuclear regulators of Eastern European countries (Bulgaria, Lithuania, Armenia, Russia, Georgia) through the European INSC/IPA programmes and the projects of the EBRD (European Bank for Reconstruction and Development) on the safety of decommissioning of nuclear facilities and the safety of radioactive waste storage and disposal facilities;
- training in the safety of waste management (decommissioning, waste treatment facilities, waste disposal) for representatives of civil society and for the experts or representatives of foreign nuclear regulators, particularly through the programmes organised by ENSTTI - European Nuclear Safety Training and Tutoring Institute (training and tutoring modules).

The IRSN's main partners are:

- GRS (Germany) and Bel V (Belgium), in the area of disposal facility safety analysis and modelling of their long-term behaviour;
- JNES and JAEA (Japan) and SwRI (USA) for actions on the safety of waste disposal facilities;
- SSTC (Ukraine), SEC-NRS (Russia) and IBRAE (Russia) for the improvement of management of waste and spent fuels and the associated safety assessments;
- CNSC (Canada) and FANC (Belgium) for the study of key mechanisms for the safety of underground disposal facilities.

The work of furthering knowledge and perfecting the assessment tools is also carried out within international bodies. IRSN has thus participated or is participating in the following programmes, among others:

- FORGE (EC) on studying the influence of gas formation in a geological repository;
- SITEX (EC) on the governance of research and expert assessment for the geological repository.

IRSN also participates in the studies conducted in the Mont-Terri Laboratory (Switzerland) concerning the safety of a geological repository for HLW-LL waste.

Lastly, IRSN takes part in the international groups and work to establish technical recommendations, guides and standards in the areas of decommissioning, radioactive waste and spent fuels and participates in particular in the preparation of the IAEA safety documents.

IRSN leads or takes part in experience-sharing projects with a view to harmonising practices under the aegis of the IAEA, with regard to the safety of geological and above-ground disposal facilities (GEOSAF2, PRISM2, HIDRA), the decommissioning of facilities (FASA, DRIMA) and the management of the resulting waste (SADRWMS and SAFRAN). IRSN takes part in the work of the NEA groups of experts on the management of radioactive waste and deep disposal facilities (Radioactive Waste Management Committee - RWMC).

Lastly, IRSN has helped to create a working group within the ETSON association which is intended to enhance the interactions and the networking of the TSOs (Technical Safety Organisations) in the research into and expert assessment of the safety of radioactive waste.

2.1.3. Participation of France in ENSREG

ENSREG (Eurôpean Nuclear Safety Regulators Group) was created by a decision of the European Commission of 17 July 2007 (2007/530/Euratom), to advise and assist the Commission in the gradual development of a joint vision, and possibly new European rules in the areas of the safety of nuclear facilities and the management of spent fuel and radioactive waste. This group constitutes a forum for interchanges between the national regulatory authorities.

ENSREG, for example, coordinated the stress tests of the European nuclear power plants after the Fukushima accident. It also organised the first peer review relative to the control of ageing of the nuclear reactors.

France is represented in ENSREG by ASN and the DGEC. More specifically, ASN is a member of the ENSREG working group dedicated to the safety of nuclear facilities. Among ENSREG's recent work concerning the scope of the Joint Convention, the DGEC and ASN participate in the working group dedicated to the management of radioactive waste and spent fuel.

On 19 July 2011, the Council of the European Union adopted Directive 2011/70/Euratom for the management of spent fuel and radioactive waste (see section A.2.1.1).The TECV Act and the Ordinance of 10 February 2016 served to transpose the provisions of the directive.

2.1.4. Andra's international cooperative actions

International actions represent an important aspect of Andra's activities. The Waste Act tasks Andra with the mission of disseminating its know-how abroad. Its other mission is to provide the public with information on the management of radioactive waste and to participate in the dissemination of scientific and technical culture in this area, which cannot be limited to the strictly national framework.

Andra also seeks to compare its approaches with those adopted in other countries in order to benefit from the experience feedback from its foreign partners. In this context, Andra sets itself the following objectives:

- promoting contacts and cooperative actions with its foreign partners. Andra endeavours to present its projects and approaches on the international scene in order to compare them with those of the other countries concerned by the subject. Thus, it conducts its research actions in the context of projects with its European partners, particularly under common research and development programmes. On this account, Andra played an important part in the preparation and setting up of the IGD-TP (Implementing Geological Disposal Technology Platform) and actively participated in the preparation of the Strategic Research Agenda and its Deployment Plan. It is currently contributing to the EURAD project (European Joint Programme on Radioactive Waste Management). Led by Andra and bringing together some one hundred European partners around a strategic vision and a joint long-term research agenda, EURAD aims to mutualise the research efforts and share scientific and technical knowledge in the long-term management of radioactive waste. EURAD (European Joint Programme on Radioactive Waste Management) brings together about one hundred European players involved in radioactive waste management: radioactive waste management agencies, such as Andra; bodies providing technical support to nuclear regulators, such as IRSN; research organisations (CNRS, CEA, BRGM, Universities, etc.);
- presence in the major international bodies: European coordination bodies, OECD (Organisation for Economic Cooperation and Development) / NEA, IAEA. At present, several representatives of Andra participate in the work of the offices of various NEA bodies. Andra is also represented at the WATEC, the annual meeting to decide on the directions of the IAEA's work in the technical area of radioactive waste management; it is active in the DISPONET network relating to above-ground disposal facilities, in the URF network on the underground research facilities of the IAEA, and in other networks of the same type organised by the IAEA; scientific, technical and economic watch, which is a structured activity within Andra;
- conducting missions to promote its skills, notably through its participation in the studies and developments of radioactive waste disposal projects in other countries;

- the provision of its publications and documents free of charge in English, and an English version of its website (www.international.andra.fr).

In the context of the European Commission's Framework Programme for Research, Andra actively participates in the projects devoted to the management of high-level radioactive waste and more particularly to the issues associated with deep geological disposal.

2.2. Cooperation of the waste and spent fuel producers

2.2.1. International cooperative actions of the CEA

The CEA, which is a scientific and technical nuclear research organisation, develops its activities in all the areas concerned, and safety in particular; these activities lead to numerous international collaborations.

With regard to the safety of its own facilities, the CEA takes part in the community research programme of the European Commission and in the work of the NEA and the IAEA on the management of spent fuel and radioactive waste. It has also established regular interchanges with several foreign counterparts: these interchanges concern on the one hand facility operating experience (notably with the United Kingdom and Belgium) and in particular the lessons learned from events (with in addition to these two countries, the USA and Japan), and on the other hand research into the packaging and the long-term behaviour of waste packages.

In the area of decommissioning, the CEA is both licensee and owner of the operations and also conducts R&D programmes to control the work performance times and costs and the volumes of waste, to improve safety and guarantee full compliance with radiation protection requirements under optimum economic conditions.

The CEA's international relations in this area are directed towards:

- finding synergies to develop solutions to shared problems;
- exchanging experience feedback with other projects;
- contributing to international standards;
- providing our industrial partners with export assistance:
  - the CEA thus continues its approach to direct the legacy collaborations towards more co-financed joint projects,
  - with ENGIE, several projects in the area of problematic waste cementation in Belgium,
  - in Japan with JAEA, in the areas of waste conditioning with geopolymers and foam decontamination of process equipment in the Uranium enrichment facilities,
  - the CEA also participates in various calls for proposals and the resulting projects.

Since 2017, in Euratom, the CEA is coordinating the INSIDER project (Sampling and characterisation methodology for intermediate and high-level activity) and participates in the THERAMIN (heat treatment of waste) and TRANSAT (cross-discipline subjects/tritiated waste) projects.

Since 2018, it also coordinates the SHARE project (development of a roadmap enabling international collaborative projects in research and innovation in decommissioning to be launched in future years, and participates in the MICADO project in the area of characterisation of decommissioning waste).

In 2019 the CEA was involved in 5 EURATOM proposals in the area of decommissioning (demonstrator for the decommissioning of Graphite reactors, laser cutting and digital tools for decommissioning, characterisation, etc.) and one proposal in the area of management of the associated waste (treatment of organic liquids and reactive metallic wastes).

In Japan, following on from the first contracts obtained as of 2014 on behalf of METI in the area of laser cutting of fuel debris from the damaged Fukushima Dai-ichi reactors, the CEA is continuing its collaboration with ONET technologies and IRSN in the management of the aerosols produced by these cutting operations through several contracts via MRI (Mitsubishi Research Institute) via JAEA.

Since 2018 the CEA has also been conducting tests to demonstrate the relevance of the "in-can melting" vitrification process. It is also continuing its collaboration with the University of South Carolina under the CHWM (Center for Hierarchical Waste Form Materials) project, conducted in response to an EFRC (Energy Frontier Research Centers) call for proposals from the US Department of Energy (DOE).

It also participates actively in the working groups of international organisations in the area of decommissioning and waste management:

- IAEA: participation in the Steering Group and member of the IDN (International Dismantling Network);
- NEA: member of the CDLM (Committee for Decommissioning and Legacy Management), member of the RWMC (Radioactive Waste Management Committee), vice chair of the CPD).

2.2.2. International cooperative actions of Orano Cycle

The international interchanges and cooperative actions in which Orano is involved in the areas of spent fuel management and radioactive waste management can be divided into three main areas:

- relations with the international institutions involved in the development of safety and radiation protection standards;
- relations with the countries in which Orano is a facility licensee or performs transport activities;
- international projects.

In the context of the European work on the subjects of safety and radiation protection, Orano participates in the work of ENISS (European Nuclear Installations Safety Standards), an association of European licensees created to hold discussions with WENRA in the context of the ongoing harmonisation initiatives within the European Union and in particular on the subjects of waste and spent fuel storage, and BNI decommissioning. Orano also takes part in the work of the ENEF (European Nuclear Energy Forum) which brings together stakeholders in the nuclear sector whose work covers the areas of safety and waste.

Orano also provides its expertise by taking part in assessments of strategies, nuclear sites and installations at the request of and to assist IAEA, as well as in the regular technical meetings to prepare or revise the IAEA technical documents, guides and safety standards, or via various inter-professional associations, such as the World Association of Nuclear Operators (WANO), of which it became a full member in 2012 as licensee of the nuclear fuel reprocessing plant in La Hague.

Orano moreover contributes to the OECD's work on decommissioning and the management of radioactive materials and waste.

Orano conducts a large part of its activities outside France by operating fuel cycle facilities and providing transport and dry storage services for foreign customers. This leads to numerous exchanges with the Orano entities concerned and with the safety authorities (nuclear regulators) of the countries concerned. This is also the case with regard to the knowledge of the waste packages developed and produced by Orano and returned to the customers. These packages thus constitute international "standards", in that they are considered as base data in many geological disposal concepts (in Germany, Japan, Belgium, Switzerland, etc.).

