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NATIONAL REPORT OF FRANCE FOR THE 8TH REVIEW MEETING

Joint Convention on the Safety of Spent Fuel Management and on the Safety of Radioactive Waste Management

August 2024

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1 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 eighth review meeting of the Joint Convention.

1.1. The safe and sustainable management of radioactive waste and spent fuel in France

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

Implementation of these principles is based on a management framework comprising 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 Plan for Radioactive Materials and Waste Management (PNGMDR), updated every five years.

1.1.1. The legislative and regulatory framework

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 Environmental Protection (ICPE) and those subject to the regulations for Basic Nuclear Installations (BNI) and defence-related nuclear installations (DBNI).

Throughout the report, the terms "spent fuel" and "radioactive waste" have the meaning given to them by the Joint Convention. Other related terms such as "radioactive substance" and "radioactive material" are defined in section 2.2. The French regulations divide radioactive substances into radioactive materials (for which a subsequent use is planned or envisaged) and radioactive waste (for which no subsequent use is planned or envisaged). The principal radioactive materials are uranium (natural, reprocessed, enriched or depleted), plutonium, thorium and nuclear fuels, both new and spent.

The long-term management prospects of a radioactive substance differ depending on whether it is classified as material or waste. If the radioactive substances are not intended to be reused, a long-term management solution is required, and this is usually disposal, possibly after an intermediate phase of treatment, conditioning, packaging and interim storage). If the radioactive materials are intended to be reused, they are stored until they are used. The required level of safety, radiation protection and environmental protection is the same, whether the radioactive substances are considered as materials or waste.

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 essentially concerns legacy waste. This waste must undergo waste retrieval and conditioning (WRC) operations.

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

- the directive on the safety of nuclear facilities (directive of 8 July 2014);
- the directive on the management of spent fuel and radioactive waste (directive of 19 July 2011);
- the directive on the basic radiation protection safety standards (directive of 5 December 2013).

It is underpinned by the following three Acts voted in the last 30 years by the French Parliament:

- the Act of 30 December 1991 defines lines of research for the management of long-lived high-level waste;
- the Act of 28 June 2006 details the lines of research and defines the general framework for the management of radioactive waste;
- 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.

The Act of 13 June 2006 relative to transparency and security in the nuclear field ("TSN" Act) instituted ASN, the French nuclear safety authority, as an independent administrative authority tasked in the name of the State with the regulation and oversight of nuclear safety and radiation protection. Legislative measures also define the procedures for public information and participation.

The Act of 21 May 2024 relative to the organisation of the governance of nuclear safety and radiation protection to meet the challenge of the revival of the nuclear power sector creates a new independent administrative authority called Authority for Nuclear Safety and Radiation Protection (ASNR). As ASN today, this future authority will be independent of the Governement and the operators. Starting from 1 January 2025, it will will be in charge of the activities of expertise, instruction, authorisation and control related to nuclear safety of civil installations.

1.1.2. The National Agency for Radioactive Waste Management

Andra, the French National Agency for Radioactive Waste Management, is a government agency created by the Act of 20 December 1991 with responsibility for designing, building and operating the radioactive waste disposal facilities and for keeping the national inventory of radioactive materials and waste, which it updates each year. Every five years Andra provides forward-looking estimates of the quantities of radioactive materials and waste, applying several scenarios with regard to the future of the nuclear facilities and the long-term energy policy of France. The last edition of the National Inventory was published in December 2023.

1.1.3. The National Plan for Radioactive Materials and Waste Management

The Environment Code requires the Government to draft and update the National Plan for Radioactive Materials and Waste Management (PNGMDR), every five years. This plan inventories the existing radioactive materials and waste management methods and the technical solutions adopted. It identifies the foreseeable need for storage or disposal facilities and specifies the capacity necessary for these installations as well as 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 defined priorities. 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 indicates the persons responsible for its implementation and the indicators for monitoring the progress of its implementation.

For the first time, the preparation of the PNGMDR for the 2022-2026 period was subject to national public debate in 2019, followed by a public consultation in 2020 and 2021. The fifth edition of the PNGMDR was published on 9 December 2022 after the consultation. The publication of the plan is accompanied by the publication of a decree and an order laying down the regulations concerning the conditions and time-frames for accomplishing certain actions.

1.2. Nuclear installations in France

France has a large number of nuclear facilities:

- 56 power generating reactors (as at 31 December 2023), and one reactor (Flamanville EPR) in the start-up phase at the end of July 2024;
- front-end nuclear fuel cycle facilities, including a uranium enrichment plant;
- back-end nuclear fuel cycle facilities, including spent fuel reprocessing plants;
- research facilities, including more particularly research reactors and facilities conducting research into the management of radioactive waste;
- radioactive waste processing, conditioning, packaging and storage (temporary storage) facilities;
- radioactive waste above-ground disposal centres (definitive management solution): two facilities for low and intermediate level, short-lived waste (one having stopped receiving waste in 1994, the other still in service)[1];
- one radiopharmaceutical and irradiator production plant;
- facilities undergoing decommissioning.

All 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 stored on the sites of the nuclear power plants (NPPs) and then transferred to the reprocessing plant at La Hague, operated by Orano, or to the facilities of the Alternative Energies and Atomic Energy Commission (CEA), pending their reprocessing then disposal of the residual waste.

Several nuclear facilities are currently under construction:

- the Jules Horowitz experimentation reactor on CEA Cadarache site;
- DIADEM interim storage facility dedicated to highly-irradiating waste on CEA Marcoule side;
- ITER nuclear fusion installation on CEA Cadarache site.

[1] France also has a facility that accepts very-low-level waste but is not classified as a nuclear installation in the legal sense, but an installation classified for environmental protection (ICPE).

ASN is examining the application for authorisation to create the deep geological repository (Cigéo) for high-level and intermediate-level long-lived waste, for which the licence application file was submitted in January 2023.

It is to be noted that in France, former uranium mines also produced mining waste rock and mining processing residues during processing of the ore to extract the uranium. The quantity of mining waste rock extracted is estimated at about 170 million tonnes and the processing residues at 50 million tonnes, spread over 17 disposal sites. These sites are ICPEs and their environmental impact is monitored.

1.3. Overview matrix

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	If it is decided to stop reprocessing spent fuel, there is the possibility of disposal in deep geological disposal (Cigéo facility currently under authorisation)
Waste from the nuclear fuel cycle	Disposal	The producer of the waste finances its management. Dedicated assets are ring-fenced.	Disposal at CSA for LL/ILW-SL* waste and at Cires for the VLL-SL* waste*. Interim storage for the other waste.	New disposal centres for HLW*, ILW-LL* (Cigéo) and LLW-LL (under study).
Waste not resulting from energy production	Disposal routes must be set up for certain types of waste.	The producer finances.	Disposal centres for VLL 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 (POCO) taken as far as reasonably possible ("optimised POCO")	The licensee finances. Dedicated assets are ring-fenced.	Dismantling in as short a time as possible after shutdown. LLW/ILW-SL wastes are disposed of in the CSA and VLL wastes in Cires; storage for the other waste.	New disposal centres for ILW-LL and LLW-LL (under study).
Sealed sources removed from service	Return to manufacturer. Disposal or recycling routes currently being implemented.	System of insurance between users and suppliers or deposit of a bond with Andra.	Some sources are disposed of in CSA and Cires. Storage in specific facilities.	New disposal centres for HLW, ILW-LL and LLW-LL (under study).
Waste from ore extraction	Waste stabilised *in-situ* and reinforced monitoring.	Responsibility of licensee (Orano)	Stabilised mines.	N/A

Table 1: Overview matrix for France

** Meaning of the abbreviations: VLL: very low level, LL: low level, IL: intermediate level, HL: high level, LL: long-lived, SL: short-lived*

1.4. Main changes since the 7th report

1.4.1. National framework and regulations

The Order of 7 February 2012 (known as the "BNI Order") and about fifteen ASN regulations set out the regulatory framework. Work is in progress on the lessons learned from application of the BNI Order with a view to revising it. The revision work is continuing.

With regard to the management of radioactive waste, the most recently published texts are the Decree and the Order of 9 December 2022 establishing the requirements of the PNGMDR. In addition to the general provisions of this Plan, it contains the provisions applicable to those in possession of radioactive materials and waste regarding the management of radioactive materials and waste storage facilities, the management of radioactive materials, and the long-term management of radioactive waste.

As part of the work on the French Energy-Climate Strategy, the Government organised a public consultation of a document presenting the broad lines of France's energy policy, from 22 November to 22 December 2023. This strategy constitutes the roadmap to achieve carbon neutrality in 2050.

1.4.2. Publication of the 5th National Plan for Radioactive Materials and Waste Management

By decision of the French National Public Debates Commission (CNDP, see 6.3.4.2), a national public debate was organised between April and September 2019 prior to the preparation of the fifth edition of the PNGMDR. The conclusions of this debate, published in November 2019, underlined the following needs in particular:

- clarification of the prospects for valorising radioactive materials;
- the need for new storage capacity for spent fuels by 2030[2] and the pertinence of underwater storage of spent fuel in the French context;
- for the management of very low-level (VLL) waste, appropriate traceability processes, effective and independent checks and involvement of civil society in any change to current management methods;
- the use of additional technical expert assessments before defining management solutions suited to the heterogeneity of the low-level 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 waste categories and governance of the plan. The fifth edition of the PNGMDR has adopted the following guidelines in particular:

- A closer interfacing between the energy policy and the management of radioactive materials and waste through an explanation of the challenges posed by the energy policy decisions. On this account, the PNGMDR provides for a document, produced under the supervision of the Ministry responsible for energy, to explicitly describe the interactions between the energy policy and the radioactive materials and waste management policy, based on design-critical scenarios defined in the PNGMDR intended to check that the management policy for these substances will stand up to possible changes in the energy policy.
- A reinforced governance of radioactive waste management[3].

[2] Time-frame re-estimated as 2040 in the most recent studies (see Focus on the "Cycle impact" in section 3.3.3)

[3] Through the setting up of a single PNGMDR governance commission, responsible for advising the owner on the preparation and content of the plan on the one hand, and the monitoring of its execution on the other.

- A reinforced oversight of the reusable nature of radioactive materials.
- The implementation of new centralised storage capacity for spent fuels, as well as the study of the conditions and situations in which dry storage could prove to be useful.
- Whenever relevant, and by means of targeted exemptions, the possibility of reusing certain very low-level metal wastes.
- Continued defining of the conditions of implementation of the Cigéo project (involving the public in the fundamental stages of the project, R&D on alternative management solutions for HLW and ILW-LL waste).
- A reinforced assessment of impacts of the management choices both locally and on the economic, health and environmental issues (impact of transport operations, harmfulness of wastes, etc.).

Production of the PNGMDR is based on the National Inventory of radioactive materials and waste (see section 3.1.1.2), whose first edition dates back to 2004 and is revised each year. 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 National Inventory was published in December 2023.

1.4.3. Submission of the Cigéo creation authorisation application

After several decades of research and development, in January 2023 Andra submitted an application for authorisation to create a deep geological waste disposal repository. This facility, called Cigéo, is intended for the disposal of high- and intermediate-level long-lived radioactive waste. The participation of civil society in the Cigéo project and the involvement of the public in the decisions concerning the management of HL/ILW-LL waste are written into the fifth PNGMDR. At the request of the Minister responsible for nuclear safety, ASN began the technical examination of this file in 2023. It is assisted by IRSN, its technical support organisation (TSO), and the advisory committee for radioactive waste. This technical examination, which is estimated to take about three years, hinges on three themes: the baseline data used for the Cigéo safety assessment (concerning the choice of site in particular); the safety of the surface and underground facilities during the operational phase; the long-term safety in the post-closure phase.

On completion of the examination, ASN will give its opinion on Andra's application. The National Assessment Board (CNE2, see 6.3.4.2) will concomitantly submit an opinion on the scientific basis of the file, taking into consideration the state of the art. The total duration of the authorisation process is estimated at about 5 years. It comprises the technical examination phase, a phase of consultations (regional authorities, environmental authority, etc.) and a public inquiry.

A consultation-based examination

Following on from the public debate on the Cigéo project in 2013, Andra has consolidated its system to foster discussion, consultation and involvement of civil society. With the aim of extending this consultative approach over the long term, Andra called upon the High Committee for Transparency and Information on Nuclear Safety (HCTISN, see 6.3.4.2) which issued several recommendations in September 2020, some of which have been taken up in the PNGMDR 2022-2026.

In response to the recommendations of HCTISN, to the expectations expressed during the public debate of 2019 and the opinion of the CNDP of 7 July 2021, the Minister responsible for energy, ASN and Andra have proposed a framework for the consultations that will be held under their respective auspices.

In order to guarantee the continuity of civil society's participation throughout the examination process and in application of the framework proposed by ASN, consultation measures are implemented when preparing the referrals for the advisory committees of experts, and the public is regularly informed, particularly after each meeting of these advisory committees of experts, the first of which will be held in the first half of 2024. This information, which is organised consistently with the referrals, will provide answers to the expectations and questions that will have been integrated in the referrals. ASN has devised a completely new consultation system for the technical examination process. Various stakeholders (some twenty organisations, including Local Information Committees (CLIs), the National Association of Local Information Committees (ANCCLI) and environmental protection associations) were consulted for the preparation of the referral to IRSN, with the aim of noting their expectations and concerns with regard to nuclear safety and radiation protection, in order to take them into account in the assessment of the file. At the end of this consultation, the draft IRSN referral was modified (incorporating, for example, aspects relative to climate change).

Furthermore, an expert assessment and discussion committee on alternatives to deep geological disposal, in which ASN participates, was created in 2023 with a view to providing recommendations for the next edition of the PNGMDR. Bringing together scientists and stakeholders, including non-institutional experts and a representative of the National Assessment Board (CNE2), the aim of this committee is to exchange views and discuss the scientific work, make proposals on directions for research and inform the public regularly of the state of progress of the work. The first meeting was held in autumn 2023.

Lastly, HCTISN has set up a committee to track the consultation and discussion initiatives concerning the Cigéo project in order to assess their readability, complementarity and coordination with the aim of giving the public a guarantee of its effective participation in the project (see 6.3.4.2).

1.4.4. Management of radioactive materials and waste

1.4.4.1. Improving existing management modes

Management of very low-level waste

Very low-level (VLL) waste comes mainly from the operation, maintenance and decommissioning of nuclear power plants, fuel cycle facilities and research centres (rubble, soils, scrap metal). At present this waste is disposed of at Cires (see 3.6.2), which has a current storage capacity of 650,000 m^3.

At the end of 2022, about 451,000 m^3 of this capacity was used up, representing about 69% of the total capacity, with an annual incoming waste volume of about 22,000 m^3. It is estimated that Cires will be filled to capacity by 2029-2030 if there is no change in the authorised capacities. In April 2023, Andra submitted an application to increase the authorised capacity of Cires to more than 900,000 m^3 (ACACI project).

With regard to the VLL waste, the PNGMDR 2022-2026 provides for:

- Andra, in addition to the abovementioned application to extend the storage capacities of Cires, to plan ahead for the creation of a new disposal centre for VLL waste;
- the feasibility studies for decentralised disposal solutions to be continued;
- the VLL waste management scenarios to be defined in order to assess their pros and cons, in order to update the industrial strategy for the VLL waste management;
- a change in the regulatory framework applicable to VLL waste management in order to introduce a new possibility of targeted waivers (as no clearance thresholds are implemented in France) allowing the recycling, on a case-by-case basis, of radioactive scrap metal after melting and decontamination, and the defining of conditions of recycling of said waste and formalising experience feedback;
- continuation of the studies into the recycling of non-metallic VLL waste and optimisation of the management of this waste.

In line with the last two orientations, the French Government worked on establishing a regulatory framework to allow the recycling of VLL metal waste. A new regulatory mechanism authorising the recycling of metal substances with a low level of radioactivity after melting and decontamination was published in early 2022. This change in the regulations aims firstly to avoid having to place a large quantity (about 500,000 tonnes) of metals resulting from nuclear activities (dismantling of nuclear installations in particular) in repositories and secondly to limit the consumption of natural resources. In this context, EDF has submitted a project for a facility to recycle low activity metal materials, called "Technocentre", to the CNDP. This project is currently in the development phase and will be subject to public debate in 2024.

Focus on the recycling of very low level (VLL) materials

Ongoing and future nuclear facility decommissioning operations will generate a very large amount of very low level radioactive waste. 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 take in all the VLL radioactive waste produced by the French nuclear facility decommissioning operations. At present this waste is disposed of in above-ground facilities, whereas some of the constituent materials could be reused in a circular economy approach. The PNGMDR 2016-2018 asked Andra and the licensees to continue their efforts to reduce the quantities of waste, more specifically by looking into the possibilities of recycling some types of VLL waste and diversifying the VLL waste management options. Thus:

- 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 recycling 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.

Following the public debate on the fifth PNGMDR, the Government made it possible to have targeted exemptions allowing the recycling, after melting and decontamination, of VLL radioactive metal waste. EDF and Orano have presented the technical and safety options of a facility that would allow such a process to be implemented. The PNGMDR provides for the feedback from the exemptions granted to be analysed one year after the VLL metals recycling facility starts functioning. The licensees must moreover list the possibilities of recycling non-metallic VLL waste both within and outside the nuclear sector.

1.4.4.2. Management routes under development

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

The management of HLW and ILW-LL waste is studied in three complementary directions, identified in the Act of 30 December 1991 and taken up in the Act of 28 June 2006: reversible disposal in a deep geological layer, conditioning, packaging and long-term storage and the separation and transmutation of long-lived radionuclides. Research is also being carried out into the processing and packaging of these wastes. 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. This project has crossed to major milestones in the last few years: the Declaration of Public Interest (DUP) by the Government in July 2022 and the filing of the Creation Authorisation Application (DAC) in January 2023.

With regard to the HLW and ILW-LL waste, the PNGMDR 2022-2026 plans for the continuation of the work necessary for the implementation of the Cigéo project, and more specifically:

- closer involvement of the public in the decisions concerning the management of HLW and ILW-LL waste;
- a description of the methods of applying reversibility;
- the defining of the main objectives, the success criteria and points requiring attention in the industrial pilot phase, which will constitute the first phase of operation of this facility;
- informing the public of the updating of the estimated costs of the project.

It also plans for the creation of a suitable framework for continuing research into alternatives to deep geological disposal, with the aim of bringing out innovative avenues for research. A specific body will be set up for this purpose: the expert assessment and discussion committee on alternatives to deep geological disposal. It will bring together scientists and stakeholders, including non-institutional experts.

Management of low-level long-lived waste

The LLW-LL waste category comprises the graphite waste from the operation of the graphite-moderated gas-cooled reactors (GCRs), the radium-bearing waste from the radium industry and its derivatives and other types of waste, such as certain bituminised wastes, substances containing radium, uranium and thorium with low specific activity, and certain disused sealed radioactive sources.

LLW-LL waste requires specific management, appropriate to its long lifetime, which rules out disposal in the existing industrial facilities. Putting in place a definitive management solution for this type of waste is one of the objectives defined by the Act of 28 June 2006. Finding such a management solution necessitates firstly having greater knowledge of LLW-LL waste and secondly conducting safety studies on the associated disposal solution.

LLW-LL waste is a priority of the PNGMDR 2022-2026 which more specifically provides for:

- Action to improve the reliability of the VLL-LL waste inventories and characteristics, and to indicate when the maximum storage capacities for this waste will be reached;
- The defining of LLW-LL waste management scenarios, so that their advantages and drawbacks can be assessed in order to update the national management strategy. These management scenarios will undergo a multi-actor multi-criteria analysis with the aim of shedding light on the associated health, safety, environmental and regional issues (see 9.3.2).
- Andra to submit a file presenting the technical and safety options chosen for a disposal facility on the Vendeuvre-Soulaines site, under study since 2015. The analysis of this file and the project follow-ups are of major importance as regards the management of VLL-LL waste in the coming years (see 9.3.2).

With regard to the low-level long-lived uranium conversion treatment residues stored in the Ecrin facility, the PNGMDR 2022-2026 provides for Orano to continue the ongoing studies to define the safety options of a disposal facility for these residues, in association with the representatives of the regions that are or could be involved.

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 currently applicable safety and radiation protection requirements. 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 legacy waste retrieval and conditioning (WRC) operations can be technically complex, leading to delays and cost overruns. The WRC operations and compliance with the regulatory deadline of 2030 (for defining management routes) represent challenges of different natures for each of the three main licensees (see 1.4.5).

Based on the lessons learned from the prescriptive framing of the WRC projects, ASN has decided to favour the short-term monitoring of the progress of these projects, without losing sight of the long-term objective, and now asks the licensees to commit to intermediate achievement deadlines ("milestones") targeting major steps in project progress and govern its smooth execution and the control of the overall deadlines. These milestones are set for a time-frame of five years at the most.

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. The studies submitted by Orano Mining for the various editions of the PNGMDR have improved the understanding of the environmental and health impact of these former sites, with regard to:

- the dosimetric impact of mining residue repositories on humans and the environment;
- the strategy to be chosen for changes to the treatment of water collected from these sites;
- the assessment of the long-term integrity of the embankments surrounding residue disposal sites;
- the mechanisms governing the mobility of uranium and radium within uranium-bearing mining processing residues.

The inventorying of mining residues was completed in 2021. Two PNGMDR working groups have been set up with increased 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 processing 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 the impact of cover deterioration scenarios, taking account of experience feedback from radioactive waste disposal sites.

Sealed radioactive sources

Disused sealed sources are among the categories of radioactive waste which, because of their properties, require special management routes. At present, the Aube repository (CSA) and the Cires have acceptance specifications allowing the disposal of radioactive waste packages containing certain types of disused sealed sources. Nevertheless, there are still difficulties with the recovery and disposal of certain disused sealed sources, due to either the absence of operational disposal routes or the financial cost of their recovery and disposal by Andra.

On this subject the PNGMDR 2022-2026 provides for:

- a complete review of the situation, indicating for each family of disused sealed sources the associated management routes, the actors concerned and the difficulties encountered, in collaboration with those who possess the sources;
- the incorporation of the disused sealed sources that do not comply with the CSA or Cires acceptance specifications in the inventories of the disposal facilities for low-level long-lived waste or high and intermediate-level long-lived waste;
- revival of the working group dedicated to the management of disused sealed radioactive sources (DSRS), to resume the work started in 2014 and find solutions to the difficulties in recovering and disposing of some of the disused sealed sources mentioned above;
- the defining of the conditions of application of the principle of recovery "as a last resort"[4] of the disused sealed sources.

1.4.4.3. Management of radioactive materials and prospects of recycling

The status of the research, the data acquired, the progress achieved and the studies still to be carried out on the reuse of radioactive materials are described in the PNGMDR. For the valorisable materials, the fifth edition of the PNGMDR adopts the following orientations:

- reinforcement of the checking of the reusable nature of the radioactive materials by having their owners produce valorisation plans which they transmit to the Minister responsible for energy for examination;
- continuation of the study of the material management issues if the materials are requalified as waste.

With regard to spent fuel[5], EDF's management strategy is based on recycling the fuels in the Orano's La Hague facilities.

The spent fuel from EDF reactors is currently stored in spent fuel pools at Orano La Hague pending reprocessing. The PNGMDR 2022-2026 requires EDF to refine the estimates of when the existing storage facilities will be filled to capacity. More generally it requires the various spent fuel producers to develop storage strategies that can cover different changes in the energy policy, taking into account the contingencies that can arise in the fuel cycle, and identify the spent fuels that can be stored dry. It also requires EDF to guarantee the provision of a new centralised spent fuel pool as soon as possible.

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 (MEP) for the period 2019-2028. It is part of a long-term perspective of complete closure of the fuel cycle with the implementation of multi-recycling of spent fuels in the generation IV reactors, fast-neutron reactors (FNR), or even pressurised water reactors – PWR (multi-recycling in PWRs is currently being studied, in accordance with the MEP). Research into generation IV reactors is now incorporated into an R&D programme designed to guarantee that fundamental expertise is maintained, so that it will still be possible to create a demonstrator in the second half of the 21st century. In this context, France has launched a programme of calls for proposals with a budget of about 500

[4] When the disused sealed sources cannot be taken back for diverse reasons (the supplier no longer exists, the conditions of retrieval by the original manufacturer are not specified) or cannot be recycled under the technical and economic conditions of the moment, the regulations stipulate that these sources must be retrieved by Andra. This is qualified as "last resort" retrieval.

[5] According to the French policy, the majority of spent fuels are considered to be recycled substances (particularly the spent fuels unloaded from the nuclear reactors).

million euros. This programme is intended to support new innovative reactor designs by fostering the emergence of young innovative companies.

1.4.5. Decommissioning of nuclear installations

At the end of 2023, 36 nuclear facilities in France were definitively shut down or undergoing decommissioning. These facilities are very varied (nuclear power reactors, research reactors, laboratories, fuel cycle facilities, support facilities, waste treatment facilities, etc.) and the decommissioning challenges differ from one facility to the next. These challenges are however all linked to the large quantity of waste produced during decommissioning, primarily LL/ILW-SL and VLL waste (usually much greater than the volumes produced during operation of the facilities).

The safety and radiation protection risks are all the greater when these facilities contain legacy waste which was not conditioned or packaged during the operation of the facilities; this is the case in particular with Orano's former fuel cycle facilities or CEA's old storage facilities. Retrieval of the legacy waste, also called waste retrieval and conditioning (WRC), is usually a major and complex step in the decommissioning of these facilities. This waste also constitutes a substantial dispersible inventory[6] (HLW, ILW or LLW-LL) in the event of an accident; the robustness of the facilities containing the waste is of major importance for safety.

Generally speaking, ASN and the Minister responsible for energy ensure that in their specific fields of competence the licensees continue to devote the resources needed to dismantle their facilities in the shortest time possible and achieve a final state in which the entire dispersible inventory (dangerous substances, including radioactive substances) has been removed. Pending decommissioning of the facilities, and particularly when this will extend over very long-time scales due to complexity, the licensees must maintain and improve their safety, in the same way as for in-service facilities.

For ASN, the decommissioning operations carried out by the licensees comprise two parts.

The first part concerns the assessment and tracking of the overall decommissioning and waste management strategy adopted by a licensee with numerous facilities to be decommissioned (EDF, CEA, Orano). ASN issued position statements for the strategies of CEA, EDF and Orano in 2019, 2020 and 2022 respectively. The strategies are progressing on the whole, even if some WRC and decommissioning operations are falling behind schedule. This is because the uncertainty of the data concerning some legacy waste, the varied nature of the waste and the complexity of the operations are such that the WRC operations come up against technical difficulties leading to delays and extra costs.

For EDF, the main challenge is the management of the graphite sleeves from the old GCR reactors. They are currently stored mainly in the Saint-Laurent-des-Eaux silos which are scheduled to be decommissioned.

For CEA, the main challenge lies in the number and complexity of the operations to carry out for all the facilities concerned. CEA's priority aim is to reduce the dispersible inventory, which at present is very high in certain facilities, particularly in some defence-related basic nuclear installations of Marcoule and in BNIs 56 and 72. The main challenges are firstly 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 does not meet current requirements, and secondly to run projects to remove legacy waste from storage.

[6] The dispersible inventory corresponds to the quantity of radioactive activity that could be involved in an incident or accident.

The main challenge for Orano concerns the short, medium and long-term management of several large-scale decommissioning projects (UP2-400 plant in La Hague, Eurodif Production plant, etc.). Implementation of decommissioning is closely linked to the radioactive waste management strategy, given the quantity and the non-standard and hard to characterise nature of the waste produced during the prior operations phase and the new waste resulting from the decommissioning operations. Furthermore, Orano must carry out special WRC operations in these old facilities. The second part concerns the assessment of the provisions in terms of security, public health and safety and protection of nature and the environment proposed by the licensee in the various files submitted: decommissioning request for the facility in question (transition from the authorisation decree to a decommissioning decree), periodic safety reviews and modifications of the facility. As at 31 December 2023, ASN was examining 23 decommissioning files for definitively shut down facilities whose decommissioning has not yet been prescribed or whose decommissioning conditions have substantially changed.

To check the progress of the decommissioning or WRC projects which are the most complex and have serious safety implications, ASN is continuing to develop innovative inspection methods, supported by the Ministry responsible for energy for the financial aspects relating to the long-term costs, as part of an exploration approach focusing on project management (CEA and EDF). ASN considers that much can be learned from the first results of this approach and plans to continue it over the longer term. ASN has also set up an "observatory of waste retrieval and conditioning and decommissioning projects" which aims to present in a summary form the next time-frames associated with the main WRC and decommissioning projects and the difficulties encountered in project implementation.

1.4.6. Financing the long-term nuclear costs

Under the control of the State, radioactive materials and waste management is financed by the 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 nuclear costs, which correspond to the decommissioning costs and the costs of managing the spent fuels and radioactive waste. They are required to secure future financing of these costs by immediately creating a portfolio of dedicated assets to cover the related provisions. Implementation of this requirement is checked by the State (see section 7.2.2.2). As at 31 December 2023, all the main licensees had a portfolio of assets with a value exceeding the base provisions to be covered.

The investment rules for assets dedicated to cover the long-term nuclear cost provisions were updated in 2023 so as to set certain limits according to the disbursement schedule and to plan for new rules concerning the concentration risk. These changes make it possible to encourage investments in the real economy while at the same time obliging the licensees to maintain prudent management of their portfolio given the time horizon of their liabilities.

1.4.7. Peer reviews

The licensees, Andra and ASN regularly participate in the peer reviews and IRRS (Integrated Regulatory Review Service) and ARTEMIS (Integrated Regulatory Review Service for radioactive waste and spent fuel management, decommissioning and remediation) missions. In view of the postponement of the IRRS mission initially planned for March 2024, due to the project to reform the governance of the oversight of nuclear safety and radiation protection in France, ASN is looking into the possibility of bringing forward the next ARTEMIS mission, currently planned for 2028, so that it can be carried out back-to-back with the next IRRS.

It can be noted that the ARTEMIS peer review mission conducted in France from 15 to 24 January 2018 had led the mission team to put forwards suggestions, particularly with a view to clarifying the governance and the role of ASN therein. These suggestions were taken into account in the preparation of the fifth edition of the PNGMDR for the 2022-2026 period.

1.4.8. International activities

In order to promote a high level of safety and to reinforce safety and radiation protection culture worldwide, France is closely involved in international work, maintaining its active participation in the working groups of the IAEA, and more specifically its five safety standards committees (NUSSC, RASSC, TRANSCC, WASSC and EPReSC), and of 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 the stakeholders in the measures taken in this field.

In its body of regulations, it also attaches importance to incorporating the WENRA reference levels regarding waste disposal and conditioning activities. France moreover held the presidency of the WENRA club between 2020 and 2023.

France was the "featured country" at the *Waste Management Symposia,* one of the most important international scientific and technical events devoted to radioactive waste management, held in Phoenix (USA) from 26 February to 2 March 2023. All the French actors involved in the management of radioactive waste were there to present the French model of radioactive waste management and share French experience and expertise in this area.

Lastly, the bilateral relations between France and its foreign counterparts are an important component of international cooperation. They allow exchanges on important issues, reciprocal visits and the implementation of cooperative measures.

1.5. Challenges for France identified at the 7th review meeting

Two challenges were identified for France at the seventh review meeting:

- The management of LLW-LL with the preparation of the technical and safety options file: section 1.4.4.2 covers the methods of addressing this challenge. Further information is provided in sections 3.1.2.2, 9.3.2 and 12.2.1.2.
- Continuation of consultation of the public and the stakeholders on the Cigéo project during the examination of the creation authorisation application. Section 1.4.3 covers the methods of addressing this challenge. Further information is provided in sections 3.1.2.1, 9.4.1 and 12.2.1.2.

France is also concerned by some of the issues identified at the seventh review meeting and which are common to all the contracting parties:

- The issue of the skills and personnel numbers in relation to the calendar of spent fuel and radioactive waste management programmes is addressed in section 7.2 which details the way in which the nuclear licensees and Andra guarantee that they have qualified and experienced human resources in sufficient numbers in the area of radioactive waste and spent fuel management.
- With regard to the question of public participation in the spent fuel and radioactive waste management programmes, it should be noted that one of the pillars of the French radioactive materials and waste management policy consists in ensuring democratic dialogue at all levels: local, with the general public, and legislative. Consequently, France has a range of processes designed to involve all the stakeholders in

the spent fuel and radioactive waste management programs (section 3.1.3). Examples include the public debate organised for the preparation of the fifth PNGMDR (section 1.4.2) and the consultations organised for the Cigéo project (section 1.4.3).

- Concerning the question of management of ageing of the packages and facilities associated with the radioactive waste and spent fuel, given the prolonged interim storage periods, this subject is addressed in France essentially during the periodic safety reviews of the nuclear facilities (section 8.2.2). These safety reviews allow the situation of the facilities to be assessed with respect to the applicable rules and the risks they present to be updated, taking into account more specifically their condition, experience acquired during operation, the development of knowledge and the operating experience feedback from similar facilities. Particular attention is paid to the issues of ageing and obsolescence in the periodic safety reviews.
- With regard to the long-term management of disused sealed sources, although precise regulatory provisions do exist (section 11), there are still some difficulties (absence of operational disposal routes for some sealed sources, financial cost of disposal). Implementation of the measures provided for in the PNGMDR to resolve these difficulties (section 1.4.4.2) remains a challenge for the years to come.

1.6. Conclusion

The French programme for managing the radioactive waste and spent fuel has, through the PNGMDR in particular, a clear roadmap for managing all the types of waste, whether a management solution already exists or is under development. For the types of waste that do not yet have management solutions, the PNGMDR constitutes a precise plan of action with milestones and identifying those responsible for its deployment.

These provisions, along with the legislative and regulatory texts governing the management of radioactive waste and spent fuel, reflect the continuing and longstanding commitment of the French Government and Parliament in this respect. They establish a high standard in terms of safety and radiation protection, to ensure protection of people and the environment, in the short, medium, long and very long term. The French radioactive waste and spent fuel management system is also characterised by the existence and application of mechanisms allowing strong involvement of the stakeholders and the public in decision making.

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.

2 SECTION A | INTRODUCTION

2.1. Purpose

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 IAEA. France approved it on 22 February 2000 and filed the corresponding instruments with the IAEA on 27 April 2000. The Joint Convention came into effect on 18 June 2001.

France has been active in international actions to reinforce nuclear safety for many years 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 eighth 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. It covers, among other things, the measures taken to meet the challenges identified for France at the seventh review meeting and the challenges common to all the contracting parties (see section 12.1).

This report also covers the good practices that France has implemented and wishes to make known to the contracting parties:

- the provisions applied for the Cigéo project consultation, notably a new initiative on the part of ASN to consult the stakeholders on the framing of the technical examination (see section 1.4.3).
- the setting up by the HCTISN of a committee to track the consultation and discussion initiatives concerning the Cigéo project, in order to assess their readability, complementarity and coordination with the aim of giving the public a guarantee of its effective participation in the project (see 6.3.4.2).

Lastly, this report addresses areas of performance that France has identified:

- the publication of the fifth PNGMDR at the end of 2022 (see sections 1.4.2 and 3.1.1.1);
- Andra's filing of the creation authorisation application for the Cigéo facility in January 2023 (sections 1.4.3 and 9.4.2);
- the improvement in the prescriptive framing mechanism put in place by ASN for the waste retrieval and conditioning projects, favouring the checking of intermediate work completion dates called "milestones", which target the major steps in project progress and determine its smooth running, and control of the deadlines (section 9.2.4);
- the continuation of the development of the project for a facility to recycle very low-level metal waste (Technocentre), with the holding of a public debate planned in 2024 (section 3.6.1.1);
- the putting in place of an assessment and future-oriented system for the nuclear fuel cycle (section 3.3.3).

As a general rules, this report provides the data available as at 31 December 2023, and in some cases more recent topical events concerning 2024.

2.2. Installations and materials 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 6).

Above certain thresholds of radioactive or fissile substance content, an installation is subject to the "basic nuclear installations" (BNI) system and placed under the control of ASN, the French nuclear safety authority. Basic nuclear installations include more specifically: nuclear reactors; facilities for the preparation, enrichment, fabrication, treatment or storage of nuclear fuels, or for the treatment, storage or disposal of radioactive waste; deep geological repositories for radioactive waste.

Below these thresholds, if an installation is subject to the regulations covering Installations Classified for Environmental Protection (ICPE), it is placed under the control of the Ministry for the Environment.

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

Definitions

Throughout the report, the terms "spent fuel" and "radioactive waste" have the meaning given to them by the Joint Convention.

Other notions are also used in the French 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.
- 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.
- 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.

According to the Public Health Code, nuclear activities are activities comprising a risk of human exposure to ionising radiation emanating either from an artificial source or from a natural source, when the natural radionuclides are processed or have been processed for their radioactive, fissile or fertile properties.

The radioactive materials present in France 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. In France these materials are not considered as waste and they are partly valorised via the existing routes.

2.3. Authors

This report was produced by ASN, the General Directorate for Energy and Climate (DGEC) of the Ministry responsible for energy, the Nuclear Safety and Radiation Protection Delegation (MSNR) of the Ministry responsible for nuclear safety, the Institute for Radiation Protection and Nuclear Safety (IRSN) and the National Radioactive Waste Management Agency (Andra), with contributions from the main nuclear installation licensees, Électricité de France (EDF) and Framatome, Orano, the Alternative Energies and Atomic Energy Commission (CEA), ITER Organisation and the Laue-Langevin Institute (ILL).

2.4. Structure

For this eighth 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 the various actors (regulatory authorities and licensees). Hence, for every chapter in which the regulatory authority is not the only entity to express its views, a two-fold structure has been adopted:

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

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: Legislative and regulatory system (Articles 18 to 20);
- Section F: Other general safety provisions (Articles 21 to 26);
- Section G: Safety of spent fuel management (Articles 4 to 10);
- Section H: Safety of radioactive waste management (Articles 11 to 17);
- Section I: Transboundary movements (Article 27);
- Section J: Disused sealed sources (Article 28);
- Section K: General efforts to improve safety.

The report is supplemented by Appendices.

2.5. Publication

As part of its mission to inform the public and to ensure the transparency of its activities, ASN will make the French national report available in French and English on its website (www.asn.fr).

3 SECTION B | POLICIES AND PRACTICES (ARTICLE 32-1)

1. *In accordance with the provisions of Article 30, each Contracting Party shall submit a national report to each review meeting of Contracting Parties. This report shall address the measures taken to implement each obligation of the Convention. For each Contracting Party, the report shall also address its:*
   i. *spent fuel management policy;*
   ii. *spent fuel management practices;*
   iii. *radioactive waste management policy;*
   iv. *radioactive waste management practices;*
   v. *criteria used to define and categorise radioactive waste.*

3.1. General policy

3.1.1. A policy covering all radioactive substances

The radioactive materials and waste management policy falls mainly within the legal framework established by the Act of 30 December 1991 and the Act of 28 June 2006, along with their implementing texts. All of these Acts are to a large extent codified in the Environment Code.

The Act of 28 June 2006 (the "Waste" Act) covers all radioactive materials and waste and sets guidelines and objectives in the research and development of management solutions for waste that does not have an operational management route, it details the financing conditions for decommissioning and management of the waste, and it reiterates the ban on the disposal of foreign waste in France and the responsibility of the producers of spent fuel and radioactive waste. The Act also establishes tools for dialogue with the public.

3.1.1.1. The National Plan for Radioactive Materials and Waste Management

The PNGMDR plays a key role in the steering of the national management policy implemented by the French Government. It is based on the knowledge of the different types of waste, notably the National Inventory (see 3.1.1.2). The PNGMDR must be established and updated every five years by the Government, published, and transmitted to Parliament who refers it to the Parliamentary Office for the Evaluation of Scientific and Technological Choices (OPECST) (see 6.3.4.1). The National Assessment Board (CNE) (see 6.3.4.2) is tasked with making an annual assessment of the state of progress of research and studies concerning the management of radioactive materials and waste.

Legal framework for establishing the PNGMDR

The guiding principles of the PNGMDR are set by the Environment Code:

- 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 be subject to deep geological disposal.

The PNGMDR inventories the existing radioactive materials and waste management methods and the technical solutions adopted. It identifies the foreseeable need for storage or disposal facilities and specifies the capacity necessary for these installations as well as 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 this implementation.

Preparation of the fifth edition of the PNGMDR for the 2022-2026 period

Since 2016, the Environment Code provides for the French National Public Debates Commission (CNDP) to be informed of all the plans and programmes of national scope with serious socio-economic implications or having significant impacts on the environment and to decide on methods of organising public participation. For the first time ever, the PNGMDR preparation process began with a public debate. The CNDP made the decision to organise the debate.

To accompany the preparation of the PNGMDR, the Ministry responsible for energy wanted to create a new body, the "PNGMDR Guidance Committee", chaired by an independent qualified person.

Before being published and after integrating the lessons learned from the public consultation and the opinions of the Guidance Committee, the draft PNGMDR was the subject of:

- an environmental report established in accordance with the requirements of the Environment Code, providing scientific and critical information in order to better assess the environmental impacts;
- an opinion from the Environmental Authority providing an integrated view of the issues associated with the management of radioactive materials and waste, of which the main recommendations and the responses from the Ministry responsible for energy are presented in the PNGMDR;
- a public consultation on the website of the Ministry responsible for energy, concerning the draft PNGMDR (the public was able to read the environmental assessment and the opinion of the Environmental Authority during this consultation phase).

Following the public debate, the Ministry responsible for energy and ASN jointly announced the broad strategic lines of the fifth edition of the PNGMDR in February 2020.

Priorities of the fifth edition

Four editions of the PNGMDR have been published since the first one came out in 2007. The successive editions have seen a gradual and continuous improvement in the different radioactive material and waste management routes. The aim of the fifth edition of the PNGMDR is to take further and reinforce the ongoing work on radioactive waste management in France, while at the same time giving the French strategy a new dimension of continuous public participation and involvement in the major strategic choices of the future.

To increase stakeholder participation in decision-making, the fifth PNGMDR introduces multi-actor multi-criteria analysis to develop waste management scenarios allowing all the stakeholders to express their views and priorities (environmental, health, economic, ethics, regional, etc.).

With regard to radioactive materials, the fifth PNGMDR intends to reinforce the framework for assessing their valorisation potential by asking the material owners to develop valorisation plans, for which the main milestones may be written into the regulations.

With regard to the spent fuel storage capacities, the fifth PNGMDR reaffirms the need for a centralised spent fuel storage pool, while paving the way for the study or perhaps even the development of dry storage capacities in order to meet the additional needs for further capacity, and underpinning the process of forward planning to meet these needs.

The fifth PNGMDR also opens the path for the recycling of certain very low-level (VLL) metal wastes on a case-by-case basis, while continuing the work to find other management options in order to meet the challenges of the future very large volumes of VLL waste (particularly through the search for additional disposal capacities, centralised or decentralised).

The objective for low-level long-lived (LLW-LL) waste is to define, by the end of the PNGMDR, a management scheme capable of addressing the great diversity of this family of waste.

As far as high-level (HL) and intermediate-level long-lived (ILW-LL) waste is concerned, the fifth PNGMDR applies two management principles: continue with the Cigéo project while at the same time taking advantage of its long deployment time to give new impetus to the search for alternative or complementary management options.

This PNGMDR also fits into a renewed governance system and enhanced pluralism since it aims in particular to involve elected officials and representatives of the regional authorities in addition to the legacy members. It also aims to guarantee closer public involvement in its implementation, with regular exchange opportunities planned throughout the five-year period. There has moreover been a change in PNGMDR ownership, since ASN is no longer a cosignatory to it. This decision was made further to the public debate in order to clarify the role of the different actors: the Government is responsible for defining the radioactive waste management strategy and ASN is responsible for checking that this strategy is implemented in compliance with the regulations (safety and radiation protection). ASN nevertheless remains heavily involved in the tracking of the works provided for in the Plan and continues to express its positions through its opinions on the waste management routes.

3.1.1.2. The National Inventory of radioactive materials and waste

Andra, the national radioactive waste management agency, is tasked with establishing the National Inventory of radioactive materials and waste present on French territory. This inventory aims to provide a full and exhaustive view of the quantities of radioactive materials and wastes already produced in France. Every five years Andra provides forward-looking estimates of the quantities of radioactive materials and waste, applying several scenarios with regard to the future of the nuclear facilities and the long-term energy policy of France. Five guiding principles govern the production of the National Inventory while guaranteeing its reliability, quality and its status as a reference:

- The availability of the information: the data are set out in form that is understandable to a wide audience and a realistic inventory is available to the public authorities for the preparation of the PNGMDR.
- Exhaustiveness: the National Inventory lists the wastes resulting from recent and ongoing production activities, but also from past activities, whether in industry, defence, the medical sector or research. The scope of the inventory is not limited solely to the waste disposal and storage facilities. It concerns all facilities accommodating radioactive waste, even on a temporary basis. It also extends to radioactive materials.
- Neutrality: the National Inventory transcribes the information collected in a factual manner, without any judgement on the nature of the situations, hazardous or not, and the methods of management described.