In addition to the cooperative actions mentioned above, Orano takes part in international actions and projects that help to improve waste and spent fuel management and the safety of the storage sites.

2.2.3. International cooperative actions of EDF

EDF's international activities cover several key areas in all its areas of activity:

- the international activities within the EDF group and development projects abroad (in the United Kingdom with EDF Energy, China, South Africa, Poland, the United States of America, etc.) ;
- the bilateral experience interchange activities, including above all twinnings and cooperative agreements;
- participation in international institutions, which can also include the secondment of experts leading to exchanges of experience: WANO and Peer-Reviews, IAEA and Osart, EPRI, ENISS within Foratom, WNA (World Nuclear Association);
- consulting and service activities (Daya Bay, Koeberg, etc.) ;
- preparation of the reactors of the future and technological watch (EUR);
- dismantling and the environment.

A first line of international cooperation at EDF concerns sharing experience. Twinnings between French and foreign NPPs and cooperation agreements with licensees that have facilities undergoing dismantling constitute the main framework for these interchanges and allow direct exchanges of information between licensees with different cultures and exercising their activity in different environments.

A second line of cooperation concerns collaborations with international institutions. As far as the IAEA is concerned, EDF participates in the preparation of standards and safety guides and the analysis of incidents (IRS), cyber security, dismantling work and waste treatment. EDF takes part in the OSART BNI safety assessment missions in France and OSART missions in other countries. With regard to WANO (World Association of Nuclear Operators), EDF is involved in various programmes and takes part in the peer reviews (both in France and abroad) and other programmes, particularly those concerning assistance visits, experience feedback, technical meetings and performance indicators, with the sharing of databases. EDF also keeps track of the work of the NEA, the EPRI, the INPO, the NRC and WNA, and participates in the working groups on spent fuel management, waste management and decommissioning.

A third line concerns consulting and service activities for other licensees, cooperation agreements (South Africa, China, etc.) with assistance missions in varied technical domains (training, engineering, chemistry, etc.) and partnerships (Eastern Europe, Russian, etc.).

SECTION L | APPENDICES

Among the facilities concerned by radioactive waste management or spent fuel management, as presented in section D, the most important ones, belonging to the BNI category as defined in section E.1.1, are distributed across the French territory as shown on the map below:

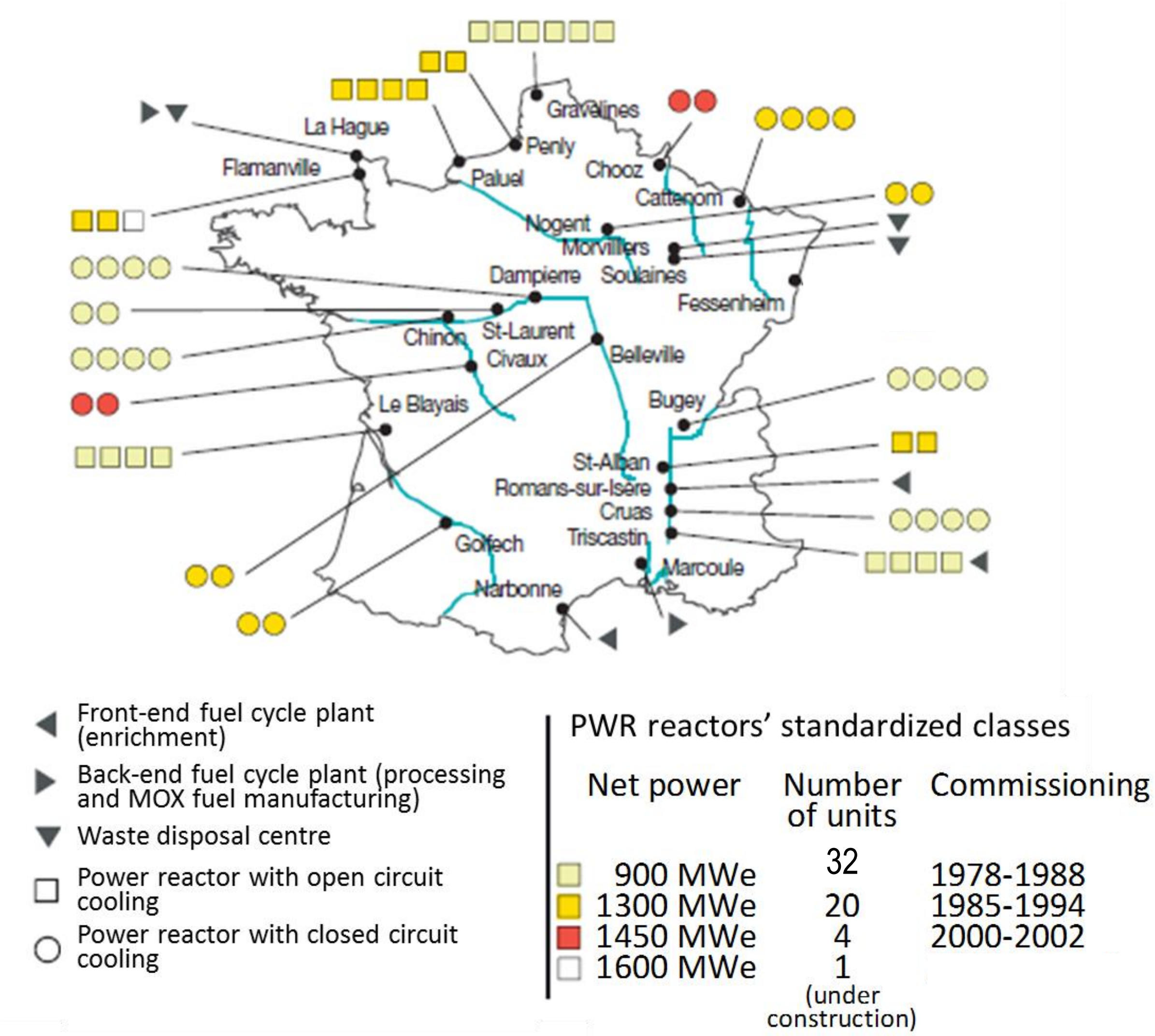

Figure 16: Location of the NPPs and nuclear fuel cycle facilities in France as at 31 December 2019[1]

[1] It is to be noted that the CEA Saclay and Cadarache sites also have waste management facilities which are not shown in this figure.

1| SPENT FUEL PRODUCTION OR MANAGEMENT FACILITES

1.1. Spent fuel production facilities as at 31 December 2019

Spent fuel is produced or could be produced in the following BNIs.

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal date:	Observations
24	CABRI and SCARABÉE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactors	27.05.64			One modification decree
39	MASURCA (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		14.12.66	15.12.66	Final shutdown declared by the CEA for 31 December 2018
40	OSIRIS - ISIS (Saclay) 91191 Gif-sur-Yvette	CEA	Reactors		08.06.65	12.06.65	Final shutdown declared by the CEA for 30 March 2019
42	EOLE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		23.06.65	28 & 29.06.65	Final shutdown declared by the CEA for 31 December 2017
67	HIGH-FLUX REACTOR (RHF) 38041 Grenoble	ILL	Reactor		19.06.69 05.12.94	22.06.69 06.12.94	One modification decree
75	FESSENHEIM NPP (reactors 1 and 2) 68740 Fessenheim	EDF	Reactors		03.02.72	10.02.72	One modification decree
78	LE BUGEY NPP (reactors 2 and 3) 01980 Loyettes	EDF	Reactors		20.11.72	26.11.72	One modification decree
84	DAMPIERRE NPP, reactors 1 and 2) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76	19.06.76	
85	DAMPIERRE NPP (reactors 3 and 4) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76	19.06.76	
86	LE BLAYAIS NPP (reactors 1 and 2) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		14.06.76	19.06.76	
87	TRICASTIN NPP (reactors 1 and 2) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76	04.07.76	One modification decree
88	TRICASTIN NPP (reactors 3 and 4) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76	04.07.76	One modification decree
89	LE BUGEY NPP (reactors 4 and 5) 01980 Loyettes	EDF	Reactors		27.07.76	17.08.76	One modification decree
92	PHÉBUS (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		05.07.77	19.07.77	One modification decree Final shutdown and decommissioning application filed by the CEA on 18 February 2015
95	MINERVE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		21.09.77	27.09.77	Final shutdown declared by the CEA for 31 December 2017
96	GRAVELINES NPP (reactors 1 and 2) 59820 Gravelines	EDF	Reactors		24.10.77	26.10.77	One modification decree
97	GRAVELINES NPP (reactors 3 and 4) 59820 Gravelines	EDF	Reactors		24.10.77	26.10.77	One modification decree
100	SAINT-LAURENT DES EAUX NPP (reactors B1 and B2) 41220 La Ferté-St-Cyr	EDF	Reactors		08.03.78	21.03.78	
101	ORPHÉE (Saclay) 91191 Gif-sur-Yvette	CEA	Reactor		08.03.78	21.03.78	Final shutdown declared by the CEA for 31 December 2019 at the latest
103	PALUEL NPP (reactor 1) 76450 Cany-Barville	EDF	Reactor		10.11.78	14.11.78	
104	PALUEL NPP (reactor 2) 76450 Cany-Barville	EDF	Reactor		10.11.78	14.11.78	
107	CHINON NPP (reactors B1 and B2) 37420 Avoine	EDF	Reactors		04.12.79	08.12.79	One modification decree
108	FLAMANVILLE NPP (reactor 1) 50830 Flamanville	EDF	Reactor		21.12.79	26.12.79	
109	FLAMANVILLE NPP (reactor 2) 50830 Flamanville	EDF	Reactor		21.12.79	26.12.79	
110	LE BLAYAIS NPP (reactors 3 and 4) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		05.02.80	14.02.80	One modification decree
111	CRUAS NPP (reactors 1 and 2) 07350 Cruas	EDF	Reactors		08.12.80	31.12.80	Two modification decrees
112	CRUAS NPP (reactors 3 and 4) 07350 Cruas	EDF	Reactors		08.12.80	31.12.80	One modification decree
114	PALUEL NPP (reactor 3) 76450 Cany - Barville	EDF	Reactor		03.04.81	05.04.81	
115	PALUEL NPP (reactor 4) 76450 Cany - Barville	EDF	Reactor		03.04.81	05.04.81	
119	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 1) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81	15.11.81	

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal date:	Observations
120	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 2) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81	15.11.81	
122	GRAVELINES NPP (reactors 5 and 6) 59820 Gravelines	EDF	Reactors		18.12.81	20.12.81	Two modification decrees
124	CATTENOM NPP (reactor 1) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
125	CATTENOM NPP (reactor 2) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
126	CATTENOM NPP (reactor 3) 57570 Cattenom	EDF	Reactor		24.06.82	26.06.82	
127	BELLEVILLE NPP (reactor 1) 18240 Léré	EDF	Reactor		15.09.82	16.09.82	
128	BELLEVILLE NPP (reactor 2) 18240 Léré	EDF	Reactor		15.09.82	16.09.82	One modification decree
129	NOGENT-SUR-SEINE NPP (reactor 1) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82	30.09.82	One modification decree
130	NOGENT-SUR-SEINE NPP (reactor 2) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82	30.09.82	One modification decree
132	CHINON NPP (reactors B3 and B4) 37420 Avoine	EDF	Reactors		07.10.82	10.10.82	One modification decree
135	GOLFECH NPP (reactor 1) 82400 Golfech	EDF	Reactor		03.03.83	06.03.83	One modification decree
136	PENLY NPP (reactor 1) 76370 Neuville-lès-Dieppe	EDF	Reactor		23.02.83	26.02.83	
137	CATTENOM NPP (reactor 4) 57570 Cattenom	EDF	Reactor		29.02.84	03.03.84	
139	CHOOZ B NPP (reactor 1) 08600 Givet	EDF	Reactor		09.10.84	13.10.84	Postponement of commissioning Decrees of 18.10.1993, J.O. of 23.10.93 and 11.06.99, J.O. of 18.06.99
140	PENLY NPP (reactor 2) 76370 Neuville-lès-Dieppe	EDF	Reactor		09.10.84	13.10.84	
142	GOLFECH NPP (reactor 2) 82400 Golfech	EDF	Reactor		31.07.85	07.08.85	
144	CHOOZ B NPP (reactor 2) 08600 Givet	EDF	Reactor		18.02.86	25.02.86	Postponement of commissioning Decrees of 18.10.93, J.O. of 23.10.93 and 11.06.99, J.O. of 18.06.99
158	CIVAUX NPP (reactor 1) BP 1 86320 Civaux	EDF	Reactor		06.12.93	12.12.93	Postponement of commissioning Decree of 11.06.99, J.O. of 18.06.99
159	CIVAUX NPP (reactor 2) BP 1 86320 Civaux	EDF	Reactor		06.12.93	12.12.93	Postponement of commissioning Decree of 11.06.99, J.O. of 18.06.99

Table 24: Spent fuel production facilities as at 31 December 2018

1.2. Spent fuel storage or reprocessing facilities as at 31 December 2019

Spent fuels are stored or reprocessed in the following BNIs (note that fuels are also stored on site at the nuclear power plants).

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal (J.O.) date:	Observations
22	PROVISIONAL STORAGE FACILITY called PÉGASE/CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	27.05.64	17.04.80	27.04.80	Ex reactor shut down on 19.12.75. Modification (creation of CASCAD): Decree of 04.09.89. J.O. of 08.09.89. Final shutdown of PEGASE declared by the CEA for 31 December 2023 at the latest
33	SPENT FUEL REPROCESSING PLANT (UP2-400) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances	27.05.64			The final shutdown and decommissioning decree of 08. 11.13 J.O. of 10.11.13
38	EFFLUENTS AND SOLID WASTE TREATMENT PLANT (STE2) AND SPENT FUEL REPROCESSING FACILITY (AT1) (La Hague)	Orano Cycle	Transformation of radioactive substances	27.05.64			Final shutdown and decommissioning decree of 08. 11.13 J.O. of 10.11.13

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal (J.O.) date:	Observations
	50107 Cherbourg						
50	SPENT FUEL TESTING LABORATORY (LECI) (Saclay) 91191 Gif-sur-Yvette	CEA	Utilisation of radioactive substances	08.01.68			One modification decree
55	ACTIVE FUEL EXAMINATION LABORATORY (LECA/STAR) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Utilisation of radioactive substances	08.01.68			Extension (creation of Star): Decree of 04.09.89, J.O. of 08. 09.89
72	SOLID RADIOACTIVE WASTE MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette	CEA	Storage or holding of radioactive substances		14.06.71	22.06.71	Updating of final shutdown declaration by the CEA for 31 December 2022 at the latest
80	OXIDE HIGH ACTIVITY FACILITY (HAO) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances		17.01.74	05.02.74	Final shutdown and decommissioning decree of 31.07.09, J.O. of 04. 08.09 .
94	IRRADIATED MATERIALS FACILITY (Chinon) 37420 Avoine	EDF	Utilisation of radioactive substances	29.01.64			One modification decree
116	PLANT FOR REPROCESSING SPENT FUEL ELEMENTS FROM ORDINARY WATER REACTORS (UP3-A) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
117	PLANT FOR REPROCESSING SPENT FUEL ELEMENTS FROM ORDINARY WATER REACTORS (UP2-800) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
141	FUEL REMOVAL UNIT (Creys-Malville) 38510 Morestel	EDF	Storage or holding of radioactive substances		24.07.85	31.07.85	Several modification decrees
148	ATALANTE CEN VALRHO Chusclan 30205 Bagnols-sur-Cèze	CEA	Laboratory for research and development and study of actinide production		19.07.89	25.07.89	Postponement of commissioning Decree of 22.07.99 J.O. of 23.07.99

Table 25: Spent fuel reprocessing or storage facilities as at 31 December 2019

2| RADIOACTIVE WASTE PRODUCTION OR MANAGEMENT FACILITIES

2.1. BNIs producing radioactive waste other than those listed in L.1, L.2.2 and L.3 as at 31 December 2019

The following BNIs produce radioactive waste, as do the BNIs that manage spent fuel (see § L1), the radioactive waste storage and treatment BNIs (see L.2.2) and the BNIs undergoing decommissioning (see § L.3.)

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal (J.O.) date:	Observations
18	ULYSSE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Reactor (undergoing decommissioning)	27.05.64			Final shutdown and decommissioning decree 2014-906 of 18.08.14 (J.O. of 21.08.14)
29	ARTIFICIAL RADIONUCLIDES PRODUCTION PLANT (Saclay) 91191 Gif-sur-Yvette Cedex	Cis Bio International	Manufacture or transformation of radioactive substances	27.05.64			One modification decree (change of licensee)
53	ENRICHED URANIUM AND PLUTONIUM STORAGE WAREHOUSE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Holding of radioactive substances	08.01.68			Final shutdown declared by the CEA for 31 December 2017
63	FUEL ELEMENT FABRICATION PLANT 26104 Romans-sur-Isère	Framatome	Manufacture of radioactive substances	09.05.67			Change of licensee: decree of 02.03.78 (J.O. of 10.03.78), decree

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal (J.O.) date:	Observations
							2014-1364 of 14.11.14 (J.O. of 16.11.14), decree 2017-1415 of 29.09.17 authorising the company New NP to take over operation of the facility currently operated by Orano (J.O. of 30.09.17) and ASN Resolution 2017-DC-0619 de of 05.12.17 relative to decree 2017-1415 of 29.09.17 (BO of ASN of 11.12.17) Order of 03.03.17 setting the perimeter of the facility (J.O. of 16.03.17) and ASN Chairman's Resolution CODEP-DRC-2017-012622 of 10.07.17 recording the facility and its perimeter as laid down by the Order of 03.03.17 (J.O. of 08.08.17). Modification: decree of 09.08.78 (J.O. of 08. 09.78)
68	DAGNEUX IONISATION FACILITY Z.I. Les Chartinières 01120 Dagneux	IONISOS	Utilisation of radioactive substances		20.07.71	25.07.71	Two modification decrees
77	POSEIDON IRRADIATION FACILITY – CAPRI (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Utilisation of radioactive substances		07.08.72	15.08.72	
98	NUCLEAR FUEL FABRICATION PLANT 26104 Romans-sur-Isère	Framatome	Manufacture of radioactive substances		02.03.78	10.03.78	Modification: decree 2006-329 of 20.03.06 (J.O. of 22.03.06). Change of licensee: decree 2014-1364 du 14.11.14 (J.O. of 16.11.14), decree 2017-1415 of 29.09.17 authorising the company New NP to take over operation of the facility currently operated by Orano (J.O. of 30.09.17) and ASN Resolution 2017-DC-0619 of 05.12.17 relative to decree 2017-1415 of 29.09.17 (BO of ASN of 11.12.17)
99	CHINON INTER-REGIONAL STORE 37420 Avoine	EDF	Fresh fuel storage		02.03.78	11.03.78	One modification decree
102	BUGEY INTER-REGIONAL STORE 01980 Loyettes	EDF	Fresh fuel storage		15.06.78	27.06.78	One modification decree
113	NATIONAL LARGE HEAVY ION ACCELERATOR (GANIL) 14021 Caen Cedex	G.I.E GANIL	Particle accelerator		29.12.80	10.01.81	One modification decree; One decree authorising the creation of phase 1 of the Spiral 2 extension
123	LABORATORY FOR RESEARCH AND EXPERIMENTAL FABRICATION OF NUCLEAR FUELS (LEFCA); (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Manufacture of radioactive substances		23.12.81	26.12.81	
138	CLEAN-UP AND URANIUM RECOVERY FACILITY (Tricastin) 26130 Saint-Paul-Trois-Châteaux	SOCATRI	Production plant		22.06.84	30.06.84	Two modification decrees
146	POUZAUGES IONISATION FACILITY Z.I. de Monlifant 85700 Pouzauges	IONISOS	Ionisation facility		30.01.89	31.01.89	One modification decree (change of licensee)
147	GAMMASTER IONISATION	ISOTRON	Ionisation facility		30.01.89	31.01.89	

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Official Journal (J.O.) date:	Observations
	FACILITY - M.I.N. 712 13323 Marseille Cedex 14	France					
151	NUCLEAR FUEL FABRICATION PLANT (MELOX) BP 2 - 30200 Chusclan	Orano Cycle	Manufacture of radioactive substances		21.05.90	22.05.90	Several modification decrees
154	SABLE SUR SARTHE IONISATION FACILITY Z.I. de l'Aubrée 72300 Sablé-sur-Sarthe	IONISOS	Ionisation facility		01.04.92	04.04.92	One modification decree (change of licensee)
155	TU 5 and W FACILITY (Tricastin) BP 16 26701 Pierrelatte	Orano	Transformation of radioactive substances		07.07.92	11.07.92	One modification decree
156	CHICADE (Cadarache) BP 1 13108 Saint-Paul-lez Durance Cedex	CEA	Research and development laboratory		29.03.93	30.03.93	
157	TRICASTIN OPERATIONAL HOT UNIT (BCOT) BP 127 84504 Bollène Cedex	EDF	Nuclear maintenance		29.11.93	07.12.93	One modification decree
168	Georges Besse II plant for separating uranium isotopes by centrifugation 26702 Pierrelatte	SET	Transformation of radioactive substances		27.04.07	29.04.07	
169	MAGENTA 13115 Saint-Paul-lez-Durance Cedex (Bouches-du-Rhône)	CEA	Reception and shipping of nuclear materials		25.09.08	27.09.08	Decree published in J.O. of 27.09.08 ASN Commissioning Resolution of 27.01.11
176	ATLAS 26702 Pierrelatte	Orano	Research and development laboratory		30.09.15	02.10.15	
178	Tricastin uranium-bearing material storage yards 26702 Pierrelatte	Orano	Storage				Downgrading of DBNIs by decision of Prime Minister of 20 July 2016. Registered as BNI by ASN Resolution of 1 December 2016

Table 26: BNIs producing radioactive waste other than the BNIs listed in L1 and L2.2 and the BNIs undergoing decommissioning figuring in L.3 as at 31 December 2019

2.2. The main radioactive waste management BNIs as at 31 December 2019

The main BNIs managing radioactive waste (processing, storage and disposal) are listed in the table below. It should nevertheless be noted that the BNIs listed in sections L.1 and L.2.1 and the BNIs undergoing decommissioning figuring in section L.3 also include radioactive waste processing and storage facilities. More particularly, BNIs 116 and 117 (La Hague plants) which figure in section L.1.2 have extensive facilities for processing and storing waste, particularly HLW and ILW-LL waste.