- Transparency: the National Inventory presents all the radioactive materials and waste, whatever their origin. To ensure compliance with this principle, a steering committee chaired by the Director General of Andra and made up of members external to the Agency coordinates the preparation of the National Inventory.
- Responsibility of the declaring party and verification of the management route by Andra: each waste producer is responsible for its declaration. Andra checks the appropriateness of the waste management rouge proposed by the producer.

Focus on the 2023 edition of the National Inventory

- The forward-looking view of the 2023 edition of the National Inventory, published on 12 December 2023, presents the data resulting from various exercises. It integrates firstly the assessment of the volumes of radioactive materials and waste in the facilities in possession of their creation authorisation at the end of 2021. This exercise is governed by several regulatory texts and takes the National Plan for Radioactive Materials and Waste Management (PNGMDR) into account. It considers scenarios that set out the successive steps of the Multi-year Energy Program 2019-2028 (MEP2) currently in effect.
- In order to cover the impact of all the energy policy orientations on the management of radioactive materials and waste, the 2023 edition of the National Inventory is supplemented firstly by information from the analysis of the impact of the radioactive waste created by the potential deployment of six additional EPR nuclear power reactors, and secondly by a qualitative analysis of the issues associated with the continued operation of the reactors through to 60 years.

All the data are available to the public on a dedicated website (https://inventaire.andra.fr/).

3.1.1.3. Valorisation prospects for materials currently with no identified use

France's ambition is to completely close the fuel cycle with the perspective of valorising the materials currently with no identified use, that is to say the fuels recycled in the water reactors (MOX and Enriched Reprocessed Uranium - ERU). 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, thereby also leading to additional savings in the needs for mined uranium resources.

In accordance with the requirements of the Multi-year Energy Programme (MEP) for 2019-2028 and the Strategic Contract of the French Nuclear Sector 2019-2022, EDF, Orano, Framatome and CEA have organised themselves to establish an R&D programme to study the benefits of Multi-Recycling in PWR (MRREP) of the materials (Pu and U) in terms of competitiveness and material and waste management and its feasibility and performance in reactors (safety and operation) and in the fuel cycle (reprocessing, fabrication, transportation, storage). This programme aims to assess the sustainability of the identified technological solutions before resorting to any generation IV reactors, and the compatibility of these solutions with the objectives of the MEP. It includes experimental burn-up of a test fuel assembly in a reactor, which will aim to demonstrate the recyclable nature of the irradiated MOX fuels with current "reactor" and "cycle" technologies, adapted if need be.

3.1.1.4. Ban on the disposal of radioactive waste from abroad

The Environment Code states that the disposal in France of radioactive waste from the reprocessing of spent fuels and radioactive waste from foreign countries is prohibited.

The law also requires that intergovernmental agreements setting a date limit for return of the ultimate waste or an equivalent quantity to its country of origin be concluded before radioactive waste or spent fuel can be brought into the country for treatment or reprocessing. Each intergovernmental agreement specifies the forecast periods of reception and processing of these substances and, where 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.

3.1.2. A policy based on research and development

3.1.2.1. High-level and intermediate-level long-lived waste

For high level and intermediate level long-lived waste (HLW and ILW-LL), three complementary areas of research are defined in the “Waste” Act of 1991:

- Area 1: separation and transmutation of the long-lived radioactive elements. Since CEA report of 2015 was submitted and the ASTRID demonstrator was abandoned in 2018, this is no longer a priority area and the corresponding R&D work led by CEA has been slowed down. At present it is carried out within a few collaborations in European projects.
- Area 2: waste disposal in deep geological formations. The R&D is continuing over the long term; a major milestone was crossed in 2023 with the filing of the Cigéo creation authorisation application (DAC).
- Area 3: long-term conditioning, packaging and storage. The studies and research are continuing with a view to creating new facilities or modifying existing ones to meet the needs identified in the PNGMDR.

Separation and transmutation of long-lived radioactive elements

Under the 2006 Act on the Management of Radioactive Materials and Waste ("Waste" Act), design studies for a technological demonstrator of Fast-Neutron Reactors (FNR) named ASTRID were initiated in 2010. The research and development work on the disruptive technologies of modular reactors bring new prospects for the long-term management of radioactive materials. In July 2021, under the France 2030 Plan investements, the Government launched a call for proposals for innovation in radioactive waste management. After examining the 49 projects submitted, 40 winning projects were chosen, representing investments of 134.9 million euros, of which 71.7 million euros will be funded by the State.

Waste disposal in deep geological repository

In 2006, based on the research work initiated by the Act of 1991, the assessment of that work and following a public debate, France chose deep geological disposal as the reference solution for the management of HLW and ILW-LL waste. This solution is also recommended by the European Union in recital 23 of Council Directive 2011/70/Euratom of 19 July 2011. This solution is deployed in France through the Cigéo project and led by Andra, which is project owner on behalf of the State. The project was declared to be of public interest and a National Interest Operation was created for it in July 2022. Andra also filed a creation authorisation application (DAC) in January 2023. Planning permission will be required in order to start the construction work.

An essential characteristic of the Cigéo project is its reversibility, provided for by the Environment Code. The creation authorisation will set the minimum period during which reversibility of disposal must be ensured as a precautionary measure. This period cannot be less than 100 years.

Long-term storage

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 have explored the different aspects of the complementarity between storage and reversible disposal. Storage is necessary but cannot be considered a final solution for the management of HLW and ILW-LL waste. In this respect, Andra has established - in collaboration with Orano, CEA and EDF - design recommendations for interim storage facilities as a complement to disposal facilities. The recommendations address provisions that are favourable to the durability and monitoring of the facilities, and design aspects relating to disposal reversibility.

3.1.2.2. Low-level long-lived waste

Low-level long-lived waste (LLW-LL) is waste that cannot be considered as either low-level or intermediate level short-lived waste (LLW or ILW-SL) or as intermediate-level long-lived waste (ILW-LL). This waste comes from the decommissioning of the old gas-cooled reactors (GCR), from non-nuclear power generating industrial activities, from the conversion of uranium (reprocessing residues) and also includes legacy waste conditioned in bitumen.

This LLW-LL waste requires specific management conditions, appropriate for long lifetime of the radionuclides involved, which means it cannot be placed in above-ground disposal facilities. However, the low activity means that this waste does not necessitate deep geological disposal either, unlike the HLW and ILW-LL waste. The Act of 2006 therefore introduced the concept of near-surface disposal as opposed to deep geological disposal (which must remain a solution of last resort compared with above-ground or near-surface disposal).

The heterogeneity of the LLW-LL wastes is reflected in differences in behaviour. Depending of the type of LLW-LL waste, the way the activity evolves over time differs. The defining of a common safety case for all these types of waste is therefore not easy, nor is it necessarily relevant. Determining the appropriate depth is delicate because it is strongly dependent on the characteristics of the waste, its packaging and the chosen geological site (depth and thickness of the medium, stability of its geology over time, its hydrogeology, the proximity of aquifers, erosion hypotheses, development scenarios envisaged, etc.). It must take into account both the presence of aquifers and erosion of the site, which could lead to waste whose radioactivity has not yet sufficiently decayed becoming exposed at the surface. Apart from defining the characteristics of such a storage site, the requirements to consider can also stem from ethical issues (acceptability of the medium- and long-term impacts of the waste).

The PNGMDR 2016-2018 did not allow full progress to be made in defining management solutions for the disposal of this LLW-LL waste, or to freeze the scope of the LLW-LL waste eligible for disposal on the Vendeuvre-Soulaines site (see 9.3.2).

In view of this situation, the fifth edition of the PNGMDR is intended to clarify the possible management scenarios for all the types of LLW-LL waste and subject them to a multi-actor multi-criteria analysis in order achieve a stable overall management strategy. The main question is to define the scope of the waste that could be emplaced in the planned facility on the Vendeuvre-Soulaines site and to identify the additional needs for disposal sites, whose locations shall be sought under regulated conditions.

3.1.2.3. Other types of waste covered by research programmes

The PNGMDR keeps track of the waste for which a management route is not yet defined: waste containing asbestos for which the disposal conditions at Cires have been discussed with the main producer concerned; mercury waste pending the final qualification of a treatment process; activated waste from small producers (from irradiators) pending radiological characterisation of the activated metals; tritiated or gaseous waste from small producers (producers other than major nuclear licensees, such as hospitals, companies, laboratories, universities, etc.).

These types of waste, with their specific problems, represent limited quantities - with the exception of asbestos-contaminated waste which represents a few thousand cubic metres - can now be disposed of at the CSA and Cires if they meet the acceptance criteria and if the authorised disposal capacity for asbestos is not exceeded. Work is 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.

Alongside this, in the framework of the French Investments for the Future programme, Andra supports and participates in some thirty R&D projects on the characterisation, treatment or conditioning of radioactive waste. It has also put out a call for proposals with a budget of €45M on the theme of optimising the management of radioactive decommissioning waste. Andra is also involved in prospective characterisation studies for the disposal of waste from future nuclear power reactor fleets, notably including the generation IV fast-neutron reactors.

Lastly, the aim of the R&D programme "Babylone" launched in March 2022 between CEA, Andra, Orano and EDF concerning the acceptance of bituminised waste in disposal repositories, is to provide coherent answers to the requests of the safety authorities so that the bituminised waste from La Hague and Marcoule can be emplaced, as is, in Cigéo. It comprises two parts focusing on the thermal reactivity and modelling of the thermal behaviour, coordinated by CEA, and one part dedicated to the long-term behaviour in the event of water absorption, coordinated by Andra and in which CEA is also involved.

3.1.3. A management policy based on foundations of transparency and democracy

One of the cornerstones of the radioactive materials and waste management policy is to ensure a democratic dialogue at all levels: at local level, with the general public, and legislative.

This dialogue is ensured continuously at the local level through the setting up of Local Information Committees (CLI) for the treatment and disposal facilities.

For the general public, the PNGMDR is an essential part of transparency (see section 3.1.3); in addition, the fifth edition is the first to have been produced following a public debate conducted under the auspices of the French National Public Debates Commission (CNDP) and a post-public debate consultation conducted by the project owner under the oversight of guarantors from the CNDP. The Cigéo project has moreover been the subject of three public debates (in 2005, 2013 and 2019).

In the legislation, the authorisation for a deep geological disposal repository is regulated by the Environment Code, amended by the Act of 25 July 2016 which introduces the setting up of an industrial pilot phase at the start of operation, serving among other things to consolidate the reversible nature of the facility and its safety case, notably through 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 (CNE2), an opinion from ASN and the opinions of the neighbouring regional authorities. At the end of the industrial pilot phase, based on the analysis of its results, the Government will present a Bill adapting the disposal facility's reversibility conditions and, if applicable, taking account of the recommendations of the Parliamentary Office for the Evaluation of Scientific and Technological Choices. ASN will then be able to issue the complete commissioning authorisation for the facility.

As the draft ASN regulations relative to nuclear installations are considered to have an impact on the environment, they are subject to public participation.

The public participation procedure consists in posting the draft ASN regulation on the ASN website for at least 21 days in order to give people time to make their comments. An indicative list of the scheduled consultations on draft ASN regulations and guides having an impact on the environment is updated every three months and posted on the website. A synthesis of the remarks received, indicating how they were taken into account, and a document setting out the reasons for the regulation are posted on line at the latest on the date of publication of the regulation.

In application of the Environment Code, the creation authorisation and decommissioning applications for a nuclear installation are subject to a public inquiry. The file that undergoes the public inquiry contains the impact analysis and the risk control analysis, among other things. The latter provides a clearly understandable inventory of the risks that the projected installation represents and an analysis of the measures taken to prevent these risks. Since 2017, the public inquiry file can be consulted on line throughout the duration of the inquiry, and is provided in printed format in one or more predetermined places as soon as the public inquiry opens.

The nuclear installation authorisation procedures also provide for consultation of the environmental authority, the regional authorities and their groupings concerned by the project, and the Local Information Committees (CLIs)[7]. Lastly, some facility projects may be the subject of public debate under the auspices of the CNDP if it so decides, which was the case with the development of the fifth PNGMDR and will be the case for the very low-level metal waste recycling facility (1.4.4.1).

3.2. France's spent fuel management policy

3.2.1. Spent fuel reprocessing-recycling policy

With its fleet of 56 nuclear power reactors operated by EDF, France produces about 400 TWhe of nuclear-generated electricity each year, which leads to the production of an average of about 1,150 t of spent fuel per year.

Like other countries, France has opted for a spent fuel reprocessing-recycling strategy. This choice was confirmed by the Waste Act of 2006. This strategy is developed according to the characteristics of these fuels and may lead to reprocessing-recycling or direct disposal, as the case may be (see section 8.7).

[7] The TSN Act provides for the creation of a CLI for each nuclear installation. It defines the duty of the CLIs as a general duty of monitoring, information and consultation regarding nuclear safety, radiation protection and the impact of nuclear activities on people and the environment, with regard to the installations of the site.

3.2.2. Justification of the choice of reprocessing-recycling

The reprocessing-recycling strategy offers a certain number of advantages from the energy and environmental viewpoint.

The recycling of nuclear materials is part of the strategy of security of supply, energy sovereignty and reducing environmental impacts. 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 system. Material recycling today brings a 10% saving in raw materials thanks to the recycling of plutonium, a figure that will rise to 25% as of 2024, in accordance with EDF's strategy for recycling the uranium contained in the spent fuels. This figure could increase to 40% with multi-recycling of the spent fuels in pressurised water reactors. This strategy also helps with the diversification of supplies, which is particularly important for France which has limited uranium resources of its own. Finally, this strategy provides energetic materials usable for the potential deployment of future fast neutron reactors.

The reprocessing of spent fuels also 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 concerning this cost. Conditioning by vitrification of the fission products 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 reduces the long-term radiotoxicity of the ultimate waste.

This strategy is also 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.

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.

3.3. Spent fuel management practices

France has implemented a reprocessing-recycling strategy for decades, thanks to:

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

Given the number or reactors in the fleet currently authorised to use MOX fuel and ERU fuel, France can save up to 25% of natural uranium in its fuel consumption.

The spent fuels waiting to be reprocessed are stored in the pools of the la Hague plant after interim storage in the NPP fuel cooling pools.

Each producer has developed and submitted in 2023 an overall long-term storage strategy for its spent fuels. These strategies are based on design-critical energy policy scenarios. They indicate the types and nature of the fuels (spent MOX fuels according to their composition, fuels from research, spent ERU fuels, etc.) that could be accepted in the various proposed storage areas. They propose deployment time-frames for these storage capacities. These strategies must be consistent with the material valorisation plans. The development principle for these strategies is now written into the Environment Code, which provides for their approval by the Minister responsible for energy.

At the end of 2021, more than 36,000 tHM (aggregate) of fuels had been reprocessed at La Hague, essentially enriched natural uranium (ENU) fuels. The plant has two production lines (UP2-800 and UP3) with an authorised capacity of 1,700 t/year of spent fuels corresponding to electrical power production of about 600 TWh/year. The feasibility of the recycling of the MOX, FNR and ERU fuels was demonstrated through specific industrial campaigns covering about a hundred tonnes of fuels in the La Hague plants, UP2-400, UP2-800 and UP3-A.

3.3.1. 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 or time limit. The strategy adopted by EDF at present is the reprocessing of spent fuels, in line with the Environment Code.

After a cooling period in the nuclear reactor fuel building pools, the spent fuel assemblies are transported to the Orano plant at La Hague. After a few years, the spent fuels are then treated by dissolution to separate the HL waste, which is vitrified, from the materials that can still be valorised. The plutonium is recycled in the form of MOX fuels fabricated in the MELOX plant which has an authorised annual capacity of 195 t of heavy metal (tHM).

The recycling of the reprocessed and re-enriched uranium in the ERU fuels started again in late 2023 with a first ERU reload in the core of the reactor 2 of the Cruas NPP. The utilisation of reprocessed uranium (RepU) in the EDF fleet installations will continue on the other 3 Cruas reactors in the coming years, and in the longer term it will be introduced in the 1,300 MWe reactors.

With the current recycling of plutonium and reprocessed uranium, the natural uranium savings can reach 25%. These reusable materials (plutonium and uranium) come from the reprocessing of spent fuel assemblies based on enriched natural uranium (ENU, while the spent MOX and ERU fuel assemblies are stored under water pending their future valorisation. The French industrial capacities are effectively limited at present to one-time recycling.

The technical and economic feasibility of multi-recycling in PWR reactors, which consists in recycling the reusable materials contained in the spent MOX and ERU assemblies by reprocessing them in addition to the ENU assemblies, is currently being studied. These studies are conducted in accordance with the orientations set by the MEP, through a project involving all the French fuel cycle industry players. 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 "Fuel Cycle impact" file). ASN completed its review of the last version of this file in 2018 (see section 3.3.3).

The PNGMDR sets the requirements that allow annual tracking of the state of EDF's spent fuel storage resources and the planning of future storage needs, estimated on the basis of scenarios that are representative of the possible reprocessing-recycling strategies and the future French nuclear fleet.

At the end of 2023, in application of the PNGMDR, Orano submitted to ASN a safety options dossier for a dry storage concept never before implemented in France and entering into the long-term storage strategy as a solution that could, in the event of contingencies, supplement the technical solutions of the strategy that is based essentially on the concept of storage under water. ASN is currently examining this dossier.

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

The management strategy for CEA's spent fuel is based on reprocessing it in the Orano La Hague plants if the reprocessing proves to be technically compatible with Orano's existing facilities and it makes financial sense.

All the fuels that can be reprocessed directly on Orano's existing facilities have been transferred to La Hague, and the majority have already been reprocessed. The fuels remaining to be reprocessed broadly belong to two categories:

- fuels that cannot be treated by conventional reprocessing technologies (PUREX process), most of which are already stored in the CASCAD facility (BNI 22) in Cadarache, or will be by 2040 (fuels from the facilities still to be emptied of their spent fuels).
- "particular" fuels (on account of their geometry, their dimensions, their physical-chemical characteristics, or their Pu content), which can theoretically be reprocessed but not on the existing facilities of Orano La Hague and for which CEA has opted for a long-term storage strategy while keeping all options open for the future, be it reprocessing-recycling on a successor of the current Orano La Hague plants (reference scenario) or direct disposal of these fuels at Cigéo (fall-back scenario).

3.3.3. Examination of the consistency of the fuel cycle

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 and means of transport (front end and back end of fuel cycle and radioactive waste management). 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, the associated ASN resolutions and the technical requirements and regulations applicable to the transport of radioactive materials.

EDF and Orano must identify and characterise the technical and regulatory constraints of the fuel cycle in order to be able to plan ahead as required to take into account the interconnections between the various steps: processing of the materials to be used, fuel fabrication, introduction into the reactor, transport of materials, reception of new fuel and removal of spent fuel, reception and storage of spent fuels, possible reprocessing of spent fuels and management of the waste.

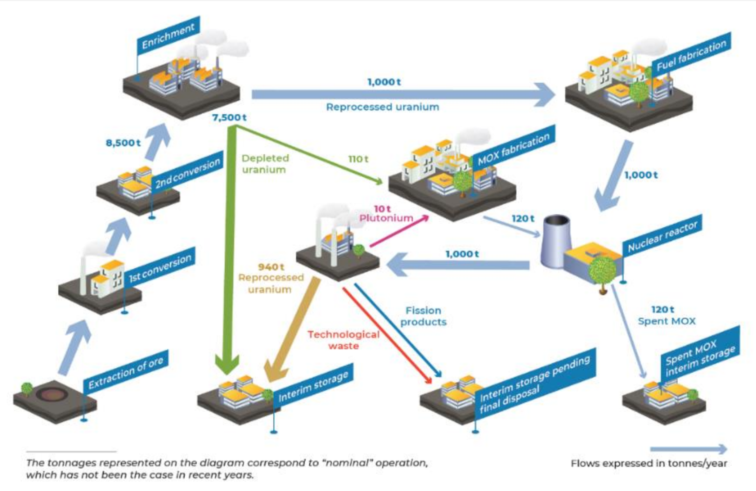
ASN monitors the industrial choices made with regard to fuel management which could have consequences for safety. Beyond the safety issues specific to each facility, the fuel cycle presents systemic challenges, particularly regarding the operating balance of the various facilities, and control of the radioactive substance inventories and the associated storage needs.

On 18 October 2018, ASN issued its opinion on the "Fuel Cycle impact" file drawn up jointly with the "fuel cycle" industry players and which sets out the consequences - for each step of the cycle - of EDF's strategy for using the different types of fuels in its reactors, of the different energy mix scenarios proposed by the MEP, and of operational difficulties in the plants involved in the fuel cycle. In its opinion, ASN underlines 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 is a question for example - given the incompressible development times for industrial projects - of ensuring that the needs for the creation of new spent fuel storage facilities or for new transport packaging designs are addressed sufficiently early.

Focus on the "Fuel Cycle Impact" file

Late 2020, EDF, in collaboration with Framatome, Orano and Andra, updated its fuel cycle management prospects in accordance with energy mix scenarios consistent with the MEP published in April 2020. These prospects have been reviewed in the light of the directions the French energy policy has taken since that date. Prospective simulations are moreover regularly presented to ASN by the licensees concerned, particularly during the joint hearings of Orano and EDF by the ASN Commission.

In view of the quantitative prospects resulting from the range of scenarios considered, and the limited available capacity in the La Hague pools, there is a risk of spent fuel storage facilities being filled to maximum capacity by 2040, assuming continued operation of the 900 MWe reactors beyond 50 years.



Although putting the centralised storage pool project into service is still the reference solution of the overall long-term storage strategy, temporary and reversible solutions must be deployed to counter the project delays: densification of the storage pools at La Hague, greater use of MOX fuel in the reactors, plus dry storage of spent fuels if necessary.

3.4. Criteria applied to define and classify the radioactive waste

The legal definition of radioactive waste is linked to that of radioactive substances and radioactive materials. It takes account of the radioactive nature of the substance in question and its planned use. The definitions of "radioactive substances", "radioactive waste" and "radioactive material" are given in section 2.2.

Naturally Occurring Radioactive Materials

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 family, radionuclides of the thorium 232 family. These radionuclides can become concentrated in the waste by the transformation processes. The exemption value defined in Table 1 of Appendix 13-8 of the Public Health Code is 1 kBq/kg for the uranium and thorium decay chains and 10 kBq/kg for potassium 40.

Radioactive sources

The Public Health Code stipulates that the possession, fabrication, utilisation, distribution, import and export of radioactive sources and products or devices containing them are exempted from licensing, registration or notification to ASN if the weighted activity and the weighted activity concentration of 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 are not subject to the obligation of recovery and disposal by the supplier or by Andra. After use, unsealed sources are considered in France to be radioactive waste and are entrusted to Andra.

Clearance

Almost all the European Union member States, in application of European Directive 96/29/Euratom of 13 May 1996, have put in place unconditional clearance thresholds below which radioactive waste can be regarded as conventional waste. The French regulatory framework defines a different approach: any substance that could be contaminated or activated is regarded as waste (unless it is a reusable material), and must therefore be subject to specific management in facilities authorised for this purpose. This waste is defined using a "zoning" approach (see 9.1.1).

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.

At present, the recycling or valorisation of materials, even with very low levels of radioactivity, takes place in the nuclear sector (nuclear facilities, waste containers, biological shielding in the waste packages, etc.).

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.

Following this public debate, the decision of 21 February 2020 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 case-by-case reuse of very low-level radioactive metal waste after melting and decontamination*. Three texts relative to the implementation of VLL waste recycling operations were voted on 14 February 2022 after having been made available to the public by the Ministry responsible for energy during the consultation following the PNGMDR debate and for the regulatory public consultation on draft texts on the dedicated website of the ministry:

- A State Council decree amends the Public Health and Environment Codes in order to create the regulatory framework for exemptions permitting the reuse of VLL waste resulting from nuclear activities, and detail the conditions for obtaining the exemptions.
- A simple decree enables the types of radioactive substance eligible for an exemption request to be specified. In accordance with the resolution of 21 February 2020, only the metal substances that did not require radiation protection controls before being used in a nuclear activity are eligible for an exemption request.
- A Ministerial Order defines the content of the exemption application file and details the associated guarantees.

A projected facility for recycling metal waste with low contamination or activation levels is currently being designed (see 3.6.1).

Classification of radioactive waste

The usual French classification of radioactive waste, defined by an Order of 9 October 2008, 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 essentially from radionuclide with a half-life of 31 years or less (half-life of ^{137}Cs) and the long-lived waste which contains a large quantity of radionuclides whose half-life exceeds 31 years.

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

- High-level waste (HLW), which comes mainly from the reprocessing of spent fuels and is conditioned by vitrification. This waste represents the large majority of the radioactivity contained in the overall quantity of waste produced in France. The activity level of the vitrified waste is of the order of several billion (Bq) per gram. Owing to its high level of radioactivity, this waste gives off heat.
- Intermediate level, long-lived waste (ILW-LL), which comes mainly from the reprocessing of spent fuels and from the operation and maintenance activities of the spent fuel reprocessing plants. This notably consists of nuclear fuel structural waste from the reprocessed spent nuclear fuel, 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), which is essentially graphite waste and radium-bearing waste. Graphite waste comes primarily from the old gas-cooled reactor (GCR) technology. The activity level of this waste is about ten thousand to one-hundred thousand Bq per gram. The radium-bearing waste, which comes mostly from non-nuclear power generating activities, has activity levels of between a few tens of Bq per gram and a few thousand Bq per gram. This category also includes other types of waste, such as certain legacy bitumen packages and uranium conversion treatment residues from the Orano plant in Malvési.
- Low level and intermediate level, short-lived waste (LLW/ILW-SL), which comes 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 activity level of this waste is between a few hundred Bq per gram and a million Bq per gram;
- Very low level (VLL) waste, which comes mainly from the decommissioning of the NPPs, of the fuel cycle facilities and research centres and, to a lesser extent, from the operation and maintenance of nuclear installations of this type. 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 used:

French acronym	Meaning	English acronym
HA	High level	**HLW**
MA-VL	Intermediate Level Waste, Long-Lived	**ILW-LL**
FA-VL	Low Level Waste, Long-lived	**LLW-LL**
FMA-VC	Low Level and Intermediate Level - Short-lived waste	**LLW-SL and ILW-SL**
TFA	Very low level	**VLLW**

Table 2: 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:

<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>0 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>HUNDREDS 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>MILLIONS Bq/g (*)</td><td>Intermediate -level (IL)</td><td rowspan="2">Deep geological disposal (planned pursuant to the Act of 28 June 2006)</td></tr>
<tr><td>BILLIONS Bq/g (*)</td><td>High-level (HL)</td><td>Not applicable (**)</td><td>Deep geological disposal (planned pursuant to the Act of 28 June 2006)</td></tr>
</table>

* Becquerel per gramme (Bq/g).
** There is no such thing as high-level, very short-lived.

Table 3: Classification of radioactive waste

It can happen that a type of waste falls into one of the categories defined above in terms of radioactivity but cannot be 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, which 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 corresponding disposal facility.

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 characteristics of the acceptable waste packages. The category of a given type of waste is therefore usually determined by the specifications with which it complies.

3.5. Radioactive waste management policy

The radioactive materials and waste management policy comes under the legal framework of the Waste Act of 28 June 2006 (see section 1.1.1).

3.5.1. The role of Andra

Andra, the National Radioactive Waste Management Agency, is an industrial and commercial public establishment responsible for the long-term management of radioactive waste. Its role has been defined by three successive acts:

- The Act of 30 December 1991, which created the Agency as a public establishment, assigned in particular to the research into the deep geological disposal of high-level and intermediate-level long-lived radioactive waste.
- The Act of 28 June 2006 which widened and reinforced the role of the Agency and its areas of activity, and which retains deep geological disposal as the solution for HLW and ILW-LL waste.
- 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 for which Andra is responsible.

Placed under the authority of the Ministries responsible for energy, the environment and research, Andra is independent of the radioactive waste producers. In accordance with 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 essentially comprises the following activities:

- operating the Aube repository (CSA) dedicated to low-level and intermediate-level waste short-lived waste (LLW/ILW-SL), and the Industrial centre for collection, storage and disposal (Cires), dedicated to very low-level (VLL) waste;
- managing the closure of the Manche waste repository (CSM), the first French above-ground disposal facility for low-level and intermediate-level radioactive waste;
- studying and designing disposal solutions for low-level long-lived (LLW-LL) and high-level long-lived (HLW-LL) and intermediate-level long-lived waste (ILW-LL) (Cigéo project);
- looking for and studying solutions to optimise radioactive waste management in order to preserve the radioactive waste disposal facilities, which are a rare resource;
- ensuring 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 each year of the National Inventory of radioactive materials and waste on French soil (last edition published in 2023 - 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.

3.5.2. ASN policy

Through its actions, ASN aims to advance the management of radioactive waste safely within the framework of its various missions (regulation, licensing, inspection, informing, research monitoring). It considers that the methods of preparing the PNGMDR and its recommendations are essential for the implementation of this improvement policy, therefore it is fully engaged in it, particularly though the opinions it issues concerning the risks of the various components of radioactive waste management with respect to safety and radiation protection. One of the priorities is the existence of safe management routes for each category of radioactive materials and waste, whatever their activity level, lifetime or origin.

For ASN, the radioactive materials and waste management 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).

To ensure that the nuclear installation licensees and the waste producers assume their responsibilities regarding the safety of radioactive waste management, ASN establishes rules and draws up guides, monitors the periodic safety reviews conducted by the nuclear installation licensees involved in radioactive waste management, conducts inspections at licensees' installations or head offices, promotes and participates in project progress meetings to identify the difficulties that could be encountered as early as possible and regularly reviews the waste management strategies of the major nuclear licensees. Checks are also carried out on the general organisation put in place by Andra for the design and operation of the disposal centres, as well as for the acceptance of waste from the producers in the corresponding facilities. These actions lead to resolutions, opinions, or follow-up letters, all of which are made public.

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 (No. 25) detailing the ways in which the licensees and industry players concerned and the public and the associations contribute to the preparation of draft ASN regulations or ASN guides concerning the nuclear installations.

With this guide ASN propose more specifically to:

- increase stakeholder involvement from the start 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.

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 research organisations 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.

3.5.3. Naturally occurring radioactive materials

Naturally occurring radioactive materials (NORM) for which no use is planned or envisaged constitute radioactive waste as defined in the Environment Code. There are several management modes for waste containing NORM:

- If the activity of the natural radionuclides exceeds 20 Bq/g, this waste is disposed of in dedicated radioactive waste disposal facilities, more specifically facilities licensed under category 2797 of the ICPEs; there is only one such facility of this type in France: the Industrial centre for collection, storage and disposal (Cires) in Morvillers, 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 (there are 4 facilities of this type in France).

Very low-level NORM which cannot be accepted in the conventional waste disposal facilities can be accepted at Cires.

Low level, long-lived (LLW-LL) waste from technologically enhanced naturally occurring radioactive materials (TENORM) is incorporated into the industrial management systems being studied by Andra. Pending the arrival of such a repository, this waste is stored on certain production sites.

3.5.4. Radioactive waste disposed of in the conventional disposal centres

In the past, waste containing radioactive substances has been disposed of in conventional waste disposal sites. 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 are put into place to prevent radioactive waste from entering these facilities and, where 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.

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, where 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 measures - more or less extensive depending on the site – provide for radiological monitoring of the groundwater.

3.5.5. 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. The regulatory mechanisms are described in section 11.

3.5.6. Unsealed sources

After use, unsealed sources are considered to be radioactive waste and are handed over to Andra. 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 can be managed according to their radioactivity decay.

3.5.7. Radioactive waste from the ICPEs

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 section 3.6).

3.6. Radioactive waste management practices

3.6.1. Radioactive waste from nuclear installations

3.6.1.1. EDF management of waste from nuclear power reactors

The waste resulting from the operation of nuclear reactors 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.
- The 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 conditioned in 2023 intended on the one hand for Cires and on the other for the CSA, either directly or after processing at CENTRACO. These volumes of packages represent the production in 2023; most of the packages have been shipped but some were present on the sites at the end of the year.

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

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

2023 result (56 PWRs considered)	Disposal route	Volume of waste to be disposed of (m^3)	Activity (TBq)
Process waste	Cires	**875**	**0,0074**
Technological waste	Cires	**2 375**	**0,01**
TOTAL		**3 250**	**0,0175**

Table n 4: Volume and activity of EDF NPP waste produced in 2023 and to be disposed of in Cires

To meet the challenges of saving natural resources by applying circular economy principles, reducing CO2 emissions and economising the disposal capacities of Cires, the possibility of valorising certain low-level radioactive metals has been studied in France and resulted in the publication of two Decrees and an Order of 15 February 2022 on the implementation of operations to valorise low-level radioactive substances.

In this context, the "Technocentre" project aims to create an industrial facility for processing very low activity metals originating essentially from the decommissioning of nuclear facilities, with a view to recycling them. The aim is to produce, after melting, ingots whose radiological characteristics place them in the conventional domain and guarantee that whatever their use, they will have no impact on health or the environment. Considering that this project involves significant environmental impacts and presents land-use planning, social and economic issues, the National Public Debates Commission (CNDP) decided, on 14 February 2024, that a public debate should be organised for the Technocentre project led by EDF.

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

2023 result (56 PWRs considered)	Disposal route	Gross volume before packaging (m^3)	Volume of packages to be disposed of in the CSA (m^3)	Activity (TBq)
Process waste	CSA/CTO*	**930**	**3,335**	**233**
Technological waste	CSA/CTO	**9,340**	**4,895**	**11**
TOTAL		**10,270**	**8,230**	**244**

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

Table 5: Volume and activity of EDF NPP waste produced in 2023 and to be disposed of in the CSA

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 followed by definitive disposal after concreting in 450-litre metal drums. Certain non-compactable technological waste is packaged in metal containers of 5 m^3 or 10 m^3. The most highly radioactive waste is packaged on site in concrete containers and disposed of directly in the CSA.
- Or, when incinerable and of low activity, the waste is shipped in plastic drums to the CENTRACO incineration unit, while the low-contamination metal scrap is sent to the melting unit of the same plant in metal containers.

Focus on CENTRACO facility

Centraco facility situated near the Marcoule nuclear site and operated by Cyclife France (EDF group), processes very low-level (VLL) and low-level and intermediate-level short-lived waste (LL/ILW-SL), either by melting in the case of metal waste, or by incineration in the case of combustible or liquid waste (oils, solvents, evaporation concentrates, chemical leaching 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. Such recycling is therefore limited to use within other nuclear facilities.

The metal waste for the melting unit arrives in bulk in containers, crates or as large individual components. The waste goes through several units where it is sorted, characterised and cut up before being transferred to the furnace. The facility handles components that can reach a length of 15 meters and weigh 50 tonnes. They are melted in an induction furnace with a capacity of four tonnes. The molten metal is then cast to produce the end-package called "'ingot". This melting process reduces the waste volume by a factor of 6 to 10. Each year between 700 and 1000 tonnes of metal waste pass through the melting furnace (the authorised capacity is 3,500 tonnes/year). Centraco also accepts foreign waste under intergovernmental agreements or contracts. Waste from CERN, the European Organisation for Nuclear Research, was thus processed in the melting units in 2022.

The solid non-metallic waste (plastics, working clothes, packagings, etc.) and the liquid waste (oils, rinsing effluents, etc.) are incinerated in a furnace. The incineration residues are packaged in 400-litre drums. Incineration reduces the waste volume by a factor of 10 to 20.

Altogether the plant incinerates about 4,000 tonnes of radioactive waste each year (the authorised capacity is 6,000 tonnes/year).

The ultimate residues from the two processes (melting and incineration) constitute radioactive waste which is sent to Cires and the CSA, the two above-ground disposal centres managed by Andra.

Furthermore, certain exceptional maintenance operations in the nuclear power plants can lead to the replacement of extremely voluminous components such as reactor vessel heads or spent fuel storage racks. These particular items of waste are stored on site then sent to either the CSA or Cires for disposal.

Over the past 25 years, considerable progress has been in reducing the quantities of low and intermediate level short-lived waste resulting from operation of the nuclear reactors. The volume of packaged waste (in ultimate disposal at the CSA) has dropped significantly, from about 360 m^3/plant unit in 1985 to 110 m^3/plant unit on average in recent years.

It is important to underline that this reduction in the production of solid waste has not been 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 has been divided by 50. Improvement measures are continuing, notably with regard to:

- "waste zoning" (see 9.1.1);
- limiting the production of waste at source (ion exchange resins, water filters and technological waste, etc.);
- waste sorting, in order to send it to the best possible route.

The results of these actions are highlighted and used in assessing the environmental performance of each of the 18 EDF sites in operation.

3.6.1.2. CEA management of waste from nuclear research facilities

CEA's strategy for decommissioning its facilities and managing its radioactive waste results in the following orientations:

- Reduce the volumes of legacy waste as soon as possible, by taking steps to retrieve and characterise it and by setting up appropriate treatment and packaging solutions, with prioritisation based on the safety issues.
- Limit the volumes of waste produced at source.
- Stop producing waste for which there is 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 this, CEA’s long-term storage facilities), ensuring that the removal rate is equivalent to the production rate: so as to avoid storing waste in large quantities or over long periods on the producer sites or in the waste treatment and packaging facilities.
- 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 small 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 optimum conditions of safety and radiation protection, but also in reasonable technical and economic conditions.

Waste from the treatment of radioactive liquid effluents

Radioactive liquid effluents are treated mainly by filtration, neutralisation, decontamination or concentration, on treatment stations which can discharge them under the discharge licenses of their sites. Some treatment stations can package the residues from these treatments.

The management strategy for CEA’s radioactive aqueous effluents facilities is based essentially on the Marcoule liquid effluent treatment station (STEL) because of its acceptance capacities. The Cadarache STEL contributes to the process to a lesser extent through the reception/storage and evaporation/concentration of the effluents.

Solid radioactive waste

Since the end of 2003, VLL waste from CEA has been shipped to Cires. Since 2003, CEA has sent about 225,000 m^3 (as at 31/12/2023), with annual transfers in the last few years of between 5,000 and 10,000 m^3.

The solid LL/ILW-SL waste is either processed in CEA's facilities before being shipped to the CSA, or it is pre-packaged then transported unprocessed to the CSA where it is either packaged definitively or incinerated in the CENTRACO plant.

The solid waste currently compacted at 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 m^3/year to be disposed of.

CEA's LLW-LL waste as declared in the National Inventory consists of graphite waste, radium-bearing waste and bituminised waste packages stored on the Marcoule site. They will be retrieved once a management solution has been put in place.

For the low and medium activity ILW-LL waste intended for geological disposal, the packaging and storage facility (CEDRA, BNI 164) has 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.

Furthermore, a storage facility for highly irradiating waste baptised DIADEM (BNI 177) will be commissioned before the end of 2030 on the Marcoule site. On the same site, the Multi-purpose Interim Storage facility (EIP) is used to store packages of LLW-LL and ILW-LL bituminised waste from the processing of effluents in the STEL of the site.

Delays are making it necessary to create new storage capacities on the Marcoule and Cadarache sites. These delays are attributed to the updating of the forecast dates of commissioning of the Cigéo repository and the disposal of LLW-LL waste, to the postponement and extension of the time-frames for the removal of certain types of waste to the disposal routes, and to CEAs prioritisations linked to the financial resources it is granted.

The other categories of waste produced by CEA (specific waste) also form the subject of studies or retrieval measures with a view to their treatment or packaging. This primarily concerns:

- Tritiated waste: the storage conditions will be examined according to the management solutions that will be defined under the PNGMDR 2022-2026.
- Waste containing sodium: 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 CSA or Cires operated by Andra.
- Contaminated metal waste and mercury, for which decontamination processes exist. There will be two management solutions: disposal by Andra (after physical-chemical stabilisation in the case of mercury) and recycling of the metal waste eligible for this route once it is in service.

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 packaging in packages appropriate for storage on its sites and, whenever possible, directly acceptable by Andra. It is in this spirit that CEA plays an active role in the discussions concerning Andra’s various projects.

3.6.1.3. Orano management of nuclear fuel cycle facilities waste

The waste produced by the operation of Orano's facilities is essentially VLL and LL/ILW-SL waste, managed on a just-in-time basis and transferred directly to Andra's disposal sites, in order to limit the quantity of waste stored. As at the end of 2022, the volumes of VLL and LL/ILW-SL waste from operation of Orano's facilities and shipped to Andra stood at about 7,948 m^3 and 988 m^3 respectively. The general management policy for all Orano waste aims to reduce waste production at source and to reduce the volume of waste produced[8]. Waste which does not yet have an operational management route is stored.

With regard to the high-level and intermediate-level long-lived waste (HLW and ILW-LL), its long-term management is being studied as part of the deep geological disposal project Cigéo. Virtually all the high-level waste from the beginning of the French nuclear programme is today conditioned as standard vitrified waste packages (CSD-V) in dedicated facilities on the Orano La Hague site (see section 5.4.1). On the other hand, the majority of the intermediate level legacy waste is still to be retrieved and conditioned.

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.

As at the end of 2022, virtually all foreign waste had been returned, and about 1% of the high-level packages and 10% of the intermediate-level packages are still stored in Orano La Hague facilities.

3.6.1.3.1. Process waste

Process Waste (PW) comes from products entering the plant to be processed, such as fission products, shearing and dissolution fines, structural waste (hulls and endpieces, magnesium cladding, graphite sleeves).

Fission products (HL)

The fission product solutions (high-level waste) are conditioned in standard vitrified waste packages (CSD-V).

Structural waste (ILW-LL)

The hulls compaction facility (ACC) at La Hague processes intermediate level, long-lived structural waste (hulls and end-pieces from spent fuels). The compacting leads to the manufacture of standard compacted waste packages (CSD-C).

3.6.1.3.2. Technological waste

Technological Waste (TW) consists mainly of the waste resulting from the operation and maintenance of the units and facilities. The sludge from effluent treatment, solvents and resins are also included in this waste.

Waste from the treatment of radioactive effluents

<u>Orano La Hague site</u>

Most of the activity and volume of the liquid effluents produced by Orano comes from the Orano La Hague facilities.

Orano has commissioned a production facility for packages of intermediate-level cold-crucible vitrified effluents (CSD-B) which enables them to be returned to its customers.

[8] For example, reduction of volume of metal waste on the Malvési site by using presses, use of compacting for the technological waste on the La Hague site, optimisation of filling of waste compartments on all the Orano sites.

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 Tricastin site

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

Orano Malvési site

The Malvési site dedicated to the conversion of natural uranium is engaged in a vast plan to manage its process residues and reduce its environmental footprint for the next 30 years.

A number of major projects are being conducted in parallel, including:

- The project to improve the management of solid residues (installation of a sealed cover over the site's shut down legacy ponds B1-B2 classified as BNI (ECRIN BNI) in order to improve their containment. The corresponding work has been carried out and the cover completed since 2020.
- The projects to improve the management of solid residues (PERLE and CERS projects for the production of sealed storage cells in which the solid residues are stored for dehydration using Geotubes©. This reduces the volumes of solids from the B5/B6 ponds by a factor of 2).
- The construction of an Aqueous Effluents Treatment facility (TEA).
- The development of an industrial and environmental performance project for nitrate treatment intended to treat the on-line flow of liquid effluents and the legacy of effluents stored in the site's evaporation ponds.

Solid technological waste

Orano La Hague site

The solid technological waste is sorted, compacted and then encapsulated or blocked in cement in the AD2 facility before being sent to the CSA.

Orano Melox

Depending on the radioactive waste categories, the current management routes for solid technological waste from Melox are - for the radioactive waste that is "Suitable for Above-Ground Disposal" – CEA Marcoule centre which has facilities approved for compacting and packaging in packages for Andra's above-ground disposal centres in the Aube, and – for the radioactive waste that is "Not Suitable for Above-Ground Disposal" –shipment to the Orano La Hague site for interim storage before processing and packaging prior to definitive disposal.

Orano Tricastin site

The solid waste treatment unit TRIDENT can treat all the solid waste generated by the operation of the site's facilities, primarily stemming from maintenance activities. The TRIDENT unit can process up to 2,500 tonnes of solid radioactive waste per year.

Orano Malvési site

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 the waste 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.

3.6.1.4. ITER management of waste

ITER (BNI 174) is an experimental facility situated at Cadarache which is designed to scientifically and technically demonstrate control of thermonuclear fusion obtained by magnetic confinement of a deuterium-tritium plasma during long-duration experiments (lasting from a few tens to a few thousand seconds with significant power level (up to 700 MW). This project enjoys financial support from China, South Korea, India, Japan, Russia, the European Union and the United States.

ITER-Organization, the nuclear licensee of the ITER facility, is responsible for managing the waste that will be produced by this facility. To meet this obligation, it can use outside contractors.

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 VLL waste, LL/ILW-SL waste, purely tritiated waste and tritiated ILW-LL waste produced during the operations phase and during the final shutdown and decommissioning phase.

Due to the ongoing redefining of the experimental programme, the inventories of the waste that will be generated in the operating and decommissioning phase are currently being updated, as is the definition of the associated management solutions, particularly the means of reducing the tritium contents and temporary on-site and off-site tritium decay storage areas that might be necessary.

3.6.1.5. Management of waste containing radionuclides with a half-life of less than 100 days

The solid and liquid waste containing radionuclides with a half-life of less than 100 days comes from medical activities. This waste can be managed by on-site decay before being disposed of by the conventional routes.

The liquid waste is discharged after verification into the sewerage systems under exactly the same conditions as non-radioactive liquid waste. To ensure its radioactive decay, this liquid waste is routed to a system of tanks, avoiding direct discharge into the sewerage system.

The solid waste is packaged as early as possible in specific bins and placed in a storage room. Detection systems such radiation monitors or radiation monitoring portals must be installed at the exit of healthcare centres that have a nuclear medicine department to check that this waste is not contaminated.

3.6.1.6. Management of waste containing radionuclides with a half-life of more than 100 days

Solid and liquid waste containing radionuclides with a half-life of more than 100 days must be disposed of via radioactive waste management routes. This waste is collected and managed by Andra. The management routes are mainly incineration at Centraco or, in the case of solid waste, disposal at Cires.

The majority of the liquid waste is incinerated at Centraco. In certain cases an authorisation to discharge into the sewerage system may be granted by ASN subject to conditions (see section 6.2.2). In this case, there are set discharge limits.

Solid waste containing tritium from small producers is integrated in an overall management scheme for future tritiated waste to be produced on French territory, of which the large majority of the inventory should come from operation of the ITER facility. Within the framework of the PNGMDR 2022-2026, Andra, in collaboration with CEA and ITER Organisation, is studying the tritiated waste management options and developing a strategy for 2026. As concerns the tritiated waste from small producers, Andra and CEA have set up a route enabling some of this waste to be accepted in facilities that are authorised and adapted to manage such waste, pending consolidation of the future management options and means.

3.6.2. Waste management by Andra

Andra operates three industrial facilities, two of which are attached to the nuclear installations system:

- The Manche repository (CSM), which is in "decommissioning – closure" phase, as Andra is still planning improvement work on the repository cover (see section 5.4.2); the repository, which was operated from 1969 till 1994, contains about 527,000 m^3 of radioactive waste.
- The Aube repository (CSA), which also includes waste conditioning facilities (compacting of drums, injection of boxes (see 5.4.2). It has been in operation since 1992, and contains about 378,000 m^3 of radioactive waste (at end of 2023) out of an authorised volume of 1,000,000 m^3.

Andra also operates an Installation Classified for Environmental Protection (ICPE): 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, described in section 5.4.2, for which an environmental authorisation application for a capacity extension to reach 900,000 m^3 was filed in April 2023 (ACACI project).
- 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 entered service in 2016.
- 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 and hospitals.

A portion of this waste, after passing via the collection building - and possibly via the sorting and treatment building - is transferred to the CENTRACO plant (Cyclife) for incineration then disposal at the CSA of the solid products resulting from incineration.

Cires can accept on a temporary basis certain specific type of radioactive waste for which there are no disposal solutions at present: radioactive lightning conductors, medical objects containing radium used in the 1920s - 1930's (needles, tubes, aiguilles, tubes, radium compresses, etc.), radioactive objects owned by private individuals, and certain long-lived waste (earth, rubble, etc.) from old sites contaminated by radioactivity.

3.7. Decommissioning policy

The decommissioning policy applied in France is based on immediate dismantling and post operational clean out of the cleared sites. These operations are financed by ring-fenced financial provisions.

Immediate dismantling

The principle of decommissioning "in the shortest time frame possible under economically acceptable conditions" figures in the regulations applicable to nuclear installations (Order of 7 February 2012). This principle has been written into legislation by the Act of 17 August 2015 on the energy transition for green growth. This approach aims to avoid placing the technical and financial burden of decommissioning on future generations. It also provides the benefit of retaining the knowledge and skills of the personnel present during operation of the installation, which are vital during the first decommissioning operations. Nevertheless, the principle of immediate dismantling is appraised with respect to the fleet of facilities to be decommissioned by a given licensee and the resources required for this, and not facility by facility.

Post operational clean out and achieving the final state

The decommissioning and post operational clean out (POCO) operations of a nuclear facility must lead to the gradual removal of the radioactive or hazardous substances from the structures and soils, with a view to delicensing the facility. In accordance with the general principles of radiation protection, the dosimetric impact of the site on the workers and public after delicensing must be as low as reasonably possible (ALARA principle).

In this context, ASN has updated the basic principles of its POCO doctrine for structures and soils, in particular:

- The complete POCO scenario must always be considered as the reference scenario. This scenario leads to unconditional release of the buildings and sites and enables the protection of people and the environment to be guaranteed over time with no reservations.
- The licensees must deploy POCO practices that integrate the best available scientific and technical knowledge under economically acceptable conditions.
- In the event of identified technical, economic or financial difficulties, the licensee can submit one or more appropriate POCO scenarios compatible with the site's futures usages to ASN.
- ASN makes sure that the chosen POCO scenario allows clean-out to be taken as far as reasonably possible and that consequently the exposure to ionising radiation is kept at the lowest level reasonably achievabl.

Financing decommissioning

The nuclear licensees are obliged to evaluate the decommissioning costs and to ring-fence funding for these future costs by creating a portfolio of specific assets to cover the related provisions. Compliance with this obligation is checked by the State: for this purpose, ASN verifies that the files submitted by the licensees to prove creation of the provisions are consistent with the envisaged or conceivable decommissioning and waste management scenarios from the nuclear safety and radiation protection aspects, and the Ministry responsible for energy verifies the robustness and adequacy of the provisions.

3.8. Assessment of the reusability of nuclear materials

Radioactive substances for which a future use is planned or envisaged are qualified as radioactive materials and not 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 the 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.

The Environment Code stipulates that, at each update of the PNGMDR, the owners of radioactive materials, with the exception of nuclear materials necessary for defence, shall inform the Ministers responsible for energy and nuclear safety of the valorisation processes they are considering, or, if they have already submitted this information, any changes being considered. After obtaining ASN's opinion, the competent 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 2022-2026 is intended to consolidate the framework for assessing the reusability of radioactive materials by asking the material owners to produce valorisation plans for these materials.

Spent fuels

According to French policy, most spent fuels are considered to be reusable substances. More specifically, the reuse of civil spent fuels is already implemented industrially for ENU (Enriched Natural Uranium) fuels. For MOX and URE fuels, the reprocessing feasibility has been proven. Similarly, except for limited quantities of certain spent fuels from research reactors, the reprocessing of fuels from research and naval nuclear propulsion reactors is envisaged.

Depleted uranium and plutonium

Depleted uranium is a reusable resource. There are different prospects for reusing this strategic resource. The depleted uranium can be:

- re-enriched in order to fabricate UOX[9] fuels;
- used in MOX fuels;
- used as biological shielding for stocks of reprocessed uranium and of thorium;
- used for applications other than nuclear energy production, depending on its properties (shielding materials, catalysts, storing heat, etc.);
- used in future generation IV fast neutron reactors (should France decide to build such reactors). These technologies will make the most of the energy potential of uranium.

The fact that the first three reuse solutions are already effective proves that depleted uranium is a reusable material.

With regard to separated non-irradiated plutonium, its valorisation is based in the short term on its effective utilisation for thirty years or so in the fabrication of MOX fuel assemblies for use as fresh fuel in reactors. Today, MOX fuel is used in 22 of the 900 MWe reactors. In a longer-term perspective, the reuse of separated non-irradiated plutonium hinges on the deployment of fast-neutron reactors which will enable the inventory to be stabilised by the introduction of multi-recycling of this material in a mixed fleet of fast-neutron and thermal-neutron reactors. Multi-recycling in PWRs is also being studied, in accordance with the multi-year energy programming (see 3.1.1.3).

Reprocessed Uranium

The reuse of reprocessed uranium, which was in effect until 2013 on 4 authorised reactors (Cruas NPP) of the current fleet, started again in 2023 on one Cruas reactor. This reuse is going to continue on the current fleet on the other 3 already-authorised Cruas reactors and be extended in the medium term to reactors of the 1,300 MWe plant series once the necessary authorisations have been obtained. In the longer term, the aim is to continue this reuse on a future fleet, as the basic design of the EPR2 reactors provides for the possibility of using ERU and MOX fuel in addition to ENU fuel.

[9] Fuel composed of uranium oxides. It can therefore be ENU fuel or ERU fuel.

Thorium-bearing materials

Orano has a closed inventory of thorium-bearing materials (legacy production from the 1960's) which constitutes the basic material for the ongoing medical sector applications of Orano Med, based on the use of 212Pb. Orano Med has a portfolio of therapies, some of which are giving rise to large-scale industrial developments for the fast-growing oncology market. About half the inventory of Orano's thorium-bearing materials is currently put aside for these applications. The reuse of another part of the inventory is planned in the short term, to meet the growing demands from the industrial sector (direct sale of thorium nitrate).

Solvay 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. The inventory of thorium-bearing materials comes partly from earlier activities which stopped in 1994 (extraction of rare earths from monazite). This is a legacy inventory (1970-2007) comprising different chemical forms, and nothing will be added to it. Solvay valorises this inventory through regular sales for non-nuclear applications on the international market. Solvay also envisages valorising thorium nitrate in the medical sector based on the use of 212Pb, but also through potential developments of the use of 225Ac. It is also conducting studies on thorium fluoride and thorium oxides, which are promising thorium compounds for advanced nuclear technologies.

In the medium term, Solvay and Orano are working in partnership for the production (purification, packaging and transport) of ThCl4 salt which can be reused in future molten-salt reactors.

4 SECTION C | SCOPE OF APPLICATION (ARTICLE 3)

i) This Convention shall apply to the safety of spent fuel management when the spent fuel results from the operation of civilian nuclear reactors. Spent fuel held at reprocessing facilities as part of a reprocessing activity is not covered in the scope of this Convention unless the Contracting Party declares reprocessing to be part of spent fuel management.

ii) This Convention shall also apply to the safety of radioactive waste management when the radioactive waste results from civilian applications. However, this Convention shall not apply to waste that contains only naturally occurring radioactive materials and that does not originate from the nuclear fuel cycle, unless it constitutes a disused sealed source or it is declared as radioactive waste for the purposes of this Convention by the Contracting Party.

iii) This Convention shall not apply to the safety of management of spent fuel or radioactive waste within military or defence programmes, unless declared as spent fuel or radioactive waste for the purposes of this Convention by the Contracting Party. However, this Convention shall apply to the safety of management of spent fuel and radioactive waste from military or defence programmes if and when such materials are transferred permanently to and managed within exclusively civilian programmes.

iv) This Convention shall also apply to discharges as provided for in Articles 4, 7, 11, 14, 24 and 26.

4.1. Spent fuel reprocessing

France considers that the reprocessing of spent fuels is an important part of their management. It helps to reduce the quantity of high and intermediate-level waste to be disposed of in repositories and it enables their energy potential to be valorised.

4.2. Radioactive waste

All the radioactive waste resulting from civil applications is covered by this report. It includes the waste from the nuclear fuel cycle as well as that from other activities exercised in particular in the medical, industrial and research fields. In France, waste that contains only natural radioactive substances and does not come from the nuclear fuel cycle can, its characteristics permitting, be managed as radioactive waste (see section 3.5.3).

4.3. Other spent fuel and radioactive waste processed

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.

4.4. Effluent discharges

Effluent discharges are covered in section 6.2.2 of this report.

5 SECTION D | INVENTORIES AND LISTS (ARTICLE 32-2)

The report comprises:

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 spent fuel that is subject to this Convention and that is being held in storage and of that which has been disposed of. This inventory shall contain a description of the material and, if available, give information on its mass and its total activity;

iii) a list of the radioactive waste management facilities subject to this Convention, their location, main purpose and essential features;

iv) an inventory of the radioactive waste that is subject to this Convention that:

a) is being held in storage at radioactive waste management and nuclear fuel cycle facilities;

b) has been disposed of; or

c) has resulted from past practices.

This inventory shall contain a description of the material and other appropriate information available, such as volume or mass, activity and specific radionuclides; a list of nuclear facilities in the process of being decommissioned and the status of the decommissioning activities at those 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.

5.1. Spent fuel management and storage facilities

5.1.1. Facilities producing spent fuel

The majority of the spent fuels currently produced in France come from the 56 pressurised water reactors (PWR) in operation, with electrical power ratings between 900 MWe and 1450 MWe (megawatts electric), commissioned between 1977 and 1999 and distributed over the 18 sites of the EDF NPPs.

The spent 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 (ERU). After 4 to 5 years of use in the reactor core, the spent nuclear fuel is replaced by fresh fuel. There are two ways of managing spent fuel:

- recycling of the reusable materials resulting from the reprocessing of the spent ENU fuel after it has been stored to cool down for a few years in the reactor pools and then in the La Hague plant pool;
- storage for subsequent recycling, depending on the spent fuel management strategy.

The other spent fuels come from the 9 research reactors, 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 CEA Cadarache, Marcoule and Saclay centres, while the ninth is in the Laue-Langevin Institute (ILL) near CEA Grenoble centre.

In all these facilities, the spent fuel is handled and stored provisionally, which makes them spent fuel management facilities, within the meaning of Article 2 of the Convention. The inventory of these facilities is given in Appendix 13.1.

The spent fuel storage capacities are indicated in the National Inventory (see 3.1.1.2).

5.1.2. Spent fuel storage or reprocessing facilities

Storage facilities in EDF NPPs

The spent fuel management facilities in EDF's in-service PWR fleet are under-water storage pools in the fuel building (BK) called "BK pools". Each PWR reactor has an adjacent BK pool in which the spent fuel rods definitively unloaded from a reactor are stored temporarily while their thermal power decays to a level where they can be transferred to the Orano Cycle storage pools in La Hague.

EDF moreover has a fuel storage facility called APEC used to store the fuel from the Superphénix fast-neutron reactor (a sodium-cooled industrial prototype with a thermal power of 3000 MW which was definitively shut down in 1997). Created in 1985, it consists essentially of a storage pool located on EDF Creys-Malville commissioned on 25 July 2000. The irradiated Superphénix fuel assemblies were removed from the reactor between 1999 and 2002, washed and since then have been stored in the APEC pool.

Orano facilities

Spent fuel storage areas

The spent fuel waiting to be reprocessed 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 they are reprocessed. 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 6: Authorised storage capacities of the Orano la Hague pools

The total storage capacity available for EDF is about 11,000 tonnes.

Reprocessing facilities

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

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 and packaging of the ultimate waste.

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

Orano's German, Belgian, Japanese, Dutch, Swiss and French (EDF) customers have used or currently use recycling of the uranium obtained from the reprocessing of spent fuels. The use of ERU (Enriched Reprocessed Uranium) fuel in the Cruas reactors was stopped in 2013 and restarted by EDF in 2023.

The other storage facilities

The spent fuel from CEA's civil programmes is stored primarily in the CASCAD facility in Cadarache. This facility, located in BNI 22, is dedicated to the dry storage of irradiated fuels in pits cooled by natural convection, pending processing in the ORANO La Hague units.

Spent fuel from CEA is also stored in the Pégase pool of BNI 22 and in BNIs 71 (Phénix) and 72 (ZGDS) respectively on the Marcoule and Saclay sites. The fuel is currently being transferred to CASCAD.

5.2. Inventory of stored spent fuel

Most of the spent fuel stored in France is essentially uranium oxide or MOX-based fuels coming from the PWRs or BWRs (boiling water reactors), as well as from research reactors. It is stored in the various facilities mentioned in the previous sections, summarised in Appendix 13.2.

Places	Mass of French spent fuel stored in tonnes of heavy metal (tHM)
La Hague	**10,376.7**
EDF NPP sites	**4,600**
CEA centres	**55**

Table 7: Mass of french spent fuel stored in France as at 31 December 2022

Origine	France	Italie	Pays-Bas	Belgique	Australie
Masse (t)	10 334,5	25,9	15,7	0,04	0,6

Table 8: Origin of spent fuel stored on the La Hague site as at 31 December 2022

In collaboration with Orano, EDF regularly conducts the studies necessary to guarantee the long-term adequacy of the storage capacities for the spent fuel generated by its reactor fleet. Each year for this purpose:

- the situation of the existing storage facilities is established (BK pools, La Hague pools);
- the future needs for storage capacities in addition to the existing capacities are assessed on the basis of contrasting scenarios taking into account experience feedback, production forecasts for the fuel cycle plants and the regulatory requirements.

The results of these studies make it possible to meet the requirements of the PNGMDR, of which one of the main objectives is precisely to lastingly ensure good management of these substances applying the most appropriate means, notably in terms of safety, radiation protection and respect for the environment.

In view of the quantitative prospects resulting from the range of scenarios considered, and the limited available capacity in the La Hague pools, there is a risk of spent fuel storage facilities being filled to maximum capacity by 2040. In view of this situation, EDF has defined, in collaboration with Orano, a strategy for responding over the short, medium and long term, to the spent fuel storage needs based on updated scenarios in terms of experience feedback and plant operating prospects, taking into account risks of contingencies and the possibilities in terms of future reprocessing-recycling strategies and the future nuclear fleet.

This strategy is based on the following technical solutions:

- development of levers (adjustable, reversible and transient) that meet the short and medium-term storage needs; gradual densification of Orano La Hague's existing storage pools (C, D, E), whose sufficiency shall be verified regularly according to the periodic updating of the needs, extension of the variability of "MOX Parity" fuel management on the 900 MWe plant series to reloading with 16 MOX fuel assemblies instead of 12 (the "+4 MOX" lever), dry storage of ERU / MOX spent fuel assemblies in addition to densification if necessary;
- development of a new centralised storage pool taking over from the abovementioned levers on a long-term basis.

5.3. Origin of the radioactive waste

The radioactive waste comes firstly from the operation of the facilities that use radioactive substances, and secondly from the decommissioning of these facilities.

Nuclear facilities in operation

The nuclear facilities in operation produce radioactive waste. The waste is handled and stored temporarily in these facilities, which makes them radioactive waste management facilities within the meaning of Article 2 of the Convention. The radioactive waste management facilities, excluding facilities undergoing decommissioning, are listed in Appendix 13.3.

Facilities undergoing decommissioning

Radioactive waste is also produced in the BNIs being decommissioned (reactors, laboratories and plants), which figure in the list in Appendix 13.4 (some of these facilities are delicensed and no longer produce radioactive waste). Some of these facilities also contain legacy waste which was neither processed nor conditioned during the operation of these facilities. The retrieval of the legacy waste, also called waste retrieval and conditioning (WRC), is usually a major and complex step in the decommissioning of these facilities. This waste also represents a significant dispersible inventory (HLW, ILW, or LLW-LL).

Installations Classified for Environmental Protection (ICPE)

In France, there are about 800 ICPEs 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.

Waste from nuclear activities intended for medicine, human biology or biomedical research

The nuclear activities intended for medicine, human biology or biomedical research produce small quantities of radioactive waste compared with those from the nuclear power generating industry. However, the waste produced varies and some of it, 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 facilities using radionuclides for analysis or healthcare 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*.

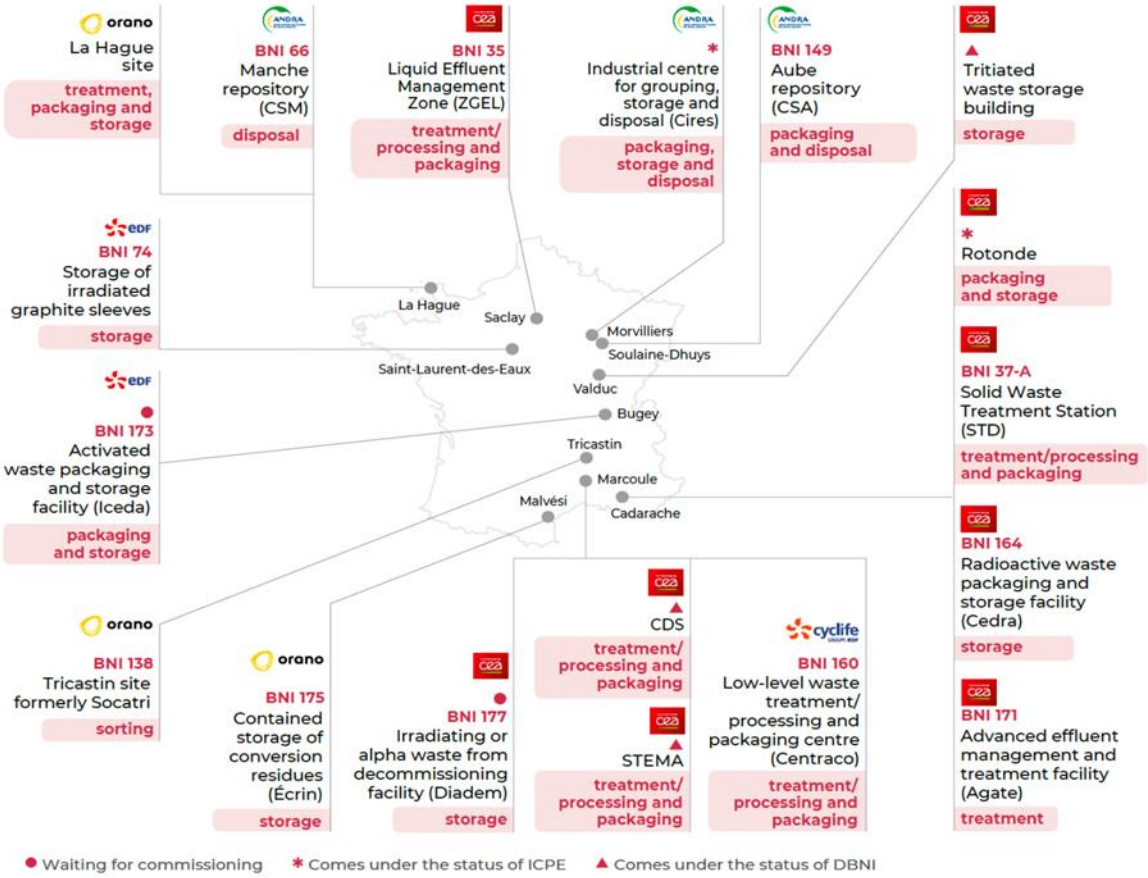
These facilities can use unsealed sources, in other words radionuclides (mainly very short lived) contained in liquid solutions. They also use sealed sources for radiotherapy, brachytherapy and equipment calibration.

In the field of medical and biological research, the radionuclides most frequently used are either 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).

The waste produced by universities is similar to that produced by biological and medical research.

5.4. Radioactive waste management facilities

Until a final management solution is found, the radioactive waste is stored in dedicated facilities on various industrial sites. These sites are managed mainly by the waste producers. This waste is intended to be disposed of by Andra in specific existing or projected facilities.



For the waste intended for the existing disposal centres, these sites are:

- interim storage areas for waste conditioned in packages of a logistic nature for managing the transfers to Andra's facilities;
- storage areas for waste, legacy waste in particular, waiting to be processed and packaged prior to transfer to Andra's facilities;

For the waste intended for projected disposal centres, these sites are:

- storages areas for waste, legacy waste in particular, pending retrieval prior to transfer to other storage areas;
- storage areas until disposal routes become available;

- storage facilities for high-level (HL) waste, which must be allowed to decay for several decades in order to be acceptable in a deep geological disposal repository.

Apart from the facilities which perform the first steps in radioactive waste management, the treatment and/or storage facilities and the disposal facilities are given in Appendix 13.3 and indicated on the following map. These facilities are basic nuclear installations (BNI) or defence basic nuclear installations (DBNI), with the exception of Cires - the facility for disposal of very low activity waste, and certain interim storage facilities (e.g., "Rotonde"), which are ICPEs.

5.4.1. Storage facilities

Orano's storage facilities

Storage of HL vitrified waste packages on the La Hague site

As at 31 December 2022, some 20,000 packages of vitrified HL waste were present in the La Hague site facilities. The 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, E/EV-LH and E/EV-LH2; planned extension E/EV-LH3). The storage capacities are as follows:

- UP2-800: R7 storage unit: 4,500 vitrified waste packages.
- UP3-A: T7 storage unit: 3,600 vitrified waste packages.
- UP3-A: Storage units E/EV-SE: 4,428 vitrified waste packages; E/EV-LH: 8,424 vitrified waste packages; E/EV-LH2: 8,424 vitrified waste packages, and extension project E/EV-LH3: 8,424 vitrified waste packages. The extensions taken as a whole will represent a vitrified fission products storage capacity corresponding to about 40,000 packages.

Storage of intermediate-level long-lived (ILW-LL) waste on the La Hague site

This waste, currently stored in pools and silos, is covered by waste retrieval and conditioning (WRC) programmes. The conditioning methods adopted are primarily compacting, drying, bituminisation and cementation. These modes of conditioning do not all have the same technological readiness level (TRL) and are still the subject of research and development programmes.

Standard compacted waste containers “CSD-C”

The maximum capacity of the “Hulls and end-pieces storage unit” is 23,432 places, sufficient to store the packages to be produced over the next six years, based on the plant programmes. An extension with a capacity of 5,928 places is scheduled for commissioning by 2024.

In 2023 Orano filed an application for a second extension allowing the storage of about 25,000 additional packages.

Bituminised waste packages

The production of bitumen drums at La Hague is very limited at present following implementation of the “New Effluents Management” process ("NGE" in French) which concentates and vitrifies the radioactive effluents. The existing capacities allow the storage of all the bitumen drums already produced and to be produced (12,074 drums stored as at end 2022 for a total capacity of 20,000 drums).

Cemented waste packages

The production of "Cement Asbestos Containers" (CAC) stopped in 1994. They represent a total of 753 packages, of which only 306 are intermediate-level long-lived waste packages. 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 CACs. CBFC'2 production will slow down significantly as the incorporation of the technological waste into the compacting unit commissioned in 2002 increases). In November 2018 EDF submitted an application file for approval of the packaging of ILW-LL waste in a package model baptised "C1PGSP" using a cement slurry. EDF received authorisation to package its waste in C1PGSP packages in July 2021. In October 2021, the first C1PGSP package was produced in the ICEDA facility and stored there. Several tens of C1PGSP packages have been produced since then.

Sludge from STE2

Effluent Treatment Station No. 2 (STE2) of the UP2-400 plant on the Orano Recyclage site in La Hague treated the low and intermediate-level waste produced by the UP2-400 plant facilities from 1966 to 1997. The decontamination of these effluents was based on a process of coprecipitation of dissolved radioactive species by adding chemical reagents.While the surnatents were discharged into the sea after decontamination checks, the 9,700 m^3 of radioactive sludge resulting from this chemical treatment (estimated dry extract mass of 3,400 tonnes) were stored in seven silos pending definitive conditioning. In 2023, Orano submitted to ASN a safety options dossier for a project to retrieve and process sludge in new silos planned to be commissioned by 2037. These new silos are compatible with the concomitant continuation of the studies of the various solutions envisaged for the final conditioning of the sludge.

EDF storage facilities

EDF stores the graphite waste (LLW-LL) from the old gas-cooled reactors (GCRs), mainly in the silos on the old Saint-Laurent-des-Eaux A power plant site. EDF plans to build a new storage facility for the graphite waste from these silos when they are emptied.

EDF also produces and stores ILW-LL on the sites of its in-service NPPs. This waste comes essentially from the fuel clusters removed from operation. Production of ILW-LL waste from the decommissioning of certain shut-down NPPs has now started. EDF conditions and stores this ILW-LL waste in the ICEDA facility, which received commissioning authorisation in July 2020 and started operating in 2021.

CEA storage facilities

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

The CEDRA storage facility in Cadarache was commissioned in 2006, taking over from BNI 56 which comprises 3 pools, 6 pits, 5 trenches and hangars. At present, CEA is conducting WRC operations in BNI 56 and transferring stored packages from BNI 56 to the CEDRA facility.

On the Saclay site, BNI 72 also stores legacy waste. It is currently being decommissioned.

On the Marcoule site, the HLW vitrified waste packages are stored in the glass disposal facility (SVM) of the AVM (Marcoule vitrification unit). The DIADEM storage facility (BNI 177), currently under construction, will accept waste emitting beta and gamma radiation or rich in alpha emitters. It will be complementary to the CEDRA facility. Its commissioning is planned for before the end of 2030.

Storage of radioactive substances of natural origin

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

Storage facilities on CEA sites for waste not produced by CEA

For historical reasons and because of their skills, CEA centres – mainly Saclay and Cadarache – accept for storage various types of waste which they themselves did not produce. The waste in question is mainly radium-bearing waste and disused sealed sources (see section 11).

Andra storage facilities

In 2012, Andra commissioned a storage facility in its industrial centre for collection, storage and disposal (Cires) dedicated mainly to low-level long-lived waste, in particular that from the Agency's public service duties (see section 3.6.2).

5.4.2. Radioactive waste disposal facilities

The Manche respository (CSM)

The Manche repository (CSM) managed by Andra was commissioned in 1969. It is situated in the immediate vicinity of the La Hague spent fuel reprocessing plan (Orano). About 527,000 m^3 of waste packages were emplaced there, until it ceased operations in July 1994. Today it is in the preparatory phase for closure and transition to the monitoring and surveillance phase.

In order for the CSM to be able to close definitively and enter the monitoring and surveillance phase, Andra must rework the existing cover to ensure its long-term durability.

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 Aube repository (CSA)

The Aube repository (CSA) operated by Andra is located at Soulaines-Dhuys, in the Aube *département* in eastern France and was commissioned in January 1992. Maximum activity levels for each radionuclide are set by the creation decree. 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, of which 30 are for disposal.

This centre also carries out waste conditioning operations: this involves either injecting cement mortar into 5 or 10 m^3 metal containers, or compacting 200-litre drums, which are then placed in 450-litre drums and blocked with mortar.

As at the end of 2023, the volume in disposal was approximately 378,600 m^3; 159 structures were closed out of a planned total of about 400. In view of the pace of deliveries, about 15,000 m^3 per year, whereas the centre was designed for an annual intake of 30,000 m^3, the facility could be filled to capacity by around 2062 (instead of 2042 as initially forecast). The figures of the National Inventory show that the CSA should be capable of absorbing the low- and intermediate-level short-lived waste resulting from the operation and decommissioning of the currently licensed nuclear facilities.

As regards the impact of the centre in terms of radiation protection, Andra has taken a maximum value of 0.25 mSv/year (compared with 1 mSv provided for by the Public Health Code), both in operation and after closure of the repository, in normal situations.

Radiological capacities were defined for a number of radionuclides in the creation authorisation decree of 4 September 1989 amended.

Radionuclides	Tritium	Cobalt 60	Strontium 90	Caesium 137	Nickel 63	Alpha emitters after 300 years
Maximum radiological capacity (TBq)	4,000	400,000	40,000	200,000	40,000	750

Table 9: Radiological capacity defined for a number of radionuclides

Other limits were set by the centre's technical specifications.

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.

The VLL waste repository (Cires)

Commissioned in 2003, the Cires VLL waste repository has an authorised capacity of 650,000 m^3. Given the total radiological activity for which it is authorised, the repository is not subject to the regulations applicable to BNIs, but to those applicable to ICPEs. It is located a few kilometres from the CSA, on the municipality of Morvilliers (Aube *département*) and occupies a surface area of 45 hectares.

As at the end of 2023, about 469,000 m^3 of waste were emplaced in it, that is to say 72% of its total capacity. It is estimated that Cires will be filled to capacity by 2029-2030 if there is no change in the authorised capacities. In April 2023, Andra filed an application to increase the authorised capacity of Cires to over 900,000 m^3 (ACACI project), in the same surface area (compared with 650,000 m^3 authorised at present), by optimising the use of the disposal space. A public inquiry involving the citizens and local authorities began in March 2024.

The design of Cires 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 leak tightness 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.

As for the CSA, the hazards related to the toxic chemicals were taken into account.

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. 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 to all the steam generators of the reactor fleet in service. Nevertheless, the non-standard dimensions included in the waste inventory led Andra to design a specific disposal cell for this type of package, which entered into operation in December 2017. This cell is 300 m long and 22 m wide and can accommodate massive or voluminous waste coming in particular from the decommissioning of the French nuclear installations.

5.5. Inventory of radioactive waste

5.5.1. Annual production

An assessment of the total quantity of waste produced (radioactive waste already emplaced in the Andra repositories or destined for them) is updated and presented each year through the National Inventory of radioactive materials and waste (see 3.1.1.2). The inventoried waste volumes correspond to the conditioned and packaged waste, that is to say for which no further treatment is envisaged by their producers prior to disposal. The waste conditioned in this way constitutes primary packages.

For the purpose of making assessments, a uniform accounting unit has been adopted: the "equivalent packaged volume". For the waste which has not be conditioned and packaged to date, assumptions are made to assess the equivalent packaged volume.

The change in quantities from one year to the next corresponds to the production of waste, but can also include changes of category as knowledge concerning certain types of waste improves.

OVERVIEW AND DIFFERENCE IN VOLUMES (IN m³) FOR WASTE ALREADY DISPOSED OF OR DUE TO BE MANAGED BY ANDRA

Category	Inventory at the end of 2022	2022/2021 trend
HLW	4,420	+100
ILW-LL	39,600	+100
LLW-LL	104,000	+1,000
LILW-SL	989,000	+7,000
VLLW	654,000	+21,000
DSF	344	+40
Total	~ 1,790,000	+30,000

The published inventory consists of rounded values. The differences were calculated on the basis of the rounded inventory values.

The differences between the quantity of waste at the end of 2021 and that at the end of 2022 can be accounted for by ongoing waste generation for all categories.

Table 10: Volumes of waste in disposal or due to be managed by Andra

Legend: DSF: Waste with no disposal solution

5.5.2. Waste present in the storage facilities

The overview of this waste at the end of 2022 is as follows:

OVERVIEW OF THE VOLUMES (m^3) OF WASTE AT PRODUCER/HOLDER SITES DISPOSED OF AT ANDRA FACILITIES AT THE END OF 2022

Category	Total	At producer/ holder sites	Disposed of at Andra facilities	Capacity of existing disposal sites
HLW	4,420	4,420	-(1)	-
ILW-LL	39,600	39,600	-(1)	-
LLW-LL	104,000	104,000	-(1)	-
LILW-SL	989,000	90,000	899,000	1,530,000
VLLW	654,000	203,000	451,000	650,000
DSF	344	344	-(1)	-
Total	~ 1,790,000 m^3	~ 441,000	~ 1,350,000	2,180,000
		25%	75%	

LILW-SL and VLLW waste is stored at the production site for retrieval, conditioning or removal to Andra disposal facilities.

Table 11: Volumes (m^3) of waste at producer/holder sites disposed of at Andra facilities at the end of 2022

Tritiated waste

At the end of 2021, the volume of tritiated waste was about 6,855 m^3. A significant increase in the inventory of tritiated waste produced in France is expected, owing to 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 m^3 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.

5.5.3. Waste in disposal centres

There is a definitive disposal solution for nearly 90% of the total volume of radioactive waste. The total volume of very low-level (VLLW), low-level (LLW) or intermediate-level (ILW) radioactive waste in disposal centres at the end of 2023 amounts to about 1,374,600 m^3 and can be broken down as follows.

	Volume (m^3)
Manche repository (CSM)	**~ 527 000**
Aube repository (CSA)	**~378 600**
Cires repository	**~469 000**

Table 12: Volumes of VLLW and LL/ILW waste in disposal centres at the end of 2023

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.

5.6. Inventory of disused sealed sources

At the end of 2023, the sources accepted into Andra's care, in either disposal or storage, are almost exclusively fire detector sources (3 million units, i.e. 99.5%) The other sources arse surge suppressors (15,000 i.e. 0.5%) and about 1,000 miscellaneous sealed sources (industrial, calibration, education, etc.). These sources can come under all the waste management categories (VLL, LL/ILW-SL, LLW-LL, ILW-LL).

It should be noted that other players (National Defence, industrial and medical sectors) also possess disused sealed sources. This is why a consolidated inventory of the sealed sources present on French territory is required under Article 43 of the PNGMDR Order of 9 December 2022. An update of the inventory of disused sealed sources considered as waste is therefore due in the future.

5.7. Nuclear installations undergoing decommissioning

At the end of 2023, 36 nuclear facilities in France were definitively shut down or undergoing decommissioning (see Appendix 13.4). These facilities are very varied (nuclear power reactors, research reactors, laboratories, fuel cycle facilities, support facilities, waste treatment facilities, etc.) and the decommissioning risks differ from one facility to the next. These risks are nevertheless all linked to the large quantity of waste produced during decommissioning (usually much greater than the volumes produced during operation) and the need to work very close to contaminated or activated zones. The risks for safety and radiation protection are all the higher if the facilities contain legacy waste, as is the case with Orano's former fuel cycle plants or CEA's old storage facilities.

The term decommissioning covers all the technical and administrative activities carried out after the final shutdown of a nuclear facility, after which the facility can be delicensed, that is to say it can be removed from the list of basic nuclear installations. These activities include removal of the radioactive materials and waste still present in the facility and disassembly of the equipment and components used during operation, clean-out of the premises, remediation of the soils, and possibly the demolition of civil engineering structures.

The decommissioning of pressurised water reactors (PWR) draws on experience acquired from numerous projects across the world and the reactor design enables decommissioning to be envisaged in relatively short time-frames (about fifteen years).The first PWR decommissioning work site in France is the Chooz A reactor, in the Ardennes *département*. This is a small-sized reactor compared with the nuclear power reactors currently in service. Decommissioning of the Chooz A reactor pressure vessel began in 2014 and is continuing satisfactorily. The 2 Fessenheim reactors were definitively shut down in 2020, and EDF submitted their decommissioning files in 2021. They will thus be the first two 900 MWe reactors representative of the reactor fleet currently operated by EDF, to be decommissioned in France.

The nuclear power reactors that are not PWRs are all industrial prototypes: first generation graphite-moderated gas-cooled reactors (GCR) (Bugey 1, Saint-Laurent A1 and A2 and Chinon A1, A2 et A3), the heavy-water reactor EL4-D on the Brennilis site, and the sodium-cooled fast-neutron reactors (SFR) Phénix and Superphénix. Some of these reactors have been shut down for several decades. In view of their unique nature and the fact that their decommissioning was not taken in consideration at the design stage, it is now necessary to develop and carry out specific and complex operations to decommission them.

The large dimensions of the GCR reactors make it necessary to use innovative cutting and access techniques in highly irradiating conditions. The decommissioning of these reactors will oblige EDF to manage significant volumes of waste. The final disposal route for some of this waste is currently being determined, such as the graphite bricks, representing some 15,000 tonnes of waste for which a disposal solution appropriate for low-level long-lived nuclear waste (LLW-LL) is envisaged.

Decommissioning of the heavy water reactor EL4-D has been slowed down, firstly due to the lack of prior experience in the decommissioning techniques to use, and secondly due to difficulties concerning the Conditioning and Storage Facility for Activated Waste (Iceda), which must accept some of the waste from these decommissioning operations. Given that Iceda is now up and running and the reactor building decommissioning scenario is established, decommissioning of the reactor will resume in 2024.

With regard to the sodium-cooled reactors (Phénix and Superphénix), the main challenge is the treatment and removal of the sodium.

The decommissioning of the research laboratories (LHA, LPC, BNI 165-Procédé), operated by CEA is either in progress or under preparation. These laboratories began operating in the 1960s and were dedicated to research to support the development of the nuclear power industry in France. These very old facilities are confronted with the problem of managing legacy waste stored on site at a time when the waste management routes had not yet been put in place: intermediate-level, long-lived waste (ILW-LL), waste without a management route (e.g. non-incinerable organic oils and liquids, or waste containing potentially water-soluble mercury compounds). Moreover, incidents occurred during their operation, contributing to the emission of radioactive substances inside and outside the containment enclosures and to the varying levels of contamination of the structures and soils, which makes the decommissioning and clean-out operations longer and more complex. One of the most important steps in the decommissioning of this type of facility, and which is sometimes rendered difficult due to incomplete archives, consists in inventorying the waste and the radiological status of the facility as accurately as possible in order to define the decommissioning steps and the waste management routes. In view of the number and complexity of the operations to carry out for all CEA's nuclear facilities, it is planned to stagger the decommissioning operations, giving priority to the facilities representing the greatest risks for safety.

At the end of 2023, eight research reactors built between the 1960s' to 1980's and operated by CEA are definitively shut down: Rapsodie (sodium-cooled fast neutron reactor), Masurca, Éole and Minerve (critical mock-ups), Phébus (experimental reactor), Osiris and Orphée ("pool" type reactors) and Isis (training reactor). The training reactor Ulysse was delicensed in 2022. At the time of decommissioning, these facilities usually present a low dispersible radiological inventory, as one of the first operations after final shutdown consists in removing the spent fuel. The main challenges concern the production and management of large volumes of VLL waste, which must be stored then disposed of via an appropriate route.

There is a considerable amount of decommissioning experience feedback for the research reactors, given the decommissioning of numerous similar installations in France (Siloé, Siloette, Mélusine, Harmonie, Triton, the Strasbourg University Reactor - RUS) and abroad. Their decommissioning usually takes about ten years, but the large number of facilities to decommission simultaneously can lead CEA to envisage surveillance periods before being able to continue decommissioning as is the case for the Eole-Minerve and Phébus reactors, whose decommissioning decrees were adopted in the December 2023 and March 2024 respectively. After clean-out of the activated or contaminated areas and subsequent removal of all the radioactive waste to appropriate disposal routes, the majority of these reactors have been demolished and the waste sent to conventional waste disposal routes.

Two fuel cycle front-end facilities are currently undergoing decommissioning. They are located on the Tricastin site: the Georges Besse I uranium enrichment plant – BNI 93, and the Comurhex I plant – BNI 105, for converting UF4 into UF6. The only radioactive materials used in these plants were uranium-bearing substances. One of the particularities of these facilities therefore lies in the presence of radioactive contamination associated with the presence of "alpha" particle-emitting uranium isotopes. Furthermore, these are old facilities whose operating history is poorly known. Determining the initial state, particularly the pollution present in the soils beneath the structures, therefore remains an important issue. Moreover, the industrial processes implemented at the time involved the use of large quantities of toxic chemical substances (such as chlorine trifluoride and hydrogen fluoride, as well as uranium itself). The decommissioning of the Georges Besse I plant is moreover characterised by the large quantity of VLL steel (about 200 thousand tonnes).

Four fuel cycle back-end facilities (BNIs 33, 38, 47, 80) have been undergoing decommissioning since 2004. Located on the La Hague site, they were specialised in spent fuel management. They were commissioned in 1966, initially for the reprocessing of the fuel from the GCR reactors. Unlike the direct on-line packaging of the waste generated by the UP2-800 and UP3-A plants in operation, most of the waste generated by these facilities has been stored without conditioning or packaging. Decommissioning is therefore carried out concomitantly with the legacy waste retrieval operations. Several projects of this type are currently in progress in the units of these four facilities (silos STE2, 115 and 130 in BNI 38, HAO silo in BNI 80). They will span several decades and are a prerequisite to the complete decommissioning of these facilities, whereas the decommissioning of the process parts of the plant is continuing with more conventional techniques.

A large number of support facilities (storage and processing of effluents and radioactive waste) commissioned in the 1960's have been shut down. The old storage facilities were not initially designed to allow the removal of the waste, and in some cases they were seen as being the definitive waste disposal site. Examples include the Saint-Laurent-des-Eaux silos (BNI 74), the pits, trenches and hangars of BNI 56 and the pits of BNI 72 and BNI 166. Retrieval of the waste from these facilities is complex and will span several decades. The waste must then be packaged and re-stored in safe conditions.

The effluent treatment stations (STEs) have been shut down due to their ageing or because the facilities producing the effluents treated in these stations have stopped functioning. Examples include BNI 37-B at Cadarache and station STE2 of the La Hague plant (BNI 38). The difficulties associated with decommissioning of the STEs depend on their shutdown conditions, particularly the emptying and rinsing of their tanks. Their decommissioning raises many issues. Firstly, poor knowledge of the operating history and the state of the facility to be decommissioned necessitates prior characterisation of the stored legacy waste and of the sludge or sediments present in certain tanks. Moreover, taking into account the quantities, the physical and chemical forms and the radiotoxicity of the waste contained in these facilities, the licensee must develop means and skills that involve complex engineering techniques (radiation protection, chemistry, mechanics, electrochemistry, robotics, artificial intelligence, etc.). Some of the waste has been stored in bulk without prior sorting. The retrieval operations therefore require remotely operated pick-up means, conveyor systems, sorting systems, sludge pumping and waste packaging systems. The development of these means and carrying out the operations under conditions ensuring a satisfactory level of safety and radiation protection represent a major challenge for the licensee. Given that these operations can last several decades, the management of ageing of the facilities is also a challenge.

With regard to CEA Grenoble site, the 6 facilities have all been delicensed.

6 SECTION E | LEGISLATIVE AND REGULATORY SYSTEM (ARTICLES 18 TO 20)

6.1. Implementing measures (Article 18)

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

Radioactive waste management falls within the general waste management framework defined in the Environment Code and its implementing decrees.

The Act of 28 June 2006 more specifically sets a calendar for research into high and intermediate-level, long-lived (HLW and ILW-LL) waste and a clear legal framework for ring-fencing the funds needed for decommissioning and for management of the radioactive waste. It also provides for the drafting of the PNGMDR, which aims at periodically assessing the radioactive substance management policy and determining its prospects.

The Act of 25 July 2016 details the conditions for creating a reversible deep geological repository for the HLW and ILW-LL waste.