It is to be noted that Andra's Cires facility, which ensure the sorting and processing of waste from small producers and the disposal of very low level waste, is subject to the regulations for ICPEs (Installations Classified for Protection of the Environment).

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Date published in J.O. (Official Journal)	Observations
22	PEGASE & CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	27.05.64			Final shutdown of PEGASE declared by the CEA for 31 December 2023 at the latest
35	LIQUID EFFLUENTS MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Transformation of radioactive substances	27.05.64			One modification decree
37A	WASTE TREATMENT STATION (STD) (Cadarache) 13115 Saint-Paul-	CEA	Transformation of radioactive	27.05.64		06.08.15	Separation of BNI 37 into two entities further to

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:	Date published in J.O. (Official Journal)	Observations
	lez-Durance		substances				Ministerial Orders of 9 June 2015 ASN Chairman's Resolution CODEP-DRC-027225 of 09.07.15 registering BNI 37-A
37B	EFFLUENT TREATMENT STATION (STE) (Cadarache) 13115 Saint-Paul-lez-Durance Cedex (Bouches-du-Rhône)	CEA	Transformation of radioactive substances	27.05.64		06.08.15	ASN Chairman's Resolution CODEP-DRC-027232 of 09.07.15 registering BNI 37-B
56	RADIOACTIVE WASTE STORAGE YARD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	08.01.68			WRP operation in progress – Decommissioning file submitted on 27/06/2018
66	MANCHE WASTE DISPOSAL FACILITY (CSM) 50448 Beaumont-Hague	Andra	Above-ground disposal of radioactive substances		19.06.69	22.06.69	Entry into monitoring and surveillance phase: Decree of 10.01.2003, J.O. of 11.01. 2003
72	SOLID RADIOACTIVE WASTE MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Storage or holding of radioactive substances		14.06.71	22.06.71	Updating of final shutdown declaration by the CEA for 31 December 2022 at the latest
74	STORAGE OF IRRADIATED GRAPHITE LINERS (SAINT LAURENT DES EAUX) 41220 La Ferté-St-Cyr	EDF	Storage or holding of radioactive substances		14.06.71	22.06.71	One modification decree (change of licensee)
118	LIQUID EFFLUENTS AND SOLID WASTE TREATMENT STATION (STE3) La Hague 50107 Cherbourg	Orano	Transformation of radioactive substances		12.05.81	16.05.81	Several modification decrees
149	AUBE WASTE DISPOSAL FACILITY (CSA) Soulaines-Dhuys 10200 Bar-sur-Aube	Andra	Above-ground disposal of radioactive substances		04.09.89	06.09.89	Two modification decrees
160	CENTRACO Codolet 30200 Bagnols-sur-Cèze	Cyclife France (EDF Group)	Transformation of radioactive waste and effluents		27.08.96	31.08.96	Two modification decrees
164	CEDRA (Cadarache) 13113 St Paul lez Durance	CEA	Conditioning, packaging and storage of radioactive substances		04.10.04	05.10.04	
171	AGATE - Effluent advanced management and treatment facility (Cadarache) 13113 St Paul lez Durance	CEA	Transformation of radioactive effluents		25.03.09	28.03.09	
173	ICEDA – Activated waste packaging and storage facility	EDF	Packaging and storage		23.04.10	25.04.10	Waiting for commissioning
175	ECRIN – Contained storage of conversion residues Malvési) 11100 Narbonne (Aude)	Orano	Storage of radioactive substances		20.07.15	22.07.15	Waiting for commissioning
177	DIADEM Irradiating or alpha waste from decommissioning (Marcoule) Chusclan	CEA	Storage			14.06.16	Waiting for commissioning

Table 27: The main radioactive wasrte management BNIs as at 31 December 2019

Note: Cires (very low level waste repository) and Rotonde are ICPEs, therefore they do not figure in this list.

3| BNIS DECOMMISSIONED OR UNDERGOING DECOMMISSIONING

3.1. Reactors decommissioned or undergoing decommissioning as at 31 December 2019

Facility Location	BNI No.	Commissioning	Final shutdown	Thermal power (MW)	Last regulatory actions	Comments
NEREIDE Fontenay-aux-Roses:	(ex-BNI 10)	1960	1981	0.5	1987: Removed from list of BNIs	Decommissioned
TRITON Fontenay-aux-Roses	(ex-BNI 10)	1959	1982	6.5	1987: Removed from list of BNIs and classified as IC	Classified as ICPE
ZOÉ Fontenay-aux-Roses	(ex-BNI 11)	1948	1975	0.25	1978: Removed from list of BNIs and classified as IC	Contained (museum) Classified as ICPE
MINERVE Fontenay-aux-Roses	(ex-BNI 12)	1959	1976	0.0001	1977: Removed from list of BNIs	Dismantled at Fontenay-aux-Roses and reassembled at Cadarache
EL2 Saclay	(ex-BNI 13)	1952	1965	2.8	Removed from list of BNIs	Partially decommissioned, remaining parts contained
EL3 Saclay	(ex-BNI 14)	1957	1979	18	1988: Removed from list of BNIs and classified as IC	Partially decommissioned, remaining parts contained
MELUSINE Grenoble	(ex-BNI 19)	1958	1988	8	2011: Removed from list of BNIs	Cleaned out
SILOETTE Grenoble	(ex-BNI 21)	1964	2002	0.100	2007: Removed from list of BNIs	Cleaned out – Institutional controls
PEGGY Cadarache	(ex-BNI 23)	1961	1975	0.001	1976: Removed from list of BNIs	Decommissioned
CESAR Cadarache	(ex-BNI 26)	1964	1974	0.01	1978: Removed from list of BNIs	Decommissioned
MARIUS Cadarache	(ex-BNI 27)	1960 at Marcoule, 1964 at Cadarache	1983	0.0004	1987: Removed from list of BNIs	Decommissioned
HARMONIE Cadarache	(ex-BNI 41)	1965	1996	0.001	2009: Removed from list of BNIs	Destruction of ancillaries building
University of Strasbourg Reactor (RUS) Strasbourg	(ex-BNI 44)	1967	1997	0.100	2012: Removed from list of BNIs	Cleaned-out - institutional controls over site memory
SILOE Grenoble	20	1963	1997	35	2015: Removed from list of BNIs	Cleaned out
RAPSODIE Cadarache	25	1967	1983	20 then 40		Preparation for final shutdown
BUGEY 1 Lagneu	45	1972	1994	1 920	1996: Final shutdown decree 2008: Decree authorising complete decommissioning operations	Decommissioning in progress

Facility Location	BNI No.	Commissioning	Final shutdown	Thermal power (MW)	Last regulatory actions	Comments
SAINT-LAURENT DES EAUX A1 La Ferté-Saint-Cyr	46	1969	1990	1 662	1994: Final shutdown decree 2010: Decree authorising complete decommissioning operations	Decommissioning in progress
SAINT-LAURENT A2 La Ferté-Saint-Cyr	46	1971	1992	1 801	1994: Final shutdown decree 2010: Decree authorising complete decommissioning operations	Decommissioning in progress
PHÉNIX REACTOR Marcoule	71	1969		350	2016: Decommissioning decree	Decommissioning in progress
SUPERPHENIX Creys-Malville	91	1985	1997	3 000	1998: Final shutdown decree 2009: Final shutdown (last stage) and complete decommissioning decree	Decommissioning in progress
Chinon A1D (ex-Chinon A1) Avoine	133 (ex-BNI 5)	1963	1973	300	1982: Decree for containment of Chinon A1 and creation of storage BNI Chinon A1D	Partially decommissioned, modified to storage BNI for waste left in place (museum)
CHINON A2D (ex-Chinon A2) Avoine	153 (ex-BNI 6)	1965	1985	865	1991: Decree for partial decommissioning of Chinon A2 and creation of storage BNI Chinon A2D	Partially decommissioned, modified to storage BNI for waste left in place
CHINON A3D (ex-Chinon A3) Avoine	161 (ex-BNI 7)	1966	1990	1 360	2010: Decree authorising decommissioning operations	Partially decommissioned, modified to storage BNI for waste left in place
EL-4D (ex-EL4) Brennilis Huelgoat	162 (ex-BNI 28)	1966	1985	250	1996: Decree for decommissioning and creation of storage BNI EL-4D Various decrees including the final shutdown and complete decommissioning decree cancelled by decision of State Council of 06. 06.07 Final shutdown and partial decommissioning decree of 27.07.11.	Decommissioning in progress
CHOOZ AD (ex-Chooz A) Givet	163 (ex-BNI A1, 2, 3)	1967	1991	1 040	1999: Decree for partial decommissioning of Chooz A and creation of storage BNI Chooz AD Final shutdown and complete decommissioning decree of 27.09.07, J.O. of 29.09.07	Partially decommissioned, modified to storage BNI for waste left in place

Table 28: Reactors decommissioned or undergoing decommissioning as at 31 December 2019