6.1.1. General legal framework

Above certain thresholds (laid down in the Environment Code) of radioactive or fissile substance content, a facility is subject to the “basic nuclear installations” (BNI) system and placed under the oversight of ASN, the French nuclear safety authority. BNIs include more specifically: nuclear reactors; facilities for the preparation, enrichment, fabrication, treatment or storage of nuclear fuels, or for the treatment, storage or disposal of radioactive waste; deep geological repositories for radioactive waste.

As at 31 December 2023, the number of basic nuclear installations stood at 123. This category includes in particular all the facilities producing, storing or processing spent fuel, facilities “whose main purpose is to manage radioactive waste" as defined in this Convention (except for Cires which belongs to the category of Installations Classified for Environmental Protection - ICPE) and a large number of facilities containing radioactive waste, even though its management is not the main objective. Below these thresholds, a facility containing radioactive substances may be an ICPE placed under the oversight of the Ministry responsible for the environment (Ministry of ecological transition). There are about 800 facilities of this type. Management of waste and effluents from nuclear facilities and ICPEs is subject to the provisions of the particular regulatory regimes applicable to these facilities.

With regard to radiation protection, the regulations in France are set by the Public Health Code and the Labour Code. The first defines the general measures for protecting the public against ionising radiation, while the second contains various provisions specific to the protection of workers exposed to ionising radiation.

Several legislative and regulatory provisions relative to the nuclear facilities stem from or take up international conventions and standards, notably those of the IAEA. Furthermore, several European Community texts are applicable to nuclear facilities. The most important are the Euratom Treaty and the two directives establishing a community framework for the safety of nuclear facilities (Directive of 8 July 2014 amending the Directive of 25 June 2009) and for the responsible and safe management of spent fuel and radioactive waste (Directive of 19 July 2011). The adoption of this second Directive contributes to reinforcing safety within the European

Union, by making the Member States more accountable for the management of their spent fuels and their radioactive waste. This Directive covers all the aspects of spent fuel and radioactive waste management, from production through to long-term disposal.

6.1.2. National texts

The Environment Code

The nuclear facility licensing and oversight system is based on chapters III, V and VI of title IX of book V of the Environment Code. The provisions of chapter II of title IV of book V of the Environment Code create a coherent and integrated legislative framework for the management of all radioactive waste.

The Environment Code retierates the principle of a 10-yearly assessment of the regulations governing nuclear safety and radiation protection with a view to ensuring their continuous improvement. International reviews on a specific topic related to nuclear safety or radiation protection within the nuclear facilities must also be organised every six years, in accordance with the European Directive of 8 July 2014. In addition, the Directive of 19 July 2011 requires the national framework relating to radioactive waste and the management of spent fuel to be assessed every ten years at least.

The basic nuclear installations system

The Environment Code underlines that the environmental protection principles apply to nuclear activities, particularly the polluter-pays principle and the principle of public participation. It reasserts the three broad principles with regard to radiation protection: justification, optimisation and limitation. It sets out the fundamental principle of the responsibility of the licensee with regard to the safety of its facility and require the licensee to produce an annual report.

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 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 producer of radioactive waste has transferred its waste to a storage or disposal facility does not mean that it is no longer financially liable for it (see 7.1.2).

The Environment Code also addresses transparency and the information concerning the nuclear facilities, relying very much on the Local Information Committees (CLI) which include representatives of State, elected officials and members of associations, and whose membership is open to people from the neighbouring States for sites located in border *départements*.

The ICPE system

The legal system 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 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 Public Health Code

The Public Health Code defines "nuclear activities" as activities presenting a risk of human exposure to ionising radiation emanating either from an artificial source, whether involving substances or devices, or from a natural source when the natural radionuclides are processed or have been processed for 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.

This Code also defines the general principles of radiation protection (justification, optimisation, limitation), established internationally (ICRP) and taken up in the reference texts of the IAEA and European Directive of 5 December 2013. These principles underpin the regulatory measures for which ASN has responsibility.

Other French texts

Decrees and Orders issued by the Ministers responsible for nuclear safety, radiation protection and energy clarify certain provisions of the Codes presented in the preceding paragraphs. ASN resolutions supplement the implementing procedures for the Decrees and Orders issued in the areas of nuclear safety or radiation protection, with the exception of those relating to occupational medicine. These resolutions are subject to the approval by the minister concerned.

6.2. 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 shall provide for:***
>
> ***i) the establishment of applicable national safety requirements and regulations for radiation safety;***
>
> ***ii) a system of licensing of spent fuel and radioactive waste management activities;***
>
> ***iii) a system of prohibition of operation of a spent fuel or radioactive waste management facility without a licence;***
>
> ***iv) a system of appropriate institutional control, regulatory inspection and documentation and reporting;***
>
> ***v) the enforcement of applicable regulations and of the terms of the licences;***
>
> ***vi) a clear allocation of responsibilities of the bodies involved in the different steps of spent fuel and of radioactive waste management.***
>
> ***3. When considering whether to regulate radioactive materials as radioactive waste, Contracting Parties shall take due account of the objectives of this Convention.***

6.2.1. The general regulatory framework for radiation protection

6.2.1.1. The legislative and regulatory bases of radiation protection

Council Directive 2013/59/Euratom of 5 December 2013 setting the basic standards for protecting health against the dangers arising from exposure to ionising radiation has been entirely transposed into French law by the Decrees of 4 June 2018 amending the Public Health code, the Labour Code and the Environment Code. These decrees thus determine the administrative system applicable to nuclear activities and the transport of radioactive substances, hinging 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 context, or in the event of contamination. Lastly, these decrees update the regulations concerning protection against ionising radiation in mining industries.

General 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 include the principles of justification, optimisation and limitation.

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*".

The optimisation principle is defined as being the principle whereby "t*he 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 desired medical goal*".

The limitation principle, also defined in the Public Health Code, is 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 the limits set by the regulations, except when this person is exposed for medical purposes or certain human subject research* ". The exposure of the general public or of workers as a result of nuclear activities is subject to strict limits.

6.2.1.2. Protection of individuals

General protection of workers

The provisions of Articles R. 4451-1 et seq. of the Labour Code, stemming from the Decree of 4 June 2018, create a unique radiation protection system for all workers liable to be exposed to ionising radiation in the course of their professional activity. The overall approach adopted by this new regulatory framework, which aims to ensure improved risk control and prevention of incidents and accidents, helps to optimise the resources implemented by the employer. These provisions more particularly include:

- application of the principles of optimisation and prevention;
- 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 a pregnant woman, or more precisely the unborn child (1 mSv);
- radiation protection zoning: requirements concerning the delimiting of the monitored areas, controlled areas and regulated work areas (special controlled areas) have been specified, regardless of the activity sector, in the Order of 15 May 2006 amended.

General protection of the public

In addition to the specific 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 concerns in particular the annual effective dose limit received by a member of the public 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. Exceeding these limits can lead to administrative or criminal penalties. A national system managed by IRSN for collecting environmental radioactivity measurements was set up in 2009; the data collected are used to help estimate the doses received by the population. These results have been available of the public since 1 January 2010 (www.mesure-radioactivite.fr).

It is pointed out that although permitted by the Euratom directive, the French regulations have not integrated the notion of generalised clearance thresholds, that is to say a level of radioactivity below which the effluents and waste from a nuclear activity can be disposed of without any controls (see section 3.4).In practice, the disposal of waste and effluents is verified on a case-by-case basis when the activities producing them are subject to a licensing system (as is the case with nuclear facilities and ICPEs); otherwise these discharges are subject to technical requirements.

6.2.1.3. Radiation protection in nuclear facilities

Nuclear activities include those carried out in nuclear facilities. They are given particular attention owing to the risks of exposure to ionising radiation.

The nuclear facility licensee provides the justifications necessary to demonstrate compliance with the radiation protection principles from the design stage and at each step in the life of its facility for which an authorisation is required: creation, commissioning and decommissioning.

The Environment Code states that the nuclear facilities system covers the collective aspects of worker radiation protection aspects (for example, sizing of biological shielding, optimisation of radiation protection zoning, etc.)

During the periodic safety reviews (see section 6.2.3.3.1), the licensee examines the situation of its facility with regard to the rules applicable to it and updates the assessment of the risks or drawbacks the facility represents, particularly with regard to exposure to ionising radiation. In addition, radiation protection in the nuclear facilities is subject to inspections when the facilities undergo modifications that have an impact on worker radiation protection.

6.2.2. Discharge licences

6.2.2.1. Nuclear facility discharge licences

The normal operation of nuclear facilities produces radioactive effluents. The regulations applicable to nuclear facilities include prescriptions governing the discharge of effluents, the monitoring of effluents and the environment, the prevention of pollution and detrimental effects, and the conditions for informing the authorities. The main provisions are:

- the application, in general, to the equipment necessary for operation of facility, a number of Ministerial Orders applicable to identical facilities governed by the ICPE regulations;
- limiting chemical discharges to the thresholds given in the general regulations applicable to ICPEs;
- limiting radiological discharges to thresholds set by prescription and defined on the basis of the impact study and consideration of the best techniques available;
- a ban on the discharge of certain hazardous substances and discharge into the water table;
- the use by the licensee of the best available techniques within the meaning of the ICPE regulations;

- setting up, by the licensee, of emissions and environmental monitoring;
- preparation by the licensee of an annual discharge forecast and an annual environmental report containing, among other things, a review of water intakes and environmental discharges, their impacts if any, and any marking events.

Technical considerations relating to discharges (limit values, monitoring, information, etc.) are defined for each site in ASN resolutions which set 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.

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 nuclear facilities represents about 100,000 measurements and 40,000 samples taken each year 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.

6.2.2.2. Discharge licences for installations classified for environmental protection (ICPE) and mines

For ICPEs, the regulations stipulate an integrated approach to the hazards. The discharge licences and conditions are stipulated in the installation's environmental licence. The general principles for setting the discharge conditions and limits are identical to those followed for nuclear facilities, because they stem from the same acts (in particular the Water Act of 3 January 1992, codified in book II of the Environment Code).

Discharges from Mines are regulated by the "ionising radiation" section of the general regulations of the mining industries. As the facilities associated with mines and for which the discharges are liable to have the greatest impacts (ore treatment plants) are generally classified as ICPEs, their discharges are regulated accordingly.

6.2.2.3. Discharge licences for the other activities covered by the Public Health Code

The general provisions for the management of contaminated waste and effluents for the other nuclear activities are laid down in ASN resolution of 29 January 2008. The contaminated effluent management methods must be described in a framework document, the contaminated waste and effluent management plan.

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 exceeding 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 stop them if certain criteria are not met.

6.2.3. The regulatory framework for safety of nuclear facilities

In addition to the generally applicable regulations such as those relative to labour law and environmental protection, nuclear facilities are subject to specific regulations covering the different phases of their life cycle and providing for several authorisations.

6.2.3.1. Procedures relating to nuclear facility authorisations

The nuclear facilities are governed by the Environment Code which provides for a creation authorisation procedure, granted by decree issued on the report of the Minister responsible for nuclear safety, followed by other authorisations issued at the main stages in the life of these facilities: commissioning, any changes to the facility, final shutdown and decommissioning, delicensing and, in the case of a repository, the post-closure surveillance and monitoring phase. Any licensee operating 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. Application of the various authorisation procedures spans from the facility creation authorisation decree through to its final decommissioning.

6.2.3.2. Choice of nuclear facility sites

Before applying for a nuclear facility creation authorisation, the licensee must inform the administration of the site(s) on which it plans building this facility. On the basis of this information, IRSN and ASN conduct an analysis of the safety-related characteristics of the sites (seismicity, hydrogeology, industrial environment, cold water sources, etc.).

If the facilities are likely to have a cross-border impact, the 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).

6.2.3.3. Procedures concerning the design, construction and safety assessment of nuclear facilities

6.2.3.3.1. Safety assessment

The safety of a nuclear facility, whether projected or in operation, is assessed at various stages of its life.

Safety options

Any person who plans operating a nuclear facility can, before making any authorisation application, ask ASN for an opinion on the options it has chosen to ensure the safety of that facility, presented in a Safety Options Dossier (DOS).The submission of a DOS thus marks the entry of a nuclear facility project into a process governed by the regulations relative to nuclear facilities. In its opinion on this dossier, ASN specifies to what extent the safety options presented by the applicant are such as to prevent or limit the risks in view 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.

Safety assessment for a nuclear facility creation authorisation application

When applying for authorisation to create a nuclear facility, the future licensee must produce a preliminary version of the safety analysis report.

Safety assessment prior to commissioning of the facility

When applying for a nuclear facility commissioning authorisation, the licensee must provide a safety analysis report containing the update of the preliminary version of the safety analysis report.

The periodic safety reviews and reassessments

In accordance with the Environment Code, the licensees must periodically carry out a safety review of their facility, taking into account the best national and international practices. "*This review is must 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 for [in terms of operating safety, public health and safety and protection of nature and the environment], taking into account more specifically the condition of the facility, acquired operating experience, changes in knowledge and 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 facility.

After analysing the report, ASN may impose new technical requirements. It communicates its analysis of the report to the Minister in charge of nuclear safety.

The periodic safety reviews take place every ten years, including for facilities undergoing decommissioning.

6.2.3.3.2. Creation authorisation

Presentation of the creation authorisation application

The creation of a nuclear facility is subject to public debate if its cost exceeds a given sum. The public debate focuses on the appropriateness, the objectives and the characteristics of the project.

The creation authorisation application for a nuclear facility is filed with the Minister in charge of nuclear safety by the industrial concern which intends to operate the facility. The application is accompanied by a file comprising a number of items, including the impact study, the preliminary version of the safety analysis report, 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 9.3.

The Minister in charge of nuclear safety assigns the technical examination of the application file to ASN. The project presentation file containing the authorisation application and the impact study is sent to the Environmental Authority for its opinion and to the local authorities and their groupings concerned by the project.

Consultation of the public and the local authorities

The authorisation cannot be issued until a public inquiry has been held in accordance with the provisions of the Environment Code. The purpose of this inquiry is to inform the public and allow its participation by gathering its observations and proposals, so that the competent authority can consider them before making any decisions. The inquiry is open in each municipality which has part of its territory situated less than five kilometres from the facility boundary. The inquiry lasts at least one and a half months. The file submitted by the licensee to support its authorisation application is made available. The opinion of the Environmental Authority is also appended to the public inquiry file.

Consultation of technical organisations

To conduct the technical review of the file, and notably of the preliminary safety analysis report, ASN calls on the expertise of its Advisory Committees of experts and of IRSN.

The creation authorisation decree (DAC)

When all the requisite conditions are satisfied, the facility creation authorisation is issued by 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. As a general rule, the validity of a nuclear facility authorisation is not limited in time.

Requirements defined by ASN for application of the authorisation decree

For application of the DAC, ASN defines the requirements relative to the design, construction and operation of the nuclear facility that it deems necessary for protection of the interests (security, public health and safety, protection of nature and the environment). It defines requirements concerning the nuclear facility's water intakes and its discharges. The specific requirements setting the facility's environmental discharge limits are subject to approval by the Minister in charge of nuclear safety.

6.2.3.3.3. Commissioning authorisation

With a view to commissioning, the licensee - in accordance with Article R. 539-30 of the Environment Code - sends ASN a file containing the updates of the documents supporting the creation authorisation application, the elements for assessing the conformity of the facility with ASN's requirements and the general operating rules. The waste management methods are described in the impact study and the general operating rules. After checking that the facility complies with the objectives and applicable rules, ASN issues the facility commissioning authorisation.

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 the introduction of radioactive substances into it.

6.2.3.3.4. Modification of the facility

During operation, the licensee informs either the Minister in charge of nuclear safety or ASN of any substantial or noteworthy modification relating to the facility.

Substantial modification of the facility

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

- a change in the nature of the facility or an increase in its maximum capacity;
- modification of the protection-important components, which figure in the authorisation decree;
- addition of a new nuclear facility within the perimeter of the facility, whose operation is linked to that of the facility in question.

A substantial modification requires a new authorisation subject to the same procedure as the creation authorisation.

Noteworthy modification of the facility

A noteworthy modification is a modification - other than substantial - of the facility, of its conditions of operation or of the elements having led to its creation authorisation or commissioning authorisation and having an impact on the protected interests. A noteworthy modification is subject to either notification to ASN or ASN authorisation, depending on its scale.

6.2.3.3.5. Incident monitoring

A nuclear facility licensee is obliged to notify ASN without delay of any accidents or incidents that occur due to operation of that facility which could significantly prejudice security, public health and safety or protection of nature and the environment. ASN systematically rates these events on the INES scale when it is applicable.

6.2.3.3.6. Final shutdown and decommissioning

A licensee planning to definitively shut down its facility must notify ASN and the Minister in charge of nuclear safety, indicating the planned date of shutdown. The licensee must submit a file detailing the planned decommissioning operations no later than two years after giving this notification. The technical provisions applicable to this facility must satisfy the general regulations concerning safety and radiation protection.

Since the Act of 22 June 2023 was introduced, if a nuclear facility has stopped functioning for an uninterrupted period of more than two years, a decree issued after obtaining the opinion of ASN, may order is final shutdown, after the licensee has been given the opportunity to put forward its observations.

Decommissioning of the facility is prescribed by decree, after obtaining the opinion of ASN and following a public inquiry and consultation of the CLI concerned. 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 facility.

For nuclear facilities 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 performed 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 repository are set out in the Environment Code, in particular that closure of this repository may only be authorised by means of an Act.

6.2.3.3.7. Delicensing

When the facility has been completely decommissioned and no longer requires implementation of the provisions of the nuclear facilities system, ASN issues the delicensing resolution which is submitted to the Minister in charge of nuclear safety for approval.

The delicensing of a nuclear facility is not authorised until post operational clean out has been taken as far as reasonably achievable under acceptable technical and economic conditions. After cleaning out the nuclear facility's structure and soils, if unconditional clearance cannot be guaranteed and residual radiological or chemical contamination remains in the soils and the groundwater limiting current or future uses, the licensee may propose the introduction of active institutional controls.

With a view to obtaining the delicensing of its facility, the licensee sends a file containing a presentation of the site after decommissioning and clean-out. The regulations provide for several public consultations and information campaigns.

From the moment the delicensing resolution come into effect, the facility is no longer subject to the legal and administrative system governing nuclear facilities and is delicensed with or without usage restrictions.

6.2.3.4. Technical rules concerning nuclear facilities

A hierarchical series of texts sets out the technical rules and practices with regard to nuclear safety. The first texts in the series, which have regulatory status, are relatively general and cover a broad scope, but in most cases do not go into the technical details. The last ones, however, deal with subjects in greater depth and detail.

6.2.3.4.1. The general technical regulations

Order of 7 February 2012 (the "BNI Order")

Issued pursuant to Article L. 593-4 of the Environment Code, the BNI Order sets essential requirements applicable to nuclear facilities, from design through to delicensing. More particularly, its section 6 on waste management includes the WENRA reference levels (responsibility, management system, record keeping, etc.) along with new requirements regarding waste conditioning and packaging:

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

These requirements are supplemented by section 8 which 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.

ASN resolutions

Pursuant to 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 for those relating to nuclear safety, the Minister in charge of energy for those concerning the means and measures for protecting sources of ionising radiation against malicious acts, and the Ministers in charge of radiation protection for resolutions concerning radiation protection.

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).

6.2.3.4.2. Basic safety rules and ASN guides

In the past ASN has issued basic safety rules (RFS) on various technical subjects and, more recently, guides. The basic safety rules constitute a set of recommendations stemming from lessons learned from the design and operation of nuclear facilities and from studies and research. They are to be gradually replaced by ASN guides.

The aim of these documents, 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 the regulations and, where applicable, describe the practices ASN considers to be satisfactory. They are not strictly speaking regulatory texts. A licensee may choose not to follow the provisions of a basic safety rule or a guide if the measures the licensee proposes enable the set safety objectives to be achieved.

The list of guides falling within the scope of the Convention is given in Appendix 13.5.

6.2.3.5. Scope of oversight

ASN oversight of nuclear activities aims to protect people and the environment. It consists in verifying that any party responsible for a nuclear activity fully assumes its responsibility and complies with the requirements of the regulations concerning nuclear safety, radiation protection and environmental protection.

Regulation of nuclear safety and radiation protection

In its inspection duties, ASN looks at the equipment in the facilities, the methods of operating the facilities, the teams in charge of operating them and the skills of those teams, the work methods and the organisation, from the start of the design process through to delicensing. The inspections carried out can concern equipment suppliers (foundries, pressure equipment manufacturers, etc.). ASN also examines the steps taken regarding safety or monitoring and limitation of the doses received by persons working in the facilities, as well as procedures for waste management, monitoring effluent discharges and environmental protection.

Environmental protection

ASN's environmental protection policy tends to approach that applied to industrial activities involving conventional risks. This approach leads to the setting of limits on chemical and radioactive substance discharges based on the impact study and consideration of the best available techniques. The requirements governing the discharges and water intakes of nuclear facilities are periodically reviewed in the light of regulatory or technological changes in order to assess the possibility of reducing discharges from the facilities and improving the monitoring conditions. Following this review, the requirements are revised as necessary.

6.2.3.6. Oversight procedures

ASN has a number of oversight procedures. These mainly comprise:

- inspections on site or in the departments linked to the licensees or on their service providers sites for activities that can have an impact on safety, radiation protection or the environment;
- inspections of worksites during facility maintenance outages and modification work;
- on-site technical meetings with the facility licensees or the manufacturers of equipment used in the facilities;
- technical review of the substantiating files and documents supplied by the licensee.

Regular exchanges are organised with the site senior management and with the head offices of the inspected licensees in order to share the assessment that emerges from ASN's inspections, to make sure they are taken into account by the licensees, and to inform each other of the regulatory and industrial prospects.

6.2.3.6.1. Inspection

To ensure good allocation of inspection resources according to the nuclear safety, radiation protection and environmental protection issues concerning the various facilities and activities, ASN draws up a programme of future inspections each year. This programme identifies the targeted facilities, activities and the particular topic. The programme is not known to those responsible for the nuclear activities.

To achieve its goals, ASN has, as at 31 December 2023, 307 inspectors qualified in view of their professional experience and their legal and technical knowledge. These nuclear safety inspectors are ASN engineers, qualified after following a training syllabus 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 are sworn in and bound by professional secrecy.

The table below shows the number of inspections carried out by ASN. These inspections represent 1,257 days of work in the field in the nuclear power plants, 841 days in the fuel cycle facilities, and 148 days in transport activities.

BASIC NUCLEAR INSTALLATION (EXCLUDING PRESSURE EQUIPMENT)	PRESSURE EQUIPMENT	TRANSPORT OF RADIOACTIVE SUBSTANCES	SMALL-SCALE NUCLEAR ACTIVITIES	APPROVED ORGANISATIONS AND LABORATORIES	TOTAL
718	147	88	771	66	**1 790**

Table 13: Number of inspections in 2023

Through dedicated inspections, ASN ensures that the licensees comply with the regulations applicable to them with regard to the management of discharges and the environmental and health impact of their facilities. Every year, it carries out about 90 inspections of this type, split into three topics: prevention of pollution and control of detrimental effects; water intakes and effluent discharges, monitoring of discharges into the environment; waste management.

6.2.3.6.2. Technical review

The review of the supporting documents produced by the licensees and the technical meetings organised with the licensees constitute part of ASN's oversight.

The files provided by the licensee for the authorisation procedures, periodic safety reviews, facility modification, decommissioning or delicensing, must show that the provisions of the regulations and the rules and objectives set by the licensee are satisfied. ASN is required to check the completeness of the files and the quality of the demonstrations.

The examination of these files may lead ASN to accept or reject the licensee's choices and substantiations, or to ask for additional information or proof, or studies or even the performance of compliance work. ASN issues its regulatory requirements in the form of resolutions containing requirements.

6.2.4. The regulatory framework for ICPEs and mines

The legislation and regulations concerning ICPEs result from Act No. 76-663 of 19 July 1976. Section 2797 of the ICPE classification system regulates the radioactive waste management implemented in an industrial or commercial entity, excluding particle accelerators and the medical sector, from the moment the quantity liable to be present exceeds 10 m^3 and the exemption conditions mentioned in 1° of I of Article R. 1333-106 of the Public Health Code are not fulfilled. These facilities are subject to authorisation. The uranium mines, their annexes and their conditions of closure are covered by the Mining Code. The disposal facilities for radioactive mining tailings come under the ICPE classification system. The mines and mining tailing disposal sites are therefore not subject to ASN oversight; they are the responsibility of the Prefect, on proposal from the Regional Directorates for the Environment, Planning and Housing (DREAL).

In the specific case of the former uranium mines, an action plan has been defined by the circular of 22 July 2009 of the Minister in charge of the environment and the ASN Chairman, along the following work themes:

- monitor the former mining sites;
- improve knowledge of the environmental and health impact of the former uranium mines and their surveillance;
- manage the waste rock (better identify its uses and reduce impacts if necessary);
- reinforce information and consultation.

6.3. Regulatory body (Article 20)

1. Each Contracting Party shall establish or designate a regulatory body entrusted with the implementation of the legislative and regulatory framework referred to in Article 19, and provided with adequate authority, competence and financial and human resources to fulfil its assigned responsibilities.

2. Each Contracting Party, in accordance with its legislative and regulatory framework, shall take the appropriate measures to ensure the effective independence of the regulatory functions from other functions where organisations are involved in both spent fuel or radioactive waste management and in their regulation.

6.3.1. The French Nuclear Safety Authority (ASN)

Created by the Act of 13 June 2006, called the TSN Act, ASN is an independent administrative authority tasked with the regulation of civil nuclear activities in France, in relation with Parliament and other State actors within the Government and the Prefectures. On behalf of the State, ASN ensures the 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. It exercises its duties in compliance with four fundamental values: competence, independence, rigour and transparency.

6.3.1.1. Independence

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 full time, with complete impartiality, receiving no instructions from either the Government or any other person or institution. The commissioners have a six-year mandate during which they cannot be relieved of their functions; the mandates are not renewable.

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 Commission defines the strategy of ASN, gives its opinions to the Government and issues ASN's main resolutions.

ASN opinions and resolutions

The Environment Code gives ASN competence to issue ASN regulations to clarify the decrees and orders relating to nuclear safety and radiation protection; ASN regulations are subject to approval by the Minister in charge of nuclear safety or radiation protection. Approval orders and approved ASN regulations are published in the Official Journal. The Environment Code also empowers ASN to impose binding requirements on the licensee throughout the lifetime of the facility, including during its decommissioning. In 2022, the ASN Commission met 62 times and issued 21 opinions and 31 resolutions.

6.3.1.2. Organisation

ASN has head office departments and regional divisions, placed under the authority of the Director General, assisted by three deputy director generals, a chief inspector and a head of private office.

ASN head office departments

The ASN head office departments comprise an Executive Committee, a General Secretary's office, a Management and Expertise Office, an Oversight Support Office, an Innovative Reactors Office and nine departments covering specific themes.

The role of the departments is to manage the national affairs concerning the activities under their responsibility. They are involved in drafting the general regulations and coordinating the actions of the ASN regional divisions. They also take part in international work.

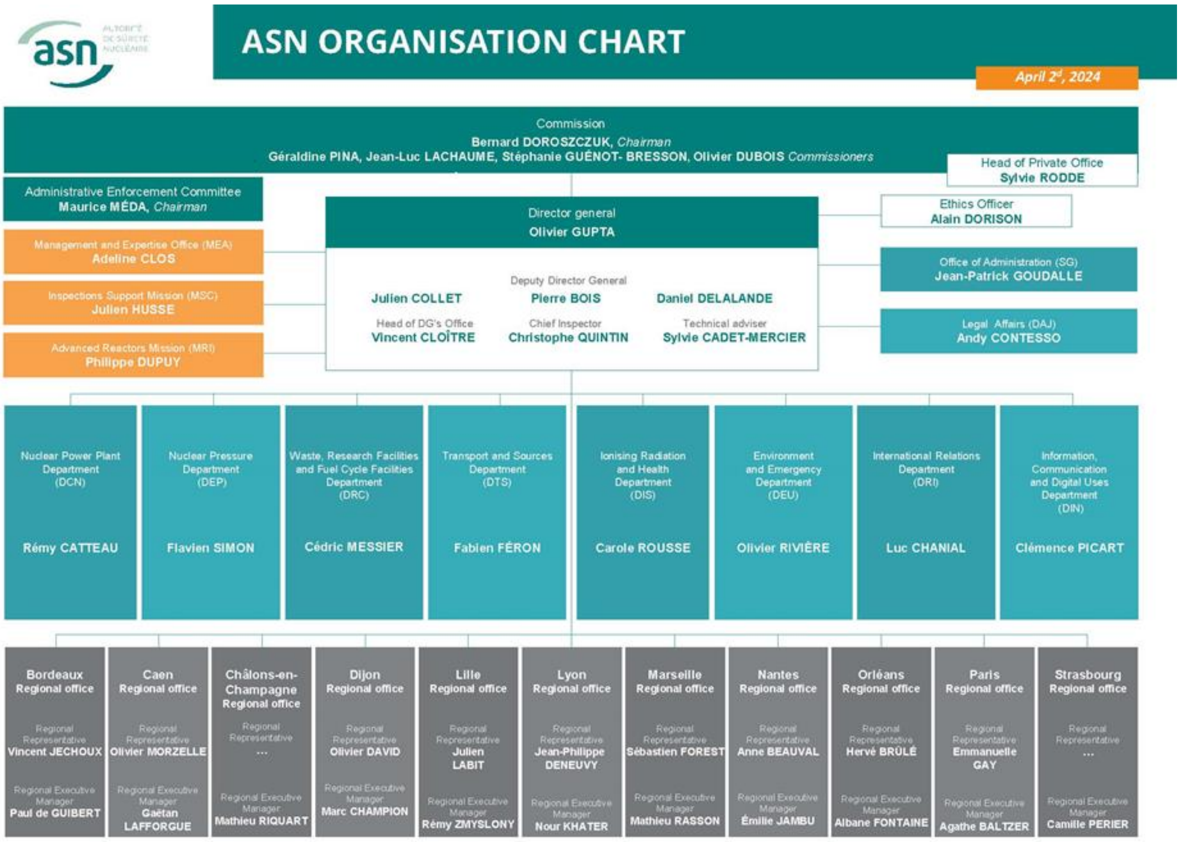
The Regulation and Oversight Support Office (MSC) ensures that the inspections carried out by ASN are pertinent, harmonised, effective and in-line with ASN's values. It reports to the chief inspector and runs inspection strategies, drafts the inspection programme, handles operating experience feedback 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 a high level of expertise and identifies the areas where knowledge is needed in the field of research. It ensures that ASN's actions are coherent, by means of a quality approach and by overseeing coordination of the workforce.

The Innovative Reactors Office (MRI) was set up in 2023 to prepare for the creation authorisation applications for small innovative reactors by mobilising resources proportionate to the technological readiness level of each project and putting in place a framework for progressive technical exchanges. The framework enables the project developers to clearly understand the safety requirements before submitting the creation application files, and ASN to plan ahead for the related application reviews.

The ASN regional representatives and divisions

For many years, ASN has benefited from a regional organisation built around its eleven regional divisions. These regional divisions conduct their activities under the authority of regional representatives. They perform the majority of the on-site inspections of the nuclear facilities and small-scale nuclear activities. They contribute to ASN's public information duty by holding press conferences in the regions. They also take part in the meetings of the Local Information Committees (CLIs) and maintain regular relations with the local media, elected officials, associations, licensees and local administrations.



ASN organisation chart as at 2 April 2024

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

- an organisation manual containing organisational notes and procedures defining rules for the conduct of each of its missions;
- internal and external audits to ensure that the system's requirements are strictly applied;
- listening to stakeholder feedback;
- performance indicators for monitoring the effectiveness of action taken;
- a periodic review of the system, to foster continuous improvement.

6.3.1.3. Human and financial resources

The overall headcount of ASN as at 31 December 2019 stood at 521 staff, including 307 inspectors. The headcount is distributed between the head office departments (303 employees) and the regional divisions (218 employees). It is made up of civil servants (71%), contract agents (18%) and agents seconded by public institutions (Andra, Paris Hospitals, CEA, IRSN, Departmental Fire and Emergency Service) (11%).

The average age of the ASN personnel is 45 years and 5 months and the median age is 44 years and 9 months. Furthermore, ASN benefits from the expertise of technical support organisations for the preparation of its resolutions, and notably IRSN, whose overall headcount as at 31 December 2023 is 1783 employees, of whom 430 are dedicated to the technical support for ASN.

Training of ASN staff

The management of ASN staff skills is based in particular on a formalised series of technical training courses. These training courses cover technical, legal and communication aspects. In 2022, 2,600 days of training were dispensed to the ASN staff in 107 training sessions delivered either face-to-face or by videoconference. Added to these figures is a large volume of hours devoted to self-study by each trainee, plus a significant amount of mentoring, particularly during the period of inspector training prior to authorisation, during which the trainee inspector participates in the missions first as an observer, then actively under the supervision of experienced inspectors.

Financial resources

All the personnel and operating resources involved in the exercise of the missions entrusted to ASN come from the general State budget. The ASN budget for 2023 was €71.62 M.

In application of the Environment Code, ASN is consulted by the Government on the share of the State grant awarded to IRSN that corresponds to the technical support provided to ASN by IRSN. The share of the IRSN budget devoted to the technical support of ASN amounted to €85.1M in 2023, of which €41.4M comes from a contribution due by the nuclear licensees.

Furthermore, the sum of the taxes on nuclear facilities collected by ASN amounted to €764M in 2023:

- €559.6M from the taxes on basic nuclear installations (paid into the general State budget);
- €124.5M from the additional "assistance", "disposal" and "research" taxes (assigned to various bodies including Andra, to certain municipalities and Public Interest Groupings[10]);
- €79.3M from the special contribution for the management of radioactive waste (assigned to Andra).

6.3.1.4. Technical support organisations

ASN benefits from the expertise of technical support organisations (TSOs) when preparing its decisions and resolutions. The French Institute for Radiation Protection and Nuclear Safety (IRSN) is the most important among them. Other TSOs can be mobilised according to the nature of the subjects to examine or a need to diversify the sources of expertise.

Institute for Radiation Protection and Nuclear Safety (IRSN)

IRSN is a State public industrial and commercial institution which carries out expert analysis and assessment and research missions in the field of nuclear safety and security, excluding any responsibility as nuclear facility licensee. IRSN reports to the Ministers in charge of the environment, defence, energy, research and health respectively.

Its activities cover many areas: safety and security of nuclear reactors, plants, laboratories, transport and waste, environmental monitoring, intervention in the event of a radiological risk, radiation protection of humans in normal and accident situations, prevention of major accidents.

The overall headcount of IRSN as at 31 December 2022 was 1,744 employees, of whom 433 were assigned to providing technical support for ASN. IRSN's overall budget for 2022 amounts to €288M of which €83.5M are

[10] For the creation of the underground laboratory and the Cigéo project, two Public Interest Groupings (GIP) were created in 2000: the "Objectif Meuse" GIP and the Haute-Marne GIP. These public establishments redistribute to the region the funds paid by the waste producers (CEA, EDF and Orano) for development projects.

devoted to technical support for ASN, part of which (€41.7 M) comes from a contribution from the nuclear licensees (this contribution was put in place under the Finance Act of 29 December 2010).

The technical support actions cover the expert assessment of safety or radiation protection files produced by the licensees; on-site interventions for sampling, measurement and analysis; participation in ASN inspections; participation in the national emergency organisation and participation in and facilitation of national and international working groups and meetings.

IRSN's research in the areas of radiation protection, radio-ecology and the safety of facilities, primarily covers the main hazards encountered in the facilities 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.

Advisory Committees of experts

When preparing its resolutions concerning important issues, ASN draws on the opinions and recommendations of 7 Advisory Committees of experts (GPE), with competence in the fields of waste (GPD), nuclear pressure equipment (GPESPN), radiation protection (GPRP), reactors (GPR), laboratories and plants (GPU), transports (GPT), and decommissioning (GPDEM).

For each subject addressed, the GPEs base their technical opinions on the reports produced by IRSN, by a special working group or by one of the ASN departments. They issue an informed and independent opinion, along with recommendations if applicable.

Each Advisory Committee member speaks in a personal capacity at the meetings. The participation of experts from other countries can bring new approaches to subjects and the benefit of international experience.

Since 2009, in its approach to ensure transparency in nuclear safety and radiation protection, ASN has made public its opinion and, as applicable, its position statement regarding the file being reviewed.

6.3.1.5. Creation of a new regulatory authority on 1 January 2025

The Act of 21 May 2024 relative to the organisation of the governance of nuclear safety and radiation protection to meet the challenge of the revival of the nuclear power sector brings together the technical skills of IRSN with those of ASN in a new independent administrative authority called ASNR (Authority for Nuclear Safety and Radiation Protection), in order to maintain the excellence of safety and radiation protection oversight in the future, and in view of the challenges associated with the relaunching of the nuclear sector which are going to place considerable strain on the competent public authorities. This organisational change brings no change in the existing legal and regulatory framework governing nuclear safety, which is based first and foremost on the accountability of the licensees, and meets four requirements:

- improved efficiency of the procedures relating to nuclear safety and radiation protection;
- independence of the Authority with respect to the nuclear licensees and the Government;
- increased transparency for the public;
- attractiveness of the nuclear sector professions to guarantee that the authority regulating nuclear safety and radiation protection will recruit the required excellence of skills and expertise.

A number of decrees will have to be adopted to detail the conditions of application of the Bill. Other points will come under the internal rules of procedures of the future independent administrative authority which will be put in place on 1 January 2025.

6.3.2. The Nuclear Safety and Radiation Protection Mission (MSNR)

The MSNR, within the General Directorate for Risk Prevention at the Ministry for Ecological Transition, is in particular tasked – in collaboration with ASN – with proposing Government policy on nuclear safety and radiation protection, except for defence-related activities and facilities and the radiation protection of workers against ionising radiations. 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 facilities 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 polluted by radioactive contamination, other than nuclear facilities (jointly with the Bureau of Soils and Sub-Soils);
- proposes the State's intervention priorities in terms of rehabilitation of orphan radiation contaminated sites jointly with Andra and the DGEC;
- ensures the secretariat for the High Committee for Transparency and Information on Nuclear Safety (HCTISN).

6.3.3. ICPEs 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 breach of these provisions.

The mines inspectorate duties are handled by the DREAL staff. This concerns the safety of mine working 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 the sites and monitoring of their impact on the environment.

6.3.4. Other actors

6.3.4.1. 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".

The OPECST holds hearings for personalities on subjects of interest within its field of competence. Some hearings are prescribed by law, such as the annual presentations of the activity reports of ASN and the National Assessment Board for Research and Studies on Radioactive Materials and Waste. Save exception, these hearings are open to the press.

The OPECST carries out evaluations following procedures defined by various Acts, notably concerning 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.

6.3.4.2. The consultative bodies

High Committee for Transparency and Information on Nuclear Safety (HCTISN)

HCTISN is an information, discussion and debating body dealing with the risks inherent in 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 controls and information relating to them. 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.

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. It issues two to three reports or opinions every year on topical or fundamental issues.

In 2020, HCTISN issued an opinion on public participation in the Cigéo deep geological disposal project further to which it set up a committee to monitor the consultation and discussion procedures undertaken by the various parties (Andra, ASN and IRSN, CNDP, Government and Ministry, ANCCLI). The purpose of this "Cigéo project consultation committee" is to assess the comprehensibility of these consultation procedures and their ability to satisfy the following broad principles:

- ensure continuity of information and participation throughout the project;
- take into account what already exists;
- ensure the informing and participation of the public at the local and national scales;
- target all the audiences ("informed" public, general public, people living near the disposal repository project, people living near the waste production, processing, conditioning and packaging or storage sites);
- choose the most appropriate methods of informing the public and ensuring its participation;
- take account of the public's concerns and provide an argued response to them.

More generally, this monitoring consultation committee will recommend the way in which the stakeholders can apply the principles and recommendations issued by HCTISN over the longer term.

Some thirty stakeholders are members of this monitoring committee which meets 3 to 4 times a year.

The High Council for Prevention of Technological Risks (CSPRT)

Consultation about technological risks takes place before CSPRT, created by an Order of 27 April 2010. Alongside representatives of the State, the Council comprises licensees, qualified personalities and representatives of environmental associations. It is obligatory for the Government to ask CSRPT for its opinion on ministerial orders concerning nuclear facilities. ASN may also refer resolutions concerning nuclear facilities to it.

The Local Information Committees and the National Association of Local Information Committees and Commissions (Anccli)

The nuclear facility CLIs have a general duty of monitoring, informing and consultation with regard to nuclear safety, radiation protection and the impact of nuclear activities on humans and the environment, for the facilities on the site(s) which concern them. They may request expert assessments or have measurements taken on the installation's discharges into the environment.

CLI members comprise representatives of the departmental councils, of the municipal councils or representative bodies of the groups of communities and the regional councils concerned, members of Parliament elected in the *département*, representatives of environmental protection associations, economic interests and representative trade unions of employees and the medical professions, and qualified personalities.

The status of CLIs is defined by the TSN Act of 13 June 2006 and by the Environment Code.

The role of Anccli is to represent CLIs in dealings with the national and European authorities and to provide assistance to the commissions with regard to questions of common interest.

The National Assessment Board (CNE2)

CNE2 made up of scientific personalities, was created by the Act of 31 December 1991 (and consolidated by the Act of 28 June 2006) to assess the results of research into the management of high-level long-lived waste (HLW-LL); it draws up an annual assessment report on the research concerning all radioactive materials and waste with respect to the objectives set by the PNGMDR.

French National Public Debates Commission (CNDP)

CNDP is an independent authority that guarantees the public's right to be informed of and to participate in the development of projects and public policies that have an environmental impact. Since 2016, the Environment Code requires that all plans and programmes of national scope be referred to the CNDP for it to decide on the methods of organising public participation. It thus decided, for example, to organise a public debate on a programme proposed by EDF for 6 type "EPR2" nuclear reactors. It is also competent with regard to the plans and programmes for applying public policies concerning the environment, such as the Multi-year Energy Programme.

7 SECTION F | OTHER GENERAL SAFETY PROVISIONS (ARTICLES 21 TO 26)

7.1. Responsibility of the licence holder (Article 21)

1. Each Contracting Party shall ensure that prime responsibility for the safety of spent fuel or radioactive waste management rests with the holder of the relevant licence and shall take the appropriate steps to ensure that each such licence holder meets its responsibility.

2. If there is no such licence holder or other responsible party, the responsibility rests with the Contracting Party which has jurisdiction over the spent fuel or over the radioactive waste.

7.1.1. Management of a licence holder's spent fuel

The spent fuel from civil nuclear activities is produced and stored in nuclear facilities. The fundamental principle underpinning the system for organisation and regulating the nuclear safety of the facilities 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 sets the essential requirements with which nuclear facility licensees must comply. On behalf of the State, ASN ensures that this responsibility is assumed in full.

Any nuclear facility licensee assumes civil liability pursuant to the Convention on third-party liability in the field of nuclear energy (Paris Convention).

7.1.2. Radioactive waste management

The licensee of a nuclear facility in which radioactive waste is processed, stored or disposed of is responsible for the safety and radiation protection of its facility during its operation, its decommissioning and, in the case of disposal facilities, its monitoring and surveillance.

A producer of radioactive waste is responsible for managing its waste, even if it sends the waste to a facility operated by another company for processing, storage or disposal, without prejudice to the responsibilities of that other company as a nuclear facility licensee. The producer must have the necessary technical and financial capacities to meet the resulting requirements (these capacities are mandatory and are verified as part of the ICPE and nuclear facility licensing procedures).

Thus, although Andra is responsible for the safety and radiation protection of the disposal facilities it operates, the producers remain responsibility for the substances emplaced in them.

The responsibility of the waste producer is reflected, among other things, in obligations to reduce the quantities or harmfulness of the waste and to sort, characterise, condition and package it. The producer may be held liable in the event of failure to comply with these requirements and the disposal centre package acceptance specifications (the packages may be refused where applicable). The liability is also of a financial nature, in application of the "polluter-pays" principle which has the party responsible for the damage to the environment bear the costs of the pollution prevention and reduction measures. For the facilities that represent the greatest risks (nuclear installations), the licensees are obliged, in application of the law, to assess conservatively their long-term costs, including the costs of management and disposal of the spent fuel and radioactive waste, and to constitute dedicated assets to finance these costs. On the basis of this legal financing mechanism and the contracts concluded with the producers concerned, Andra has the possibility, with no time limit, of turning to the producers to finance management operations concerning the emplaced waste, if necessary, as long as Andra is responsible for operation of the repositories (for example, to carry out consolidation work, or if additional provisions should be made necessary by new legal or regulatory obligations). For the producers who are not subject to the legal mechanism for financing the long-term cost of radioactive waste management, the law requires them to have the financial capacities for this purpose; Andra can then ensure the collection, transport and management of the radioactive waste, or the remediation and, where applicable the management, of sites contaminated by radioactive substances at their request and their expense. Nevertheless, this financial responsibility is most often transferred to Andra when it places the waste in its disposal facilities, such that unexpected changes in the waste management costs are borne by Andra.