3.2. Other facilities decommissioned or undergoing decommissioning as at 31 December 2019

Facility Location	BNI No.	Type of facility	Commissioning	Final shutdown	Last regulatory actions	Current status
LE BOUCHET	(ex-BNI 30)	Ore processing	1953	1970	Removed from list of BNIs	Decommissioned
GUEUGNON	(ex-BNI 31)	Ore processing	1965	1980	Removed from list of BNIs	Decommissioned
STED Fontenay-aux-Roses:	BNI 34	Treatment of solid and liquid waste	Before 1964	2006	2006: Removed from list of BNIs	Integrated in BNI 166
ALS Saclay	(ex-BNI 43)	Accelerator	1965	1996	2006: Removed from list of BNIs	Cleaned out – Institutional controls
SATURNE Saclay	(ex-BNI 48)	Accelerator	1958	1997	2005: Removed from list of BNIs	Cleaned out – Institutional controls
ATTILA Fontenay-aux-Roses:	(ex-BNI 57)	Reprocessing pilot in 1 cell of the BNI	1966	1975	2006: Removed from list of BNIs	Integrated in BNIs 165 and 166
LCPu Fontenay-aux-Roses:	(ex-BNI 57)	Plutonium chemistry laboratory	1966	1995	2006: Removed from list of BNIs	Integrated in BNIs 165 and 166
BAT. 19 Fontenay-aux-Roses:	(ex-BNI 58)	Plutonium metallurgy	1968	1984	1984: Removed from list of BNIs	Decommissioned
RM2 Fontenay-aux-Roses	(ex-BNI 59)	Radio-metallurgy	1968	1982	2006: Removed from list of BNIs	Integrated in BNIs 165 and 166
LCAC Grenoble	(ex-BNI 60)	Analysis of fuels	1968	1984	1997: Removed from list of BNIs	Decommissioned
STEDS Fontenay-aux-Roses	(ex-BNI 73)	Radioactive waste decay storage	1989		2006: Removed from list of BNIs	Integrated in BNI 166
ARAC Saclay	(ex-BNI 81)	Fabrication of fuel assemblies	1975	1995	1999: Removed from list of BNIs	Cleaned out
IRCA Cadarache	(ex-BNI 121)	Irradiator	1983	1996	2006: Removed from list of BNIs	Cleaned out – Institutional controls
FBFC Pierrelatte	(ex-BNI 131)	Fabrication of fuel	1983	1998	2003: Removed from list of BNIs	Cleaned out – Institutional controls
MIRAMAS URANIUM STORE Istres	(ex-BNI 134)	1964	2004		2007: Removed from list of BNIs	Usage restriction
SNCS Osmanville	(ex-BNI 152)	Ioniser	1983	1995	2002: Removed from list of BNIs	Cleaned out – Institutional controls
ATPu Cadarache	32	Fuel fabrication plant	1962	2003	2009: Final shutdown and decommissioning decree	Decommissioning in progress
UP2-400 PLANT La Hague	33	Transformation of radioactive substances	1964	2004	2013: Final shutdown and partial decommissioning decree	Decommissioning in progress
STED and High-level waste storage unit Grenoble	36 and 79	Waste treatment and waste storage station	1964/ 1972	2008	2008: Final shutdown and decommissioning decree	Decommissioning in progress
STE2 and AT1 La Hague	38	Effluent treatment station	1964	2004	2013: Final shutdown and partial decommissioning decree	Decommissioning in progress
ELAN II B La Hague	47	Manufacture of Cs-137 sources	1970	1973	2013: Final shutdown and decommissioning decree	Decommissioning in progress

Facility Location	BNI No.	Type of facility	Commissioning	Final shutdown	Last regulatory actions	Current status
High-activity laboratory (LHA) Saclay	49	Laboratory	1960	1996	2008: Final shutdown and decommissioning decree	Decommissioning in progress
ATUE Cadarache	52	Uranium processing	1963	1997	2006: Final shutdown and decommissioning decree	Decommissioning in progress
LPC Cadarache	54	Laboratory	1966	2003	2009: Final shutdown and decommissioning decree	Decommissioning in progress
LAMA Grenoble	61	Laboratory	1968	2002	2008: Final shutdown and decommissioning decree	Delicensed
SICN Veurey-Voroize	Ex-BNI 65 and 90	Fuel fabrication plants	1963	2000	2019 : Removed from list of BNIs	Cleaned out – Institutional controls
HAO facility La Hague	80	Transformation of radioactive substances	1974	2004	2009: Final shutdown and decommissioning decree	Decommissioning in progress
AMI CHINON	94	Utilisation of radioactive substances	1963	2015		Preparation for final shutdown
Orano Cycle Pierrelatte	105	Uranium chemical transformation plant	1979	2008	2019: Decommissioning decree	Preparation for decommissioning
LURE Orsay	106	Particle accelerator	From 1956 to 1987	2008	2015: Removed from list of BNIs	Cleaned out – Institutional controls
PROCEDE Fontenay-aux-Roses	165	Grouping of former process facilities	2006		2006: Final shutdown and decommissioning decree	Decommissioning in progress
SUPPORT Fontenay-aux-Roses	166	Waste treatment and packaging	2006		2006: Final shutdown and decommissioning decree	Decommissioning in progress

Table 29: Other facilities decommissioned or undergoing decommissioning as at 31 December 2019

4| NUCLEAR INSTALLATION STRESS TESTS FOLLOWING THE FUKUSHIMA ACCIDENT - LIST OF THE INSTALLATIONS AND SITES CONCERNED

The Fukushima accident in Japan led the French safety authorities, in response to the Prime Minister's referral, to ask the licensees to carry out stress tests on their installations and their support functions.

Based on the specifications drawn up by the French safety authorities, the stress tests consist in analysing the beyond-design-basis safety margins of nuclear installations with respect to extreme natural phenomena (earthquakes, floods, etc.). They involve a deterministic approach that consists in increasing the level of aggression in question to assess the resistance of the installation to extreme situations and the current measures to counter them. The postulated successive losses of safety functions (electrical power supplies, cooling systems, etc.), and the management of accidents resulting from these situations are examined.

The aim is to identify any situations that could lead to a sudden deterioration of the accident sequences ("cliff-edge effect") and propose additional measures to prevent such situations and to increase the robustness of the installation with regard to defence in depth.

After a first series of stress tests carried out in 2011 on those installations considered as priorities by the safety authorities (batch 1), a second series of stress tests was carried out in 2012 on other CEA installations and on the resources shared by the Cadarache and Marcoule centres (batch 2). These stress tests were supplemented in 2013 by stress tests on the shared resources of the Saclay centre and on other CEA installations for which stress tests results are to be transmitted to the authorities when the periodic safety review of the installation becomes due (batch 3).

See section A.3 for the stress test follow-ups.

4.1. Priority installations and sites tested in 2011 (batch 1)

4.1.1. Installations operated by Électricité de France (EDF) – Power reactors

- Belleville NPP (BNI 127 and 128)
- Blayais NPP (BNI 86 and 110)
- Bugey NPP (BNI 78 and 89)
- Cattenom NPP (BNI 124, 125, 126 and 137)
- Chinon B NPP (BNI 107 and 132)
- Chooz B NPP (BNI 139 and 144)
- Civaux NPP (BNI 158 and 159)
- Cruas NPP (BNI 111 and 112)
- Dampierre NPP (BNI 84 and 85)
- Fessenheim NPP (BNI 75) shutdown since June 2020
- Flamanville site, including reactor Flamanville 3 (BNI 108, 109 and 167)
- Golfech NPP (BNI 135 and 142)
- Gravelines NPP (BNI 96, 97 and 122)
- Nogent NPP (BNI 129 and 130)

- Paluel NPP (BNI 103, 104, 114 and 115)
- Penly NPP (BNI 136 and 140)
- Saint-Alban-Saint-Maurice NPP (BNI 119 and 120)
- Saint-Laurent B NPP (BNI 100)
- Tricastin NPP (BNI 87 and 88)

4.1.2. Installations operated by the CEA

Cadarache site	• Jules Horowitz reactor (experimental and irradiation reactor) (BNI 172) • Masurca (critical mock-up) (BNI 39) • ATPu (laboratory undergoing decommissioning (BNI 32)
Saclay site	• OSIRIS (experimental reactor (BNI 40)
Marcoule site	• Phénix (BNI 71)

4.1.3. Installations operated by the Orano group

La Hague site Orano	• UP3-A (BNI 116) • UP2 800 (BNI 117) • UP2 400 (BNI 33) • STE2 AT1 (BNI 38)	• HAO (BNI 80) • ELAN IIB (BNI 47) • STE3 (BNI 118)
Marcoule site	• Orano: Melox plant (BNI 151)	
Tricastin site	• EURODIF-Pro: George-Besse I plant and its annex (BNI 93) • SET: George-Besse II plant and its annex RECII (BNI 168) • Orano: TU5 W plant (BNI 155) • Orano Pierrelatte – Tricastin (BNI 105) • SOCATRI – Plant (BNI 138)	

4.1.4. Installation operated by the Laue-Langevin Institute

Grenoble site	• High flux reactor (HFR), (BNI 67)

4.2. Installations and sites tested in 2012 (batch 2)

4.2.1. Installations operated by the CEA

Cadarache site	• Rapsodie (BNI 25) • MCMF (BNI 53) • LECA (BNI 55) • CHICADE (BNI 148)	• Cabri (BNI 24) • PEGASE (BNI 22) • Storage yard (BNI 56) • Site support functions
Saclay site	• Orphée (BNI 101)	
Marcoule site	• Atalante (BNI 156) • Site support functions	

4.2.2. Installations operated by Framatome

Romans site	• Framatome (BNI 63) (former CERCA plant) and BNI 98 (former FBFC plant)

4.2.3. Installation operated by Cisbio International

Saclay site	• Cisbio plant (BNI 29)

4.2.4. EDF installations undergoing decommissioning

Creys Malville site	• Superphénix including TNA (BNI 91) • APEC (BNI 141)
Bugey NPP site	• Bugey 1 (BNI 45)
Chinon NPP site	• Chinon A1 (BNI 133) • Chinon A2 (BNI 153) • Chinon A3 (BNI 161)
Saint-Laurent NPP site	• Saint-Laurent A1 (BNI 46) • Saint-Laurent A2 (BNI 46)
Chooz NPP site	• Chooz A (BNI 163)
Brennilis site	• Monts d'Arrée - EL4-D (BNI 162)

4.2.5. Installation under construction ITER organization

Cadarache site	• ITER

4.3. Other non-priority installations, to be covered by specific requests from ASN, possibly including bringing forward periodic safety reviews (batch 3)

4.3.1. Installations operated by the CEA

Cadarache site	• Phébus (BNI 92) • EOLE (BNI 42) • MINERVE (BNI 95) • STAR (BNI 55) • Magenta (BNI 169) • CEDRA (BNI 164) • LPC (BNI 54) • LEFCA (BNI 123) • CASCAD (BNI 22) • AGATE (BNI 171) • STEDS Treatment (BNI 37)
Saclay site	• LECI (BNI 50) • POSEIDON (BNI 77) • ZGDS Storage (BNI 72) • ZGEL Treatment and storage (BNI 35)

The following BNIs are not concerned by the stress tests: ATUe (BNI 52) on the Cadarache site, Ulysse (BNI 18) and LHA (BNI 49) on the Saclay site, STED (BNI 36), LAMA (BNI 61), STED (BNI 79) and Siloé (BNI 20) on the Grenoble site.