Furthermore, in the event of defaulting of the waste producers (judicial liquidation of a company, real or alleged insolvability of the person(s) responsible, etc.), the State bears ultimate responsibility for these substances if they have been produced on French territory. In such cases the State can task Andra with the management of these substances, with the remediation of the contaminated site and, where applicable, its management. To accomplish this mission, Andra can receive a state grant to help finance it. However, in application of the principle of prime responsibility of the waste producer, Andra can be reimbursed for the costs incurred should the responsible entities be identified or become solvent again. A number of sites contaminated by radioactive substances used in the radium or watchmaking industry (radium-based paints) at the beginning of the 20th century are concerned by this ultimate cost-bearing mechanism.

7.2. Human and financial resources (Article 22)

Each Contracting Part shall take they appropriate steps to ensure that:

i) qualified staff are available as needed for safety-related activities during the operating lifetime of a spent fuel and radioactive waste management facility;

ii) adequate financial resources are available to support the safety of the facilities for spent fuel and radioactive waste management during their operating lifetime and for decommissioning;

iii) financial provision is made which will enable the appropriate institutional controls and monitoring arrangements to be continued for the period deemed necessary following the closure of a disposal facility.

7.2.1. Regulatory provisions

During the creation authorisation procedure for a nuclear facility, the technical and financial capacities of the future licensee are taken into consideration. They must enable the licensee to conduct the project in compliance with the safety and radioprotection requirements, in particular to cover the costs of decommissioning the facility and rehabilitating, monitoring and maintaining its installation site.

The Environment Code defines the system for securing the funds to meet the nuclear costs incurred by the decommissioning of the nuclear facilities and managing the spent fuel and the radioactive waste. This system is clarified by the Order of 21 March 2007 relative to securing the financing of the nuclear costs. This order aims to secure the financing of the nuclear costs by applying the “polluter-pays” principle. It is therefore up to the nuclear licensees to take charge of this financing by setting up a dedicated portfolio of assets capable of covering the expected costs. These costs must be evaluated conservatively, taking the various uncertainties into account. The licensees are thus obliged to submit triennial reports on these costs along with annual update notices to the Government.

7.2.2. Financing of the radioactive materials and waste management policy

In view of the issues involved in radioactive waste management, the public authorities wanted to secure the financing of the research and of the waste management in itself, and the financing of decommissioning of the nuclear facilities.

7.2.2.1. Securing the financing of the costs

The system used by France for financing the decommissioning of nuclear facilities and managing the spent fuel and radioactive waste produced by these facilities, is based on the entire financial responsibility of the licensees.

The nuclear facility licensees must make a conservative 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 assets of a value at least equivalent to the amount of these provisions, excluding 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 will be financed directly by operating products drawn from the facilities that use the 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. 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 Environment Code establishes prudential rules applicable to the management of dedicated assets: nature of the permissible assets, diversification rules, etc. These rules include a ban on the possession of bonds issued by entities of the licensee's group. The regulations also provide for requirements with regard to governance, the performance of internal 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 provides for verification by the State, along with the power to issue binding requirements and penalties, up to and including seizure of the funds.

7.2.2.2. Verification by the State

The Environment Code defines the methods of verifying the ring-fencing of financing of the long-term nuclear costs.

There are several levels of verification of compliance with these obligations:

- The internal verification by the licensees provided for in the Environment Code. It focuses as much on the evaluation of the long-term nuclear costs as on the management of the covering assets.
- The verification carried out by the company auditors, who more specifically audit the annual accounts.
- The verification exercised by an administrative authority mentioned in the Environment Code. The General Directorate for Energy and the Climate (DGEC), together with the General Directorate for the Treasury, exercise this function by delegation from the Ministers in charge of the economy and energy. The DGEC asks ASN to issue a technical opinion on the hypotheses adopted by the licensees. Whatever the case may be, the nuclear licensees remain responsible for the satisfactory financing of their long-term costs.

Every three years, the licensees send the administrative authority a report describing the evaluation of the long-term nuclear costs, the methods used to calculate the provisions for 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 administrative authority a note updating this report and must inform it immediately of any event liable to modify its content. They also send it a quarterly inventory of the dedicated assets.

The administrative authority is empowered 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. 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 failure to meet the obligations incumbent upon the licensee, the authority may also pronounce an administrative penalty against it.

Moreover, 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.

The administrative authority can call upon ASN, the Defence Nuclear Safety Authority (ASND) and the French Prudential Supervision and Resolution Authority (ACPR). Thus, each year the competent nuclear safety authorities (ASN and ASND) issue opinions on the reports submitted by the nuclear licensees in their area of competence, while the administrative authority can call upon the expertise of the ACPR for the financial aspects of the nuclear costs. ASN makes public its opinions on the triennial reports.

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. In this context, the authority to date has coordinated six external audits, two concerning EDF, two concerning Orano, one concerning CEA and one concerning Framatome. 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 which, for the last audits, concern topics such as: reinforcement of the project management process; the decommissioning scenario and the related waste management strategy; the scope of the costs considered in the quotation; improvement in the quantitative management of the evolution of the quotations in the light of their effective implementation; consideration of uncertainties regarding the macroeconomic context.

7.2.2.3. 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. These levies serve to ring-fence Andra's financing sources.

7.2.2.4. Financial guarantees for ICPEs

ICPE legislation contains an obligation to create financial guarantees for quarries, waste storage facilities and the 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 facilities, these guarantees are intended to cover the monitoring and surveillance of the site and maintain the safety of the facility, 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. This guarantee is obligatory for existing sites as from 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.

7.2.2.5. Financing the taking back of radioactive sources

The supplier is obliged to take back its sources at the request of the user and must set up a financial guarantee to overcome the consequences of its potential defaulting.

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.

The decision taken by Ressources at the end of 2021 to exclude foreign suppliers of high-activity sealed radioactive sources (cobalt-60, caesium-137) intended for "pool" type industrial irradiators used for the sterilisation of various products or foodstuff due to the very high cost of the financial guaranteed required for sources of this type, is to be noted. Although alterative solutions have been put in place, such as taking the recovery costs into account in the long-term provisions (see section 1.4.6), long-term solutions to the problems raised by the association's decision will have to be found. They concern more specifically updating of the methods of calculating the sums due and possible changes in the associated financial guarantee mechanisms.

7.2.3. Andra’s human and financial resources

Andra is an industrial and commercial public establishment (EPIC).

As at 31 December 2023, the Andra headcount stood at 720 employees, 73% of whom are engineers and managerial personnel. The organisation of Andra is presented in section 13.6.1.

More than 30 Andra employees work at Cires, 100 at CSA, 9 at CSM and 180 at the CMHM (Meuse/Haute-Marne Centre). More than 450 people work at the head office in the various divisions and departments of Andra (see 13.6.1). Out of all the employees, about 170 are assigned to general management or transverse support functions: human resources, corporate social responsibility, knowledge management, purchasing, accounting and finances, legal, information system and communication.

Andra predicts a significant increase in its headcount in the next 5 years correlated with the ramping up of the Cigéo project examination and construction. Andra is financed through:

- Commercial contracts with the radioactive waste producers (EDF, Orano, CEA, hospital, research centres, etc.) for the operation and monitoring of the disposal centres, examination of the waste management requests, waste processing and storage, or international projects;
- A public subsidy for production of the National Inventory, the collection and management of radioactive objects from private individuals and local authorities and the rehabilitation of sites contaminated by radioactive substances when the responsible party has defaulted;
- A tax assigned to research on the Cigéo project and a special contribution for the facility design studies and preliminary work, both financed by the 3 waste producers (EDF, CEA, Orano).

Pursuant to Article L. 542-12-1 of the Environment Code, Andra manages an internal "Research fund" for financing the research and studies on the storage and deep geological disposal of high-level and intermediate-level long-lived radioactive waste (Cigéo project). This Research fund is financed by an additional tax to the "Research" tax that already exists for nuclear facilities. 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 have been financed by an Andra internal "design" fund (Environment Code), financed in turn by a contribution paid by the waste producers. The Finance Act 2022 has extended the existence of this fund until the date of publication of the creation authorisation decree and at the latest until 31 December 2025. The Order of 24 December 2020 has set new coefficients.

The nuclear facility 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 necessary assets 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 www.andra.fr/nos-publications.

7.2.4. CEA's human and 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" facilities, including the waste produced and stored on the sites during the operation of these facilities, the financing is based on funding from the State budget, which currently stands at €780M per year. At the same time, CEA is applying measures to reduce the operating costs and fixed costs associated with the shutdown facilities, while at the same time ensuring an appropriate level of safety, so as to free additional resources for the clean-out, decommissioning and waste retrieval and conditioning (WRC) 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.

Lastly, 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.

CEA's organisation is presented in the Appendix 13.6.2. As at 31 December 2022, CEA counted 16,848 permanent employees. Female employees represented 34.6% of the staff. At that date CEA also hosted 1,530 doctoral students and 183 post-doctoral researchers. The employees assigned to CEA's civil programmes are divided among 5 centres located in Paris-Saclay, (comprising two sites at Fontenay-aux-Roses and Saclay), Cadarache, Marcoule and Grenoble.

The human resources assigned to nuclear safety, excluding the staff assigned to radiation protection or safety, represent some 300 qualified employees in the operational units, the centres and CEA head office: Particular attention is devoted to ensuring that the appropriate human resources are constantly assigned to nuclear safety.

7.2.5. Orano's human and financial resources

Orano is administered by a Board of Directors comprising three members at least and eighteen members at the most including, if necessary, a state representative and administrators appointed by the General Meeting of Shareholders on proposal by the State. As at 15 February 2023, the Board of Directors comprised 13 members: 10 members appointed by the General Meeting (including 5 administrators – natural persons appointed on proposal by the State, 2 members representing the employees designated by the trade unions and 1 State representative.

The aim of the separation of the functions of Chairman of the Board and of Director General put in place in 2017 is to ensure there is a clear distinction between the strategic guidance, decision-making and oversight functions exercised by the Chairman of the Board of Directors and the operational and executive functions exercised by the Director General. The Director General, as a member of the Board of Directors, participates in determining the strategic directions of the company and the group.

The group's Executive Committee is made up of the directors of each Business Unit and the directors of the group's main support functions.

As at the end of 2023, Orano employed 16,507 employees, virtually all of them (apart from support functions) in the nuclear sector. The hierarchy of each unit is responsible for deciding on the allocation of competent personnel to the performance of the required tasks and thus assessing their competence. It does this on the basis of their initial training and experience and determines whether there is a need for additional training and qualification or clearance for specific tasks. It receives support from the competent services of the human resources department and its functional extensions within the establishments, which are responsible for providing training and keeping training records.

The gross turnover of the Orano group in 2023 was €4,775M and the net income was €322M. 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 decommissioning costs, the cost of legacy waste retrieval and conditioning (WRC), the costs of long-term management of radioactive waste packages and the costs of surveillance and monitoring after closure of the disposal facilities.

As at 31 December 2022, Orano's provisions for end-of-cycle operations totalled €7,808M for all of the group's nuclear facilities concerned under the Environment Code (€7.5M in market value). These provisions concern the following subsidiaries and sites: Orano La Hague, Marcoule, Pierrelatte and Cadarache, as well as the undertakings made for SICN, Orano Malvési and Marcoule (Melox), EURODIF-Pro, SOCATRI and SOMANU.

The French State is a major shareholder in the Orano limited company, for which the shareholder breakdown as at the end of 2023 was as follows:

Shareholder	% of the capital
French State	**89.47%**
CEA	**0.0000004%**
Japan Nuclear Fuel Limited	**5.26%**
Mitsubishi Heavy Industries, Ltd	**5.26%**
TOTAL	**100%**

7.2.6. EDF's human and financial resources

At the end of 2023, the workforce of the EDF Nuclear Production Division (DPN) in charge of operating the nuclear reactors, stood at about 22,867 employees spread over the 18 production sites and the 2 national engineering units. Engineers and managerial staff represent 36% of the headcount (8,376 employees), supervisors 60% (13,620 employees) and technicians 4% (871 employees).

Added to this are the EDF human resources devoted to design, new constructions, engineering of the fleet in service and support functions, and to the dismantling of nuclear reactors: about 4,600 engineers and technicians in the New Nuclear Projects Engineering Department (DIPNN), 973 engineers and technicians in the Dismantling/Waste Projects Department (DP2D), 2,293 engineers and technicians in the Nuclear Fuel Division (DCN), and nearly 2,000 engineers and technicians in the EDF Research and Development Division (EDF R&D).

The headcount has increased in the last few years to match the renewal of skills and to have the necessary manpower for the projects concerning the operational nuclear fleet. There have been many recruitments: in the space of 5 years nearly 3,800 new employees have joined DPN (16% of the headcount).

Training course figures are also greatly increasing and reached 2.6 million hours for the DPNT in 2023.

With regard to engineering, the New Nuclear Projects Engineering Department (DIPNN) has been running a "nuclear engineering key skills development plan" (PDCC) since 2006, 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 forward-looking management of jobs and skills.

In 2022, the Group achieved consolidated sales of 143.5 billion euros, a gross operating surplus (EBITDA) of 5 billion euros and a net income of 12.7 billion euros.

The provisions created by EDF SA at the end of 2022 (in updated values in accordance with international standards) amounted to about 23.9 billion euros for the end of the nuclear fuel cycle (management of spent fuel and long-term management of radioactive waste) and about 19.5 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 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 pro rata 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 57 power reactors in service, for which annual appropriations are determined each year, and the provisions for the decommissioning of the 11 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 2022, these dedicated assets represented an actual value of 33.9 billion euros, as compared with the 31.7 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 has taken over the Romans-sur-Isère nuclear site. For the Romans site, the provisions set up by Framatome as at the end of 2022 amounted to about 111 million euros for decommissioning and the management of the corresponding radioactive waste.

7.2.7. ILL's human and financial resources

The Laue Langevin Institute (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 world's most intense neutron source used essentially for fundamental research.

The Laue Langevin Institute is managed by three associate countries: France (CEA and CNRS), Germany and the United Kingdom. Eleven scientific partners also take part in its financing. Its budget for 2023 was €116M.

At the end of 2023, ILL headcount stood at 562 employees of 30 different nationalities. About 30 employees are assigned to safety (including conventional safety and radiation protection). ILL also draws on external skills and expertise.

The financial resources of ILL are provided by the associates, who account for more than half the budget (about 69%), the scientific members (about 18%), but also through industrial resources and participation in national and regional projects.

7.3. Quality assurance (Article 23)

> *Each Contracting Party shall take the necessary steps to ensure that the appropriate quality assurance programmes concerning the safety of spent fuel and radioactive waste management are established and implemented.*

7.3.1. Regulatory provisions

The provisions relative to the quality of design, construction and operation of the nuclear facilities are described in the BNI Order. This Order includes general provisions that the licensee must follow for the protection-important components and activities (PIC and PIA), such as to guarantee that they effectively protect interests, including the safety of the facility. More specifically, the licensee must define the requirements that each protection-important component or activity must comply with so that it can fulfil its role as stipulated in the safety case. Consequently, these requirements are called “defined requirements”.

Furthermore, the PICs must be qualified so as to guarantee their ability to perform their functions with regard to the loadings and ambient conditions associated with the situations in which they are needed; and the PIAs must be carried out such that they satisfy the requirements defined for these activities and for the PICs concerned by these activities. The PIAs must be carried out by persons with the necessary skills and qualifications and be checked by other persons.

The order also stipulates that the licensee must define and implement a management system enabling it to ensure that the requirements concerning protection of the interests of the nuclear facilities system are systematically taken into account in all decisions concerning its facility. The licensee must thus set up, formally define and seek to improve a plant-specific integrated management system ensuring that the requirements concerning the protection of the protected interests are taken into account in the management of its facility.

This order also requires that:

- the detected deviations and significant events be corrected with due diligence and that preventive and corrective measures be implemented;
- suitable documents provide evidence of the results obtained;
- the licensee monitors its contractors and checks that the organisation implemented to guarantee quality does indeed operate satisfactorily.

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

7.3.2. Andra’s quality assurance policy and programme

The protection of interests – integrating nuclear safety in particular - is a priority for Andra. Andra's policy is based on the following principles:

- a commitment to achieve a high level of protection of interests as a nuclear licensee;
- a clearly defined system of responsibility, committing the licensee in the first instance;

- the organisation in place implies formal sequencing of power delegations enabling the holder of the delegation to have the necessary authority and the technical and material means as well as the skills necessary to exercise that responsibility;<0}
- the deployment of competent support services;
- a resilient organisation to manage emergency situations;
- the deployment of functions dedicated to the "protection of interests".

As with the other Andra facilities already in operation, management of the protection of interests is based essentially on:

- a policy of protecting the interests (which meets a requirement of the BNI Order) explicitly stating the priority given to the protection of interests over and above any other consideration;
- an appropriate organisation and human, material, and financial resources to implement this policy;
- an integrated management system (IMS) that ensures that the requirements relative to protection of the interests are always taken into account in any decision concerning the facility;
- technical and organisational provisions to control the activities governed by the IMS, whether they are activities important for the protection of interests (PIAs) or any other activity relating to the protection of interests;
- continuous efforts to improve the measures implemented.

This policy satisfies all the requirements of the applicable regulations, the prescribed commitments and the baseline requirements set in particular by the standards ISO/IEC, EN ISO 9001 of 2015, EN ISO 14001 of 2015 and ISO 45001 of 2018 to which Andra is certified.

This approach integrates the organisation and human aspects and involves all the service providers.

7.3.3. CEA’s quality assurance policy and programme

The main aim of CEA's policy is to make the organisation an exemplary and innovative player while also guaranteeing protection of the interests mentioned in Article L. 593-1 of the Environment Code (occupational safety, public health and safety, protection of nature and the environment) and optimising the financial resources assigned to it. Consequently, the protection of interests is a priority theme for CEA, for the implementation of the Medium/Long-Term Plan (PMLT) and the State-CEA multi-year objectives and performance contract.

CEA's main quality measures concern project-based management, identification of processes, control of their interfaces and production of a generic internal reference baseline defining the applicable rules, the associated organisation and the appropriate training. This management system is applied in the operational department which operates the nuclear facility, namely the Energies Department (DES) and in the departments of CEA centres in which the nuclear facilities are installed. Some of these departments have obtained ISO 9001 or 14001 certification of their system as implemented and/or the COFRAC (French accreditation committee) accreditation for laboratories (standard ISO/IEC 17025).

With regard more particularly to the Energies Department, which received AFNOR ISO 9001 and 14001 certification in November 2022, its integrated management system is managed by processes set out in documents and procedures with provisions that enable it to check compliance with the requirements of the BNI Order, particularly in terms of quality, for the activities important for protection of the interests indicated in Article L. 593-1 of the Environment Code.

In the area of design, construction, operation and decommissioning of the nuclear facilities, CEA has a project management documentary baseline that integrates the waste management requirements, including the regulatory obligations.

In this baseline the good practices are identified, enhanced and made available to all the units concerned. Remarks and non-compliances may be highlighted by audits and internal inspections, in which case they lead to both corrective and preventive measures.

7.3.4. 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 SO 45001 integrated management systems, certified on all the sites concerned, thereby meeting the requirements of the BNI Order. This certification is periodically reassessed by a third-party organisation.

Since 2022, Orano also deploys the IS0 19443 certification to reinforce the safety culture and control of critical supplies, in its entities and Business Units (BU) (Orano Project BU, Nuclear Fleet Operations Department of the DS BU are certified, Orano Temis of the RE BU and the NPS BU have started a certification process with completion targeted for late 2025) and for its main regular suppliers concerned by safety-important activities or components.

Lastly, two sites (La Hague and Tricastin\SET) received ISO 50001 certification in 2022.

In application of the regulatory provisions of the Environment Code and the BNI Order, Orano selects outside contractors through an assessment of their ability to work safely on its sites or in its activities, and it monitors its service providers and their subcontractors. Orano group's Safety-Health-Environment Policy (accessible on http://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. Lastly, Orano systematically implements the formal oversight plan for contracts with major safety or environmental protection implications.

7.3.5. 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 life cycle of a nuclear facility (design, construction, operation and decommissioning), the EDF entities (Nuclear Production Division and the entities of the New Nuclear Projects Engineering Department, the Dismantling Projects and Waste Department, the Nuclear Fuel Division, and the Fleet Engineering, Dismantling and Environment Division, working on behalf of the nuclear facilities) 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 assigned 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 programme focuses in particular on the quality of work done, contracts giving more importance to the “best bidder”, and facilitation of the working conditions in the field.

7.3.6. ILL's quality assurance policy and programme

ILL applies a policy with regard to protection of the interests mentioned in Article L. 593-1 of the Environment Code (occupational safety, public health and safety, protection of nature and the environment), in which the institute's senior management undertakes to give priority to nuclear safety and to limit the environmental impacts of its activities. This policy is set out in an integrated management system (IMS), thereby complying with requirements of the BNI Order.

The IMS structure is based on an approach in which processes are grouped by category and which covers all ILL activities linked to the protection of interests:

- “operational” processes for ILL's core activities (operation of the reactor and the scientific instruments for scientific output),
- “support” processes for the activities supporting the core activities (human resources, safety, radiation protection, etc.),
- “control” processes, for the activities specific to the integrated management system (continuous improvement, documentation management, etc.).

Operation of the IMS is based primarily on:

- the process coordinators, who ensure that their process is correctly applied and improved,
- the quality, safety, risks Unit (CQSR), which guarantees the overall consistency and improvement of the IMS,
- senior management’s engagement which, via the Protection of Interests Policy, sets the short and medium-term priority strategic lines and ensures that the human resources needed for operation of the processes are available.

The “safety” process comprises the identification methodology and the list of PICs and PIAs, along with the corresponding defined requirements.

A process defines the monitoring of the contractors working on PIAs, which uses specifically trained assignment managers. In addition, audits of the working personnel are carried out by the CQSR in accordance with an annual programme or reactively.

Continuous improvement of the system and the protection of interests is ensured by the anomalies and deviations management and operating experience feedback (OEF) processes, but also via process reviews and IMS management reviews, as well as internal audits, or spot checks carried out by the CQSR.

7.4. Operational radiation protection (Article 24)

1. Each Contracting Party shall take the appropriate steps to ensure that during the operating lifetime of a spent fuel or radioactive waste management facility:

i) the radiation exposure of the workers and the public caused by the facility shall be kept as low as reasonably achievable level, economic and social factors being taken into account;

ii) no individual shall be exposed, in normal situations, to radiation doses which exceed national prescriptions for dose limitations which have due regard to internationally endorsed standards on radiation protection; and

iii) measures are taken to prevent unplanned and uncontrolled releases of radioactive materials into the environment.

2. Each Contracting Party shall take appropriate steps to ensure that discharges shall be limited:

i) to keep exposure to radiation as low as reasonably achievable, economic and social factors taken into account; and

ii) so that no individual shall be exposed, in normal situations, to radiation doses which exceed the national prescriptions for dose limitations which have due regard to internationally endorsed standards on radiation protection.

3. Each Contracting Party shall take appropriate steps to ensure that during the operating lifetime of a regulated nuclear facility, in the event that an unplanned or uncontrolled release of radioactive materials into the environment occurs, appropriate corrective measures are implemented to control the release and mitigate its effects.

7.4.1. Regulatory provisions

The regulatory framework is presented in section 6.2.1.

7.4.2. Radiation protection and effluent limitation at Andra

Radiation protection and effluent limitation are major focuses of Andra's environmental policy. Annual reports are published for each site and can be consulted on Andra's website at www.andra.fr/nos-publications.

Radiation protection objectives

Andra considers that, for the public, the radiological 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. 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 the 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.

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 objectives of monitoring and surveillance cover 3 themes: verification that there is no impact, checking of compliance with the technical requirements issued by the administrative authority (ASN for the CSA repository and the Prefect for Cires) and detection of any abnormal change as early as possible.

Radiological measurements are taken in 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 dosimetry 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.

In 2022, the annual radiological impact of the Manche and Aube repositories on the reference group[11] for an adult is estimated to be less than a Nano Sievert, a value that is far below the reference of 1 mSv/year.

7.4.3. Radiation protection and effluent limitation at CEA

Occupational radiation protection

The control of external and internal exposure of workers at CEA starts from the design of the facilities and continues throughout their operational life and their decommissioning in accordance with the ALARA optimisation principle. The work organisation provides for:

- zone delimiting/signalling according to the exposure risks,
- radiological monitoring of the workplaces by real-time or deferred time measuring devices (external and internal exposure),
- classification of the workers further to the exposure evaluation and optimisation procedure and individual monitoring of exposure to ionising radiation,
- individual monitoring of occupational exposure to ionising radiation by personal dosimetry monitoring for external exposure (passive or active dosimetry) or internal exposure (by whole-body radiation measurements and radiotoxicological analyses), depending on the type of radiological risk.

In 2022, 6,533 CEA workers were subject to personal dosimetry monitoring by reference dosimetry (passive dosimetry). For 87% of the workers, the dosimetry showed no results above the recording threshold (50 µSv for the passive dosimeters used at CEA). For the others, the average annual individual dose was 0.23 mSv/year. The maximum dose measured over the year was 3.8 mSv.

Limiting effluent discharges

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 part of these effluents may be either filtered before discharge to reduce the environmental impact, or stored and/or transferred to a facility for 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. The continuous improvement of the

[11] A reference group is a group of individuals of the population for which the exposure from a given source is relatively uniform and which is representative of the individuals who receive the highest doses from that source.

environmental performance of the facilities and processes has allowed a gradual reduction in effluent emissions into the environment for many years now.

The environmental discharge of these radioactive effluents is authorised subject to regulatory requirements (annual and monthly limits, maximum limits on the concentrations added to the receiving environment), as are the discharge conditions and the methods of environmental monitoring.

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.

Thus, for the public situated outside the bounds of the various CEA centres, the impact of the discharges calculated from the actual discharges from the facilities of each centre, although based on conservative assumptions, is extremely low, with an annual dose estimate for the reference groups that is always very much lower than 10 µSv/year.

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.

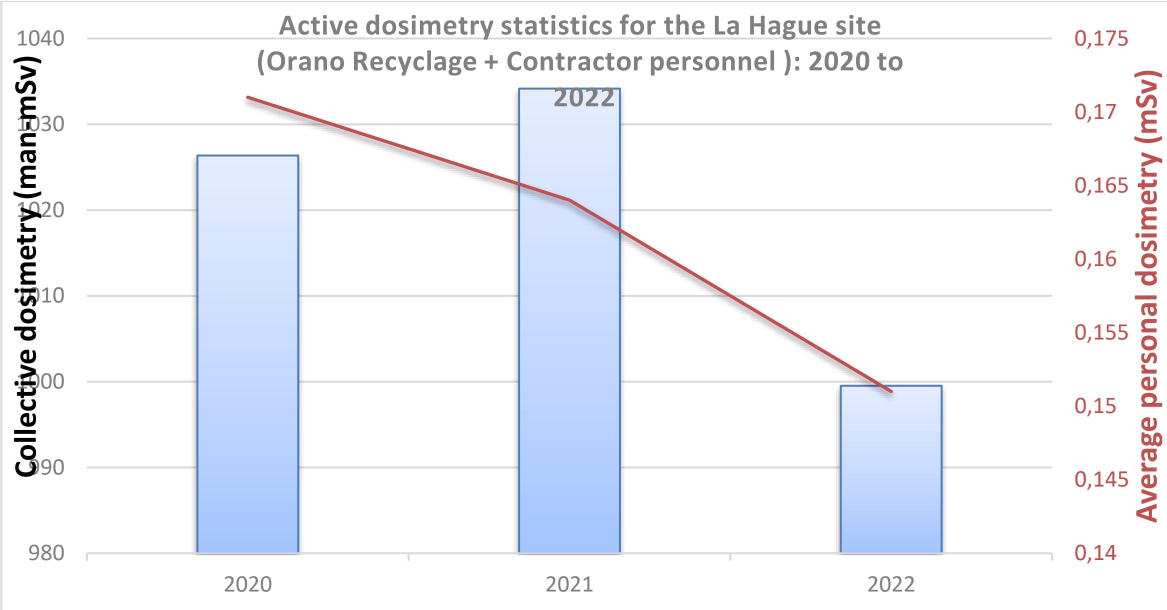
This monitoring ensures that the measures taken by the facilities are effective. Samples are taken from the main radionuclide transfer routes in the different environmental compartments (surface water, water table, atmosphere, soil and sediments, flora and fauna) and analysed in CEA's test laboratories. The monitoring results are widely accessible to the public via the CLI information and CEA centres' nuclear safety and radiation protection report, drawn up each year under the "Nuclear security and transparency" Act.

Environmental monitoring represents several tens of thousands of radiological and physical-chemical analyses each year, the results of which are close to the quantification limits of laboratories' measurement protocols. Tritium is the main artificial radionuclide detected at levels of a few tens of Bq/L in the environmental waters of certain centres and in grass samples taken from the environment on the sites with the highest emissions authorisations.

7.4.4. Radiation protection and effluent limitation at Orano

Occupational radiation protection

Control of worker exposure has always been one of Orano's major responsibilities. 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. The average dose in 2022 was 0.15 mSv/year and the collective dose was 999.5 man-mSv for 847,197 interventions by 6,606 workers.



Doses received per year by the employees and outside contractors 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 generalising remote management of the operations;
- conventionally, by installing radiological shielding adapted to all the foreseeable operating and maintenance situations;
- by planning for extremely rigorous static and dynamic containment to prevent internal exposure;
- 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.), remotely, without breaking containment and under radiological shielding (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 level reasonably achievable, in view of current technology, economic factors and the nature of the operations to be performed, as prescribed in the French regulations.

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.

Impact of discharges

The liquid and gaseous discharges from the Orano facilities are monitored throughout the year to ensure compliance with the applicable limit values and allow rapid corrective action when necessary. Furthermore, to verify that the industrial site has no real impact, off-line monitoring (based on sampling) is carried out in the various ecosystems and along the entire radionuclide transfer chains leading to humans.

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.

Since 1999, Orano La Hague has set itself the target of keeping the radiological impact of its discharges below 0.03 mSv/year for the reference population groups or representative individuals, i.e., about 1% of the average exposure of the French population to naturally occurring radioactivity which is 5 mSv/year. The radiological impact of the site in 2022 was more than 100 times less than that of naturally occurring radiation. The impact of the discharges from the Orano la Hague on the population groups likely to be the most exposed was less than 0.01 mSv/year. This dose corresponds to less than 0.2% of the average exposure of the French population from naturally occurring radioactivity

In accordance with French regulations, the dosimetry is estimated annually as realistically as possible from the actual measured discharges and from impact calculation models developed and qualified under strict quality assurance procedures.

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 means for monitoring chemical and radioactive discharges, while ensuring permanent environmental monitoring. Each year Orano takes more than 100,000 measurements and analyses from about 1,000 sampling points around its sites for the purpose of environmental monitoring. The results of these analyses constitute in-depth environmental reviews of the impacts of the emissions in the air, water and waste. They can be consulted on the Orano website in the annual reports on nuclear safety transparency (TSN).

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 and they participate in the inter-laboratory comparisons organised by IRSN in order to obtain the approvals.

All the regulatory monitoring data are transmitted to the RNM managed by IRSN and published on the Internet. The radiological assessment of the RNM published every 3 years by IRSN reviews the measurements taken over 3 years. It concludes thar :

- The doses that the populations living near French nuclear facilities could receive, estimated from the measurement results, are very low.
- These doses are in good agreement with those estimated by calculation (modelling of dispersion and transfers) by the nuclear site licensees, based on the activities actually discharged.
- Knowledge of the environmental radioactivity, based on the various environmental monitoring programmes of the French nuclear sites, makes it possible to estimate the essential part of the doses that could be received by the neighbouring populations.
- It also helps to validate the licensees' calculations based on the discharges and the dosimetric impact calculation models.

Informing the public

Orano's actions regarding safety and the environment are accompanied by a constant dialogue with the French and foreign stakeholders. These exchanges take place by various means, including participation in discussion forums, visits to industrial sites, participation in suppliers' associations, in meetings, in local sessions of national debates, etc. For example, in France the group is a member of the HCTISN and actively contributes to its work. It also participates in the consultation meetings for the National Radioactive Materials and Waste Management Plan (PNGMDR).

In consideration of the operational context of each site on which it operates, the group participates in the bodies for discussion with the local populations and stakeholders. In France, the group maintains a longstanding and regular dialogue with the local stakeholders, particularly through the local information committees (CLI) and the site monitoring commissions (CSS).

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.

7.4.5. Radiation protection and effluent limitation at EDF

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. This section therefore concerns the operation of nuclear power reactors as a whole.

The various radiation protection measures implemented on the EDF fleet have reduced the collective dose of the workers (EDF and industrial partners) to 0.72 man-Sv/plant unit in 2023.

From the personal dosimetry aspect, these measures have reduced the dosimetry of the most exposed workers. In 2023, particular cases excluded, no worker presented a dose (over 12 sliding months) exceeding 14 mSv. The average individual dose is less than 1 mSv/year, which represents the annual limit for the public.

Among the noteworthy radiation protection actions undertaken over the last few years, a Risk Prevention Supervision Station has been installed in all the nuclear power plants (NPPs). This station allows the remote monitoring of the worksites involving significant risk-prevention and radiation protection challenges, while anticipating possible radiological changes.

Multi-year monitoring of the dispersible inventory has been put in place, allowing targeting of the plant units undergoing major operations (chemical clean-out for example), with regard to the radiological situation and the industrial programme for the coming years.

Some measuring equipment has been replaced by new equipment with better measurement and detection characteristics. In particular, the C2 radiation portal monitors at the exit from controlled zones have been replaced.

A "high performance" contamination detection sensor is currently being deployed on the sites. The sensor can measure low levels of contamination in environments with a high background radiological level. This sensor has been developed in view of the problem of contamination transfer raised by various recurrent body contamination incidents.

To improve the identification and characterisation of the dispersible inventory of the plant units, a gamma camera is currently being deployed on the sites. This gamma camera enables the origin of the equivalent dose rates to be better identified in terms of localisation and radiological characterisation. This enables the installation of biological shielding to be optimised, for example. The possible usages will be extended as this tool becomes more widely used.

These developments will continue in the years to come, with the aim of obtaining results close to those of the world's top licensees.

The Euratom Directive 2013-59 was transposed into the French regulations in 2018. EDF's radiation protection reference baseline has been rewritten, incorporating the regulatory changes and simplifying implementation by the NPPs.

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.

Radioactive effluent discharges and environmental monitoring

The liquid and gaseous effluent discharges are subject to general regulations which define more specifically: the procedures for obtaining the discharge licences; 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 discharges and their potential radioactive impact 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 limiting the environmental and dosimetric impacts. The efforts to limit effluent discharges by improving the effluent collection and treatment channels and by reducing their production at source are continuing, as well as by raising personnel awareness.

These measures have reduced very significantly the liquid radioactive effluent discharges (apart from tritium and carbon-14, whose production is proportionate to the amount of electricity produced), which originally had the biggest impact on the environment and on the exposure of the neighbouring populations (dose). The large reduction in liquid discharges observed for several years now (divided by 100 since 1984) means that today the dosimetric impact that can be attributed to the radioactive discharges from an in-service NPP is essentially due to discharges of tritium and carbon 14.

The dosimetric impact (or dose to the neighbouring populations) remains low since it is roughly a few µSv per year, calculated for a representative person. This value is well below the natural exposure level in France (2,400 µSv/year) and below the exposure limit set for the public in the Public Health Code (1,000 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 checking effluent discharges and monitoring the environment. This programme, established in agreement with ASN, is conducted under the licensee's responsibility.

In addition to the controls and measurements carried out on the effluent discharges, EDF deploys significant means for measuring the radioactivity around its nuclear facilities in order to detect any abnormal change in the environmental radioactivity levels and to have good knowledge of these levels in the environment of the sites and their possible changes in time and space. These surveillance measures cover the various external and internal human exposure pathways (inhalation and ingestion).

The results of the measurements taken for the purpose of checking discharges and environmental monitoring are communicated to 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.

Further to the setting up of the National Environmental Radioactivity Measurement Network (RNM - www.mesure-radioactivite.fr) (see section 6.2.1), all the environment laboratories of the EDF NPPs have undertaken a procedure with the aim of obtaining ASN approval for taking the main routine measurements used for monitoring environmental radioactivity, the results of which are transmitted to this network and, at the same time, obtaining accreditation per standard EN ISO/IEC 17025.

Furthermore, a ten-yearly assessment of the radiological status of the site and its environment, comparable with the "background level" assessment performed when the first reactor of a site is commissioned, is carried out voluntarily by the licensee. Depending on their age, all the sites have now carried out either their third or their fourth ten-yearly assessment.

Each year EDF thus takes some 50,000 regulatory measurements to which it voluntarily adds hundreds of annual expert appraisal measurements to characterise more finely the radiological status of the environment of its nuclear facilities. All these measurements confirm the very low impact of radioactive discharges from the NPPs on humans and the environment and the general reduction in the activity of artificial gamma-emitting radionuclides measured in the monitored environmental matrices.

7.4.6. Radiation protection and effluent limitation at ILL

The Radiation Protection Safety Environment Department (SRSE) of ILL acts as a Radiation Protection Competence Centre for prevention of the risks of exposure to ionising radiation as defined by the Labour Code and the Environment Code.

The main duties of the Radiation Protection Competence Centre concern:

- radiation protection zoning, defining it, conducting the corresponding periodic verifications and management of temporary zoning modifications,
- assessing the radiological risks at the work stations,

- optimising radiation protection by defining means of prevention and protection and establishing dose predictions,
- ensuring the dosimetric monitoring of the workers,
- managing and monitoring radioactive sources.

The water intakes from the environment, the management, monitoring and removal of radioactive effluents and cooling waters are carried out in accordance with the water intake and effluent discharge management plan provided for in title IV of the BNI Order.

The SRSE is the guarantor of compliance with the requirements of the orders, resolutions and agreements with regard to discharges. It gives the authorisation for the discharges in question. It is responsible for establishing the water intake and discharge forecasts, the results of monitoring measurements and the annual reports required by the regulations. The water intakes and the volume and toxicity of the liquid and gaseous effluent discharges into the environment are minimised. The water intakes are measured and monitored. The liquid and gaseous effluent discharges are quantified and characterised.

7.5. Emergency preparedness (Article 25)

1. Each Contracting Party shall ensure that before and during operation of a spent fuel or radioactive waste management facility there are appropriate on-site and, if necessary off-site emergency plans.

2. Each Contracting Party shall take the appropriate steps for the preparation and testing of emergency plans for its territory insofar as it is likely to be affected in the event of a radiological emergency at a spent fuel or radioactive waste management facility in the vicinity of its territory.

7.5.1. General organisation for emergencies in the nuclear facilities

Protection of the populations against the risks created by nuclear facilities is based on several pillars:

- risk reduction at source, wherein the licensee must take all steps to reduce the risks to a level that is as low as possible in acceptable economic conditions;
- the emergency and contingency plans, designed to prevent and mitigate the consequences of an accident;
- control of urbanisation around nuclear facilities;
- informing the populations.

The emergency and contingency plans relative to accidents occurring in a nuclear facility define the measures necessary to protect the site personnel, the neighbouring population and the environment, and to control the accident.

How radiological emergency situations are dealt with is specified in the interministerial directive of 7 April 2005 on the action of the public authorities in the case of an event leading to a radiological emergency situation. At national level, ASN participates actively in the interministerial work on nuclear emergency management.

In an emergency situation, several parties have the authority to take decisions locally:

- The licensee of the affected nuclear facility deploys the response organisation and the resources defined in its on-site emergency plan.

- ASN has a duty to monitor the licensee's actions in terms of nuclear safety and radiation protection. In an emergency situation, it uses IRSN's assessments and can at any time require the licensee to perform any assessments and take any actions it deems necessary.
- The Prefect of the département in which the installation is located takes the necessary decisions to protect the population, the environment and the property threatened by the accident.
- the Prefect of the defence and security zone is responsible for coordinating reinforcements and the support needed by the Prefect of the département, for ensuring that the steps taken between départements are consistent, and for coordinating communications between the regional and national levels.
- Owing to his or her role in the local community, the mayor has an important part to play in anticipating and supporting the measures to protect the population. Under the responsibility of the mayors, the local response plans (PCS) provide for certain provisions and means to respond to the risks identified on their municipalities.

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 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.

7.5.2. Role and organisation of ASN

ASN is involved in the management of emergency situations, for the questions concerning the monitoring of nuclear safety and radiation protection and, backed in particular by the expertise of its technical support organisation, IRSN.

ASN is tasked with the following four duties:

- check the steps taken by the licensee and ensure that they are appropriate;
- advise the authorities on population protection measures;
- take part in the dissemination of information to the population and media;
- act as competent authority within the framework of the international Conventions on Early Notification and Assistance.

In the same way as in a normal situation, ASN acts as the regulatory authority in an accident situation. In this particular context, ASN ensures that the licensee exercises in full its responsibility for keeping the accident under control, mitigating the consequences, and rapidly and regularly informing the public authorities. It can at any time require the licensee to perform appraisals and take the necessary actions, without however taking the place of the licensee in the technical management of the facility.

Focus on the steering committee for managing the post-accident phase (Codirpa)

In 2005, at the request of the Prime Minister, ASN set up a Steering Committee for the Management of the Post-Accident Phase (Codirpa) to prepare for management of the post-accident phase, following on from the management of a radiological emergency.

This pluralistic committee comprises experts, representatives of the State's services, local elected officials, local information committees (CLI), associations, etc. It focuses on addressing, over time, the economic, sanitary, environmental and social consequences of lasting environmental contamination by radioactive substances following a nuclear accident, with a view to restoring a situation that is considered acceptable. The approach followed by Codirpa resulted in the publication first in 2012 and then in 2022 of a proposal for a national doctrine for the post-accident management of a nuclear accident. These recommendations were taken up by the Government in the national crisis planning, particularly in the National Major Nuclear or Radiological Accident Response Plan.

The recent work of Codirpa has integrated the lessons learned from the Fukushima nuclear accident and from the national emergency exercises in the national strategy for post-accident management of the consequences of a nuclear accident. The work currently being done by the committee has also resulted in the defining of a strategy to reduce the contamination of an area affected by a radiological or nuclear accident related to management of the associated waste, while taking account of the risks for the various types of environments affected (urban, agricultural, forest, etc.).

Since 2021, Codirpa has increased public involvement in its work by setting up citizen panels to discuss and consolidate its draft recommendations.

7.5.3. Emergency organisation for accidents not involving nuclear facilities

Apart from the incidents or accidents which could affect nuclear facilities or radioactive substance 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;
- if radioactive sources are discovered in places where they are not supposed to be.

In these situations, it is necessary to take action to limit the risk of exposure of individuals to ionising radiation.

Together with the Ministries and the parties concerned, ASN thus drafted the Circular of 23 December 2005 relative to the principles of intervention in the case of an event that could lead to a radiological emergency, other than situations covered by a contingency plan or an emergency response plan.

7.6. Decommissioning (Article 26)

Each Contracting Party shall take the appropriate steps to ensure the safety of the decommissioning of a nuclear facility. Such steps shall ensure that:

i) qualified staff and adequate financial resources are available;

ii) the provisions of Article 24 with respect to operational radiation protection, discharges and unplanned and uncontrolled releases are applied;

iii) the provisions of Article 25 with respect to emergency preparedness are applied; and

iv) records of information important to decommissioning are kept.

7.6.1. Regulatory provisions and non legally binding provisions

Given that a nuclear facility remains subject to the regulations applicable to basic nuclear installations for as long as it has not been delicensed, the provisions applicable to the licensee's technical and financial resources, to the qualification of the personnel, to the in-service radiation protection, to the emergency organisation and to the documents, continue to apply. These regulatory provisions are presented in 6.2.3.

Decommissioning plan

The regulations require the licensee to provide a decommissioning plan for all nuclear facilities as of their creation authorisation application. This plan must be updated regularly, particularly when the facility is commissioned, when the creation authorisation decree is modified in any way, if necessary, when the facility undergoes modifications, each time a periodic safety review is submitted, and when final shutdown is declared.

This plan must more specifically present, with the necessary justifications, the planned operations, the decommissioning methodology and steps, the equipment and the times frames. It must also present the waste management methods, taking into account the existing or projected management solutions and the methods of effluent management.

Decommissioning management

ASN subjects the decommissioning operations conducted by the licensees to two levels of assessment. 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 decommissioning operations. Its purpose is to assess the measures proposed by the licensee in the submitted files: decommissioning request for the facility in question (transition from the authorisation decree to a decommissioning decree), periodic safety reviews and modifications of the facility.

Clean-out of structures and soils

The decommissioning and clean-out operations for a nuclear facility 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 facility 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 areas called "potential nuclear waste production 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 "potential nuclear waste production areas" are downgraded to "conventional waste areas".

In accordance with the provisions of article 8.3.2 of the BNI Order, “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”.

ASN thus updated and published in 2016 a technical guide relative to structure clean-out operations (Guide No. 14). In 2016, ASN also published a guide relative to the management of contaminated soils in nuclear installations (Guide No. 24).

Delicensing

The delicensing of a nuclear facility can take place after its decommissioning and clean-out. It is necessary to conserve the memory of the past existence of the delicensed nuclear facilities and, where necessary, to put in place utilisation restrictions as appropriate for the final state of the site. Either the licensee can demonstrate that the decommissioned facility and the land on which it was located present no risk whatsoever: in this case, passive institutional controls are always put in place (the aim of the controls is to preserve the information concerning the former presence of a nuclear facility on the plots concerned, to inform the successive buyers). 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 either restrictions on the utilisation of the site or the implementation of surveillance measures. In this case a public inquiry must be held.

7.6.2. Measures taken by CEA

Qualified personnel

In order to have personnel qualified in decommissioning and post operational clean out, CEA relies on its general skills management policy which hinges on 4 principles: have the necessary skills at all times; attract talent; provide career development opportunities and accompany the career paths; develop the skills.

The forward-looking jobs and skills management approach applied by CEA enables it to plan ahead for the short, medium and long-term needs and to make arrangements to have the necessary skills to fulfil its assignments at all times.

Financial resources

The large number of clean-out/decommissioning and WRC worksites is a severe constraint on the scheduling and execution of these projects in view of the human and financial resources governed by the State. CEA therefore applies a general strategy based on the prioritisation of these worksites, taking into account the management of the resulting material and waste movements and the organisation necessary for the management of these projects.

Applying a logic of proportionality to the risks, the prioritisation takes particular account of the dispersible inventory, the other nuclear and non-nuclear risks, the robustness of the lines of defence present in the facilities, the state of progress of the work, the state of knowledge, the monitoring costs and other fixed costs and the robustness of the studied scenarios. The progress of this strategy and maintaining the consistency of its components are monitored at central level.

Provisions concerning radiation protection during operation, effluent discharges and unplanned and uncontrolled releases

The radiation protection measures are based on the principles and provisions mentioned in 7.4.3. To limit the discharges of effluents and unplanned and uncontrolled releases in accordance with the "Avoid, Reduce, Compensate" approach, CEA ensures that:

- during the clean-out / decommissioning operations, measures are deployed to contain, filter and check the discharges;
- the waste sorting and characterisation rules enable the waste to be categorised for the appropriate management route (conventional route, nuclear route) with a high level of confidence;
- the radioactive waste is conditioned in dedicated packages in compliance with the safety requirements applicable for their interim storage, transportation and final disposal;

- conventional waste does not contain any added radioactivity, which is verified through control measures set up as successive lines of defence (waste zoning, radiological measurements in the facility and when leaving the site).

Lastly, on completion of the decommissioning and final clean-out operations, CEA determines the radiological impact of any residual contamination and checks its compatibility with the planned future uses (nuclear site of lasting nature, site closed to the public, possibility of industrial use).

Emergency situation organisation

The emergency organisation during the decommissioning and clean-out phase follows the principles of emergency preparedness described in 7.5. CEA relies on its local level in the centres and its national crisis management level for the management of emergency situations. Depending on the nature of the accident, various expert assessments are conducted to determine the management measures required to return the facility to a defined safe state and to mitigate the consequences outside the facility.

Retention of information

All the historical information on the radiological state of the facility is recorded and kept throughout its lifetime until it is delicensed. All the documents recording work interventions indicating the procedures and protocols implemented to achieve the delicensing of the facility must also be kept. Once the facility is delicensed, these records are kept in CEA's archives department.

7.6.3. Measures taken by Orano

Within Orano, the end-of-cycle operations for nuclear facilities are placed under the responsibility of the Waste and Decommissioning Project Ownership Department (DPS2D), which assigns the Project Management duties to its Decommissioning and Services Business Unit (BU) or, for the WRC 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 the Environment Code (security, public health and safety, protection of nature and the environment), 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 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 and compatible with the envisaged uses.

The nuclear installations No. 69 and 90 located on the SICN site of Veurey-Voroize were delicensed and removed from the list of BNI. The delicensing of these two nuclear facilities and the introduction of active institutional controls enable the site to be completely reindustrialised, in partnership with the industries that are already established there.

The SICN site in Annecy, which accommodated nuclear activities regulated under the ICPE system, has undergone restoration and 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 and WRC studies and work which began several years ago, is continuing on the 4 nuclear facilities undergoing decommissioning. At the end of 2023, work progress had reached 42.3%.

On the Orano Tricastin site, decommissioning applications for the former enrichment plant George-Besse 1 (BNI 93) and the Uranium conversion facility (BNI 105) have been examined by the authorities and the corresponding decrees were signed on 16 December 2019 and 5 February 2020 respectively.

7.6.4. Measures taken by EDF

The aim of the dismantling programme currently deployed by EDF is to completely decommission the following facilities:

- nine shut down reactors: six graphite-moderated gas-cooled reactors at Chinon, Saint-Laurent-des-eaux[12] and Bugey; the Brennilis heavy water reactor, built and operated jointly with CEA; the Chooz A PWR reactor and the 2 Fessenheim PWR reactors; 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.

Nature of the facilities	Units	Power (MWe)	Industrial commissioning	Shutdown	BNI No.
6 GCR 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**
3 PWR reactors	Chooz A	300 MWe	1967	1991	**163**
	Fessenheim 1	900 MWe	1977	2020	**75**
	Fessenheim 2	900 MWe	1978	2020	
1 FNR 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		2000	2020	**157**

Table 15: EDF facilities in the decommissioning programme

In 2016, EDF redefined the decommissioning strategy for its GCR reactors, changing from a strategy based on reactor dismantling under water to dismantling in air, favouring remotely operated means. This new strategy comes with a more gradual approach aiming to "derisking" the operations by putting into service an industrial demonstrator and capitalising on the lessons learned from the first-off operation.

[12] The 2 reactors are grouped in a single facility.

Installation	DAD[13] 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	not applicable	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
Silos de Saint-Laurent A	30/09/22		
Chinon A1	16/12/22		
Chinon A2	16/12/22		
Chinon A3	29/09/06	02/03/07	20/05/10
AMI	20/06/13	16/06/17	30/04/20
Fessenheim 1 & 2	11/20	03/24	

Tableau 16: Administrative dates for the complete decommissioning decree

The schedule corresponding to the GCR reactor dismantling strategy is as follows:

- dismantling in air of a first-off reactor (Chinon A2) starting by 2030. With this in mind, in 2022 EDF built and commissioned and industrial demonstrator close to Chinon in which the remotely operated tools needed for these operations are tested;
- dismantling of the other 5 reactors after completing the first-off reactor 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 conduct all the dismantling programmes, the Waste and Decommissioning Project Ownership Department (DP2D) was created in 2016, and within this structure a project is dedicated to each of the structures currently being dismantled. The corresponding human and financial resources are mentioned in 7.2.7.

These measures guarantee that these operations will be able to be carried out under suitable conditions.

7.6.5. The case of ICPEs

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 of the state of the site specifying the actual or planned environmental protection measures. The licensee must restore the site to a state such that it presents

[13] Decommissioning authorisation decree.

no hazard or nuisance for the neighbourhood or the environment. 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 environmental protection, even after the site has been rehabilitated.

7.6.6. 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, which are established through an order called a *"second donné act"*), is to relieve the licensee of responsibility for policing the mines on condition that it has met all its obligations.

On completion of the normal 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 mining site ICPEs are the main potential sources of radioactive pollution of these sites, the mine policing orders simply accompany the orders issued on account of the ICPEs.

Although the order 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 22 August 2021, if the licensee is no longer solvent or has been liquidated, the State representatives can refer the matter to the court to have the responsibility of the licensee's parent company recognised and have the said company bear all or part of the cost of financing the work cessation measures of the sites that are ceasing their activity or the measures necessary to repair damages. Since the Act of 30 March 1999, in the event of the disappearance or defaulting of the responsible person or entity, if there is no parent company 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.

8 SECTION G | SAFETY OF SPENT FUEL MANAGEMENT (ARTICLES 4 TO 10)

8.1. General safety requirements (Article 4)

Each Contracting Party shall take appropriate steps to ensure that at all stages of spent fuel management, individuals, society and the environment are adequately protected against radiological hazards.

In doing so, each Contracting Party shall take the appropriate steps to:

i) ensure that criticality and removal of the residual heat generated during spent fuel management are adequately addressed;

ii) ensure that the generation of radioactive waste associated with the spent fuel management is kept to the minimum practicable, consistent with the type of fuel cycle policy adopted;

iii) take into account interdependencies among the different steps in spent fuel management;

iv) provide for effective protection of individuals, society and the environment by applying at the national level suitable protective methods as approved by the regulatory body in the framework of its national legislation which has due regard to internationally endorsed criteria and standards;

v) take into account the biological, chemical and other hazards that may be associated with spent fuel management;

vi) strive to avoid actions that impose reasonably predictable impacts on future generations greater than those permitted for the current generation;

vii) aim to avoid imposing undue burdens on future generations.

8.1.1. Regulatory provisions

In France, the civil spent fuel management facilities have the status of basic nuclear installations (BNIs). This system is said to be "integrated" because it aims to prevent or control all risks and detrimental effects a nuclear facility could create for people and the environment, whether or not these are of a radioactive nature. Radiological, biological, chemical and other risks are taken into account under the protection of the interests mentioned in the Environment Code (security, public health and safety, protection of nature and the environment).

The Environment Code and the BNI Order lay down the essential requirements applicable to nuclear facilities throughout their lifetime, from design through to delicensing:

- Control of the nuclear chain reactions, removal of thermal power resulting from the radioactive substances and the nuclear reactions, containment of radioactive substances, protection of individuals 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 facility.
- The provisions to be made by the licensees and their coverage by dedicated assets (these requirements for financing the long-term costs apply to the management of spent fuel).

These French regulatory provisions are designed to guarantee the safety of spent fuels in France. The possessors of fuel have therefore not identified any further safety requirements.

8.1.2. Measures taken by the licensees

8.1.2.1. Measures taken by CEA

CEA takes care to prevent the risk of dispersion of radioactive substances and to limit the exposure of workers to ionising radiation, whatever the facility and the nature of the radioactive substances concerned. 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.

The management of the spent fuel and the facilities concerned lies within this general principle with an integrated analysis of all the risks for the safety case from which the safety requirements stem, particularly for spent fuel management. Entities independent of those of the facility have an oversight function and the necessary authority to fulfil this role. The oversight function 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 measures taken by CEA consist in breaking down the safety requirements into technical and organisational provisions that guarantee compliance with the associated safety criteria, as part of the safety case.

8.1.2.2. Measures taken by Orano

The safety of the storage and spent fuel reprocessing facilities is a priority for Orano. The group formalises its nuclear safety and radiation protection commitments in a Safety, Health, Security, Radiation Protection, Environment Policy, renewable every 3 years, which aims to guarantee the best safety standards throughout the lifetime of its facilities.

Beyond applying the regulatory requirements, the Orano group:

- formalises its fundamental internal rules and capitalises on its good practices, particularly regarding the risk analysis, safety case and facility conformity verification,
- organises the sharing of experience and disseminating good practices for the benefit of the operational entities,
- has a body of safety inspectors, appointed by name by the Director General and tasked with verifying and assessing compliance with the regulatory requirements and correct application of the internal rules and good practices,
- promotes and develops the safety culture within the company by practising regular self-assessments of the safety culture with the operational entities and by cross-company sharing of strong points and improvement actions,
- accompanies job take-up and the enhancement of risk prevention skills through training courses and dedicated practical situation exercises, for the managers, heads of facilities, project managers and safety engineers.

8.1.2.3. Measures taken by EDF

The EDF Group's nuclear safety policy of 12 February 2021 applies to all the Group entities operating nuclear facilities or conducting activities or projects intended for the nuclear facilities: design, construction, equipment manufacture, provision of services, maintenance, supply of fuel, nuclear material transport, radioactive waste management, dismantling. It designates each entity as being responsible for its facilities and nuclear activities and affirms the absolute priority given to nuclear safety and the importance of a sound safety culture in the Group and in its industrial partners. It applies the principles stemming from the IAEA standards and fundamentals in particular, and details the associated requirements:

- each entity guarantees the safety of its facilities and its nuclear activities, and constantly seeks to improve safety and ensure compliance with the regulations in effect;
- each entity defines a safety management organisation and system;
- each entity takes into account the quality and safety requirements of its industrial partners;
- continuous improvement based on experience feedback, periodic safety reviews and peer reviews;
- all the entities maintain an effective emergency organisation;
- setting up of an independent safety assessment function, often structured as an "independent safety organisation" within each entity and at Group level;
- transparency and discussion, particularly with respect to the safety authorities.

Safety of spent fuel transport

The regulations governing the transport of radioactive goods are supplemented by a set of rules of good practice which constitute the common EDF-Orano baseline for the verification of non-contamination of spent fuel convoys. EDF has set out the regulatory requirements supplemented by good practices in the "EDF transport baseline" for the different types of radioactive transport (uranium-bearing materials, waste, fresh fuel and spent fuel):

- the consignor is responsible for the conformity of the consigned packages, particularly the quality of the checks and the consignment documents;
- providing the EDF and outside contractor employees involved in the transport of radioactive goods with training in the regulations applicable in this area;
- 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 operational 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.

8.1.2.4. Measures taken by ILL

ILL'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, etc.) are placed between the fuel elements, the personnel and the environment. Nuclear safety is a major priority for ILL. The head of the facility takes the necessary measures to implement the legislative, regulatory and particular provisions and requirements applicable to the Protection-Important Activities (PIA) presenting nuclear risks, and for the organisation of nuclear safety at ILL. The head of the facility is assisted by the Safety Unit (CS), the Quality, Safety and Risks Unit (CQSR) and the security and protection department of the Reactor Division, bodies tasked with preparing the decisions relative to the commitments and functioning with regard to nuclear safety. The heads of facilities ensure the nuclear safety of the activities, facilities and materials under their authority.

8.2. Existing facilities (Article 5)

> ***Each Contracting Party shall take the appropriate steps to review the safety of any spent fuel management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility.***

8.2.1. Regulatory provisions

The law obliges the licensees, in addition to the continuous analysis of experience feedback, to perform a periodic safety review of their nuclear facilities every 10 years. This process must allow continuous improvement of the safety of the facilities and may lead to modifications of the facility or its operating envelope. After examination and expert assessment of the licensee's periodic safety review report by ASN's technical support organisation, ASN notifies the licensee of its decision which sets any additional requirements for the continued operation of the facility.

8.2.2. Review of the safety of spent fuel management by the licensees

The periodic safety review comprises two main parts:

- a review of compliance of the facility with the applicable regulations and the safety and radiation protection baseline requirements in effect in the facility;
- a reassessment of the safety and radiation protection requirements applicable to the facility.

The licensee sends ASN a report containing the conclusions of the periodic safety review. In this report, the licensee presents the conclusions of the various inspections and analyses. It adopts a position firstly on the conformity of its facility with the regulations and its various technical baselines, and on the modifications already carried out or planned to remedy the deviations observed, and secondly on the standard of safety and radiation protection of the facility, proposing improvements where applicable. The periodic safety reviews show the importance of an *in-situ* verification of the conformity of the Protection-Important Components (PICs) that is as exhaustive as possible, or as representative as possible of the PICs that are not accessible. They also illustrate the need for a robust approach to the control of the ageing of fuel cycle facilities. This is the case in particular with the fuel cycle back-end facilities, for which control of ageing is a priority concern. After examining the periodic safety review report, ASN transmits its conclusions to the Minister in charge of nuclear safety and notifies the licensee of the resolution which sets the additional requirements for continued operation of the facility.

8.2.2.1. Safety review by CEA

CEA's spent fuel storage facilities are described in 5.1.2.

CEA implements a project-based organisation for the periodic safety reviews of the facilities. In view of the challenges and the means necessary for the carrying out the periodic safety reviews, they are all subject to multi-year scheduling. For each facility, the scheduling takes into account not only the regulatory 10-yearly review frequency, but also any planned significant modifications and what is to become of the facility in the event of definitive shutdown and decommissioning.

The periodic safety review provides proof that the measures in place or to be introduced are proportionate to the risks and allow the continued operation of the facility under conditions that ensure adequate safety and protection of interests through to the next safety review, on the basis of a consolidated safety case.

8.2.2.2. Safety review by Orano

Orano's spent fuel storage facilities are described in 5.1.2.

The ten-yearly safety review of these facilities is an important milestone in terms of safety, 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. It calls for continuous action within the Orano Group, which has set up an organisation dedicated to this, 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.

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 safety functions of the facility. 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.

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.

8.2.2.3. Safety review by EDF

In accordance with the French regulations governing nuclear facilities, every 10 years EDF conducts a safety review of its facilities by standardised plant series.

EDF also deploys a post-Fukushima programme which forms part of the response to the Fukushima nuclear accident (phases 1 and 2), and fits in with the safety aspirations for the 4th periodic safety review of the 900 and 1,300 MWe plant series or the 3rd periodic safety review of the 1,450 MWe plant series (phase 3). The hardened safety core will more specifically make it possible, in extreme situations (i.e., natural hazard significantly beyond the design-basis level), to prevent the risks of core melt, exposure of the spent fuel assemblies stored in pools or during handling and the risk of a spent fuel package and fuel assemblies being dropped during handling operations. This unprecedented industrial and investment programme is currently being deployed on the 900 MWe plant series on the occasion of the 4th periodic safety review and will be deployed on the 1,300 MWe plant series as of their 3rd periodic safety review.

Spent fuel cooling pools on the sites, storage and removal of spent fuel

The 4th periodic safety review of the 900 ad 1,300 MWe plant series and the 3rd periodic safety review of the 1,450 MWe plant series include the safety of the fuel building (BK) and of the fuel assembly cooling pool (cooling capacity and limits to observe, monitoring, operating procedures for incidents, resistance to internal and external hazards).

The scenarios examined are the risks of emptying of the spent fuel storage pools and of loss of cooling. The modifications currently being applied aim to prevent exposure of the fuel assemblies (examples include automatic stopping of the BK pool cooling system pumps on reaching very low level and measurement of the rate of emptying, which reduces very significantly the risks of the fuel assemblies being uncovered). Additional requirements have moreover been defined further to the Fukushima nuclear accident.

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 increase the robustness of the reactors to loss-of-cooling situations.

8.2.2.4. Safety review by ILL

For the 2017 periodic safety review, ILL detailed its strategy for defining the future functions and operating missions of the High Flux Reactor (HFR), and its duration.

ILL takes appropriate measures to:

- bring the facility to a level of safety equivalent to that of the new generation reactors;
- reduce personnel exposure to ionising radiation to as low a level as reasonably achievable;
- reduce the detrimental effects for the environment (discharges and waste) to as low a level as reasonably achievable.

ILL puts in place measures that reinforce the lines of defence (prevention, mitigation) or allow new lines to be added; these measures are materialised by requirements concerning the Protection-Important Components (PIC).

ILL uses its safety analysis methodology, which is regularly assessed by IRSN, to determine these reinforcement measures. The PICs and their defined requirements result from this analysis. ILL also conducts a conformity assessment, both regulatory and technical.

Thanks to the regular investments made in the HFR, the periodic safety review leads to a large number of modifications (structures, equipment, operating rules, etc.). The complete ten-yearly safety review file was submitted to ASN on 2 November 2017. A meeting of the Advisory Committee for Nuclear Reactors (GPR) was held in November 2020. The resolution authorising continued operation, accompanied by requirements, was issued by ASN in August 2022. The file for the next periodic safety review is to be submitted in November 2027.

8.3. Siting of proposed facilities (Article 6)

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed spent fuel management facility:

(i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime;

(ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment;

(iii) to make information on the safety of such a facility available to members of the public;

(iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In so doing, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 4.

Any spent fuel management facility is a nuclear facility in itself or forms part of a nuclear facility. Consequently, any new facility is subject to the general regulations governing nuclear facilities which, as regards the choice of sites, is presented in section 6.2.3.2.

New spent fuel storage pool project

For several years now EDF has been working on a new spent fuel storage pool project on the La Hague site, with commissioning targeted for 2034. A surface area of about fifteen hectares is planned to accommodate the facility and allow the subsequent possible addition of a second pool.

EDF examined several criteria: the availability of existing industrial land, the technical characteristics of the site (quality of the ground and underlying subsoil, low seismicity, etc.), the logistic and transport aspects, the presence of a well-established industrial fabric.

This choice of site takes account of the fact that the spent fuel that will be stored in this pool could undergo subsequent processing, which in principle will be carried out on the Orano La Hague site. It also takes account of the fact that the spent fuels to be stored in the EDF pool are already present on the Orano La Hague site. Choosing the La Hague site thereby limits the transport requirements.

The construction project underwent public consultation between November 2021 and July 2022, after which the report on the consultation findings and the follow-ups to it were published by EDF in October 2022. Further to this preliminary consultation, EDF put in place a permanent consultation which will continue until the public inquiry on the facility creation authorisation application is held.

8.4. Design and construction of facilities (Article 7)

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

i) the design and construction of a spent fuel management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a spent fuel management facility are taken into account;

iii) the technologies incorporated in the design and construction of a spent fuel management facility are supported by experience, testing or analysis.

The general regulations applicable to nuclear facilities are applicable to spent fuel management facilities. More specifically, the BNI Order details the provisions with regard to design, construction, operation, final shutdown, decommissioning and upkeep and surveillance of nuclear facilities. Their application is based on an approach that is proportional to the extent of the risks or drawbacks inherent to the installation. It specifies the elements that must be included in the safety case of any nuclear facility project. It contains the measures relative to the control of detrimental effects and the impact on health, which must be taken into account as of the design stage.

The technologies used for the design and construction are based in particular on past experience, the implementation of periodic tests or analyses of the facilities.

The procedures are described in section 6.2.3.3, the technical rules in section 6.2.3.4, while the rules concerning discharges are described in section 6.2.2.1. The safety measures taken by the licensees are presented in section 8.2.2. ASN checks implementation of the regulations through the examination of technical files, the analysis of significant events and the inspections it carries out in accordance with procedures presented in section 6.2.3.6.

8.5. Assessment of safety of facilities (Article 8)

Each Contracting Party shall take appropriate steps to ensure that:

i) before construction of a spent fuel management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

ii) before the operation of a spent fuel management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in i) above.

The general regulations applicable to nuclear facilities described in section 6.2 are applicable to spent fuel management facilities.

When applying for authorisation to create a nuclear facility, the future licensee must produce a preliminary version of the safety analysis report to support its application. It must also produce an impact study, which is submitted to the Environmental Authority for its opinion. Once the creation authorisation has been issued, the introduction of radioactive substances into the facility is conditional upon a commissioning authorisation issued by ASN on the basis of a file submitted by the licensee containing more specifically an update of its safety baseline requirements (general operating rules, safety analysis report and on-site emergency plan in particular).

The measures taken by the licensees are presented in section 8.2.2.

The regulations concerning the safety assessment are presented in section 6.2.3.

ASN implements the regulations through the analyses and inspections it carries out in accordance with procedures described in section 6.2.3.6.

8.6. Operation of facilities (Article 9)

Each Contracting Party shall take appropriate steps to ensure that:

i) the license to operate a spent fuel management facility is based upon appropriate assessments as specified in Article 8 and is conditional on the completion of a commissioning programme demonstrating that the facility, as constructed, is consistent with design and safety requirements;

ii) operational limits and conditions derived from tests, operational experience and the assessments, as specified in Article 8, are defined and revised as necessary;

iii) operation, maintenance, monitoring, inspection and testing of a spent fuel management facility are conducted in accordance with established procedures;

iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a spent fuel management facility;

v) incidents significant to safety are reported in a timely manner by the holder of the license to the regulatory body;

vi) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

vii) decommissioning plans for a spent fuel management facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body.

8.6.1. The licensing process

The licensing process for the operation of nuclear facilities, including spent fuel management facilities, is described in section 6.2.3.3.3.

8.6.2. CEA's in-service safety practices

Licences are issued to CEA in accordance with the procedures described in section 6.2. In-service safety is ensured in conformity with the general and particular regulations and forms the subject of periodic safety reviews (see 8.2).The quality and durability of the safety, technology and engineering support are guaranteed by the quality commitments described in section 7.3.3 and by the human and material resources described in section 7.2.4. The practice regarding delicensing is described in section 7.6.2.

The baseline safety requirements of 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.

Periodic security visits are conducted by the head of the facility or his/her delegate in order to check the configuration of the facility against the safety baseline requirements. These audits can focus on targeted themes in line with the operating experience feedback from the facility or from one or more centres. Likewise, periodic audits of centres and general management are scheduled by the safety inspection unit for the centre and by the general nuclear safety inspectorate for general management.

The analysis of deviations observed and/or events that have occurred in the facility is used to identify the root causes and to define the corrective and preventive actions to implement to prevent their recurrence. CEA has put in place measures to centralise this experience feedback and to disseminate the lessons learned at national level to improve safety for all the facilities. The significant events are notified to ASN.

8.6.3. Orano's in-service safety practices

Operation is ensured in conformity with the baseline requirements of the facility described in 8.2.2.2.

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. In effect, the control of risks often rests in part on the operating rules, which must minimise the potential risk of organisational and human error. In such cases it is important that the understanding and justification of the operating constraints be perceived by those responsible for applying them as a true reflection of the risks. Training, skills assessment and information campaigns are implemented at all levels of the hierarchy.

8.6.4. EDF's in-service safety practices

The licenses are issued to EDF in accordance with the procedures described in section 6.2.
The facilities undergo conformity and change reviews as part of the periodic safety reviews, as described in 8.2.2.3.
Day-to-day operation of the facilities is ensured in conformity with the general and particular regulations, deviations are analysed and significant events are notified to ASN.

The quality and durability of the safety, technology and engineering support are guaranteed by the provisions described in section 7.3.5 and by the human and material resources described in section 7.2.6. The practice regarding delicensing is described in section 7.6.4.

8.7. Disposal of spent fuel (Article 10)

> *If, pursuant to its own legislative and regulatory framework, a Contracting Party has designated spent fuel for disposal, the disposal of such spent fuel shall be in accordance with the obligations of Chapter 3 relating to the disposal of radioactive waste.*

At present, spent fuels are not intended for direct disposal. Spent fuels are either reprocessed (UOX), or stored with a view to potential multi-recycling in the current-generation reactors (see section 3.3) or in a generation IV fleet of fast-neutron reactors (MOX and ERU fuels).

These fuels are taken into account in the "reserve" inventory of the Cigéo project, in case they are considered as waste in the future. This reserve inventory takes into account, for facilities licensed before 31 December 2016, the uncertainties associated in particular with the setting up of new waste management routes or changes in the energy policy (for example, a decision to stop reprocessing spent fuel). Adaptability studies are carried out within the scope of this inventory and appended to the Cigéo creation authorisation application, thereby serving to verify that nothing in the current design of the Cigéo facility could render unacceptable the disposal of these spent fuels in the event of requalification to radioactive waste status.

The measures taken to protect individuals, society and the environment against the radiological risks associated with operation of the Cigéo disposal facility would apply to the disposal of spent fuel in the same way as to the disposal of high-level or intermediate-level long-lived waste.

9 SECTION H | SAFETY OF RADIOACTIVE WASTE MANAGEMENT (ARTICLES 11 TO 17)

9.1. General safety requirements (Article 11)

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.

9.1.1. Regulatory provisions

The majority of the radioactive waste management facilities in France come under the system of basic nuclear installations (see. 6.1). 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. These requirements with respect to the financing of long-term costs apply to the management of radioactive waste.

The management of radioactive waste from nuclear installations is subject to strict regulations, defined by the Environment Code, the BNI Order and the ASN resolution of 21 April 2015 concerning the study of waste management and the assessment of the waste produced in nuclear installations.

All the requirements concerning waste management are now incorporated into the impact assessment or the general operating rules of the nuclear facilities. 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 flows;
- the waste zoning plan stipulated in article 6.3 of the BNI Order which justifies the methodological principles relative to:

  - the delimiting of potential nuclear waste production zones, that is to say in which the waste produced is contaminated, activated or likely to be so, and conventional waste zones, 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 preservation 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 BNI Order, 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.

The waste management regulations were amended by a Decree of 14 March 2019. The impact assessment, transmitted with the nuclear facility creation authorisation application and updated at the major stages in its life, must now demonstrate waste management optimisation, notably in the light of the effects of the facility on the environment and health. This amendment cancelled the waste management study as a stand-alone document, as the majority of its content is incorporated in the impact assessment. An Order of 16 February 2023 approves ASN resolution of 29 November 2022 amending ASN resolution of 21 April 2015 on the waste management study and the assessment of the waste produced in the basic nuclear installations and ASN resolution of 30 November 2017 on noteworthy modifications of nuclear installations, drafted to take these regulatory changes into account.

9.1.2. ICPEs and uranium mines

As was indicated earlier in this report, the radioactive waste - apart from naturally occurring radioactive material (NORM) – from the ICPEs and uranium mines is managed via the same routes as the waste from the nuclear facilities. The safety of management is therefore identical.

The mining industry no longer produces any new waste, other than the sludge from the stations treating the water from the former mining sites. The public and the environment must be protected from the waste produced in previous years (mining tailings, decommissioning waste) and from mining waste rock. The ore processing tailings are now in disposal facilities classified as ICPEs. The deposition of sludges is still effective on a few sites. The sludge is managed as waste and generally deposited on a few former mining sites or treatment residue disposal facilities situated near the water treatment stations.

The inventorying of mining waste rock reused in the public domain, required by the Circular of 22 July 2009, has been completed and corrective measures implemented where necessary. Under the PNGMDR, ASN has recommended conserving the memory of the locations of the mining waste rock in the public domain if the average cumulative effective annual dose exceeds 0.3 mSv/year. This action is borne by the administrative authority (Prefect), assisted by the Regional Directorates for Environment, Planning and Housing (DREAL) in collaboration with ASN and the local Regional Health Agencies.

Focus on mining waste rock

The extraction of ore in the past necessitated the extraction of the surrounding rocks, called "waste rocks". This mining waste rock is not considered to be radioactive waste. The working of the uranium mines produced about 170 million tonnes of waste rock in France, of which there are two types:

- the barren rock, in which the average uranium content corresponds to the characteristic level of the natural ambient background level (to give an example, between 0.0015% and 0.01% of uranium in the Limousin *département*),
- the sub-grade ore in which the contents are not high enough from the economic viewpoint to warrant processing (between 0.01% and 0.04% of uranium).

The majority of the mining waste rock has been disposed of on the extraction sites as spoil heaps. A small proportion of this waste rock has also been used to form the solid cover of mining tailings disposal sites. Only 2 million tonnes of mining waste rock have been reused in the public domain as backfill, earthworks or road basement materials.

9.1.3. Waste from industrial, medical and research activities

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 identified disposal routes. 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 of 29 January 2008 defines the requirements for the management of contaminated waste and effluents for these activities. ASN has published a guide detailing the methods of application of this resolution (Guide No. 18).

The methods of managing contaminated solid and liquid waste must be described in a waste management plan.

9.2. Existing facilities and prior practices (Article 12)

Each Contracting Party shall in due course take the appropriate steps to review:

i) the safety of any radioactive waste management facility existing at the time the Convention enters into force for that Contracting Party and to ensure that, if necessary, all reasonably practicable improvements are made to upgrade the safety of such a facility;

ii) the results of past practices in order to determine whether any intervention is needed for reasons of radiation protection bearing in mind that the reduction in detriment resulting from the reduction in dose should be sufficient to justify the harm and the costs, including the social costs, of the intervention.

9.2.1. Regulatory provisions

The management of the radioactive waste from the nuclear facilities is regulated by the Environment Code, the BNI Order and ASN resolution of 21 April 2015 amended in 2022 (see section 9.1.1). Lastly, more specifically to establish an annual waste management assessment, the licensee is obliged under the BNI Order, 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 an implementation guide (Guide No. 23) for the resolution of 21 April 2015 which reiterates the methods of setting up waste zoning based on the distinction between the potential nuclear waste production zones and the conventional waste zones, and proposes that the licensees define zone sub-categories allowing the implementation of radiological controls proportionate to the risks presented by each of these zone sub-categories and anticipation of the problems linked to the decommissioning of the facilities. 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 threshold implies that the waste coming from potential nuclear waste production zones must always be managed in nuclear routes.

Orano, 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.

In its resolution of 9 December 2014, ASN prescribed measures for Orano concerning its legacy waste retrieval and conditioning (WRC) on its La Hague site. This resolution sets some sixty milestones governing the WRC operations for the projects concerned. In 2019, in view of the delays observed in the implementation of the retrieval projects (those containing large dispersible inventories in the event of an accident), ASN began an exploratory approach for monitoring the progress of the waste retrieval and conditioning projects.

In some cases, the time frames of the WRC operations and the level of safety of storage are such that ASN is obliged to demand that the safety of the facility be reinforced (as was the case for the Saint-Laurent silos, for example).

Alongside this, Orano, CEA and EDF have, under the various editions of the PNGMDR, 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 civil nuclear facilities or experimental nuclear facilities concerning defence;
- waste depots with high natural radioactivity which are not subject to the regulations of classified installations.

The Order of 9 December 2022 establishing the requirements of the PNGMDR 2022-2026 provides for the licensees to present the monitoring and surveillance programmes put in place on each *in situ* legacy waste disposal site taking into account the hydrogeological conditions of the site, identifying the parameters to monitor and considering all the types of waste. It also requires the implementation of a multi-actor multi-criteria analysis of all the scenarios envisaged for the legacy disposal sites. ASN has therefore set up a pluralistic working group, chaired by an independent personality, to carry out this work over the 2023-2024 period. This group's work results will be used to assist the licensees in defining appropriate long-term management plans.

9.2.2. Measures taken by the waste producers

Management of the waste in the nuclear facilities comprises the following main phases: waste zoning; collection; sorting; characterisation; treatment and packaging; storage; shipping.

Collection and sorting are sensitive waste management phases in the facilities. 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 effectively determine the corresponding management route and the measures to take to effectively protect individuals and the environment against the associated risks. 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 radiological characterisation in particular is established on the basis of tried and tested scientific methods that comply with international standards.

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 as early as possible in order to limit interim storage on the production sites, and therefore to limit the associated risks. Hazardous waste (radioactive waste in particular) is transported in accordance with the regulations in force.

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.

Among the facility's reference documentation, the waste chapter of the impact studies, the content of which is set by an ASN resolution, presents the management methods for all the waste and the analysis of the facility's performance with regard to the best techniques available in order to determine whether areas for improvement or optimisation must be found. These impact studies are regularly updated and transmitted to ASN.

Furthermore, each licensee establishes an annual assessment of its waste management in a form specified by an ASN resolution. It transmits this assessment to ASN and the competent regional authorities.

Lastly, in application of the Environment Code, the radioactive waste producers draw up, for each of their sites, reports on the safety and radiation protection measures taken, on the events, the environmental discharge measurements and the waste stored in their facilities.

9.2.3. Measures taken by Andra

The radiation protection objectives chosen by Andra are described in section 7.4.2.

As regards the chemical toxicity risks that the waste can potentially represent, Andra – in accordance with basic safety rule RFS III.2.e. and the safety guide relative to the deep geological disposal of radioactive waste – asks the waste producers to quantify the presence in the waste of elements referred to in the regulations applicable to hazardous waste or the regulations relative to water quality. These elements are integrated in the disposal facility impact studies. Specific actions are also undertaken to reduce quantities of these elements, especially lead, in the delivered packages.

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 work areas.

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 acceptable 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.

9.2.4. Legacy waste

Although the majority of the radioactive waste produced at present in France is packaged in packages, some legacy waste is not packaged or has been packaged unsatisfactorily (deterioration of the containers for example) and is not compatible with the subsequent management conditions as required by Article 6.7 of the BNI Order. This legacy waste is the result of past practices. Appropriate management methods must therefore be assessed and implemented.

Progress has been observed in legacy waste retrieval. Nevertheless, despite ASN asking the licensees to increase their efforts to meet the expected safety requirements for the legacy waste storage areas, it would appear difficult to reach the target set by Article L. 542-1-3 of the Environment Code, of packaging before 2030 all the ILW-LL waste produced before 2015.

The main legacy waste storage areas in France are:

- the graphite sleeves storage facility at Saint-Laurent-des-Eaux (EDF);
- certain facilities on the Orano La Hague (see 9.2.4.3);
- certain facilities in CEA centres of Cadarache (BNI 56), Marcoule (DBNI), Saclay (BNI 72 and BNI 35).

The main problems encountered by the licensees are the following:

- The data concerning the legacy waste are sometimes incomplete. At the time this waste was placed in storage, 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 stored in silos is often heterogeneous.
- 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.
- The licensees must cope with technical difficulties with retrieval.
- The licensees implement industrial strategies which may be subject to modifications, and the waste management issues have not always 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 has effectively analysed the feedback from the prescriptive framing of the WRC projects and decided to improve it by favouring short-term monitoring of the progress of these projects without losing sight of the long-term objective. ASN now asks the licensee to commit to intermediate achievement deadlines called milestones which target major steps in the progress of the projects and determine their smooth running and control of the overall deadlines. These milestones are set for a time-frame of five years at the most. New milestones can be defined each year, with this process being repeated in a sliding manner until the project in question is completed. This legacy waste is or will be treated and packaged either in the existing facilities currently in service or undergoing decommissioning, or in new facilities which have been or will be built.

9.2.4.1. Measures taken by EDF

EDF stores the graphite waste (LLW-LL) from the operation of the two GCR reactors of Saint-Laurent-des-Eaux A in silos built near these reactors in the 1970's. EDF plans to build a new storage facility for the graphite waste from these silos when they are emptied. This facility should be commissioned by 2030. The graphite constituting the cores of the GCR reactors (Saint-Laurent-des-Eaux A1 and A2, Chinon A1, A2 and A3 and BUGEY 1), which represents the large majority of the graphite waste from the GCR reactor technology, is still in place in these reactors pending their decommissioning.

9.2.4.2. Measures taken by 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 waste contained in tanks, cylinders or drums;
- solid waste, usually placed in drums stored in wells, vaults or pits;
- solid waste buried in diverse forms, sometimes in open ground (in bulk in vinyl bags, in metal drums, in concrete shells).

The aim of CEA is to retrieve and condition this waste using appropriate treatments so that it can be directed to management routes that either exist already or are being created.

In this approach, in the same way as for decommissioning (see 7.6.2), priority is given to the legacy waste retrieval based on a reduction of the dispersible inventory.

After sorting and suitable conditioning and packaging, this waste is either transferred to Andra's Aube repository (CSA) or 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 in a dedicated facility in the Marcoule centre (BNI 177 DIADEM). CEA shall acquire additional specific packaging units for the primary packages of LLW-LL and ILW-LL waste, to package them directly in disposal containers and dispatch them to the future disposal centres.

The waste retrieval programme is continuing on CEA sites of Marcoule (UP1 plant), Fontenay-aux-Roses, Saclay and Cadarache, and will extend over several decades.

9.2.4.3. Measures taken by Orano

Retrieval of legacy waste in La Hague

Part of the operational waste from the UP2-400 plant, which has been undergoing decommissioning since 2004 (fuel cycle back-end facilities), has been stored on the La Hague site until specifications for the future disposal centres that are suitable for the radiological and physical-chemical characteristics of the waste have been defined. The waste in question is mainly LL and ILW-LL waste.

This legacy waste is covered by a waste retrieval and conditioning (WRC) programme with a view to its subsequent removal. The WRC strategy hinges around prioritisation with respect to safety (reduction of the dispersible inventory of certain storage facilities that do not meet current safety requirements) on the one hand, and optimising the overall schedules for decommissioning the site's nuclear facilities as early as possible on the other.

Focus on legacy waste retrieval projects on the La Hague site

The projects below illustrate the new WRC strategy, established in view of the number of WRC projects to carry out simultaneously on the La Hague site, of the technical contingencies encountered and performance of the operations in as short a time frame as possible under economically acceptable conditions:

- The sludge stored in STE2 station was to have been retrieved for continuous treatment by a new process replacing the bituminisation process planned initially. This new process was abandoned in 2022 and further studies (at the research and development or more advanced stages) are in progress to find the best conditioning process. Following the abandoning of this process, Orano has decided to build new storage silos that meet current safety standards to guarantee retrieval of the sludge as of 2037.
- The retrieval of the waste from HAO silo required the installation of a waste retrieval and sorting unit above the silo. Tests are in progress and the waste retrieval operations should start in 2027. After retrieval and sorting in the unit, the structural waste (hulls and endpieces) shall be transferred to the plant's compacting unit; the technological waste (aluminium covers) shall be cut up and stored then packaged in CBF-K (concrete fibre package); the fines and resins shall be retrieved and transferred to the new cementation unit, adjacent to the retrieval unit, to be cemented in drums. This HAO silo retrieval unit will also be used for the retrieval, sorting and packaging of waste store din the pools of the SOD and the SOC. The hulls and endpieces they contain will undergo the same treatment as the structural waste from HAO silo. Technological waste (empty containers, covers, etc.) will be cut up and decontaminated, if necessary, then packaged in CBF-K packages.
- Retrieval of the GCR waste from silo 130 began in January 2020 in a new modular facility joined to silo 130. Numerous technical problems (harrows cable breaks, drum filling percentage, etc.) made it necessary to extend the test phase, pushing back entry into industrial service until April 2022. The rate of waste retrievel nevertheless remains significantly lower than initially planned. Steps are being taken to improve it. Completion of GCR waste retrieval is planned for late 2030.

9.2.4.4. Measures taken by Andra

The measures concerning the CSM repository are detailed in sections 5.4.2 and 9.7.

9.2.5. Tritiated waste

The majority of the tritiated waste produced in France is operational and decommissioning waste from facilities associated with CEA's military applications (98%), while the remainder comes from small producers other than nuclear power production (research, pharmaceutical and hospital sector, etc.).

The operational solutions for the long-term management of tritiated waste are:

- limited at present in terms of storage capacity: the majority of the waste is stored on CEA sites, particularly Valduc and Marcoule;
- complex, involving as the case may be: heat treatment of metal waste by melting, baking of organic waste in Valduc; incineration of liquid waste in Centraco; waste that cannot be accepted in Centraco or the Andra centres is placed in interim storage to allow radioactive decay; tritiated waste with low degassing properties is placed in disposal.

To complement storage on the Marcoule and Valduc sites, management solutions associated with the future waste from ITER, especially the means of reducing the tritium content and temporary storage areas for tritium decay that might be necessary are being studied, in relation with the ITER schedule and in response to the related requirements in the PNGMDR 2022-2026.

Pending the commissioning of management solutions for the future waste from ITER, Andra - jointly with 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 make the request, without calling into question the main intended purpose of CEA Valduc facilities. This waste will be transferred to operational disposal routes as soon as their level of radioactivity permits.

9.2.6. Technological alpha-emitting waste from Orano and CEA

Orano's technological waste containing alpha emitters comes mainly from the La Hague and Melox plants. Since 2010, Orano has been working on a method of treatment and conditioning based on an incineration/melting/vitrification process. In March 2023 Orano decided to abandon the industrial application of this process due to the industrialisation difficulties it encountered. The new scenario adopted by Orano is conditioning by densification and encapsulation of the alpha-emitting waste in a concrete matrix. This new process will undergo detailed studies in the coming years.

9.2.7. Mining processing tailings

Working of the uranium mines in France between 1948 and 2001 led to the production of more than 50 million tonnes of uranium ore processing tailings.

The tailings have the same mineralogical composition as the original ore, to which are added various chemical precipitates linked to the static or dynamic treatment reagents (sulphates, for example). The tailings are considered as radioactive waste (very low-level to low-level) and are emplaced in the 17 disposal facilities installations which are regulated as installations classified for environmental protection, under the responsibility of a single licensee.

Coming from uranium ore processing facilities, the tailings have been disposed of primarily on former mining sites, close to these facilities, with the mining waste rock and other materials from the working of the mines. The tailings disposal areas, to give a simplified description, consist of a succession of layers of different materials ensuring mechanical and radiological protection with respect to the higher-activity tailings placed in the bottom section. Thus, on most sites, a solid compacted cover consisting of lower-activity tailings and mining waste rock has been put in place above the higher-activity residues. Usually, a layer of topsoil has been spread over it to promote development of the vegetation in order to limit erosion and make for better integration into the landscape.

These sites are nevertheless prohibited to the public. The uranium mining tailings disposal sites are regulated under system of installations classified for environmental protection.

The studies submitted by Orano Mining for the various editions of the PNGMDR have improved the understanding of the environmental and health impact of these former sites, with regard to:

- the dosimetric impact of the mining tailings repositories on man and the environment, in particular through the comparison of data obtained from monitoring and the results of modelling;
- the strategy to be chosen for changes to the treatment of water collected from these sites;
- the assessment of the long-term integrity of the embankments surrounding residue disposal sites;
- the mechanisms governing the mobility of uranium and radium within uranium-bearing mining tailings.

The studies supplied by Orano through the successive PNGMDRs constitute a major step forward in guaranteeing the safety of these disposal sites. ASN has issued an opinion on these studies at each PNGMDR and has formulated recommendations. The actions to be taken accordingly have been widely taken up in the successive PNGMDRs. Recently, the working group on the stability of the civil engineering works finalised the methodological assessment of the long-term resistance of the structures surrounding the uranium ore tailings disposal sites. Published in January 2023, this methodology informs the stakeholders of the challenges associated with the assessment of the long-term maintenance of these structures and verifying and guaranteeing their long-term robustness. It has already been applied by the licensee and is currently being examined by ASN.