4.3.2. Installations operated by IONISOS

- Dagneux site (BNI 68)
- Pouzauges site (BNI 146)
- Sablé sur Sarthe site (BNI 154)

4.3.3. Installations operated by Andra

- The Manche waste repository - CSM (BNI 66)
- The Aube waste repository - CSA (BNI 149)

4.3.4. Installations operated by EDF

Tricastin site	• Tricastin operational hot unit (BCOT) (BNI 157)
Chinon site	• Irradiated materials facility (AMI) (BNI 94) • Inter-regional fuel store (MIR) (BNI 99)
Bugey site	• Inter-regional fuel store (MIR) (BNI 102) • ICEDA (BNI 173)
Saint-Laurent site	• St Laurent storage silos (BNI 74)

4.3.5. Installations operated by the Orano group

Narbonne site	• Orano Malvési (ECRIN)

4.3.6. Other licensees

SOCODEI	Marcoule site	• CENTRACO (BNI 160)
GIE GANIL	Caen site	• GANIL (BNI 113)
ISOTRON		• GAMMASTER - Marseille (BNI 147) • GAMMATEC – Chuslan (BNI 170)

The following BNIs are not concerned by the stress tests: the Strasbourg University reactor (BNI 44) – Louis Pasteur University, LURE (BNI 106), SICN (BNI 65 and BNI 90).

5| MAIN LEGISLATIVE AND REGULATORY TEXTS

5.1. Acts and regulations

Environment Code (chapter II of title IV of book V and title IX of book V – legislative and regulatory sections)

Public Health Code (chapter III of title III of book III of the first part – legislative and regulatory section)

Labour Code

Act 2006-739 of 28 June 2006 ("Waste" Act)

Relative to the sustainable management of radioactive materials and waste

Decree 2007-150 of 5 February 2007

Defining the perimeter of the proximity zone provided for in Article L. 542-11 of the Environment Code concerning the underground laboratory of Meuse and Haute-Marne intended for studying deep geological formations in which radioactive waste could be disposed of.

Decree 2007-243 of 23 February 2007

Relative to the ring-fencing of funds to finance nuclear expenses

Decree 2007-721 of 7 May 2007

Setting the fraction of the assistance tax paid to municipalities which have part of their land situated less than 10 kilometres from the main access to the underground facilities of the Bure research laboratory (Meuse *département*) in application of point V of Article 43 of Act 99-1172 of 30 December 1999 amended introducing the Finance Act for 2000

Decree 2008-209 of 3 March 2008

Relative to the procedures applicable to the reprocessing of spent fuels and radioactive waste originating from other countries

Ministerial Order of 7 February 2012 (the "BNI" Order)

Setting the general rules concerning basic nuclear installations

5.2. Safety guides (as at 30 June 2019)

5.2.1. Basic safety rules (RFS)

RFS I.1.a Integration of risks related to airplane crashes (7 October 1992).

RFS I.1.b Integration of risks related to the industrial environment and communication routes (7 October 1992).

RFS 2001-01 Determination of seismic movements to be considered for the safety of the facilities (revision of RFS-I.1.c – 16 May 2001).

RFS I.2 Safety objectives and design bases for surface facilities intended for long-term disposal of solid radioactive waste with short or intermediate half-life and low or intermediate specific activity (8 November 1982 - revision of 19 June 1984).

RFS-I.2.d Integration of risks related to the industrial environment and communication routes (7 May 1982).

RFS-I.3.a Use of the single failure criterion in safety analyses (5 August 1980).

RFS-I-3.b Seismic instrumentation (8 June 1984).

RFS I.3.c Geological and geotechnical site studies; determination of soil characteristics and study of soil behaviour (1 August 1985) (18 October 1984).

RFS I.4.a Fire protection (28 February 1985).

RFS II. 2. Design and operation of ventilation systems in BNIs other than nuclear reactors (20 December 1991).

RFS-II.4.1.a Software for safety-classified electrical systems (15 May 2000).

RFS III.2.a General provisions applicable to the production, monitoring, processing, conditioning and interim storage of various types of waste resulting from reprocessing of fuel irradiated in pressurised water reactors (24 September 1982).

RFS III.2.b Special provisions applicable to the production, monitoring, processing, conditioning and storage of high-level waste conditioned by vitrification and resulting from reprocessing of fuel irradiated in pressurised water reactors (12 December 1982).

RFS III.2.c Special provisions applicable to the production, monitoring, processing, conditioning and interim storage of low or intermediate-level waste encapsulated in bitumen and resulting from reprocessing of fuel irradiated in pressurised water reactors (5 April 1984).

RFS III.2.d Special provisions applicable to the production, monitoring, processing, conditioning and interim storage of waste encapsulated in cement and resulting from reprocessing of fuel irradiated in pressurised water reactors (1 February 1985).

RFS III.2.e Prerequisites for the approval of packages of encapsulated solid waste intended for surface disposal (31 October 1986 - revision of 29 May 1995).

RFS-IV.1.a Classification of mechanical equipment, electrical systems, structures and civil engineering works (21 December 1984).

RFS-IV.2.a Requirements to be considered in the design of safety-classified mechanical equipment carrying or containing a fluid under pressure and classified level 2 and 3 (21 December 1984).

RFS-IV.2.b Requirements to be considered in the design, qualification, implementation and operation of electrical equipment included in safety-classified electrical systems (31 July 1985).

RFS-V.1.a Determination of the activity released outside the fuel and to be considered in accident safety studies (10 June 1982).

RFS-V.1.b Meteorological measurement means (10 June 1982).

RFS-V.2.b General rules applicable to civil engineering works (30 July 1981).

RFS-V.2.c General rules applicable to the production of mechanical equipment (8 April 1981).

RFS-V.2.d General rules applicable to the production of electrical equipment (28 December 1982).

RFS-V.2.j General rules relative to fire protection (20 November 1988).

RFS-V.2.h General rules applicable to the construction of civil engineering works (4 June 1986).

RFS 2002-1 Development and utilisation of probabilistic safety studies (26 December 2002).

5.2.2. Guides

ASN Guide No. 3: Recommendations for writing annual public information reports concerning basic nuclear installations (20 October 2010).

ASN Guide No. 6: Final shutdown, decommissioning and delicensing of basic nuclear installations in France (30 August 2016).

ASN Guide No. 7: Civil transport of radioactive packages or substances on the public highway (15 February 2016)

ASN Guide No. 8: Conformity assessment of nuclear pressure equipment (4 September 2012).

ASN Guide No. 9: Determining the perimeter of a BNI (31 October 2013).

ASN Guide No. 10: Local involvement of CLIs in the 3rd ten-yearly outages of the 900 MWe reactors (1 June 2010).

ASN Guide No. 13: Protection of basic nuclear installations against external flooding (8 January 2013)

ASN Guide No. 14: Clean-out of structures in basic nuclear installations (30 August 2016)

ASN Guide No. 15: Control of activities in the vicinity of basic nuclear installations (24 March 2016)

ASN Guide No. 17: Content of radioactive substance transport incident and accident management plans (22 December 2004).

ASN Guide No. 18: Disposal of effluents and waste contaminated by radionuclides produced in facilities licensed under the Public Health Code (26 January 2008)

ASN Guide No. 19: Application of the Order of 12/12/2005 relative to nuclear pressure equipment (21 February 2013)

ASN Guide No. 21: Processing of non-compliance with a requirement defined for a protection-important component (PIC) (6 January 2015).

ASN Guide No. 23: Drafting and modification of the waste zoning plan for basic nuclear installations (30 August 2016)

ASN Guide No. 24: Management of soils contaminated by the activities of a basic nuclear installation (30 August 2016)

ASN Guide No. 25: Production of an ASN regulation or an ASN guide (22 November 2016)

ASN Guide No. 27: Securing radioactive packages, materials or objects for transport (30 November 2016)

ASN Guide No. 28: Qualification of scientific computing tools used in the nuclear safety case – first barrier (26 July 2017)

ASN Guide No. 29: Radiation protection in radioactive substance transport activities (29 March 2018)

ASN Guide No. 30: Policy with regard to control of the risks and drawbacks of BNIs and the licensees' integrated management system (2 June 2020)

ASN Guide No. 31: Procedures for reporting events associated with the transport of radioactive substances (24 April 2017)

ASN Guide No. 34: Implementation of the regulatory requirements applicable to on-site transport operations (27 June 2017)

Guide to the procedures for reporting and codifying criteria related to significant safety, radiation protection or environmental events applicable to basic nuclear installations (2005)

Guide indicating the conditions of application of the fire provisions of the Order of 31/12/1999 amended (1 April 2006)

Guide to the regulatory requirements applicable to the transport of radioactive materials in airports (February 2006)

Safety Guide on the final disposal of radioactive waste in deep geological formations (February 2008)

Methodological guide: Management of sites potentially polluted by radioactive substances (December 2011)

General safety guidance notice in view of the search for a site for disposal of low specific activity, long-lived waste (June 2008)

6| ORGANISATION OF THE PRINCIPAL NUCLEAR LICENSEES

6.1. Organisation of Andra

Andra was created within the CEA in 1979, and became an Industrial and Commercial Public Establishment (EPIC) with a Board of Directors, led by a Director General who has functional departments and operational departments under his authority.

6.1.1. The functional departments

The general secretariat proposes to general management the Agency's orientations with regard to budgetary, legal, management control, purchasing and information technology matters, then implements them. It is responsible for questions relating to accounting, fiscal aspects, financing and cash flow. It prepares the meetings and ensures secretaryship of the board of directors and the finance committee. It is responsible for relations with the State comptroller and the advisory committee on contracts.

The human resources department implements the Agency's human resources policy.

The department of communication and dialogue with civil society proposes Andra's strategy regarding information, consultation and outreach with its internal and external audiences.

6.1.2. The operational departments

The Cigéo project management represents Andra, the owner, for the design and construction of surface infrastructures (nuclear and non-nuclear) and underground infrastructures (nuclear and non-nuclear) necessary for the general vision of deep geological disposal (Cigéo) and the construction of its section 1.

The Engineering Department is a skills department working for the Agency's projects and activities. The Engineering Department is the technical guarantor of Andra's acquired expertise in projects and programmes relative to the specification, design, production and qualification of disposal facility constituents.

The Research and Development Department (DRD) is tasked with defining and implementing the Agency's R&D work which integrates all the scientific studies and the underground laboratory experimental work. It is involved in particular in package inspection means, facility monitoring systems, new materials and alternative waste treatment processes. It carries out digital simulations for Andra's various activities. It defines and carries out the geological reconnaissance campaigns.