Alongside this, the work of the PNGMDR working group on the management of water from the former mining sites and the disposal of mining tailings in particular is being completed, with the development of a tool to support the decision of whether to continue treating the water (improving the treatments insofar as necessary) or to stop doing so in the light of an assessment of the overall impact (radiological and chemical) of the discharges on the receiving environment.

Since 2003, in order to conserve the institutional memory of the former mining sites and provide information for the general public, the programme MIMAUSA (Memory and Impact of Uranium Mines: Synthesis and Archives) records the history of all the French uranium mining sites (http://mimausabdd.irsn.fr/). It contains information on the 250 uranium mining sites in metropolitan France, and on the mining tailings disposal sites in particular. This programme is implemented by IRSN in collaboration with the General Directorate for Risk Prevention (DGPR) of the Ministry in charge of the environment, and with ASN.

9.2.8. Legacy waste from non-nuclear facilities

The policy and practices in effect concerning this waste were presented in the general context in sections 3.5 and 3.6. Mining tailings are covered in section 9.2.7. The legacy waste from sources other than nuclear facilities comes mainly from the rehabilitation of sites contaminated by radioactivity from past activities (former Marie Curie laboratories, paint containing radium or tritium from the watchmaking industry for example). This waste is mainly very low-level or low-level radium-bearing or tritiated waste.

9.3. Siting of proposed facilities (Article 13)

1. Each Contracting Party shall take the appropriate steps to ensure that procedures are established and implemented for a proposed radioactive waste management facility:

i) to evaluate all relevant site-related factors likely to affect the safety of such a facility during its operating lifetime as well as that of a disposal facility after closure;

ii) to evaluate the likely safety impact of such a facility on individuals, society and the environment, taking into account possible evolution of the site conditions of disposal facilities after closure;

iii) to make information on the safety of such a facility available to members of the public;

iv) to consult Contracting Parties in the vicinity of such a facility, insofar as they are likely to be affected by that facility, and provide them, upon their request, with general data relating to the facility to enable them to evaluate the likely safety impact of the facility upon their territory.

2. In doing so, each Contracting Party shall take the appropriate steps to ensure that such facilities shall not have unacceptable effects on other Contracting Parties by being sited in accordance with the general safety requirements of Article 11.

9.3.1. Regulatory requirements

The siting procedure for a nuclear facility is indicated in section 8.3. Concerning the siting of the disposal facilities more particularly, ASN has published:

- the basic safety rule 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 for the deep geological disposal of HLW and ILW-LL radioactive waste published in 2008.

For the LLW-LL waste, ASN published a general safety guidelines notice in June 2008 with a view to finding a disposal site for this waste, and it should be revised and taken up in a guide in the near future.

These documents define the objectives to be retained for radioactive waste disposal sites, as from the site investigation and facility design phases so that its safety can be ensured after closure. They address in particular the geological environment and the technical criteria governing the choice of site.

With respect to deep geological disposal, the Act of 30 December 1991 introduced the need to carry out research into the French sub-soil over a period of at least fifteen years. According to this same act, the construction and operating licence for an underground laboratory was to 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 actual fact, three files corresponding to three different sites were submitted by Andra in 1996. Only the Bure laboratory received construction authorisation in 1999. The purpose of this laboratory is to characterise the argillaceous geological layer to confirm its ability to confine radioactive substances. To grant authorization by decree, a public inquiry is carried out as part of the operating authorization process.

Focus on Andra's underground laboratory

After several decades of research and development, in January 2023 Andra submitted a creation authorisation application (DAC) for a deep geological waste disposal repository. This facility, called Cigéo, is intended for the disposal of high- and intermediate-level long-lived radioactive waste. This DAC is based in particular on the data and experiments conducted in the Underground Laboratory of Meuse/Haute-Marne (LSMHM), situated in the municipality of Bure.

This laboratory has, since 2000, provided Andra with large amounts of data on the geological environment in which the Cigéo facility will be established if its construction is authorised. More than 2 km of galleries have been dug at depths of 445 m and 495 m, within a Callovo-Oxfordian argillite geological formation, which extends from a depth of 403 m to 561 m below the surface. This argillite layer, which is 160 million years old, will guarantee the confinement of the radionuclides for the time required for their radiological decay, independently of any human action.

Andra has also dug 28 test disposal vaults for the high-level waste (HLW), and one test disposal vault for intermediate-level long-lived waste. Numerous experiments have been carried out over the years, particularly on the methods of digging the tunnels and vaults (installation/removal of voussoirs to make intersections, study of soil fragmentation on contact with the tunnel boring machine, etc.), as well as on the means of introducing the packages into the HL vaults, the ageing of the glass in the vitrified waste packages, etc. The galleries and other facilities are also instrumented to track changes in the behaviour of the rock: some 28,200 measuring points have been installed. Andra is thus accruing knowledge to demonstrate the industrial-scale feasibility of the project and to guarantee its safety during the operating and post-closure phases.

In 2006 the act on the sustainable management of radioactive materials and waste reinforced the existing provisions; this act stipulates that the creation application for a deep geological disposal facility concerns a geological layer that has been studied by means of an underground laboratory and that the creation authorisation application for the facility is preceded by a public debate based on a file produced by Andra. This act also supplements the procedures concerning any creation authorisation application for a nuclear facility by stipulating that the creation authorisation application gives rise to a report from the National Assessment Board, an opinion from ASN and gathering of the opinions of the neighbouring regional authorities. The application is then sent to the OPECST which evaluates it and reports its work to the competent Parliamentary commissions.

The Act of 25 July 2016 which defines the principle of reversibility and introduces the industrial pilot phase for a deep geological disposal centre. The commissioning authorisation is limited to the pilot industrial phase, for which the results give rise to a report to Andra, an opinion from the National Assessment Board, an opinion from ASN and opinions from the neighbouring regional authorities. These documents are sent to the OPECST. Based on this, the Government presents a Bill adapting the disposal facility’s reversibility conditions and, as necessary, taking account of the OPECST's recommendations. ASN is then responsible for issuing the complete commissioning authorisation for the facility.

9.3.2. Measures taken by Andra and by the licensees

Measures taken by Andra for management of the LLW-LL

The LLW-LL waste is commonly associated with a concept of near-surface disposal in clay, a concept which can provide a solution that is proportionate to the danger the waste represents. However, the wide range of characteristics of the LLW-LL waste leads to several management options being considered for it. At present, studies are being conducted on the site of the municipal federation of Vendeuvre-Soulaines (CCVS) in the Aube *département*. A file concerning the development of a near-surface LLW-LL waste disposal facility on the CCVS site represents a first work step. The main purpose of this report, required by the PNGMDR 2022-2026, is to analyse - when defining the main technical and safety options - the possibilities of setting up a LLW-LL waste disposal facility on the Vendeuvre-Soulaines site, and studying the candidate waste categories by providing information on post-closure safety. The inventory of waste to study to define the disposal safety operations shall be defined subsequently, if it is decided to continue the studies, applying an iterative process in which this study is the initial phase. This file addresses the safety issues by presenting Andra's proposed approach to demonstrate the long-term safety of this type of disposal facility. It also addresses the environmental issues identified on this site. Lastly, the file presents the technical possibilities of creating a near-surface disposal facility on the CCVS site by studying the best available construction techniques. This report sets out an initial programme of studies that will be necessary to establish a safety options dossier if, after examining this report, it is decided to continue the studies.

Measures taken by CEA

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 at 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.

CEA's general waste management strategy aims at shipping the final packages from each centre directly to the disposal facilities; if the definitive package is not produced directly, after cursory conditioning at the production centre, the strategy aims at directing to Cadarache or Marcoule the waste requiring complex conditioning treatment, as reversible as possible pending receipt of acceptance specifications for the projected disposal facilities, and possible interim storage until they are commissioned. 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.

9.4. Design and construction of facilities (Article 14)

Each Contracting Party shall take appropriate steps to ensure that:

i) the design and construction of a radioactive waste management facility provide for suitable measures to limit possible radiological impacts on individuals, society and the environment, including those from discharges or uncontrolled releases;

ii) at the design stage, conceptual plans and, as necessary, technical provisions for the decommissioning of a radioactive waste management facility other than an ultimate disposal facility, are taken into account;

iii) at the design stage, technical provisions for the closure of a disposal facility are prepared;

iv) the technologies incorporated in the design and construction of a radioactive waste management facility are supported by experience, testing or analysis.

9.4.1. Regulatory requirements

The general regulations applicable to nuclear facilities are applicable to radioactive waste management facilities. The BNI Order setting the general rules applicable to nuclear facilities details the provisions with regard to design, construction, operation, final shutdown, decommissioning and upkeep and surveillance of nuclear facilities. Their application is based on an approach that is proportional to the extent of the risks or drawbacks inherent to the installation. The regulations specify the elements that must be included in the safety case of any nuclear facility project. This order contains the measures relative to the control of detrimental effects and the impact on health and the environment, which must be taken into account from the design stage.

In the case of a radioactive waste disposal facility, "*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 individuals 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 facilities for the treatment, conditioning, packaging, storage or disposal of waste, in which the processes and equipment 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 nuclear facilities 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 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.

The measures taken to facilitate decommissioning and limit the production of waste must be considered from the nuclear facility design stage. For a waste disposal facility, 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 various work steps necessary for the accomplishment of all the closure preparation operations and subsequent monitoring and surveillance, justifying their respective durations.

9.4.2. Cigéo project

Cigéo has crossed the last two crucial milestones. First of all in 2022, the project was declared to be of public utility (DUP). Then in January 2023, the creation authorisation application (DAC) was filed.

The Cigéo project is the result of a long democratic and iterative process with the voting of three acts in 1991 (Act of 30 December 1991 on research into radioactive waste management, Planning Act of 28 June 2006 on the sustainable management of radioactive materials and waste and Act of 25 July 2016 detailing the methods of creating a reversible deep geological disposal facility for high-level and intermediate-level long-lived radioactive waste) and three national public debates (2005, 2013 and 2019) which contributed to the collective finding of management solutions for the HLW and ILW-LL waste (https://cpdp.debatpublic.fr/cpdp-cigeo/ and https://pngmdr.debatpublic.fr).

Several files and interim reports were evaluated and enabled the project to move forward: "the feasibility file" (2005), the "interim report " (2009), and the "Safety Options Dossier" (2016).

All these documents are available on Andra's website https://www.andra.fr/cigeo/les-documents-de-reference. The opinions of ASN are available on the website Cigéo disposal centre project - 22/04/2022 - ASN.

The declaration of public utility (DUP) was a milestone for the Cigéo project and for Andra. It attests the recognition of the general interest of the project. The public utility declaration application file for the Cigéo project had been submitted to the Ministry of Ecological Transition in August 2020. After examination by the State services and obtaining the opinion of the Environmental Authority of the General Council for the Environment and Sustainable Development, and of the regional authorities concerned by the project, the DUP application underwent a public inquiry in autumn 2021. This public inquiry resulted in 4,150 contributions and in December 2021 it received a favourable opinion with no reservations from the inquiry commission, accompanied by recommendations. After examination of the file by the State Council, the Government signed the public utility declaration decree, which was published in the Official Journal on 8 July 2022.

Over and beyond the recognition of the public utility of the Cigéo project, the DUP guarantees more specifically control of the land and constitutes a first milestone before submitting a series of authorisation applications necessary for the project to move forward, but it does not authorise creation of the repository.

Andra's submission of the creation authorisation application (DAC) for Cigéo on 16 January 2023 represented the culmination of 30 years of studies and research. It marks the beginning of a new phase: the examination of the file by ASN, with consultations and a public inquiry among other things, after which the project could be authorised and its initial construction launched. This application comes with a supporting file containing 23 documents representing about 10,000 pages reporting on the level of acquired scientific and technical knowledge and presenting the safety case for Cigéo in all the phases of its life (construction, during operation and after its closure). This file is currently being examined by ASN and IRSN. ASN is also assisted by the Advisory Committees of Experts and holds a consultation with the stakeholders. Examination of the file should take from 3 to 5 years. If the creation authorisation decree is issued, construction of the support facilities and the first disposal vaults of the Cigéo repository will be able to begin. The DAC does not authorise the disposal of radioactive waste packages: only a commissioning authorisation issued by ASN will permit this.

9.4.3. The case of ICPEs

For the radioactive waste management facilities classified as ICPEs, a general prescription order may be applied, depending on the waste categorisation. When designing a facility, the applicable safety standards (layout, traffic movements, accessibility, etc.) must be met, as must the applicable regulatory provisions necessitating design modifications.

The regulatory authority (the Prefect of the *département*) checks implementation of the regulations through the examinations and inspections it carries out in accordance with procedures presented in section 6.2.3.36.2.3.3.2.

To give an example, Andra's Industrial centre for grouping, storage and disposal (Cires), which has been dedicated to the disposal of very low level (VLL) waste since 2003, is an ICPE.

Naturally occurring radioactive material (NORM), when considered as waste and depending its activity concentration, can be emplaced in Cires or other waste disposal facilities with ICPE status (category 2760). In 2024, four hazardous waste disposal facilities are authorised by Prefectural Order to receive waste containing NORMs.

9.5. Assessment of safety of facilities (Article 15)

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

i) before construction of a radioactive waste management facility, a systematic safety assessment and an environmental assessment appropriate to the hazard presented by the facility and covering its operating lifetime shall be carried out;

ii) in addition, before construction of a disposal facility, a systematic safety assessment and an environmental assessment for the period following closure shall be carried out and the results evaluated against the criteria established by the regulatory body;

iii) before the operation of a radioactive waste management facility, updated and detailed versions of the safety assessment and of the environmental assessment shall be prepared when deemed necessary to complement the assessments referred to in i) above.

9.5.1. Regulatory requirements

The law requires nuclear facility licensees to conduct a periodic safety review of their facilities every 10 years, whether they are in operation or being decommissioned.

9.5.2. Practices of Andra

For the creation of the Aube repository (CSA), the safety assessment and the environmental assessment focused on the operating phase, 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 repository (CSM) was carried out applying the same measures as for the creation of a new facility in accordance with the practices in effect at the time of the application.

9.5.3. Practices of the other licensees

The practices of CEA, Orano and EDF are identical to those applied for the spent fuel management facilities which are described in section 8.2.2.

9.6. Operation of facilities (Article 16)

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

i) the license to operate a radioactive waste management facility is based upon appropriate assessments as specified in Article 15 and is conditional on the completion of a commissioning programme demonstrating that the facility as constructed is consistent with design and safety requirements;

ii) operational limits and conditions, derived from tests, operational experience and the assessments as specified in Article 15 are defined and revised as necessary;

iii) operation, maintenance, monitoring, inspection and testing of a radioactive waste management facility are conducted in accordance with established procedures; For a disposal facility the results thus obtained shall be used to verify and to review the validity of assumptions made and to update the assessments as specified in Article 15 for period after closure;

iv) engineering and technical support in all safety-related fields are available throughout the operating lifetime of a radioactive waste management facility;

v) procedures for characterisation and segregation of radioactive waste are applied;

vi) incidents significant to safety are reported in a timely manner by the holder of the licence to the regulatory body;

vii) programmes to collect and analyse relevant operating experience are established and that the results are acted upon, where appropriate;

viii) decommissioning plans for a radioactive waste management facility other than a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility, and are reviewed by the regulatory body;

ix) plans for the closure of a disposal facility are prepared and updated, as necessary, using information obtained during the operating lifetime of that facility and are reviewed by the regulatory body.

9.6.1. Regulatory requirements

The following paragraphs present the way in which the provisions of Article 16 of the Joint Convention are applied in 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 6.2.3.3, which includes a safety assessment.

The general operating rules (RGE) established by the licensee in accordance with the regulations define the operating limits and conditions of the facility in question. These RGEs form part of the file submitted to ASN with a view to obtaining the commissioning authorisation. They are revised if the facility undergoes a modification and, if necessary, during the periodic safety reviews.

The operation, maintenance and surveillance of nuclear facilities (which include radioactive waste management facilities) are ensured in accordance with procedures established as part of the integrated management system that the licensees must establish (BNI Order).

In accordance with the BNI Order, the licensee must have all the skills necessary to carry out the activities concerned by safety and radiation protection. It may nevertheless call upon third-party engineering and technological assistance in all safety-related areas.

In accordance with the Environment Code and the BNI Order, the incidents or accidents significant for safety or radiation protection must be notified to ASN as soon as possible. The BNI Order states that the licensee must provide a detailed report of each incident or accident, analysing the technical, organisational and human causes.

Furthermore, in application of the BNI Order, the licensee must maintain a continuous improvement approach. This Order stipulates 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 shall take all necessary steps, including with outside contractors, to systematically collect and analyse the information that could enable it to improve the safety of its facility.

With regard to waste management, the BNI Order contains the following requirements:

- the licensee shall set up waste sorting at source, preventing any mixing of waste categories or of incompatible materials;
- the licensee shall characterise the waste produced in its facility, condition and package the hazardous and radioactive waste and label the waste packages.

The licensee must provide a decommissioning plan as soon as it files the application for authorisation to create a nuclear facility other than a radioactive waste disposal facility. For the radioactive waste disposal facilities, the licensee must provide a decommissioning, closure and monitoring, and surveillance plan. These various plans, which are reviewed by ASN, must be updated throughout the lifetime of the facility.

9.6.2. Andra's in-service safety practices

As regards its in-service safety practices for its facilities, Andra follows the doctrines, best available techniques, dedicated regulations and procedures in effect, of which some described in section 6.2, apply to the commissioning and operation of its facilities. The procedures govern the safety of the facility and in particular the control of the protection-important components and activities and related defined requirements and, in the event of deviation, management of the resulting consequences, particularly notifying ASN of significant events or informing it of events of interest concerning safety, radiation protection, the environment or the transport of radioactive waste packages.

The general operating rules (RGE) and the general surveillance rules (RGS) specific to the centres in the decommissioning/closure phase or in the monitoring and surveillance phase, define the normal operating range and the degraded operating range 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 when originated.

Under the supervision of the engineers specialised in operational safety, subsequent modifications to these documents are subject to the rules in effect concerning the modifications applicable to nuclear facilities (dedicated ASN resolution) which, depending on their nature and their significance with respect to the protection of interests, are either managed directly or notified to ASN or possibly subject to the authorisation of the engineers.

Andra also draws up environmental monitoring plans. It specifies the measures (qualitative and quantitative) and their frequency, taken on the centres and in their vicinity to follow over time the environmental impact of the facility's activities and to assess the impact on protection of the interests (the objective being to prove there is either no impact or that it is negligible). Furthermore, application of these measures meets the requirements of the discharge authorisation order and, for the centres in the monitoring and surveillance phase, to meet the obligations set by the decree authorising transition to the monitoring and surveillance phase. They are subject to a critical review and approval by ASN before being applied. As with the RGEs, changes to these measures are subject to the modification management process.

These measures are implemented in both the Aube repository (CSA), which is in service, and the Manche repository (CSM). For the Cires facility, Andra complies with the requirements of the regulatory framework of the ICPEs, as described in section 6.2.4.

As a general rule, all Andra's activities in the centres, with operation coming first and foremost, but also maintenance, risk prevention, monitoring and surveillance of the disposal centres for example, are carried out in accordance with established procedures and Andra's integrated management system. Andra's organisation aims to maintain the necessary operational, scientific and technical skills in the facility, for its operational needs and for all the areas concerned by protection of the interests of its facilities implementing protection-important activities, identified in application of the safety case for the disposal centre concerned.

9.6.3. Practices of the licensees CEA, Orano and EDF

The radioactive waste management facilities of CEA, Orano and EDF (including Centraco) are designed to meet the needs of each licensee and they allow, according to these needs, processing operations (sorting, cutting, compacting, melting, incineration, conditioning), radiological measurements and controls, and/or the interim storage for periods that depend on the nature of the waste. These facilities, which meet the requirements of the Environment Code and ASN resolutions, are operated under associated rules of security and safety. They are regulated and monitored by ASN like all the nuclear facilities.

As described in 9.1.1., the measures taken to meet the requirements of the regulations and of the design and operating baseline requirements associated with these facilities:

- are described in the reference documentation of the facility, particularly in the impact studies waste chapter, which is regularly updated and sent to ASN,
- are covered each year, in application of the Environment Code, by a report to evaluate their relevance and effectiveness with regard to the safety and radiation protection requirements, on the basis more specifically of the reported events and the inventories of the waste stored in each facility.

9.6.4. Case of the ICPEs and mining waste disposal facilities

In the case of ICPEs, the requisite measures with regard to operation, maintenance, monitoring, and possibly on cessation of activity, are set by the technical requirements laid down in the Prefect Order in application of the Environment Code. With regard to mining waste, as all the facilities have stopped their operations, the practices concern closure and surveillance. They are presented in next section.

9.7. Institutional measures after closure (Article 17)

> *Each Contracting Party shall take appropriate steps to ensure that after the closure of a disposal facility:*
>
> *i) records of the location, design and inventory of that facility required by the regulatory are preserved;*
>
> *ii) active or passive institutional controls such as monitoring or access restrictions are carried out, if required; and*
>
> *iii) if, during any period of active institutional control, an unplanned release of radioactive materials into the environment is detected, intervention measures are implemented, if necessary.*

9.7.1. Waste from nuclear installations or ICPEs

The legislative framework

The legislative framework applicable to radioactive waste disposal facilities 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 facility, qualified as monitoring and surveillance phase, are defined by the decommissioning decree;
- the delicensing decision can be made once the facility 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 to accomplish all the closure operations and subsequent monitoring and surveillance, justifying their respective durations;
- the general monitoring and surveillance rules;
- a detailed file recording the memory of the facility;
- and, if applicable, active institutional controls that may be introduced by the administrative authority.

Lastly, the BNI Order stipulates in particular that the protection of the interests mentioned in the Environment Code (security, public health and safety, protection of nature and the environment) must be ensured passively and not require human intervention beyond a limited period of monitoring and surveillance, 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.

The Manche repository (CSM)

The CSM stopped accepting waste on 30 June 1994. In application of the Decree of 28 June 2016, the CSM - under the responsibility of Andra - is considered to be in the decommissioning phase (operations prior to its closure) until the definitive cover has been completely installed, providing protection over a period covering the monitoring and surveillance and post-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 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 stipulates that, during this period, the monitoring and surveillance plan 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 review. They must take operating experience feedback into account. For the CSM this is therefore a gradual and cautious approach.

9.7.2. Mining waste

The uranium mines, their annexes and their conditions of closure are covered by the Mining Code. The disposal facilities for radioactive mining tailings come under category 1735 of the ICPE nomenclature.

A major aspect of the monitoring and surveillance system is based on institutional control which aims to ascertain that the possible modifications to the land will not affect risk control. 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 decide to put in place a "mining risks prevention plan" (PPRM).

The radionuclides present in the mining processing tailings and the associated radon are taken into account for the impact assessments and site monitoring.

Studies on the long-term behaviour of the mine tailings disposal sites were submitted as soon as the PNGMDR was put in place in 2007 and 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 (see section 9.2.7).

10 SECTION I | TRANSBOUNDARY MOVEMENTS (ARTICLE 27)

1. Each Contracting Party involved in transboundary movement shall take the appropriate steps to ensure that such movement is undertaken in a manner consistent with the provisions of this Convention and the relevant binding international instruments.

In so doing:

- *a Contracting Party which is a State of origin shall take the appropriate steps to ensure that transboundary movement in authorised and takes place only with the prior notification and consent of the State of destination;*
- *transboundary movement through States of transit shall be subject to those international obligations which are relevant to the particular modes of transport utilised;*
- *a Contracting Party which is a State of destination shall consent to a transboundary movement only if it has the administrative and technical capacity, as well as the regulatory structure, needed to manage the spent fuel or the radioactive waste in a manner consistent with this Convention;*
- *a Contracting Party which is a State of origin shall authorise a transboundary movement if it can ascertain, in accordance with the consent of the State of destination, that the requirements of subparagraph iii) are met prior to the transboundary movement;*
- *a Contracting Party which is a State of origin shall take the appropriate steps to permit re-entry into its territory if a transboundary movement is not or cannot be completed in conformity with this Article, unless an alternative safe arrangement can be made.*

2. A Contracting Party shall not license the shipment of its spent fuel or radioactive waste to a destination south of latitude 60 degrees South for storage or disposal.

3. Nothing in this Convention prejudices or affects:

i) the exercise, by ships and aircraft of all States, of maritime, river and air navigation rights and freedoms, as provided for in international law;

ii) rights of a Contracting Party to which the radioactive waste is exported for processing to return, or provide for return of, the radioactive waste and other products after treatment to the State of origin;

iii) the right of a Contracting Party to export its spent fuel for reprocessing;

iv) rights of a Contracting Party to which the spent fuel is exported for reprocessing to return, or provide for return of, radioactive waste and other products resulting from the reprocessing operations to the State of origin.

10.1. Regulation of the transport of radioactive substances

As transport operations can cross borders, the regulations governing the transport of radioactive substances are based on international prescriptions developed by the IAEA and set out in the document Specific Safety Requirements – 6 (SSR-6), which serves as the basis for the modal regulations (maritime transport, air transport, UN Orange Book, etc.), as well as the European and French regulations.

To allow the movement of dangerous good between countries, the regulations concerning the transport of hazardous materials (TMD) are essentially international. These regulations are based on different international regulations concerning the transport of dangerous goods, which France adapts, as necessary, in its regulations, and more specifically:

- carriage by rail: the RID regulation;
- road transport: the ADR agreement;
- river transport: the European ADN agreement;

- maritime transport: the maritime codes and compendia for the transport of dangerous goods in packages and in bulk;
- air transport: the Technical Instructions for the Safe Transport of Dangerous Goods by Air published by the International Civil Aviation Organisation (ICAO).

Directive 2008/68/EC of the European Parliament and Council on the inland transport of dangerous goods makes application of the ADR, the RID and the ADN (land transport) obligatory within the European Union member states. This has been done in France through the Order of 29 May 2009 on the transport of dangerous goods by land (the "TMD Order"), which also allows the transposition of Directive 2008/68/EC.

The maritime codes and compendia are implemented in France through the Order of 23 November 1987 on the safety of ships and the prevention of pollution and its appended regulation.

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. On this account, apart from the examination and issuing of certificates (for type B package models for example) and other authorisations provided for by the regulations, ASN conducts about a hundred inspections on the transport of radioactive substances each year. It also ensures that the significant event notifications it receives relating to the transport of radioactive substances are properly addressed.

10.2. Authorisation for transboundary movements of radioactive waste

France is attached to the principle whereby each nuclear facility licensee is responsible for the waste it produces, translated in the Environment Code by a ban on the disposal in France of radioactive waste from other countries and of radioactive waste resulting from the reprocessing of spent fuels from other countries. Furthermore, introducing such waste into France for 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 3.1.1.4). In addition, France obliges the radioactive waste produced in France to be disposed of in France.

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 national standards for safety, transport, security, physical protection and law enforcement. More specifically it applies the provisions of Directive 2006/117/Euratom on the supervision and control of shipments of radioactive waste and spent fuel, transposed into French law in the Environment Code, which makes the Minister in charge of energy the competent French authority for examining authorisation applications for transboundary transfers of radioactive waste and spent nuclear fuels. When France is the State of origin, the Minister authorises the transfer after obtaining the consent of the State of destination and the transit States under the conditions provided for in the directive. If necessary, the Minister in charge of energy can decide that an authorised transfer will not be completed, in which case the holder is obliged to take back the radioactive waste or spent nuclear fuel whose transfer cannot be completed, unless another arrangement guaranteeing nuclear safety has been concluded. The person holding the authorisation takes corrective safety measures if necessary. Since the last edition of this report, no authorisation or consent application has been refused and the Minister in charge of energy has made no decision preventing the completion of an authorised transfer.

The most sensitive 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 (Germany, Belgium, Japan, the Netherlands and Switzerland). Since 1977, the reprocessing contracts provide for the return of the ultimate residues from the reprocessing of irradiated fuel to their country of origin, conditioned and packaged in a form permitting their safe and environmentally-friendly transport and storage or disposal.

Transboundary movements with European countries are made mainly 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.

11 SECTION J | DISUSED SEALED SOURCES (ARTICLE 28)

1. Each Contracting Party shall, in the framework of its national law, take the appropriate steps to ensure that the possession, remanufacturing or disposal of disused sealed sources takes place in a safety manner.

2. A Contracting Party shall allow for re-entry into its territory of disused sealed sources if, in the framework of its national law, it has accepted that they be returned to a manufacturer qualified to receive and possess the disused sealed sources.

11.1. The regulatory framework

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 disused sources.

The principle adopted is that the suppliers of sealed radioactive sources ensure the end-of-life management of the sources they have distributed:

- 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 on request (Public Health Code).

Article R. 1333-161 provides for the possibility of sources being recovered by any supplier of sealed radioactive sources (and no longer only the original supplier or its takeover entity) and, as a last resort, by Andra if, and only if, it has not been possible to identify the original supplier or if there is no possibility of recycling the disused sealed radioactive sources under the prevailing technical and economic conditions.

Furthermore, the Public Health Code makes several provisions for managing "orphan" radioactive sources, one of them being "last resort" recovery by Andra as part of its public service duty.

French regulations provide for the suppliers to set up a financial guarantee to cover the costs of recovering and disposing of each source they have distributed. Its calculation takes into account more specifically the nature of the radionuclide, the initial activity of the source and whether a disposal route exists for it in France. To receive ASN authorisation to distribute sources in France, each supplier must prove that it has set up the financial guarantee in accordance with article R.1333-162 of the Public Health Code. The decision taken by the association "*Ressources*"[14] at the end of 2021 to exclude foreign suppliers of high-activity sealed radioactive sources (cobalt-60, caesium-137) intended for "pool" type industrial irradiators used for the sterilisation of various products or foodstuff is to be noted. Long-term solutions must be found to resolve the difficulties raised by this decision concerning the amount and the conditions of the financial guarantee.

[14] Private association, enabling the member source suppliers to constitute the financial guaranted by the French regulations by depositing a bond. The large majority of sealed radioactive source suppliers are members of the association.

11.2. The role of CEA

Under French regulations, since 1989, sealed source suppliers are responsible for taking back disused sealed radioactive sources (DSRS) if requested to do so by the user. This obligation now figures in the Public Health Code.

CEA and its former subsidiary CIS-Bio International were major manufacturers and suppliers of a very large variety of sealed sources in the past (all isotopes, all applications). Taking back the DSRS's is therefore a statutory obligation for CEA, resulting from its past activities as a sealed source supplier. Given the special status of CEA with regard to the management of its own sources until April 2002, CEA manages the DSRS's acquired before that date, whoever the initial supplier was.

CEA's DSRS management programme aims at achieving its objectives within a limited time frame. This implies:

- gradual closing of the recovery routes to finalise the retrieval of unused sources or sources which are still being used;
- the creation and operation of disposal routes for the time necessary to dispose of the stocks of sources already taken back and the sources currently being taken back;
- the closure or transfer to Andra of the developed disposal routes by 2030.

At the end of 2022, CEA officially stopped accepting further disused sources in its "CERISE" facility for packaging, storage and recovery of unused sources, as from 1 January 2024, considering that it has fulfilled its obligations to take back radioactive sources in accordance with article R. 1333-161 of the Public Health Code. And yet sources waiting to be accepted for disposal have been found in various sectors such as education and the nuclear activities. CERISE facility was also used to store sources not manufactured by CEA. Today there are no operational alternatives that can take over the storage functions of CERISE. Its closure means that there is no longer an operational and long-term national route for disposing of the sources, which now remain stored on the premises of their possessors, pending the deployment of a new management route.

11.3. Disposal of sealed sources

On account of their properties, disused sealed sources lie within the categories of radioactive waste that require special management routes. Not all disused sealed sources present on French territory have operational disposal routes at present.

The particularity of sealed sources lies in their concentrated activity and their potentially attractive nature (they are manufactured objects of small size which can be placed in a pocket or kept as an ornament, destroyed or ingested). They must therefore be disposed of in facilities where they are protected against commonplace human intrusions for the time it takes for them to no longer present any significant radiological risk.

CSA today, and 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 compatible with its acceptance specifications. 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.

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.

12 SECTION K | GENERAL EFFORTS TO IMPROVE SAFETY

12.1. Measures taken to meet the challenges identified in the previous review meeting

Two challenges were identified for France at the seventh review meeting:

- The management of LLW-LL waste with the preparation of the technical and safety options dossier: Section 1.4.4.2 covers the methods of addressing this challenge. Further information is provided in sections 3.1.2.2, 9.3.2 and 12.2.1.2.
- Continuation of consultation of the public and the stakeholders on the Cigéo project during the examination of the creation authorisation application. Section 1.4.3 covers the methods of addressing this challenge. Further information is provided in sections 3.1.2.1, 9.4.2 and 12.2.1.2.

France is also concerned by the following issues identified at the seventh review meeting and which are common to all the Contracting Parties:

- The skills and headcounts with respect to the schedule of spent fuel and radioactive waste management programmes: this challenge is broached in section 7.2 which details the way the nuclear licensees, Andra and ASN guarantee that they have sufficient qualified and experienced human resources in the field of radioactive waste and spent fuel management.
- Public participation in the spent fuel and radioactive waste management programmes: one of the cornerstones of the French radioactive materials and waste management policy is to ensure a democratic dialogue at all levels (at local level, with the general public, and in the legislation). Consequently, France has a range of processes designed to involve all the stakeholders in the spent fuel and radioactive waste management programs (section 3.1.3). Examples include the public debate organised for the preparation of the fifth PNGMDR (section 1.4.2) and the consultations organised for the Cigéo project (section 1.4.3).
- The management of ageing of the packages and facilities relating to radioactive waste and spent fuel, given the long storage periods: in France this issue is addressed in the periodic safety reviews of the facilities (sections 6.2.3.3.1 and 8.2.2).
- The long-term management of disused sealed sources: section 11 covers this challenge. Although specific regulatory provisions exist, some difficulties remain. Implementation of the measures provided for in the PNGMDR to resolve these difficulties (section 1.4.4.2) remains a challenge for the years to come.

12.2. 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.

12.2.1. Measures taken by ASN

12.2.1.1. Measures concerning the regulatory framework

Continuation of the overhaul of the regulatory framework applicable to nuclear facilities

ASN is continuing its work to overhaul of the regulatory framework applicable to nuclear facilities. It is continuing the preparation of ASN regulations and guides giving recommendations and practices that ASN considers satisfactory. An exhaustive list of the published guides is provided in Appendix 13.5. ASN is also continuing the preparation of a draft ASN regulation concerning radioactive waste disposal facilities. This draft regulation will be submitted to public consultation in 2024. In the same context, ASN has started producing a safety guide relative to the disposal of low-level long-lived radioactive waste.

12.2.1.2. Measures concerning radioactive materials and waste

Deep geological disposal of high and intermediate-level, long-lived waste

After several decades of research and development, in January 2023 Andra submitted a creation authorisation application) for a deep geological waste repository for high-level and intermediate-level long-lived waste (the Cigéo project). ASN began examining this application in 2023. In this process ASN calls upon its Advisory Committees of Experts (GPEs), especially the one dedicated to radioactive waste, and the expertise of IRSN. This technical examination, which is estimated to take about three years, hinges on three themes: the baseline data used for the Cigéo safety assessment, particularly concerning the choice of site in particular, the safety of the surface and underground facilities during the operational phase; the long-term safety in the post-closure phase.

On completion of the technical review, ASN will render an opinion on Andra's application, as provided for by article L.542-10-1 of the Environment Code. The total duration of the authorisation process is estimated at about 5 years. It effectively comprises, in addition to the technical review phase, a phase of consultations (regional authorities, environmental authority, etc.) and a public inquiry before starting preparation of the decree which will finalise the procedure, if it is approved.

In order to meet the high expectations for civil society participation in the Cigéo project, and in line with the actions planned in this respect by the fifth PNGMDR, ASN has set up a completely new consultation mechanism around the technical review process. Thus, various stakeholders (some twenty organisations, including Local Information Committees, the National Association of Local Information Committees (ANCCLI) and environmental protection associations) were consulted for the preparation of the referral to IRSN - ASN's TSO, concerning the Cigéo creation authorisation application, with the aim of noting their expectations and concerns with regard to nuclear safety and radiation protection, in order to take them into account in the assessment of the file. At the end of this consultation, the draft IRSN referral was modified to incorporate, for example, aspects relative to climate change. In order to guarantee the continuity of civil society's participation throughout the technical examination process, consultation measures shall also be implemented when preparing the referrals for the Advisory Committees of Experts on the three themes mentioned above, and the public will be regularly informed, particularly after each meeting of the Advisory Committees, the first of which is planned for April 2024. This information, which is organised consistently with the referrals, will provide answers to the expectations and questions that will have been integrated in the referrals.

All these actions meet the challenge identified for France in the 7th review meeting, concerning the continued consultation of the public and stakeholders on the Cigéo project during the examination of the creation authorisation application.

Disposal of low-level, long-lived waste

The LLW-LL radioactive waste essentially comprises graphite waste from the first-generation reactors (GCRs), radium-bearing waste and bituminised waste from the treatment of radioactive liquid effluents on the Marcoule site. Analysis of the file submitted by Andra in 2015 has shown that it will be difficult to demonstrate the feasibility - in the area currently investigated - of a disposal facility for all the LLW-LL waste.

One of the challenges for France identified at the last review meeting concerned the preparation of the safety options dossier for this disposal facility. Under the PNGMDR 2022-2026, Andra must submit a file in 2024 presenting the technical and safety options chosen for a disposal facility on the site of Vendeuvre-Soulaines, which has been being studied since 2015, with a technological readiness level corresponding to a preliminary design study. The examination of this file will be a key step for the continuation of the project. If this management option is confirmed, Andra will be required to submit a safety options dossier for the deployment of this waste disposal facility with the TRL of a preliminary design study within five years at the most after ASN issues its opinion.

Periodic safety review

During the 2020-2024 period, the following nuclear facilities for managing radioactive waste have undergone a periodic safety review (procedure completed or in progress): waste processing station (BNI 37-A) in Cadarache, liquid effluents treatment station (BNI 35) in Saclay, Centraco facility (BNI 160), Cedra storage facility (BNI 164), the Manche repository (BNI 66) and the Aube repository (BNI 149).

Assessment of the radioactive waste management strategies

ASN periodically assesses the strategies implemented by the licensees to ensure that each type of waste has an appropriate management route. ASN in particular remains attentive to ensuring that the licensees have the necessary treatment or storage capacity to manage their radioactive waste and plan sufficiently ahead for the construction of new facilities or renovation work on older facilities. ASN also relies on the Minister in charge of energy to ensure that the main recommendations of the PNGMDR are implemented by the waste producers and the material owners.

12.2.1.3. Measures concerning decommissioning

In 2024, 36 nuclear facilities 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 nuclear facilities in operation other than the power reactors. The decommissioning operations are usually long and costly, involving the removal of large 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.

During the 2020-2024 period, ASN's main actions concerned tracking the progress of decommissioning projects through the examination of the decommissioning files submitted by the nuclear licensees. ASN will be particularly attentive to CEA and Orano's legacy waste retrieval and conditioning projects, which are significantly behind schedule. At present, ASN is examining 23 decommissioning files for definitively shut down facilities whose decommissioning has not yet been prescribed or whose decommissioning conditions have been substantially changed. In addition to this, ASN is examining the periodic safety reviews of facilities undergoing decommissioning.

Furthermore, ASN has validated CEA and Orano's decommissioning and waste management strategy files, and has finished examining EDF's change of strategy request for the decommissioning of its GCR reactors.

Lastly, ASN set a schedule for the nuclear licensees to submit their stress tests further to the Fukushima accident, which extended until 2020. ASN is completing the examination of these studies through the submitted periodic safety review concluding files.

12.2.1.4. Measures concerning the fuel cycle

ASN monitors the potential safety impacts of the industrial choices made with regard to fuel management. Beyond the safety issues specific to each facility, the fuel cycle presents systemic challenges, particularly regarding the operating balance of the various facilities, and control of the radioactive substance inventories and the associated storage needs. Since 2021, ASN has put in place periodic joint hearings of Orano and EDF in order to share the view of the state of the fuel cycle and its short, medium and long-term prospects, to identify the risks of contingencies to which the facilities and their operational balance are exposed, and to check that appropriate measures are planned ahead and implemented to ensure their overall robustness. These hearings play a key role in ensuring that the safety issues are duly taken into account in the industrial decisions concerning the fuel cycle.

After several years of malfunctions, the situation of the Melox plant improved in 2023 compared with the preceding years in terms of quality and quantity of MOX fuel production. These factors help to stabilise operation of the fuel cycle, even if there is still little margin to cope with contingencies, and measures have yet to be put in place to overcome the problem of the spent fuel storage pools of Orano La Hague reaching maximum filling capacity. With regard to the performance of the sites in 2023 and the steps taken by their licensees to improve it, ASN considers that the operation of the fuel cycle as a whole is improving but remains fragile.

12.2.2. Licensee measures and objectives

12.2.2.1. Andra's measures and objectives

The Objectives and Performance Agreement (COP) is intended to constitute a strategic steering tool for Andra and supervisory bodies. A contract defining Andra's objectives for the period from 2022 to 2026 was signed with the State in 2022 (https://www.andra.fr/contrat-dobjectifs-et-de-performance-2022-2026-de-landra). It ensures continuity of action with the 2017-2021 objectives contract. This new COP is organised around three major challenges:

- give the public authorities the means of making decisions on the management routes for all types of waste, in application of the PNGMDR 2021-2025;
- organise Andra to make the transition from the design to the construction of Cigéo and to start the preliminary works;
- maintain Andra at a high standard of performance in safety and the environment, public health and safety, social responsibility, dialogue and consultation, control of the costs and satisfaction of Andra's customers, the waste producers.

To meet these 3 challenges, the Objectives and Performance Contract 2022-2026 is broken down into 7 strategic themes and 41 operational objectives, whose annual progress will be tracked through indicators. Some of the COP objectives, with their deliverables and associated milestones, stem directly from the PNGMDR 2022-2026.

These 7 cross-cutting strategic themes cover all of Andra's activities within the scope of its missions: make a collective success of Cigéo; anticipate the future radioactive waste management needs and organise the corresponding management routes; maintain the industrial operating excellence of the disposal centres, of the waste collection and storage, and of site decontamination; adapt and lead the research and studies necessary for the developments and upgrading of the waste management routes; consolidate the integration of the environment, health and safety into the centre of Andra's projects and activities; continue the dialogue with civil society and guarantee intergenerational and regional equity; improve Andra's performance and lead its transformation. Andra's contribution to the 17 Sustainable Development Goals (SDGs) of the United Nations has also been integrated and is subject to specific tracking.

Andra also contributes to the two challenges identified for France at the seventh review meeting: preparation of the safety options dossier for the management of LLW-LL waste (see sections 1.4.4.2, 3.1.2.2, 9.3 and 12.2.1.2) and the continuation of the consultation of the public and the stakeholders on the Cigéo project during the examination of the DAC (see sections 1.4.3, 3.1.2.1, 9.4.2 and 12.2.1.2).

12.2.2.2. CEA's measures and objectives

Maintaining its nuclear facilities at the optimum level of safety remains a major priority for CEA. On this account, CEA performs periodic safety reviews of its facilities every ten years. Lessons drawn from the accident that hit the Fukushima 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 progress of these action plans is tracked internally.

CEA is also conducting a major programme to renovate its transport packaging to meet its needs and the changes in regulations. To clearly identify how needs evolve, it periodically updates its transport master plan for the next 15 years.

Training and awareness-raising actions continue to be implemented to reinforce the security, radiation protection and nuclear safety culture of the personnel, with the creation of new modules targeting the operational safety culture and the implementation of safety in the decommissioning projects. Likewise, the entire chain of command is mobilised in the progress approach on which the safety policy of the facilities is founded, and which implies its commitment and accountability as regards defining objectives and allocating resources.

CEA is implementing a major radioactive clean-out and decommissioning programme on those of its installations whose continued 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, CEA strives to minimise waste production and to categorise it as accurately as possible to optimise management in the existing routes and to ensure there is a management route for each type of waste produced.

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. On this account, CEA is conducting a waste conditioning R&D programme to capitalise on the knowledge necessary to maintain the maximum level of safety for radioactivity confinement.

12.2.2.3. Orano's measures and objectives

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 facilities 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 facilities or equipment or changes in work methods and procedures;
- reducing worker dosimetry by optimising or reorganising the working environments;
- 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;
- 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 valorisation by material recycling;
- measures to enhance transparency and communication of information, particularly with the local authorities and local players.

In addition, in a context of energy sobriety, saving natural resources and reducing its environmental footprint, Orano is continuing its investments to renew or maintain the durability of its industrial facilities, taking into account the best safety standards. These investments concern:

- waste storage and treatment units;
- renovations and compliance work on sustainable facilities and equipment;
- waste retrieval, conditioning and packaging, and in decommissioning and the management of waste from shut down facilities;

R&D actions to develop new processes and more resistant materials, to use fewer polluting reagents and acquire a better understanding of certain risks and phenomena.