The role of the Environmental Safety and Waste Management Strategy Department (DISEF) is to guarantee that all the facilities designed and operated by Andra, and the waste management methods it proposes, have a controlled impact on man and the environment today, tomorrow and over the long term. It coordinates the expertise in terms of safety and the environment, capitalisation of knowledge of packages, controlling their quality and safety, and the strategy for determining waste management routes.

The Meuse/Haute-Marne Centre is responsible for the construction, operation and maintenance of the underground research laboratory. It also fulfils this role for the Technological Space and the "Ecotheque". It contributes to the regional development initiatives around the Cigéo project, in close collaboration with the regional authorities and the government departments. It prepares its local industrial presence.

The Industrial Operations Department operates the disposal facilities and implements the industrial solutions for accepting radioactive waste. For these activities it is the chief point of contact for all waste producers for the acceptance of waste in the industrial waste management routes of the Cires and CSA centres, and for the acceptance of waste (including LLW-LL and ILW-LL waste) from all small waste producers and holders.

The Development, Innovation and International Relations Department coordinates innovation and the development of industrial solutions. It showcases and capitalises on the results obtained in contractual and/or partnership contexts both nationally and internationally. It represents Andra in the international bodies.

6.2. Organisation of the CEA

The CEA is public research body created in 1945. With the publication of the legislative section of the Research Code (Ordinance No. 2004-545 of 11 June 2004), the CEA (formerly the Commissariat à l'Energie Atomique - Atomic Energy Commission), became the Alternative Energies and Atomic Energy Commission on 10 March 2010 (Supplementary Budget Act 2010-237 of 9 March 2010) and now belongs to the category of Industrial and Commercial Public Establishments (EPIC), in the research EPIC category.

Its status and missions are defined in Articles L. 332-1 to L. 332-7 of the Research Code.

A major player in research, development and innovation, the CEA is involved in four broad areas: low-carbon energies (nuclear and renewables), information technologies, health technologies, defence and global security. In each of these four broad areas, CEA has first-class fundamental research resources and plays a role in dynamic development through innovation in collaboration with industry. It coordinates and takes part in the research work conducted in the TGIRs (Très grandes infrastructures de recherche - Very large research infrastructures).

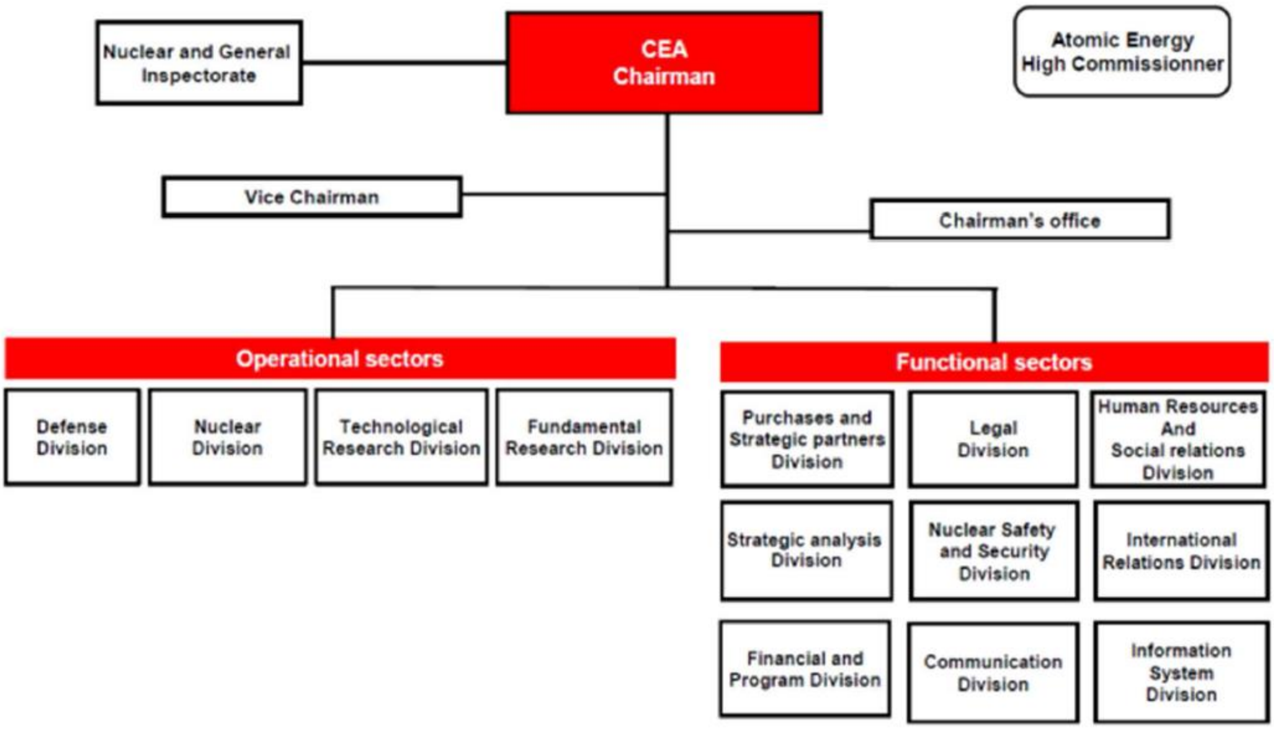

Figure 17: CEA organisation chart

6.3. Organisation of Orano

Refocused on all the activities of the nuclear fuel cycle, Orano develops activities in the Mines, in the front end and back end of the fuel cycle and in other activities such as nuclear medicine

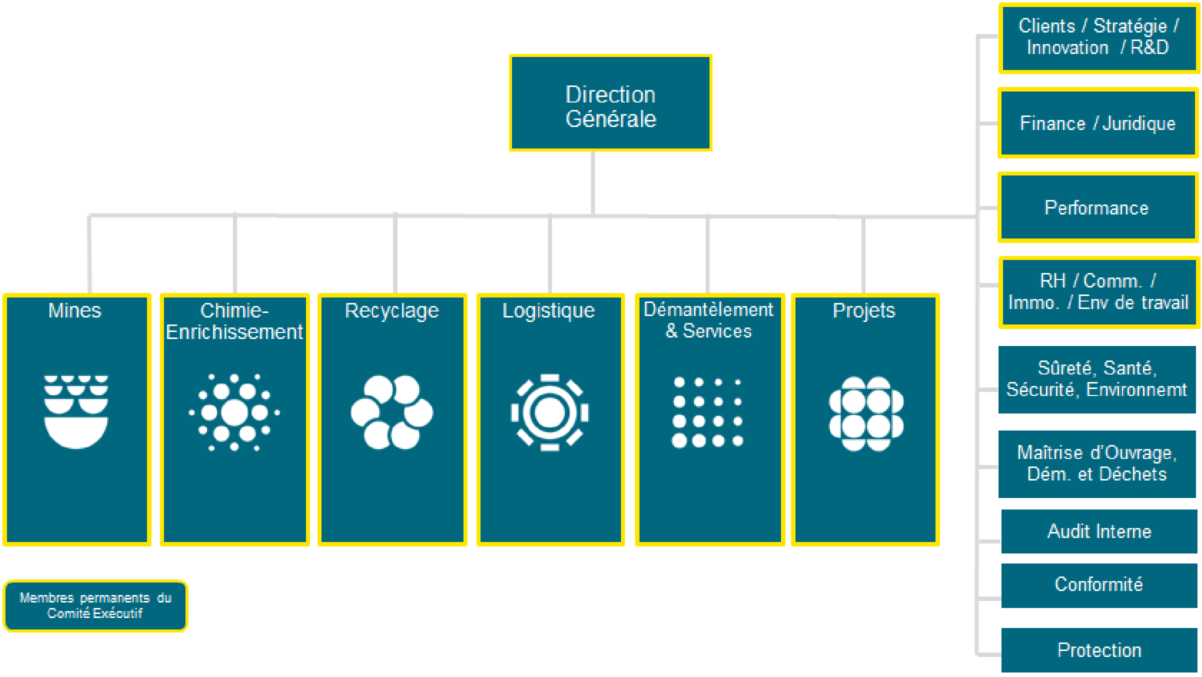

Figure 18: Organisation of Orano before 31 December 2019.

The activities relating to the design of reactors, the manufacture of components and fuel, including the Romans-sur-Isère facilities, and services to the installed base have been transferred to Framatome, the reference player in these areas and which joined the EDF group on 1 January 2018.

6.4. Organisation of EDF

EDF is the main electricity production company in France and the only one to operate nuclear power reactors. EDF fulfils these missions through various departments, divisions and entities.

The DPNT (Nuclear and Thermal Generation Division) is the centralised producer, responsible for nuclear and thermal electricity generation.

Its broad duties within EDF are:

- to maintain the safety of the nuclear fleet at the highest level while achieving the set production targets;
- ensure the success of the "Grand Carénage" Programme (extension of service life and post-Fukushima measures);
- develop an industrial route for nuclear dismantling and the management of radioactive waste;
- have a strong, high-performance and innovative engineering base working for the Grand Carénage Programme and dismantling/waste projects;
- secure the procurement of nuclear fuel and management of the nuclear cycle;
- manage the operational waste and spent fuels;
- adapt the thermal fleet and diversify the thermal engineering activity.

The DIPNN (New Nuclear Projects & Engineering Division) is:

- the architect-integrator of the New Nuclear build, working on a group of projects covering all the phases of the new nuclear build engineering;
- supporting the operating performance and the extension of the service life of the EDF nuclear power plants in France;
- responsible for the development of the EDF Group's international nuclear projects.

6.4.1. Nuclear and Thermal Generation Division

The missions of the main entities or organisations in the Nuclear and Thermal Generation Division having nuclear-related activities are described below.

6.4.1.1. The Nuclear Generation Division

The Nuclear Generation Division assumes the responsibility of nuclear licensee for the sites in operation and through to final shutdown. The DPN is the project owner for generic actions. As such, it bears the related costs which, as far as waste is concerned, include the fixed costs of the "preprocessing" facilities (mobile packaging units and CENTRACO) and disposal facilities (CSFMA, Cires). The DPN Director is the chief point of contact with the ASN Director General, particularly regarding the management of radioactive waste from the fleet in operation.

6.4.1.2. The nuclear power plants

In accordance with the regulations, the NPPs are responsible for their waste (from the place of production through to the final destination) and the conformity of the packages they manufacture. They are obliged to apply the doctrine developed for the nuclear fleet as a whole and to use the generic waste packages approvals when they exist. They ascertain that any specific approvals they have are consistent with the existing national provisions. They are supported essentially by the UNIE (National Engineering Unit) and the UTO (Operational Technical Unit).

6.4.1.3. The National Engineering Units

The Operational Technical Unit (UTO) is the National Engineering Unit that the NPPs rely upon for the management of their operational waste. It is tasked in particular with:

- developing the operational waste management doctrine (baseline requirements, internal directives, etc.) and providing the methodological support necessary for its implementation;
- examining the package approvals;
- providing the NPPs with the products (packages, shells, drums) and materials (dry loads) necessary for conditioning and packaging the waste and managing the common conditioning and packaging means (mobile units, etc.) ;
- coordinating the scheduling of waste removals from the sites in operation to the treatment and disposal routes.

The Operation Engineering Unit (UNIE) also intervenes in the area of waste for the "zoning" aspects and leading activities brought together within the sites' Nuclear Logistics services.

The Nuclear Fleet Dismantling and Environment Engineering Division

The Nuclear Fleet, Dismantling and Environment Engineering Division (DIPDE) ensures the engineering of the nuclear fleet in operation and of dismantling through technical studies and works.

The DIPDE has three main partners: The "Grand Carénage" major overhaul programme, the DPN and the DP2D.

The DIPDE ensures the integrity of design (role of Design Authority) with respect to nuclear safety and protection of the interests in behalf of the DPN; it participates in the performance of the nuclear fleet in operation through its contribution to maintaining the production level. The DIPDE ensures the technical and financial management of the Grand Carénage Programme. The DIPDE contributes to the DP2D dismantling projects by performing technical studies and implementing modifications on the plant units in operation.

The Dismantling and Waste Projects Division

The mission of the Dismantling and Waste Projects Division (DP2D) is to be the EDF group's integrated operator for nuclear power plant dismantling and waste management.

The DP2D was set up to create greater synergy between the dismantling of definitively shut down power plants and the management of radioactive waste. As a responsible industrial player, EDF must ensure that all the waste resulting from dismantling will be able to be treated, stored and ultimately disposed of in appropriate facilities by contributing to the setting up of a true industrial waste management route in this area.

The Nuclear Fuel Division

By delegation from the DPNT, the nuclear fuel division (DCN) acts as project owner, for EDF, for the activities linked to the fuel cycle and therefore more specifically the defining and applying of the spent fuel management strategy; the DCN is also in charge of the logistics of operational nuclear waste.

The DCN manages the contracts for uranium procurement, conversion, enrichment and manufacture of UO_2 and MOX fuel, and the transport, reception, storage and reprocessing contracts for spent fuel and induced waste.

The "Grand Carénage" major overhaul programme.

The Grand Carénage Programme is a project structure tasked with modernising and extending the operating life of the fleet in service operated by the Nuclear Generation Division (DPN).

The DIPDE and the UTO, as engineering units, contribute to the Grand Carénage Programme in the studies and production phases.

The Production Industrial Support Division (DAIP) provides heavy maintenance services, training, exceptional transport operations, etc.

The National Electricity Generating Equipment Centre (CNEPE), the Industrial Division (DI) and the Technical Division (DT), as engineering units, contribute to the Grand Carénage Programme projects in the studies and production phases.

6.4.1.4. The New Nuclear Projects & Engineering Division

The missions of the main entities or organisations in the DIPNN having nuclear-related activities are described below.

National Electricity Generating Equipment Centre

In its role as Architect-Integrator, the CNEPE is responsible for the design and production engineering of the conventional part of the installations for:

- the reactor fleet in operation: improving the systems and facilities of the nuclear plant units in operation to meet the requirements for safety, security, and environmental quality;
- the design and construction of the new nuclear power plants (Hinkley Point C, Taishan, etc.);
- meeting the demands of the DIPNN for products under development.

Edvance

Created in May 2017, Edvance, a subsidiary of EDF (80%) and Framatome (20%), is a Nuclear Island (NI) "Engineering Procurement Construction and Commissioning" company. It is responsible for the design and production of the nuclear islands of new EDF nuclear power plant projects in France and abroad. Over the perimeter of the NI, it integrates the activities of the main suppliers, including Framatome for the nuclear steam supply system. The know-how and expertise of the Edvance teams contribute to the outreach and competitiveness of the French nuclear sector while maintaining the skills necessary for the development of the new nuclear build in the world.

The Technical Division

The role of the DT is to fulfil a role of design integration and expertise and to be the "Responsible Designer" of the safety case for the existing fleet.

The DT is responsible for the performance of the nuclear fleet in operation and for the extension of its service life. It is involved in the Grand Carénage Programme and the new nuclear build.

The Industrial Division

The DI is EDF's expert assessment unit responsible for the inspection and monitoring of the manufacture of materials for the current and new nuclear build.

The Projects and Digital Transition Support Division

Its missions hinge around 4 challenges:

- develop new methods and tools to professionalise project management;
- lead operating experience feedback (OEF) for the New Nuclear Build sector;
- be a major player in the digital transformation of nuclear engineering;
- contribute to the success of the major international projects by assisting the Project Departments, engineering entities and the Development Department.

7| BIBLIOGRAPHY

7.1. Documents

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2 | Guidelines concerning the form and structure of national reports, INFCIRC/604/Rev.3, of 13 January 2015.
3 | Public Health Code – Official Journal of the French Republic*.
4 | Environment Code – Official Journal of the French Republic.
5 | The State of Nuclear Safety and Radiation Protection in France in 2019 – ASN Annual Report, 2020

7.2. 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 websites in particular can be consulted:

ASN	www.asn.fr
Andra	www.andra.fr
CEA	www.cea.fr
EDF	www.edf.fr
IAEA	www.iaea.org
ILL	www.ill.eu
IRSN	www.irsn.fr
Legal texts	www.legifrance.fr
MTES	www.developpement-durable.gouv.fr/
Orano	www.orano.group
RNM	www.mesure-radioactivite.fr.

* A large number of legislative and regulatory texts are available on the website: www.legifrance.fr

8| LIST OF MAIN ABBREVIATIONS

ALARA	As Low As Reasonably Achievable
Andra	French national agency for radioactive waste management (*Agence nationale pour la gestion des déchets radioactifs*)
ASN	French nuclear regulator (Autorité de sûreté nucléaire)
ASND	French defence nuclear regulator (*Autorité de sûreté nucléaire défense)*
BNI	Basic Nuclear Installation
CEA	Alternative Energies and Atomic Energy Commission (*Commissariat à l'énergie atomique et aux énergies alternatives*)
CENTRACO	Low-level waste treatment and packaging centre
CET	Landfill site (*Centre d'enfouissement technique*)
CIC	Interministerial Crisis Committee
CIRES	Industrial grouping, storage and disposal centre (*Centre industriel de regroupement, d'entreposage et de stockage*)
CNE	National Assessment Commission (*Commission nationale d'évaluation*)
CNRS	French National Centre for Scientific Research (*Centre national de recherche scientifique*)
COFRAC	French accreditation committee
COGIC	Interministerial emergency management operational centre (*Centre opérationnel de gestion interministérielle des crises*)
DBNI	Defence Basic Nuclear Installation
DGSCGC	General Directorate for Civil Security and Emergency Management (*Direction générale de la sécurité civile et de la gestion des crises*)
DGEC	General Directorate for Energy and the Climate (*Direction générale de l'énergie et du climat*)
DGEMP	General Directorate for Energy and Raw Materials (until 2008) (*Direction générale de l'énergie et des matières premières*)
DGPR	General Directorate for Risk Prevention (*Direction générale de la prévention des risques*)
DGS	General Directorate for Health (*Direction Générale de la Santé*)
DPN	Nuclear Generation Division (*Division production nucléaire*) of EDF
DSND	Nuclear safety and radiation protection delegate for defence-related facilities (Ministry responsible for defence and the Ministry responsible for industry).

ECC	Hulls and compacted endpieces storage unit
EDF	Électricité de France
EU	European Union
EPIC	Industrial and Commercial Public Establishment (*Établissement public à caractère industriel et commercial*)
FNR	Fast-Neutron Reactor
GCR	Gas-Cooled Reactor
GP	Advisory Committee of experts (*Groupe permanent d'experts*)
GPD	Advisory Committee for Nuclear Waste
GPESPN	Advisory Committee for Nuclear Pressure Equipment
GPMED	Advisory Committee for Radiation Protection in Medical and Forensic Applications of Ionising Radiation
GPRADE	Advisory Committee for Radiation Protection in Non-medical Applications
GPR	Advisory Committee for Nuclear Reactors
GPT	Advisory Committee for Transport
GPU	Advisory Committee for Laboratories and Plants
HLW	High Level Waste
HCTISN	High Committee for Transparency and Information on Nuclear Security
HFDS	Defence and Security High Official (*Haut fonctionnaire de défense et de sécurité*)
IAEA	International Atomic Energy Agency of the UNO
ICEDA	Activated waste storage and packaging facility (*Installation de conditionnement et d'entreposage de déchets actives*)
ICPE	Installation Classified for Protection of the Environment
ICRP	International Commission on Radiological Protection
ILW	Intermediate Level Waste
INES	International Nuclear Events Scale
IRSN	French Institute for Radiation Protection and Nuclear Safety (*Institut de radioprotection et de sûreté nucléaire*)

LL	Long-Lived (waste)
LLW	Low-Level Waste
LLW-ILW	Low and Intermediate Level Waste
MOX	Fuel based on mixed oxides of uranium and plutonium
MSNR	Nuclear Safety and Radiation Protection Mission of the MTES
MTES	Ministry of Ecological and Solidarity-based Transition (*Ministère de la transition écologique et solidaire*)
NEA	Nuclear Energy Agency of the OECD
NORM	Naturally Occurring Radioactive Material
NPE	Nuclear Pressure Equipment
NPP	Nuclear Power Plant (EDF)
OPECST	Parliamentary Office for the Evaluation of Scientific and Technological Choices (*Office parlementaire d'évaluation des choix scientifiques et techniques*)
Orano	New ORANO company, renamed Orano Cycle
PNGMDR	French National Radioactive Materials and Waste Management Plan
PPI	Off-site emergency plan (*Plan particulier d'intervention*)
PUI	On-site emergency plan (*Plan d'urgence interne*)
PWR	Pressurised Water Reactor
R&D	Research and Development
RFS	Basic safety rule (*Règle fondamentale de sûreté*)
RGE	General operating rules (*Règles générales d'exploitation*)
RNM	French national environmental radioactivity monitoring network
SGDSN	General Secretariat for Defence and National Security (*Secrétariat général de la défense et de la sécurité nationale*)
SL	Short-Lived (waste)
STE	Operating Technical Specifications (*Spécifications techniques d'exploitation*)
TECV	Act 2015-992 of 17 August 2015 relative to the energy transition for green growth

TSN Act 2006-686 of 13 June 2006 relative to transparency and security in the nuclear field

UOX Uranium oxide based fuel

VLLW Very Low Level Waste

WENRA Western European Nuclear Regulators Association

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