12.2.2.4. EDF's measures and objectives

EDF aims at having optimised and safe management routes that are calibrated to the risks for all its waste, and it 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. These developments involve more specifically:

- The recycling of very low-level radioactive metals: To meet the challenges of saving natural resources by applying circular economy principles, reducing CO2 emissions and economising the disposal capacities of Cires, the possibility of valorising certain low-level radioactive metals has been studied in France and resulted in the publication of two Decrees and an Order of 15 February 2022 on the implementation of operations to valorise very low-level radioactive substances. In this context, the "Technocentre" project aims to create an industrial facility for processing very low activity metals originating essentially from the decommissioning of nuclear facilities. The aim is to produce, after melting, ingots whose radiological characteristics place them in the conventional domain and guarantee that whatever their use, they will have no impact on health or the environment.
- The integration from the design stage of reduction targets for solid, liquid and gaseous radioactive waste in the new ERP2 reactors: design measures contribute to reducing waste, such as the choice of materials, the addition of extra filters or improvements in conditioning processes. More efficient utilisation of the fuel can also produce lower volumes of waste for the same quantity of electricity produced, but with the same quantity of radionuclides.

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, ILW-LL and LLW-LL waste.

12.3. International cooperation actions

12.3.1. ASN's cooperative actions

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. ASN remains strongly involved on the international work scene by maintaining its active participation in international working groups (IAEA, OECD/NEA, WENRA/WGWD, ENSREG).

On the more specific subject of deep geological repositories, ASN has participated since 2015 in the Deep Geological Repositories Regulators' Forum (DGRRF), a working group in which 6 countries participate (Canada, Finland, France, Sweden, Switzerland and the United States). This working group was created in response to the recognised need for multinational cooperation to better understand the regulatory approaches in terms of licensing, siting, assessing the safety of, and building, deep geological repositories. The member countries organised annual workshops to facilitate the exchange of ideas and experience.

ASN's European activities

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 in particular on nuclear safety, including waste management.

ASN is deeply involved 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.

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 facilities, waste management, radioactive substance transport and radiation protection. It is a member of the Waste Safety Standards Committee (WASSC) for the safety of radioactive waste. It also participates in the IAEA projects GEOSAF (on the safety of a deep geological repository during the operating phase) and HIDRA (on the unintentional impacts of human activities on deep geological repositories).

Relations with the NEA

Within the NEA, ASN participates in particular in the work of the Regulatory Forum (RF), of the Radioactive Waste Management Committee (RWMC) and of the Committee on Decommissioning and Legacy Management (CDLM).

Participation in ENSREG

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. The TECV Act and the Ordinance of 10 February 2016 transposed the provisions of the Directive.

Bilateral relations

Bilateral relations between ASN and its foreign counterparts represent an essential vector for international actions. They allow exchanges on topical subjects and the setting up of cooperation actions, particularly on questions of waste and spent fuel management.

Peer reviews

ASN was to host an IRRS (Integrated Regulatory Review Service) mission in March 2024. In view of the forthcoming reform of the oversight of nuclear safety in France, it was decided to postpone this IRRS mission to a later date. In 2022, ASN experts took part in IRRS missions in Slovenia, Argentina, Finland, Sweden and Bosnia-Herzegovina. The reports for the 2006, 2009, 2014 and 2017 IRRS missions can be consulted on www.asn.fr.

The licensees, Andra and ASN also regularly participate in ARTEMIS missions. In view of the postponement of the IRRS mission initially planned for March 2024, due to the project to reform the governance of the oversight of nuclear safety and radiation protection in France, ASN is looking into the possibility of bringing forward the next ARTEMIS mission, currently planned for 2028, so that it can be carried out back-to-back with the next IRRS mission.

12.3.2. 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;
- 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 various countries (Armenia, Iraq, Morocco, Ukraine) through European INSC programmes on the safety of nuclear facility decommissioning and the safety of radioactive waste storage and disposal sites, and to the nuclear regulators of Bulgaria, Norway and the Netherlands through a direct commercial service;
- 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 IRSN Academy (training and tutoring modules).

The IRSN's main partners are:

- Bel V (Belgium), E3NSI (Switzerland) in the area of disposal facility safety analysis and modelling of their long-term behaviour;
- JAEA (Japan) and VTT (Finland) for exchanges on the safety of waste disposal facilities;
- CNSC (Canada) and FANC (Belgium) for the study of key mechanisms for the safety of underground disposal facilities (TENOR project around the IRSN facility in Tournemire).

The work of furthering knowledge and perfecting the assessment tools is also carried out within international bodies. IRSN is thus a stakeholder in many European "Euratom" R&D consortia, including the EURAD (European Joint Programme on Radioactive Waste Management) which brings together more than 110 organisations from more than 20 countries. The aim of this co-financed European project is to strengthen European cooperation in radioactive waste management. EURAD 2 will also integrate "pre-disposal".

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 participates in experience-sharing projects with a view to harmonising practices under the auspices of the IAEA, with regard to nuclear facility decommissioning (COMDEC – Completion of Decommissioning 2018-2024) and management of the resulting waste. IRSN also takes part in the development of the IAEA safety standards (Revision of SRS 50 on decommissioning strategies, revision of Guide WG-S-G-5.2 to the safety analyses for facilities undergoing decommissioning).

IRSN also participates in the work of the NEA expert groups on decommissioning and rehabilitation of complex sites (Committee on Decommissioning and Legacy site Management (CDLM), HDCS Working Group – IRSN leader)

Lastly, through its contribution to the ETSON association, IRSN continues to enhance the interactions and networking of the TSOs in the research into and expert assessment of the safety of radioactive waste. As a complement, the association SITEX, a network with 19 partners from three sectors (nuclear regulators, TSOs, civil society), constitutes a pluralistic network of partners in activities relating to the safety of waste management, research, expert assessments of safety, training and dialogue with civil society.

12.3.3. Andra's cooperative actions

Andra takes part in many international activities, particularly through institutional cooperation and bilateral cooperation.

Institutional cooperation with the IAEA and the NEA

Present in the IAEA, Andra sits on the WATEC committee, a technical working group on the radioactive waste management, and is a member of several permanent networks such as the URF (Underground Research Facility) on underground laboratories, DISPONET focusing on surface disposal centres and Status and Trends on the radioactive waste inventories. These working groups organise annual plenary meetings and the production of documents, particularly technical (Tecdoc) on specific subjects. Andra thus shares its experience and expertise within these groups. Other contributions, particularly in the preparation of training media for deployment in the requesting member countries, were made in 2021 and 2023, on the subject of managing site studies when choosing a site for a deep geological repository.

Andra receives international delegations on its sites via the IAEA, for either scientific visits or training courses coordinated by the IAEA. In 2023, the CSM received a group of this type as part of a training course on the fuel cycle and radioactive waste management organised by Orano and INSTN. Lastly, expert assessment missions have also taken place. In 2023, Andra sent 3 experts to participate in the IAEA's Artemis missions in Lithuania, Greece and the Czech Republic.

In November 2023, the IAEA Director General, Mr Rafael Grossi visited the Meuse Haute-Marne Centre. He was thus able to discover the maturity of the Cigéo deep geological repository project first-hand by walking through the galleries of the underground laboratory.

In the NEA, Andra is a member of the RWMC (Radioactive Waste Management Committee). There are several expert assessment groups and sub-groups attached to this committee and addressing different subjects, such as the safety of the facilities, the rocks hosting geological repository projects, the management of knowledge and site memory. Andra is present in most of the working groups. We can mention more specifically the RIDD (Regulator – Implementer Dialogue) group in which Andra and ASN have participated since 2019. It is a group of experts for building constructive dialogues between nuclear regulators and waste managers when putting in place radioactive waste disposal solutions. ASN and Andra thus share their joint experience of interactions between the operator and the French nuclear regulator.

Another recent initiative at the NEA is the launching of a joint project on socio-economic studies. The aim of the project, signed in 2023, is to share and valorise this type of evaluation. This follows on from the recognition of the socio-economic evaluation of Cigéo as a good practice during the Joint Convention in June 2022.

Bilateral cooperation

Andra collaborates actively with its counterparts on the international scene through some fifteen bilateral cooperation agreements. These agreements define a framework for the exchanges and the subjects addressed.

EDRAM: International association for environmentally-safe disposal of radioactive materials

EDRAM is an association that groups the directors of agencies responsible for the long-term management of radioactive waste of 12 countries. Andra is a member of EDRAM. An annual meeting is organised with the participants taking the chair on a rotating basis. Providing a discussion forum for the General Directors, these high-level meetings focus on topical subjects and allow strategic international exchanges.

12.3.4. CEA's cooperative actions

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, 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 firstly operating experience of the facilities (notably with Belgium and Canada) and, in particular, the lessons learned from events (with in addition to these two countries, the USA and Japan), and secondly research into the conditioning and packaging and the long-term behaviour of waste packages.

In the area of decommissioning, 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.

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;
- export support for our industrial partners:
    - CEA thus continues its approach to direct the legacy collaborations towards more co-financed joint projects (institutional projects),
    - with ENGIE and ONDRAF on several waste management projects (processing/packaging and behaviour of waste under various stresses) in Belgium,
    - in Japan with JAEA, in the area of decommissioning (A&D project management and laser cutting), waste conditioning (geopolymer matrix, encapsulation in bitumen) and waste characterisation according to the criteria of the management routes,
    - CEA also participates in various calls for proposals and the resulting projects.

In Euratom, from 2017 to 2021, CEA coordinated:

- the INSIDER project: Sampling and characterisation methodology for intermediate and high-level activity;
- the SHARE project: Development of a roadmap for launching international collaborative projects in research and innovation in decommissioning in the coming years;
- the MICADO project: Technical platform for the characterisation of decommissioning waste.

Over the same period, it participated in the several other projects, namely THERAMIN (heat treatments of waste), TRANSAT (cross-cutting subjects/tritiated waste), INNO4GRAPH (Demonstrator for the decommissioning of Graphite reactors, laser cutting and digital tools), TITANS (Tritium Impact and Transfer in Advanced Nuclear reactorS).

Today CEA participates in the PREDIS waste management project associated with the treatment of organic liquids and reactive metallic waste, and the proposal for three projects, namely INNO4GRAPH2 (follow-up to the INNO4GRAPH project), STREAM for the formulation of reactive metal decontamination gels, and XS-AXILITY for the development of characterisation means on a stand-alone mobile system.

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 reactors, 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.

CEA is also continuing its collaboration with South Carolina University on the CHWM project (Centre for Hierarchical Waste Form Materials), conducted in response to an EFRC (Energy Frontier Research Centers funded by the U.S. Department of Energy – DOE) call from proposals.

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, member of the IDN (International Decommissioning Network) and chair of the *On Decommissioning and Environmental Remediation Group*;

- NEA: member of the CDLM (Committee for Decommissioning and Legacy Management), member of the RWMC (Radioactive Waste Management Committee), vice chair of the CPD (Co-operative programme on Decommissioning).

12.3.5. Orano's cooperative actions

The international exchanges 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 safety and radiation protection, Orano participates in the work of ENSREG as a member 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 the decommissioning of nuclear facilities. 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 and the work of EURADWASTE (Euratom Conference Radioactive Waste Management).

Orano also provides its expertise by taking part in assessments of strategies, nuclear sites and facilities at the request of and to assist the 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 also contributes to the work of the NEA on decommissioning and the radioactive materials and waste management, on the diversification of supplies and on the fuels of the future.

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.

12.3.6. EDF's cooperative actions

The international activities of the EDF Group in the area of safety of management of spent fuel assemblies and waste is continuing and developing along several main lines presented below and illustrated by a few examples.

A first line of international cooperation concerns sharing experience. Twinnings or partnership agreements for activities such as consultancy, services, assistance assignments in varied technical areas, or training courses, with foreign licenses with facilities in service or undergoing decommissioning, constitute the main framework for these direct exchanges between licensees with different cultures and exercising their profession in different environments. This is the case for example with the NPPs of Daya Bay, Taishan, Kœberg, Olkiluoto, Barakah, or countries like South Korea, Switzerland and Japan. EDF has a permanent representative at the Electric Power Research Institute (EPRI) in the United States to facilitate the utilisation of operating experience feedback from the North American fleet essentially. EDF also proposes training courses such as that on the back-end of the fuel cycle (waste management) for Saudi Arabia, within the framework of the KA CARE project.

On another level, EDF puts forward and shares its experience with the Chinon Graphite Industrial Demonstrator in the European project *INNOvative tools FOR dismantling of GRAPHite moderated nuclear reactors* (INNO4GRAPH) through visits of foreign delegations and meetings within with bodies and international organisations.

Lastly, jointly with other French actors, EDF has developed a qualifying training course in remote operation and robotics dedicated to decommissioning and recognised first at European level, and at global level in a 2nd phase, with the aim of being recognised as an "IAEA Collaborative Centre".

A second line of international cooperation concerns collaborations with international organisations.

As regards the IAEA, EDF participates in the preparation or revision of safety standards and guides on the circular economy in the management of decommissioning and radioactive waste.

EDF also participates in the IAEA's work concerning radiation protection and dismantling.

Each year the IAEA is invited to conduct an OSART (Operational Safety Review Team) mission on one of the 57 reactors in France (therefore FLA3 is included); radiation protection and fuel in the broad sense are focal points of these missions; EDF experts also take part in the OSART missions carried out in other countries.

EDF also keeps track of or participates in the work of the NEA in the Committee on Decommissioning of Nuclear Installations and Legacy Management (CDLM) which oversees the back-end activities of the cycle of the NEA, of the Institute of Nuclear Power Operations (INPO), of the European Nuclear Installations Safety Standards (ENISS), of the EPRI mentioned earlier, of the European Atomic Energy Community (EAEC or EURATOM), of the World Nuclear Association (WNA) through its participation in its working groups, such as the Decommissioning Working Group and the Used Fuel Management Working Group, as well as within nucleareurope and its working group on the integration of the taxonomy criterion on Accident Tolerant Fuel (ATF). EDF experts are seconded to most of these organisations. Lastly, EDF sits on the Board of the WNA and of nucleareurope.

A third line concerns the international development projects. These projects concern medium or high-power reactor projects in the Czech Republic (Dukovany and Temelín), Slovakia (Mochovce), Slovenia (Krško), Poland, Bulgaria (Béléné), the Netherlands (Borsele), Finland, the United Kingom (HPC, Sizewell), Singapore, India (Jaitapur), and Bahrain.

EDF also cooperates with Japan for the decommissioning of the sodium-cooled fast-neutron reactor (FNR) of Monju and two units undergoing decommissioning (Genkai 1&2); Japanese delegations are regularly received on this account in France on different nuclear facilities of EDF and other licensees.

EDF has signed a contract for the decommissioning of the two graphite reactors of the Ignalina NPP in Lithuania.

12.4. Good practices, areas of good performance and challenges for the future

In view of all the national measures take and described in this report, France identifies the following as good practices (as defined in the context of the Joint Convention):

- the provisions applied for the Cigéo project consultation, notably the new initiative on the part of ASN to consult the stakeholders on the framing of the technical examination (see section 1.4.3).
- the setting up by the HCTISN of a committee to track the consultation and discussion initiatives concerning the Cigéo project, in order to assess their clarity, complementarity and coordination with the aim of giving the public a guarantee of its effective participation in the project (see 6.3.4.2). Given the extent of the consultation initiatives deployed in France around this project, the setting up of such a tracking committee seems relevant and innovative, and conducive to ensuring the consistency of all the consultation procedures implemented and their clarity for the public

In addition, France considers that the following points constitute areas of good performance:

- the publication of the fifth PNGMDR at the end of 2022 and the implementation of the actions provided for in it, transparently and with the participation of all the stakeholders concerned (sections 1.4.2 and 3.1.1.1);
- the submission by Andra in January 2023 of the creation authorisation application for the Cigéo facility (licence application), which is a major milestone in the setting of a management solution for HLW and ILW-LL waste (sections 1.4.3 and 9.4.2);
- the improvement in the prescriptive framing mechanism put in place by ASN for the waste retrieval and conditioning projects, favouring the checking of intermediate work completion milestone dates, which target the major steps in project progress and determine its smooth running, and the control of deadlines (section 9.2.4.);
- the continuation of the development of the project for a facility to recycle very low-level metal waste (Technocentre), with the holding of a public debate planned in 2024 (section 3.6.1.1);
- the setting up of an evaluation and forecasting system for the nuclear fuel cycle, both in the fuel cycle facilities and in the system formed by the facilities as a whole. This system, which takes concrete form more specifically during the joint hearings of Orano and EDF by ASN, is underpinned by extensive and continuous work involving monitoring and modelling of the fuel cycle and the associated safety issues (section 3.3.3).

Lastly, the following subjects, already identified in the past, still represent challenges for France:

- the management of LLW-LL waste, whose volumes and heterogeneity (see 3.1.2.2) imply that the site currently being studied will not be able to accept all the waste in this category. On this account, the PNGMDR provides for the creation of a management scheme for LLW-LL waste by 2026 and for Andra to submit by 2030 a safety options dossier for the disposal facility for LLW-LL waste on the land of the municipal federation of Vendeuvre-Soulaines;
- the implementation of the measures provided for in the PNGMDR in order to resolve the difficulties in retrieving and disposing of certain disused sealed sources due to the absence of existing operational management routes or because of the financial cost of this disposal.

13 SECTION L | APPENDICES

13.1. Facilities producing spent fuel

Spent fuel is produced or could be produced in the following nuclear facilities.

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
24	CABRI and SCARABÉE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactors	27.05.64	
39	MASURCA (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		14.12.66
40	OSIRIS - ISIS (Saclay) 91191 Gif-sur-Yvette	CEA	Reactors		08.06.65
42	EOLE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		23.06.65
67	HIGH-FLUX REACTOR (RHF) 38041 Grenoble	ILL	Reactor		19.06.69 05.12.94
78	LE BUGEY NPP (reactors 2 and 3) 01980 Loyettes	EDF	Reactors		20.11.72
84	DAMPIERRE NPP, reactors 1 and 2) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76
85	DAMPIERRE NPP (reactors 3 and 4) 45570 Ouzouer-sur-Loire	EDF	Reactors		14.06.76
86	LE BLAYAIS NPP (reactors 1 and 2) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		14.06.76
87	TRICASTIN NPP (reactors 1 and 2) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76
88	TRICASTIN NPP (reactors 3 and 4) 26130 Saint-Paul-Trois-Châteaux	EDF	Reactors		02.07.76
89	LE BUGEY NPP (reactors 4 and 5) 01980 Loyettes	EDF	Reactors		27.07.76
92	PHÉBUS (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		05.07.77
95	MINERVE (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Reactor		21.09.77
96	GRAVELINES NPP (reactors 1 and 2) 59820 Gravelines	EDF	Reactors		24.10.77
97	GRAVELINES NPP (reactors 3 and 4) 59820 Gravelines	EDF	Reactors		24.10.77
100	SAINT-LAURENT DES EAUX NPP (reactors B1 and B2) 41220 La Ferté-St-Cyr	EDF	Reactors		08.03.78
101	ORPHÉE (Saclay) 91191 Gif-sur-Yvette	CEA	Reactor		08.03.78
103	PALUEL NPP (reactor 1) 76450 Cany-Barville	EDF	Reactor		10.11.78

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
104	PALUEL NPP (reactor 2) 76450 Cany-Barville	EDF	Reactor		10.11.78
107	CHINON NPP (reactors B1 and B2) 37420 Avoine	EDF	Reactors		04.12.79
108	FLAMANVILLE NPP (reactor 1) 50830 Flamanville	EDF	Reactor		21.12.79
109	FLAMANVILLE NPP (reactor 2) 50830 Flamanville	EDF	Reactor		21.12.79
110	LE BLAYAIS NPP (reactors 3 and 4) 33820 Saint-Ciers-sur-Gironde	EDF	Reactors		05.02.80
111	CRUAS NPP (reactors 1 and 2) 07350 Cruas	EDF	Reactors		08.12.80
112	CRUAS NPP (reactors 3 and 4) 07350 Cruas	EDF	Reactors		08.12.80
114	PALUEL NPP (reactor 3) 76450 Cany - Barville	EDF	Reactor		03.04.81
115	PALUEL NPP (reactor 4) 76450 Cany - Barville	EDF	Reactor		03.04.81
119	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 1) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81
120	SAINT-ALBAN - SAINT-MAURICE NPP (reactor 2) 38550 Le Péage-de-Roussillon	EDF	Reactor		12.11.81
122	GRAVELINES NPP (reactors 5 and 6) 59820 Gravelines	EDF	Reactors		18.12.81
124	CATTENOM NPP (reactor 1) 57570 Cattenom	EDF	Reactor		24.06.82
125	CATTENOM NPP (reactor 2) 57570 Cattenom	EDF	Reactor		24.06.82
126	CATTENOM NPP (reactor 3) 57570 Cattenom	EDF	Reactor		24.06.82
127	BELLEVILLE NPP (reactor 1) 18240 Léré	EDF	Reactor		15.09.82
128	BELLEVILLE NPP (reactor 2) 18240 Léré	EDF	Reactor		15.09.82
129	NOGENT-SUR-SEINE NPP (reactor 1) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82
130	NOGENT-SUR-SEINE NPP (reactor 2) 10400 Nogent-sur-Seine	EDF	Reactor		28.09.82
132	CHINON NPP (reactors B3 and B4) 37420 Avoine	EDF	Reactors		07.10.82
135	GOLFECH NPP (reactor 1) 82400 Golfech	EDF	Reactor		03.03.83

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
136	PENLY NPP (reactor 1) 76370 Neuville-lès-Dieppe	EDF	Reactor		23.02.83
137	CATTENOM NPP (reactor 4) 57570 Cattenom	EDF	Reactor		29.02.84
139	CHOOZ B NPP (reactor 1) 08600 Givet	EDF	Reactor		09.10.84
140	PENLY NPP (reactor 2) 76370 Neuville-lès-Dieppe	EDF	Reactor		09.10.84
142	GOLFECH NPP (reactor 2) 82400 Golfech	EDF	Reactor		31.07.85
144	CHOOZ B NPP (reactor 2) 08600 Givet	EDF	Reactor		18.02.86
158	CIVAUX NPP (reactor 1) BP 1 86320 Civaux	EDF	Reactor		06.12.93
159	CIVAUX NPP (reactor 2) BP 1 86320 Civaux	EDF	Reactor		06.12.93

Table 17: Facilities producing spent fuel as at 31 December 2023

13.2. Spent fuel storage or reprocessing facilities

The spent fuel is stored or reprocessed in the following facilities (note that the spent fuels are also stored temporarily before being transferred to the Orano storage facilities at La Hague, in the "BK" pools, on the sites of the electricity producing NPPs identified in the preceding paragraph).

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
22	PROVISIONAL STORAGE FACILITY called PÉGASE/CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	27.05.64	17.04.80
33	SPENT FUEL REPROCESSING PLANT (UP2-400) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances	27.05.64	
38	EFFLUENTS AND SOLID WASTE TREATMENT PLANT (STE2) AND SPENT FUEL REPROCESSING FACILITY (AT1) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances	27.05.64	
50	IRRADIATED FUEL TESTING LABORATORY (LECI) (Saclay) 91191 Gif-sur-Yvette	CEA	Utilisation of radioactive substances	08.01.68	
55	ACTIVE FUEL EXAMINATION LABORATORY (LECA/STAR) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Utilisation of radioactive substances	08.01.68	
80	OXIDE HIGH ACTIVITY FACILITY (HAO) (La Hague) 50107 Cherbourg	Orano Cycle	Transformation of radioactive substances		17.01.74

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
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
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
141	FUEL STORAGE FACILITY (APEC) (Creys-Malville) 38510 Morestel	EDF	Storage or holding of radioactive substances		24.07.85
148	ATALANTE CEN VALRHO Chusclan 30205 Bagnols-sur-Cèze	CEA	Research, development and actinide production studies laboratory		19.07.89

Table 18: Spent fuel storage or reprocessing facilities as at 31 December 2023

13.3. Radioactive waste management facilities

The main facilities managing radioactive waste (processing, storage, disposal) are listed in the table below. It should nevertheless be noted that the facilities listed in 13.1 and 13.2 and the facilities undergoing decommissioning figuring in 13.4 also include radioactive waste processing and storage facilities. In particular, BNIs 116 and 117 (La Hague plants) which figure in 13.2 feature major waste processing and storage facilities, particularly for HLW and ILW-LL waste, or BNI 166 located in CEA Fontenay–aux-Roses centre which is being decommissioned and is used at present for the storage of decommissioning waste.

It is to be noted moreover that Andra's Industrial centre for grouping, storage and disposal (Cires), which sorts and processes the waste from small producers and the disposal of very low-level waste, is subject to the regulations for Installations Classified for Environmental Protection (ICPEs), therefore it does not figure in the table below.

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
22	PÉGASE & CASCAD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	27.05.64	
35	LIQUID EFFLUENTS MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Transformation of radioactive substances	27.05.64	
37A	WASTE TREATMENT STATION (STD) (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Transformation of radioactive substances	27.05.64	
37B	EFFLUENT TREATMENT STATION (STE) (Cadarache) 13115 Saint-Paul-lez-Durance Cedex (Bouches-du-Rhône)	CEA	Transformation of radioactive substances	27.05.64	
56	RADIOACTIVE WASTE STORAGE YARD (Cadarache) 13115 Saint-Paul-lez-Durance	CEA	Storage of radioactive substances	08.01.68	

BNI No.	Name and location of the facility	Licensee	Type of facility	Declared on:	Authorised on:
66	MANCHE REPOSITORY (CSM) 50448 Beaumont-Hague	Andra	Above-ground disposal of radioactive substances		19.06.69
72	SOLID RADIOACTIVE WASTE MANAGEMENT ZONE (Saclay) 91191 Gif-sur-Yvette Cedex	CEA	Storage or holding of radioactive substances		14.06.71
74	STORAGE OF IRRADIATED GRAPHITE SLEEVES (SAINT LAURENT DES EAUX) 41220 La Ferté-St-Cyr	EDF	Storage or holding of radioactive substances		14.06.71
118	LIQUID EFFLUENTS AND SOLID WASTE TREATMENT STATION (STE3) La Hague 50107 Cherbourg	Orano	Transformation of radioactive substances		12.05.81
149	AUBE REPOSITORY (CSA) Soulaines-Dhuys 10200 Bar-sur-Aube	Andra	Above-ground disposal of radioactive substances		04.09.89
160	CENTRACO Codolet 30200 Bagnols-sur-Cèze	Cyclife France (EDF Group)	Transformation of radioactive waste and effluents		27.08.96
164	CEDRA (Cadarache) 13113 St Paul lez Durance	CEA	Conditioning, packaging and storage of radioactive substances		04.10.04
171	AGATE - Effluent advanced management and treatment facility (Cadarache) 13113 St Paul lez Durance	CEA	Transformation of radioactive effluents		25.03.09
173	ICEDA – Activated waste conditioning and storage facility	EDF	Conditioning, packaging and storage of radioactive substances		23.04.10
175	ECRIN – Contained storage of conversion residues (Malvési) 11100 Narbonne (Aude)	Orano	Storage of radioactive substances		20.07.15
177	DIADEM Irradiating or alpha waste from decommissioning (Marcoule) Chusclan	CEA	Storage		

Table 19: The main radioactive waste management BNIs as at 31 December 2023

13.4. Nuclear facilities decommissioned or undergoing decommissioning

Reactors decommissioned or undergoing decommissioning as at 31 December 2023 are the following.

Facility Location	BNI No.	Commissioned in	Final shutdown	Thermal power (MW)	Last regulatory acts	Current status
NEREIDE Fontenay-aux-Roses	(ex-BNI 10)	1960	1981	0,5	1987: Removed from list of BNIs	Delicensed
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	Delicensed Confined (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 confined
EL3 Saclay	(ex-BNI 14)	1957	1979	18	1988: Removed from list of BNIs and classified as IC	Partially decommissioned, remaining parts confined
MELUSINE Grenoble	(ex-BNI 19)	1958	1988	8	2011: Removed from list of BNIs	Delicensed with institutional control on memory
SILOETTE Grenoble	(ex-BNI 21)	1964	2002	0,100	2007: Removed from list of BNIs	Delicensed
PEGGY Cadarache	(ex-BNI 23)	1961	1975	0,001	1976: Removed from list of BNIs	Delicensed
CESAR Cadarache	(ex-BNI 26)	1964	1974	0,01	1978: Removed from list of BNIs	Delicensed
Marius Cadarache	(ex-BNI 27)	1960 at Marcoule, 1964 at Cadarache	1983	0,0004	1987: Removed from list of BNIs	Delicensed
HARMONIE Cadarache	(ex-BNI 41)	1965	1996	0,001	2009: Removed from list of BNIs	Delicensed, - Building destroyed Institutional controls
University of Strasbourg Reactor (RUS) Strasbourg	(ex-BNI 44)	1967	1997	0,100	2012: Removed from list of BNIs	Delicensed with institutional control on memory
SILOE Grenoble	20	1963	1997	35	2015: Removed from list of BNIs	Delicensed, building destroyed – Institutional control on memory

Facility Location	BNI No.	Commissioned in	Final shutdown	Thermal power (MW)	Last regulatory acts	Current status
RAPSODIE Cadarache	25	1967	1983	20 then 40	2021: Decommissioning Decree	Decommissioning in progress
BUGEY 1 Lagneu	45	1972	1994	1 920	1996: Final shutdown decree 2008: Decree authorising complete decommissioning operations	Decommissioning in progress
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 confinement of Chinon A1 and creation of the Chinon A1 D storage BNI	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

Facility Location	BNI No.	Commissioned in	Final shutdown	Thermal power (MW)	Last regulatory acts	Current status
EL-4D (ex-EL4) Brennilis Huelgoat	162 (ex- BNI 28)	1966	1985	250	1996: Decree ordering decommissioning and creation of the 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. 2023: Decommissioning decree amending decree of 1996	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, O.J. of 29.09.07	Partially decommissioned, modified to storage BNI for waste left in place
23 FESSENHEIM (reactors 1 and 2)	75	1977	2020	2 700	Final shutdown in 2020	

Table 20: Reactors decommissioned or undergoing decommissioning as at 31 December 2023

Other facilities decommissioned or undergoing decommissioning as at 31 December 2023 are the following:

Facility Location	BNI No.	Type of facility	Commissioned in	Final shutdown	Last regulatory acts	Current status
LE BOUCHET	(ex-BNI 30)	Ore processing	1953	1970	Removed from list of BNIs	Delicensed
GUEUGNON	(ex-BNI 31)	Ore processing	1965	1980	Removed from list of BNIs	Delicensed
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	Delicensed – Institutional controls
SATURNE Saclay	(ex-BNI 48)	Accelerator	1958	1997	2005: Removed from list of BNIs	Delicensed – Institutional controls
ATTILA Fontenay-aux-Roses	(ex-BNI 57)	Reprocessing pilot in 1 cell of BNI	1966	1975	2006: Removed from list of BNIs	Integrated in BNIs 165 and 166

Facility Location	BNI No.	Type of facility	Commissioned in	Final shutdown	Last regulatory acts	Current status
LCPu Fontenay-aux-Roses	(ex-BNI 57)	Plutonium chemistry laboratory	1966	1995	2006: Removed from list of BNIs	Integrated in BNIs 165 and 166
Bdg. 19 Fontenay-aux-Roses	(ex-BNI 58)	Plutonium metallurgy	1968	1984	1984: Removed from list of BNIs	Delicensed
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)	Fuel analysis	1968	1984	1997: Removed from list of BNIs	Delicensed
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	Delicensed
IRCA Cadarache	(ex-BNI 121)	Irradiator	1983	1996	2006: Removed from list of BNIs	Delicensed – Institutional controls
FBFC Pierrelatte	(ex-BNI 131)	Fabrication of fuel	1983	1998	2003: Removed from list of BNIs	Delicensed – 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	Delicensed – 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 processing station and waste storage	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	Commissioned in	Final shutdown	Last regulatory acts	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	2021: Decree amending Final Shutdown and Decommissioning Decree of 2006	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	Delicensed – 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	2020: Decommissioning Decree	Decommissioning in progress
Orano Cycle Pierrelatte	105	Uranium chemical transformation plant	1979	2008	2019: Decommissioning Decree	Preparation for decommissioning
LURE Orsay	106	Particle accelerators	From 1956 to 1987:	2008	2015: Removed from list of BNIs	Delicensed – 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
Tricastin operational hot unit (BCOT)	157	Equipment maintenance and waste processing	2000		2023: Decommissioning Decree	Decommissioning in progress

13.5. ASN Safety Guides

ASN Guides in effect in December 2023 and relating to the purpose of the report:

Guide No. 1	Safety Guide on the final disposal of radioactive waste in deep geological formations (February 2008)
Guide No. 6	Final shutdown, decommissioning and delicensing of nuclear facilities in France (30 August 2016)
Guide No. 7	Civil transport of radioactive packages or substances on the public highway (15 February 2016)
Guide No. 14	Clean-out of structures in basic nuclear installations (30 August 2016)
Guide No. 17	Content of radioactive substance transport incident and accident management plans (22 December 2004)
Guide No. 18	Disposal of effluents and waste contaminated by radionuclides, produced in facilities licensed under the public health code (26 January 2008)
Guide No. 23	Drafting and modification of the waste zoning plan for basic nuclear installations (30 August 2016)
Guide No. 24	Management of soils polluted by the activities of a basic nuclear installation (30 August 2016)
Guide No. 27	Stowage of radioactive packages, materials or objects for transportation (30 November 2016)
Guide No. 31	Notification procedures for events relating to the transport of radioactive substances (24 April 2017)
Guide No. 34	Implementation of the regulatory requirements applicable to on-site transport operations (27 June 2017)
Guide No. 44 (updated)	Quality management system applicable to the transport of radioactive substances on public highways (6 July 2023)
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 to the regulatory requirements applicable to the transport of radioactive materials in airports (February 2006)	
Methodological guide - Management of sites potentially contaminated 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)	

13.6. Organisation of the principal nuclear licensees

13.6.1. Organisation of Andra

Andra was created within 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.

The functional departments

The General Secretariat (SG) proposes to general management the Agency's orientations with regard to budgetary, legal, management control, purchasing and information system aspects, then implements them. It is responsible for accounting, fiscal, financing and cash flow aspects. It prepares the meetings and ensures the 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 Dialogue and Forecasting Department (DDP) is tasked with proposing the strategy with regard to information, dialogue with internal and external audiences, in France and on the international scene. It also coordinates innovation, transformation and knowledge management and intellectual property, the institutional memory and social sciences and the humanities. It is a cross-disciplinary department. It supports and assists all the other departments in these subjects.

The Human Resources Department (HRD) is mandated to define and implement Andra's human resources policy. This policy is described in section 7.2.3.

The operational departments

The Cigéo Programme Department (DIRPROG) has a programmatic and strategic mandate. It is responsible for ensuring compliance with requirements and arbitrates on all major technical questions. The DIRPROG constitutes the technical and strategic authority of the Cigéo programme, with its gradual development notably including adaptability and flexibility.

The Operational Department of the Cigéo Programme (DIROP) is in charge of operational management of the Cigéo programme, which is supervised by the DIRPROG, over the scope of the first tranche of the Cigéo repository. It is more specifically a question of configuration management and managing the requirements, system engineering; obtaining administrative procedures; preparatory work for the actual construction work, to be carried out before the creation authorisation (DAC) is obtained to plan ahead for the initial construction; and lastly the preparation of the creation/construction phase by major component of this first tranche.

The Scientific and Technical Department (DISTEC) is mandated to provide scientific and technical support for all the activities, for the existing and projected disposal facilities in the different phases of their life. This includes the defining of the management routes, the search for and characterisation of a site, the design, building, operation, monitoring and surveillance, closure and post-closure phases.

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 Industrial and Greater Eastern Region Department (DIGE) has the following main missions:

- Operation and surveillance of the Aube repositories (CSA et Cires) and the implementation of all the components for managing radioactive waste;
- Surveillance of the Manche repository (CSM) and the implementation of the modifications necessary for the operation of its facilities or with a view to its definitive closure;
- Operation of the Meuse/Haute-Marne Centre with the design, construction, operation and maintenance of the facilities to allow the acquisition of the scientific and technological data necessary for the Cigéo project;
- Representing Andra in the regions in which its centres are established.

13.6.2. Organisation of CEA

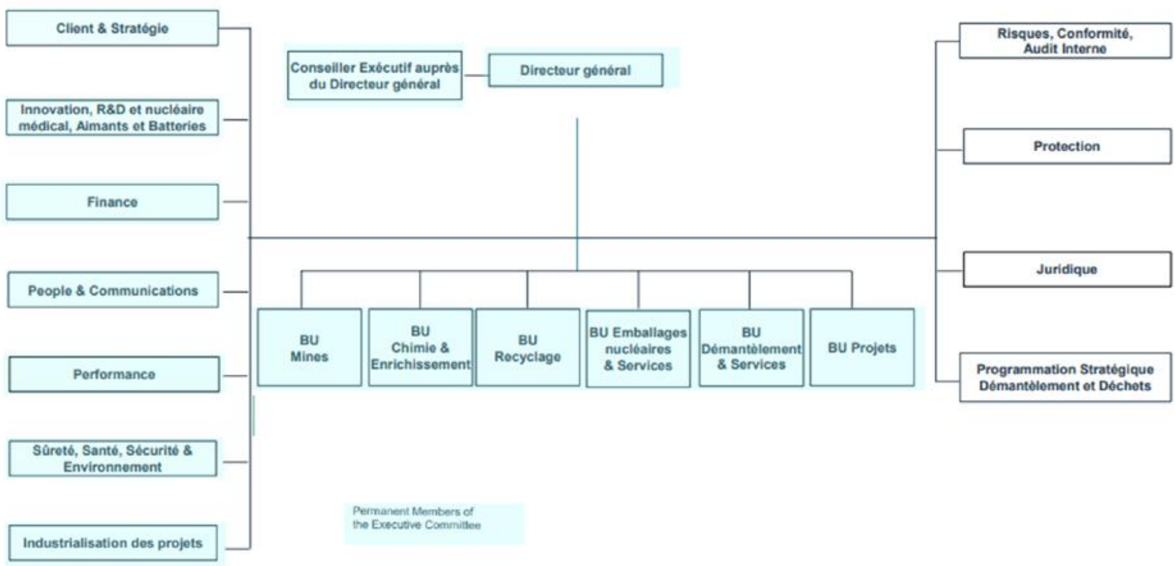
Spent fuel and waste management fit into the general organisation of CEA, more particularly in the context of the control of CEA's decommissioning and clean-out strategy. This strategic control is ensured by the clean-out and decommissioning project owners. It is assisted by the Department of Decommissioning Projects, Nuclear Services and Waste Management, an entity of the Energies Department for management of the projects and programmes dedicated to the management of radioactive waste and spent fuel in compliance with the commitments, safety rules and allocated human and financial resources.

The Department of Nuclear Security and Safety, senior management of the centres and the Safety, Security and Radiation Protection Support Units of the Operational Departments watch over compliance with the application of safety baseline requirements in an approach that is proportionate to the risks.

13.6.3. 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

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, which joined the EDF group on 1 January 2018.



Organisation of Orano at 1 February 2024

13.6.4. Organisation of EDF

EDF is the main electricity production company in France and the only one operating nuclear power reactors in 2024. 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. It is the focal point of EDF's missions relating to the management of spent fuel and radioactive waste: to develop an industrial route for nuclear dismantling and the management of radioactive waste, have a strong, highly efficient and innovative engineering resources working to serve the dismantling/waste projects, safeguarding nuclear fuel supplies and management of the nuclear cycle, manage the operational waste and the spent fuel.

The missions of the main entities or organisations in the Nuclear and Thermal Generation Division with activities related to spent fuel and radioactive waste management are described below.

Nuclear Generation Division

The Nuclear Generation Division assumes the responsibility of nuclear licensee for the sites in operation and through to final shutdown, in complete safety to produce safe, low-carbon and competitive kWh. 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 for the management of radioactive waste from the fleet in operation.

Electricity generating nuclear power plants

In accordance with the regulations, the nuclear power plants (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 package 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).

The National Engineering Units

The Operational Technical Unit (UTO) is the National Engineering Unit that assuists NPPs in the management of their operational waste. It is responsible in particular for developing the operational waste management doctrine (baseline requirements, internal directives, etc.) and providing the methodological support necessary for its implementation, for examining the package approvals, for supplying NPPs with the products (packagings, hulls, drums) and materials (dry loads=) necessary for the conditioning of the waste and managing the shared conditioning means (mobile units, etc.), and manging the scheduling of waste transfers from the sites in operation to the processing and disposal routes.

The Operation Engineering Unit (UNIE) also intervenes in the area of waste for the "zoning" aspects and leading the activities grouped within the sites' Nuclear Logistics services.

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 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. DIPDE contributes to the DP2D's dismantling projects by applying the modifications on the plant units in operation.

The Nuclear Fuel Division (DCN) is project owner for EDF's fuel cycle activities, therefore it is responsible for defining and implementing the spent fuel management strategy. DCN is also in charge of operational nuclear waste logistics. DCN manages the contracts for uranium procurement, conversion, enrichment and manufacture of ENU, ERU and MOX fuel, and the transport, reception, storage and reprocessing contracts for spent fuel and induced waste.

13.7. Websites

Information that is relevant to this report is available on the Internet. The following websites can be of particular interest:

- Legal texts .... www.legifrance.fr
- ASN .... www.asn.fr
- Andra .... www.andra.fr
- CEA .... www.cea.fr
- CISBIO .... https://www.curiumpharma.com/fr/a-propos/cis-bio-international/
- Orano .... www.orano.group
- EDF .... www.edf.fr
- ILL .... www.ill.eu
- ITER .... https://www.iter.org/
- IRSN .... www.irsn.fr
- Ministry of Ecological Transition .... www.ecologie.gouv.fr

13.8. List of main abbreviations

ACPR	Prudential and Resolution Oversight Authority (*Autorité de contrôle prudentiel et de resolution*)
ADR	European agreement concerning the international carriage of dangerous goods by road
AIP	Activity important for the protection of interests
ALARA	As Low As Reasonably Achievable
ANCCLI	National Association of Local Information Committees
Andra	National Radioactive Waste Management Agency
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
CIC	Interministerial Crisis Unit (*Cellule interministérielle de crise*)
Cires	Industrial grouping, storage and disposal centre (*Centre industriel de regroupement, d'entreposage et de stockage*)
CNDP	French National Public Debates Commission (*Commission nationale du débat public*)
CNE	National Assessment Commission (*Commission nationale d'évaluation*)
CNRS	French National Centre for Scientific Research (*Centre national de la recherche scientifique*)
COFRAC	French accreditation committee (*Comité français d'accréditation*)
CSA	Aube waste repository
CSM	Manche waste repository
DAC	Creation Authorisation Decree (*Décret d'autorisation de création*)
DBNI	Defence Basic Nuclear Installation
DGEC	General Directorate for Energy and the Climate (*Direction générale de l'énergie et du climat*)
DGPR	General Directorate for Risk Prevention (*Direction générale de la prévention des risques*)
DPN	Nuclear Generation Division of EDF (*Division production nucléaire*)
DREAL	Regional Directorate for the Environment, Planning and Housing (*Direction régionale de l'Environnement, de l'Aménagement et du Logement*)
EDF	Électricité de France
EIP	Element important for the protection of interests
EPIC	Industrial and Commercial Public Establishment (*Établissement public à caractère industriel et commercial*)
EU	European Union
FNR	Fast-Neutron Reactor
GCR	Gas-Cooled Reactor
GPE	Advisory Committee of experts (*Groupe permanent d'experts*)
GPR	Advisory Committee for Reactors (*Groupe permanent d'experts pour le domaine des réacteurs*)
HLW	High Level Waste
HCTISN	High Committee for Transparency and Information on Nuclear Safety (*Haut comité pour la transparence et l'information sur la sécurité nucléaire*)
IAEA	International Atomic Energy Agency

ICEDA	Activated waste conditioning and storage facility (*Installation de conditionnement et d'entreposage de déchets actives*)
ICPE	Installation Classified for Environmental Protection (*Installation classée pour la protection de l'environnement*)
ICRP	International Commission on Radiological Protection
INES	International Nuclear Events Scale
IRSN	Institute for Radiation Protection and Nuclear Safety (*Institut de Radioprotection et de Sûreté Nucléaire*)
ILW	Intermediate Level Waste
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 Ministry in charge of energy
NEA	Nuclear Energy Agency of the OECD
NORM	Naturally Occurring Radioactive Material
NPE	Nuclear Pressure Equipment
NPP	Nuclear Power Plant (EDF)
OEF	Operating Experience Feedback
OPECST	Parliamentary Office for Evaluating Scientific and Technical Choices (*Office parlementaire d'évaluation des choix scientifiques et techniques*)
PNGMDR	National Plan for Radioactive Materials and Waste Management (*Plan national de gestion des matières et déchets radioactifs*)
PWR	Pressurised Water Reactor
R&D	Research and Development
RNM	French national environmental radioactivity monitoring network
RFS	Basic safety rule (*Règle fondamentale de sûreté*)
RGE	General operating rules (*Règles générales d'exploitation*)
STE	Operating Technical Specifications (*Spécifications techniques d'exploitation*)
SL	Short-Lived (waste)
TECV	Act 2015-992 of 17 August 2015 relative to the energy transition for green growth
tHM	Tonne equivalent heavy metal
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
WRC	Waste Retrieval and Conditioning